MNS® Low Voltage Switchgear

Installation and maintenance manual

- MNS, a sustainable, flexible and reliable low voltage switchgear
- Reducing total cost of ownership by optimizing energy consumption & reducing downtime
- MNS Digital with the latest technologies for data analytics and data communication

The MNS platform has been evolving for over 45 years. Since its inception, the MNS design has been based upon on the fundamental principles of safety, reliability, availability.
MNS utilizes the IEC standards as the baseline for the performance required. Verification testing is performed over and above the IEC requirements.
This coupled with its modularity and scalability makes the MNS system the definitive solution for low-voltage energy distribution and process control applications.

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01

Safety first

Safety first

Safety requirements when working on electrical systems.

1.1 Safety relevance

This Service Manual contains further safety relevant aspects in the document. This is highlighted with the following symbol:

When working on specific tasks or areas in the switchgear it is mandatory to follow the safety requirements and advises outlined in this document.

1.2 Understanding and managing the risk

Any person working on or near electrical systems is required to understand the danger and risk such work may impose to his/her life as well as to any person and property in the vicinity.

It is of utmost importance that the danger of electrical energy is understood and following characteristics associated with electrical energy should be noted:

- Electrical energy cannot be seen, heard or smelt, with the result that it is not possible to determine whether a circuit is alive or dead by relying on senses. Electrical apparatus must therefore always be considered **LIVE** until it is proved to be DEAD.
- **DEAD** means zero volts between conductor and earth is confirmed.
- **LIVE** or **DEAD** status is determined and confirmed by equipment specifically designed for the purpose, **NEVER** by touch.

Personnel shall not work on any electrical apparatus until approval has been granted by the responsible authority and the working environment has been classified as safe, the following must be controlled:

- Any prohibited area,
- Compartments containing potentially live apparatus/conductors/and terminals.

Electrical energy will follow along the path of least resistance. This may include all metallic and conductive components, the human body and many fluids. Conditions that influence the flow of electrical energy are:

- Intact Insulation. Under these conditions the circuit fulfils its designed function and the flow of energy can be predicted.
- Breached Insulation. Under these conditions a short circuit may occur. This could prove hazardous to life and property. The flow of energy is random and may not be predictable. Damaged insulation must always be reported. There are two reasons for accidental contact with live parts:
  - Apparatus being made live whilst others are working on it,
  - Unsafe working practices.

The highest danger to human life and property is the situation with the occurrence of an electrical arc. An electric arc is a dangerous release of energy created by an electrical fault or short circuit. It contains thermal energy, pressure waves, acoustic energy and debris. The intense energy and very short duration of an electric arc flash represents a very unique event. The temperature of an electric arc can reach up to 20 000 °C (35 000 °F), or two to three times the surface temperature of the sun! Exposure to these extreme temperatures both burns the skin directly and causes ignition of clothing, which adds to the burn injuries.

An electrical arc flash describes an explosive electrical event that presents an extremely significant hazard to people and property. It is of vital importance to use suitable tools and instruments as well as personal protection equipment for commissioning, inspection or any kind of maintenance work on electrical systems.

1.3 Warning signs and labels

Electrical systems shall be labeled according to the hazard risk level. ISO3864 and its ANSI equivalent Z535.4 prescribes the layout and application of signs. Following sings are typically applied:

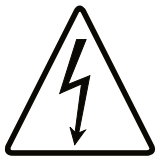
High Voltage ISO3864	Arc Flash Hazard ISO3864	Warning Sign ANSI Z535.4	Danger Sign ANSI Z535.4
			

Table 1-01 Typical warning signs and labels

1.4 Basic principles and precautions to be observed

In accordance with the valid local regulations, all installation and maintenance work involving MNS low voltage switchgear systems may only be performed by skilled and qualified personnel. For work at low voltage electrical system and components, the component to be modified or worked on must be isolated and confirmed dead. If in doubt of the task to be carried out, ABB Service technicians should be utilized for the work. Never utilize untrained personnel who are not certified with the system.

The mandatory guideline for working in electrical systems is the instruction EN50110-1 2013. Local country law for work on electrical systems must also be observed. Minimum precautions are to be observed:

- THINK – The greatest safety asset is an alert, focused mind,
- Maintain strict discipline regarding safety procedures,
- Use appropriate personnel protection equipment and tools,
- Communicate clearly and ensure all communications are fully understood,
- Query all instructions that are unclear, not understood or that appear to be in breach of safety requirements,
- Prove all circuits to be safe if they have been unattended for a period of time,
- Maintain safety clearance (air Insulation) when working in the proximity of live conductors,
- Do not improvise. Use purpose designed equipment and tools,
- Use the pre-start checklist prior to starting or commencing any work.

1.5 Areas of work

Working on electrical systems may occur at different times and different conditions. To clearly understand the conditions helps to understand and eliminate any risk. In low voltage switchgear systems following work conditions are defined:

- Operation (operation of circuit breaker, main switch or push button while all doors and compartments are closed – closed door condition)
- Visual inspection (open doors and compartments to perform any visual inspection, no parts are touched and no physical work is performed on the electrical system – open door condition)
- Any other maintenance and work (e.g. modification, extensions, cable connection) on low voltage electrical system (either open or closed door condition)

The procedure for performing switching operations is defined by the instruction EN50110-1 2013 “Operation of electrical installations”.

Keep doors and covers closed & locked whenever possible.
Check if lock couplings are utilised otherwise, each lock must be locked.

1.6 Five safety rules

The DEAD circuit condition must be established prior to commencement of work and must be ensured at the place of work for the duration of work in compliance with the five safety rules (EN50110-1 2013 chapter 6.2):

1. Disconnect completely;
2. Ensure no re-connection is possible;
3. Verify that the installation is dead;
4. Carry out earthing and install any shorting links required[1];
5. Ensure that any adjacent live parts are suitably shrouded and provide the required protection.

Any circuit that has not been proven dead is to be considered as **LIVE**.

1.7 Permit to work

Permission to start work shall be given by nominated person in control of electrical installation (plant-responsible person or PrP) to the nominated person in control of any work activity (work-responsible-person or WrP). The permit to start working must be recorded and signed by all parties in a Safety Permit to Work document.

1.8 Personal Protection Equipment (PPE)

Personal protection equipment refers to clothing and additional devices to enhance personal protection to a safe level while working on electrical systems. Depending on the area of work certain level of PPE is required.

When working on or near live parts, that means on switchgear with closed doors and covers that are correctly secured, the minimum standard for clothing is that products shall be capable of withstanding e.g. electrical arc with an incident energy of 8cal/cm^2. For the majority of work on or near energised systems, this means that the clothing provided must be manufactured and tested to the following standards:

- For IEC: **Class 1 Garments to IEC 61482-1-2** (Formerly ENV 50354 and CLC/TS 50354).

Specific Risk Assesment and Arc Flash analysis shall be carried out and as per the task the minimum PPE should be decided.

1.9 Special considerations when working on electrical equipment

1.9.1 Capacitors

The power supply to a capacitor by a remote auxiliary power source, if any, shall also be isolated. When the system has been isolated, allow the voltage stored in the capacitor to be discharged, the outgoing capacitor circuits must be tested for discharged condition using voltage measurement device. The automatic capacitor must be installed in accordance with the standards IEC 60831-1&2 and all national regulations.

1.9.2 CT´s

Ensure that the current transformer secondary circuits have been shorted when no load is connected.

1.9.3 Auxiliary or temporary supply

Ensure that any auxiliary supply that may be required to perform testing or commissioning tasks is securely switched off and protected against operation while working on the electrical equipment.

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1 Earthing and shorting is not mandatory as per EN 50110-1 2013 ch 6.2.5.2. However, earthing becomes mandatory under the risks described therein and if also requested by local requirements or customer guidelines and where provision is made for earthing or other proper means are available.

02

Technical description

2. Technical description

2.1 Technical data

Standards	Enclosed low-voltage switchgear and controlgear assemblies	General rules	IEC 61439 - 1
		Power switchgear and controlgear assemblies	IEC 61439 - 2
		Testing under conditions of arcing due to internal fault (internal arc)	IEC TR 61641
	Seismic	Recommended practices for nuclear generating station	IEC 60980
	Vibration	Environmental testing Test Fc: Vibration (sinusoidal)	IEC 60068-2-6
	Shock	Environmental testing Test Ea and guidance: Shock	IEC 60068-2-27
	Protection against electric shock	Common aspects for installation and equipment	IEC 61140
		General rules	IEC 61439-1
Test certificates		ASTA / United Kingdom DEKRA / Netherlands Germanischer Lloyd, Hamburg / Germany IPH, Institut für Prüffeld- und Hochspannungstechnik, Berlin / Germany High Power Laboratory, ABB AG, Ratingen / Germany Technology center laboratory, ABB s.r.o, Brno / Czech Republic	
Approvals		Design and engineering practice	Shell
Electrical data	Rated voltages	Rated insulation voltage U_i Rated operating voltage U_e Rated impulse withstand voltage U_{imp} Overvoltage category Degree of pollution Rated frequency	up to 1 000 V 3~, 1 500 V- up to 690 V 3~, 750 V- 6 / 8 / 12 kV, depending on equipment II / III / IV 3 up to 60 Hz
	Rated currents	**Main busbar** Rated current I_e Rated peak withstand current I_{pk} Rated short-time withstand current I_{cw}	 up to 7 300 A***) up to 220 kA up to 100 kA
		Distribution bars Rated current I_e Rated peak withstand current I_{pk} Rated short-time withstand current I_{cw}	 up to 2 000 A up to 220 kA up to 100 kA
	Arc fault containment	Rated operational voltage Prospective short-circuit current Duration Criteria (IEC TR 61641)	up to 690 V up to 100 kA 300/500 ms 1 to 7
Mechanical characteristics	Dimensions	Sections and frames Recommended height Recommended width Recommended depth Basic grid size	ISO 2768 2 200 mm *) 400, 600, 800, 1 000, 1 200, 1 400 mm 400, 600, 800, 1 000, 1 200 mm, 1400 mm for MNS Rear E = 25 mm acc. to DIN 43660
	Surface protection	Frame incl. Internal subdivision Cladding, internal, roof and bottom plate Cladding, external, front, rear and side	Zinc or Alu-zinc coated **) Zinc or Alu-zinc coated Zinc or Alu-zinc coated and powder coated RAL 7035 (light grey)
	Degree of protection	According to IEC 60529	External from IP 30 to IP 54 Internal from IP XXB
	External mechanical impact (IK)		up to IK10
	Plastic components	Halogen-free, self-extinguishing, flame retardant, CFC-free	IEC 60707, DIN VDE 0304 part 3
	Steel components	Frame incl. internal subdivisions 2,0 / 2,5 mm Cladding, internal 1,5 / 2,0 mm; external 1,5 mm	
	Forms of separation	up to Form 4	
	Internal subdivision	Equipment compartment Busbar compartment Cable compartment	
Extras	Paint finish	Enclosure	Special colours (standard RAL 7035, other colours on request)
	Busbar system	Busbars	Bare copper Insulated with heat shrinkable sleeving Silver or tin plating Aluminium busbar systems
	Optional	Project specific solutions available on request	

Table 2-01 Technical data of MNS 3.0 switchgear *) 2 300 mm for MNS Rear **) As alternative coatings Magnelis or MagiZinc may be utilized. ***) 6 300 A for MNS 3.0

2.2 MNS Switchgear

MNS is a Power Switchgear Assembly (PSA) designed tested and manufactured in accordance with IEC 61439-2 and IEC TR 61641. The following definition can be found in IEC 61439-2:

- **ASSEMBLIES intended for use in connection with the generation, transmission, distribution and conversion of electric energy, and for the control of electric energy consuming equipment.**

The MNS platform is of a modular construction enabling flexible configuration of the assembly to be engineered to meet a wide spectrum of individual designs requested to meet the most demanding applications.

Full details of the respective design and configuration of the assembly e.g. technical data, electrical schematics and detailed equipment lists can be found in the relevant project documentation.

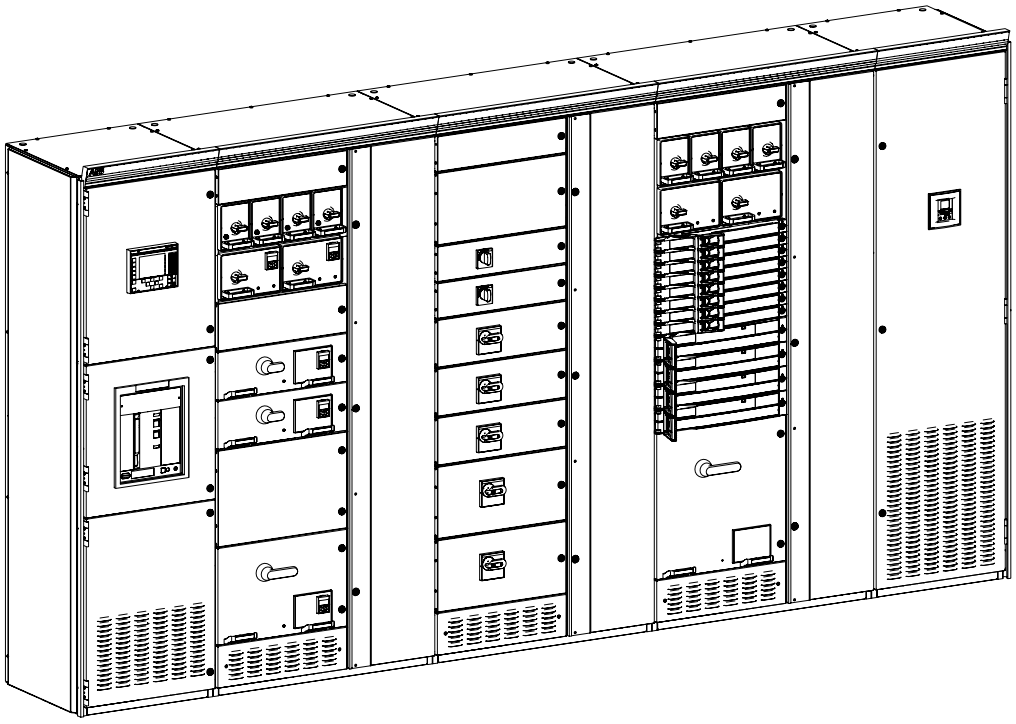


Figure 2-01 MNS 3.0 front access switchgear

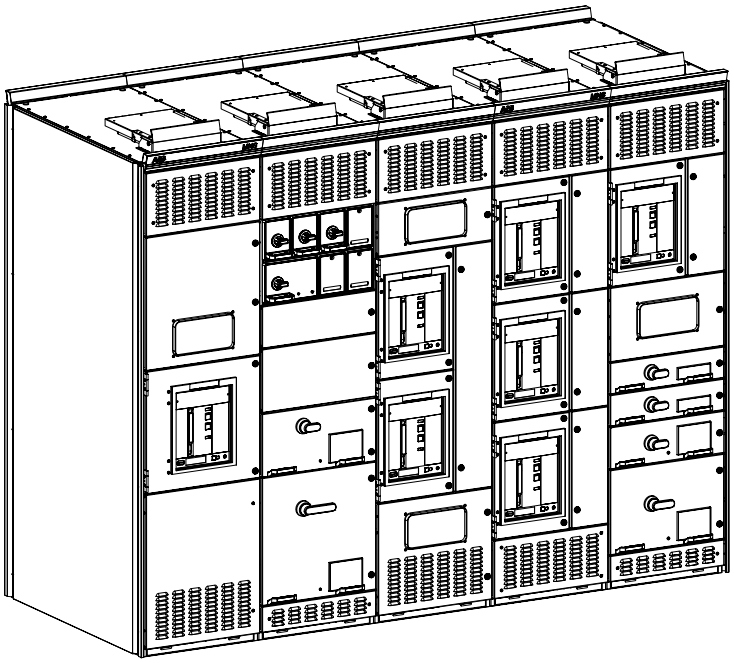


Figure 2-02 MNS Rear access switchgear

2.3 Service conditions & operating environment

MNS power switchgear assemblies are designed to operate under the environmental conditions as described in IEC 61439-1. It is essential to keep the installation & operation environment surrounding the switchboard to the design as described in IEC 61439-1. Optimum operating environment conditions will have positive affect on the switchboard operating thermal performance & will ensure the switchboard to last the design life expectancy of ~30 years. Operating the switchboard in a controlled environment like in air-conditioned switchroom can greatly improve the working performance.

Environmental conditions for low-voltage switchboards are classified as:

- Normal service conditions acc. IEC 61439-1, section 7.1, indoor installation

Environment conditions	Environment parameters	Correction measures available
Ambient air temperature for indoor installations	Higher limit temperature does not exceed +40 °C and its average over a period of 24 h and does not exceed +35 °C. The lower limit of the ambient air temperature is -5 °C.	Air-conditioned room with controlled temperature.
Humidity conditions for indoor installations	The relative humidity of the air does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidity may be permitted at lower temperatures, for example 90 % at +20 °C.	Air-conditioned room with controlled humidity and installed switchgear anti-condensation heater.
Pollution degree. The pollution degree refers to the environmental conditions for which the switchboard is intended.	Conductive pollution occurs or dry, non-conductive pollution occurs which is expected to become conductive due to condensation.	Regular maintenance to protect IP rating of switchboard.
Altitude	The altitude of the site of installation does not exceed 2000 m.	Apply altitude factor for switchgear rating at design stage.

Table 2-02 Normal service conditions acc. IEC 61439-1, section 7.1

MNS switchgear assemblies are intended for use in the normal service environmental conditions described above. Any other service condition (for example outdoor installation) must be reviewed into on case by case basis. Refer to IEC 61439- 1 Annex C or IEC 61439-2 Anex BB.

2.3.1 Special service conditions acc. IEC 61439-1, section 7.2

If special service conditions are specified they must be part of special agreements between the switchgear manufacturer and the user and to be agreed upon. The user must inform the switchgear manufacturer about such extraordinary service conditions.

Special service conditions include, for example:

1. Values of temperature, relative humidity and / or altitude differing from those specified in IEC 61439-1, section 7.1;
2. Applications where variations in temperature and/or air pressure take place at such a speed that exceptional condensation is liable to occur inside the switchgear;
3. Heavy pollution of the air by dust, smoke, corrosive or radioactive particles, vapours or salt;
4. Exposure to strong electric or magnetic fields;
5. Exposure to extreme climatic conditions;
6. Attack by fungus or small creatures;
7. Installation in locations where fire or explosion hazards exist;
8. Exposure to heavy vibration, shocks, seismic occurrences;
9. Installation in such a manner that the current-carrying capacity or breaking capacity is affected, for example equipment built into machines or recessed into walls;
10. Exposure to conducted and radiated disturbances other than electromagnetic, and electromagnetic disturbances in environments other than those described in IEC 61439-1 section 9.4;
11. Exceptional overvoltage conditions or voltage fluctuations;
12. Excessive harmonics in the supply voltage or load current.

2.4 Functional compartments and segregation

The forms of separation detailed in IEC 61439-2 Annex AA defines the basic configuration for the MNS system. Shown below are the functional areas for the incoming and outgoing sections.

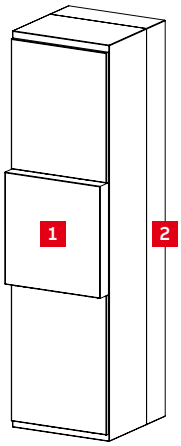


Figure 2-03
Circuit breaker section

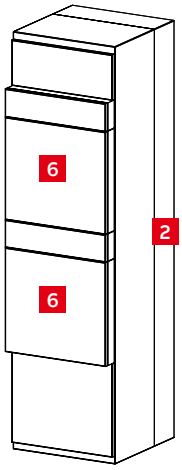


Figure 2-04
Double stacked circuit breaker section

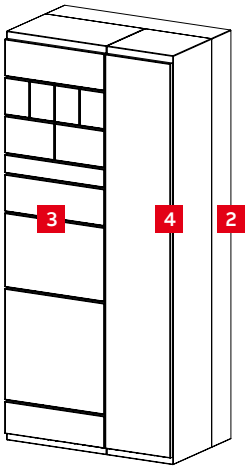


Figure 2-05
Outgoing section

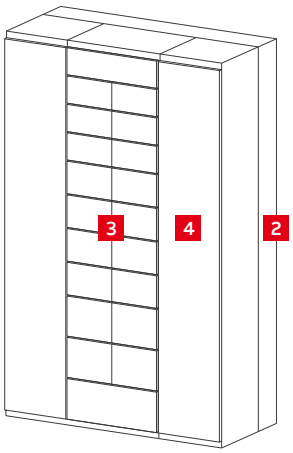


Figure 2-06
Compact outgoing section

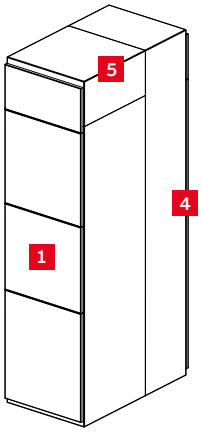


Figure 2-07
Rear circuit breaker section

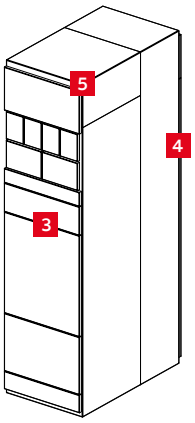


Figure 2-08
Rear outgoing section

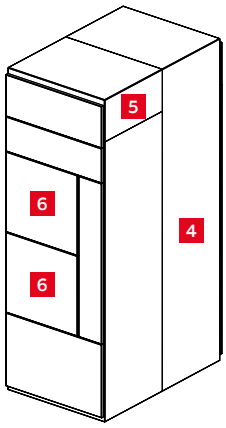


Figure 2-09
Rear double stacked ACB section

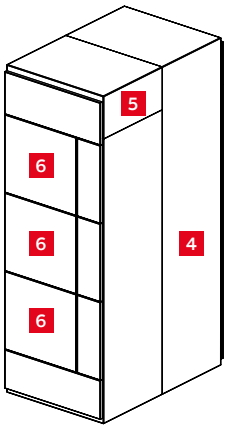


Figure 2-10
Rear triple stacked ACB section

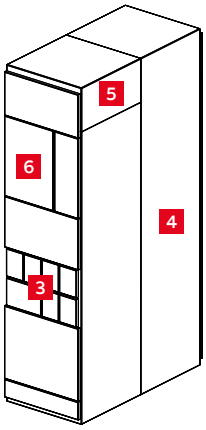


Figure 2-11
Rear combined ACB and withdrawable modules section

1 Equipment compartment
The equipment compartment is divided into 3 sub sections, each sub section having its own door.
The center sub section accommodates the circuit breaker and associated equipment in withdrawable design.
The auxiliary compartment is located behind the door in the upper sub section.

2 Busbar compartment
Located at the rear and contains the MNS 3.0 main busbar system.

3 Equipment compartment
The equipment compartment is the defined area for the functional units of the MNS universal design and may be configured for plug-in and withdrawable designs. The compartment can be divided into horizontal and vertical sub compartments.

4 Cable compartment
Located at the front or rear contains control cables and terminals, as well as power cables and connection units. Cable entry may be top or bottom.

5 Busbar compartment
Located at the top and contains the MNS Rear main busbar system. The distribution bars are embedded in the multifunction separation wall (MFSW) which is located between the equipment compartment and cable compartment.

6 Equipment compartment
The equipment compartment is for stacked section, each ACB unit having its own door.
It accommodates the circuit breaker and associated equipment in withdrawable design.
The auxiliary compartment is located on the top/middle/bottom and/or on the right side of equipment compartment.

2.5 Assembly arrangements

MNS sections can be arranged in the following configurations.

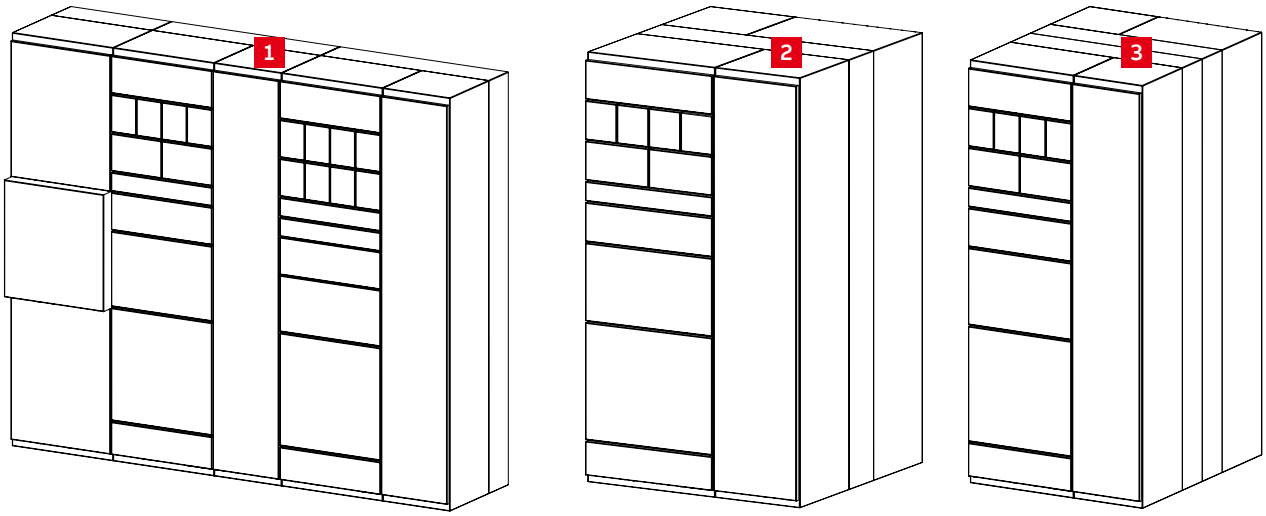


Figure 2-12 Assembly arrangements (from left): standard / duplex / back to back arrangement

1. Standard arrangement as free standing or back to wall.
2. Duplex arrangment with a common main busbar configuration.
3. Back to back arrangement with two main busbar configuration.

2.5.1 MNS Rear assembly arrangements

MNS Rear sections are arranged as a free standing, access is required both front and rear side.

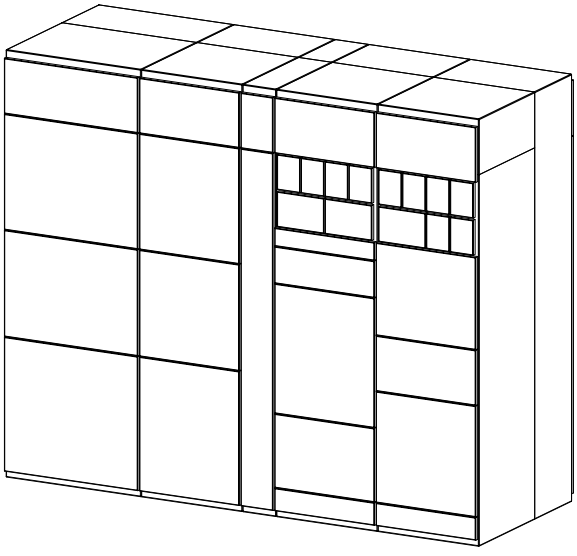


Figure 2-13 MNS Rear assembly arrangement

2.6 MNS dimensions

The following representative dimensions are applicable to the MNS sections, variations in ACB and main busbars can increase the overall depth. The following variations may be applied to both the width and depth of the MNS sections, 400, 600, 800, 1000, 1200, 1400 mm.

Note

For exact values refer to chapter 4 Erection and Installation

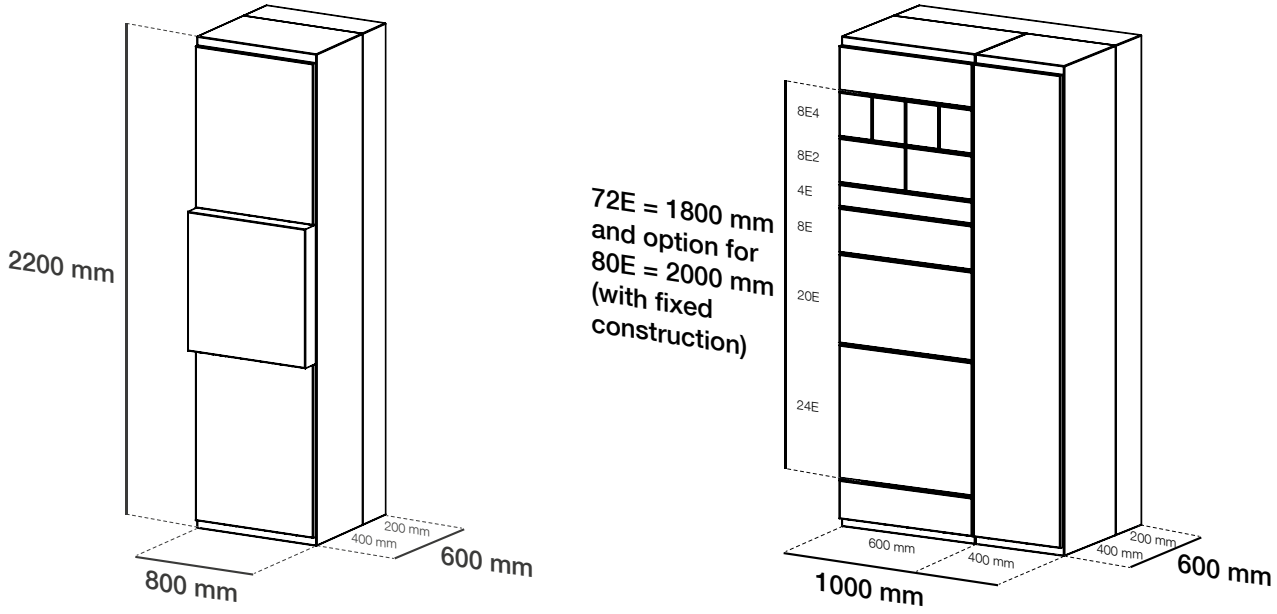


Figure 2-14 Incoming / outgoing circuit braker section (left), outgoing section (right)

2.6.1 MNS Rear dimensions

MNS Rear sections have options of section depth, 1000 mm, 1200 mm and 1400 mm.
The following variations are applied to the width of MNS Rear sections: 400, 600, 800, 1000, 1200 mm.

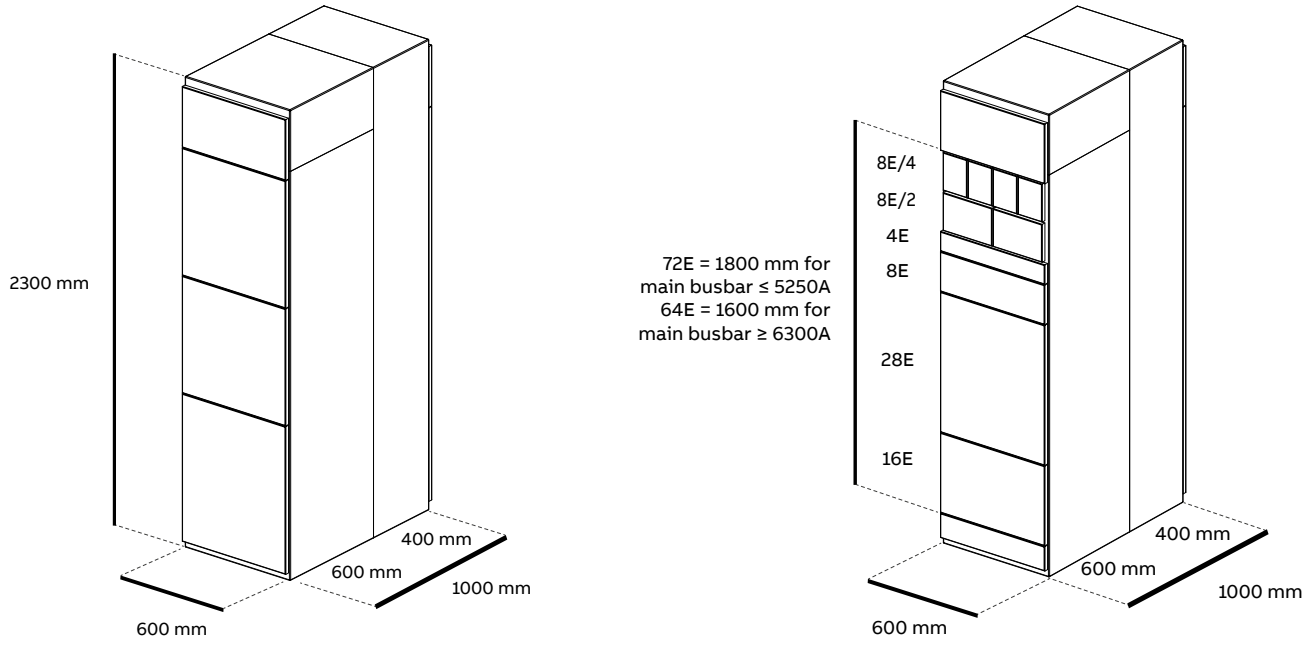


Figure 2-15 MNS Rear ACB section (left), module section (right)

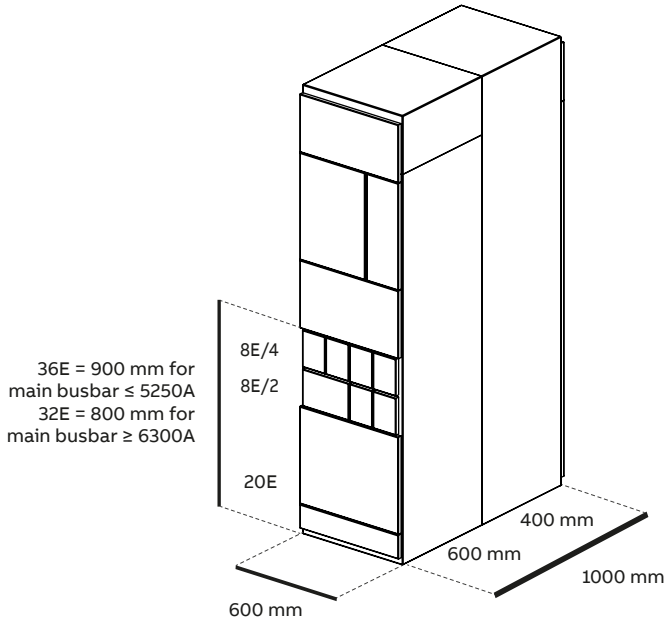


Figure 2-16 MNS Rear combined ACB and withdrawable modules section

2.7 Mechanical construction

The basic mechanical design comprises:

- The frame
- The enclosure / external cladding
- Internal construction / internal cladding

2.7.1 MNS frame

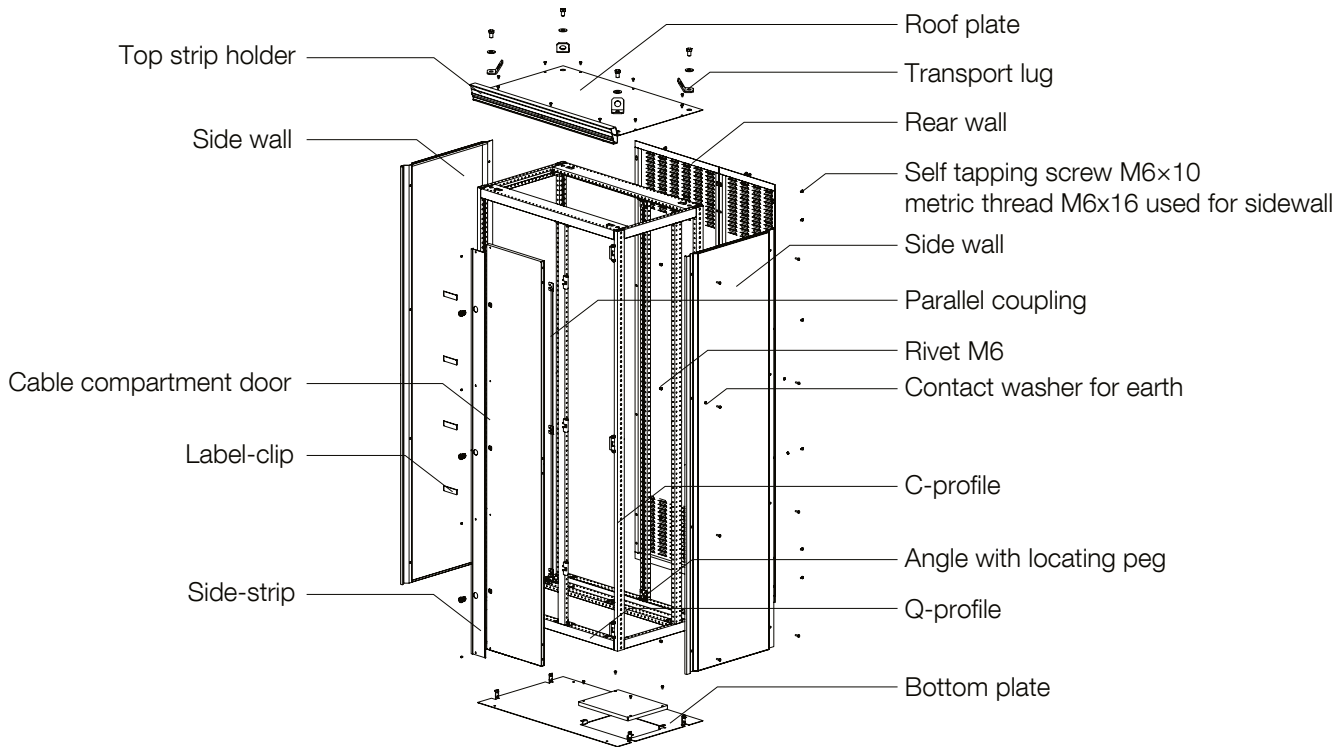


Figure 2-17 MNS frame & enclosure

The basic elements of the MNS frame construction are “C“ shaped steel profiles with a 25 mm hole pitch according to DIN 43660. The Q Profile provides constructional horizontal rigidity front and rear at the top and bottom of the assembly.

The 25 mm hole pitch equals the dimension of 1E applied in MNS to define the area usage within the switchgear. Each section 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 galvanically protected (Zn or Al/Zn) against corrosion.

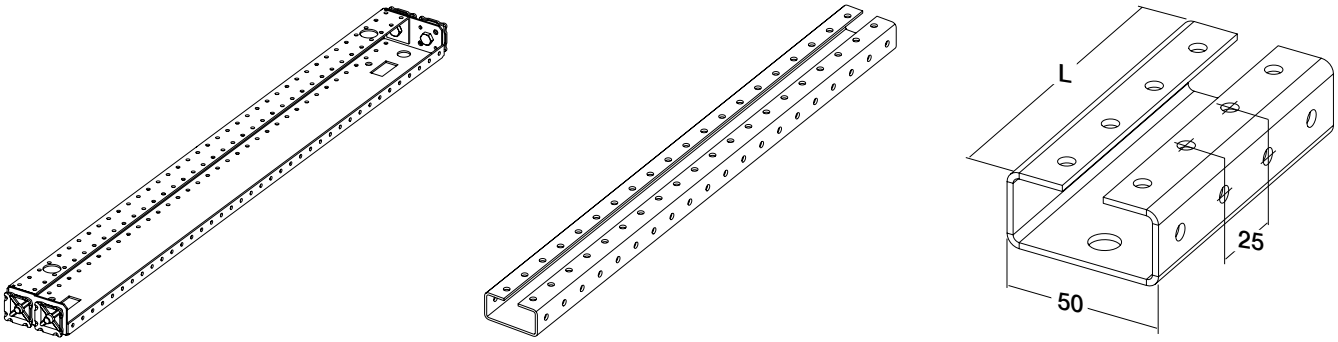


Figure 2-18 “Q“ Profile (left), “C“ profile (middle) and detail of “C“ profile (right)

2.7.2 MNS Rear frame

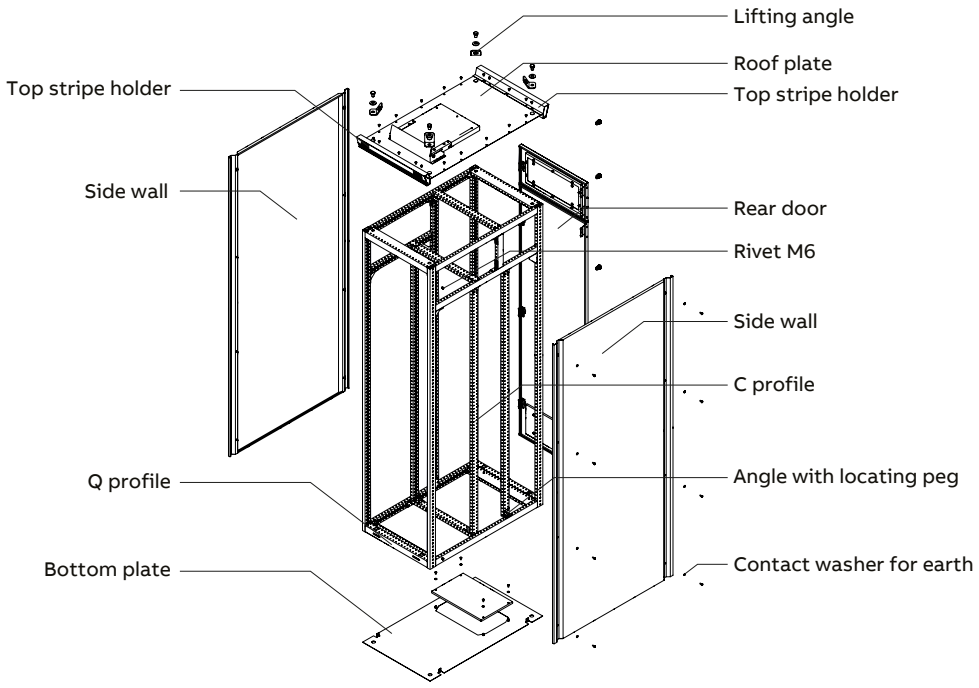


Figure 2-19 MNS Rear frame & enclosure

2.7.3 The enclosure / external cladding

MNS switchboard enclosure comprises of sheet steel protected by galvanic coating and powder coating for maximum durability. The fixing of the enclosure with respect to doors, roof plates, rear and side walls is achieved with thread forming screws. Final construction varies depending upon the required degree of protection.

2.7.4 Internal construction / internal cladding

Due to the modular construction of MNS the actual assembly is engineered to meet the design requested by the user. Electrical and mechanical properties will define the arrangement of the sections in conjunction with the “Form of separation” requirements.

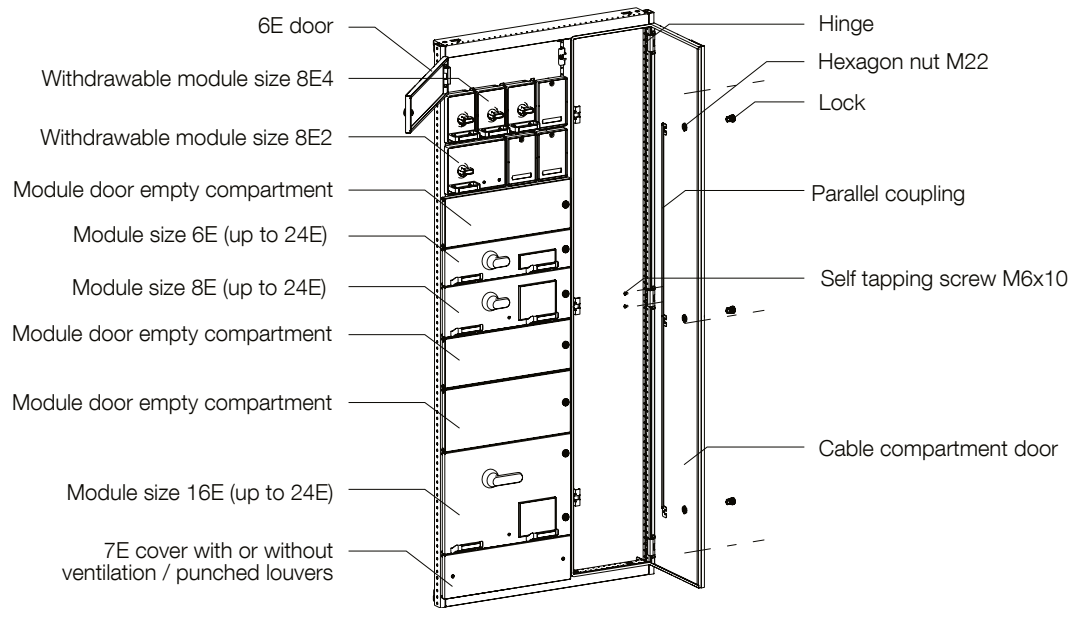


Figure 2-20 Front access modules and cable compartment (example)

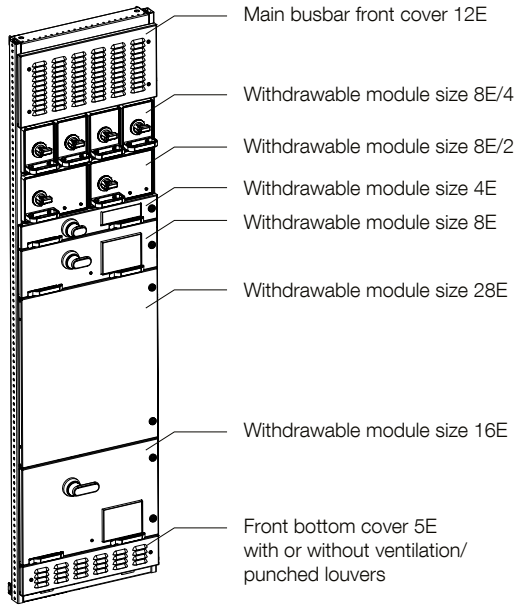


Figure 2-21 MNS Rear modules (example)

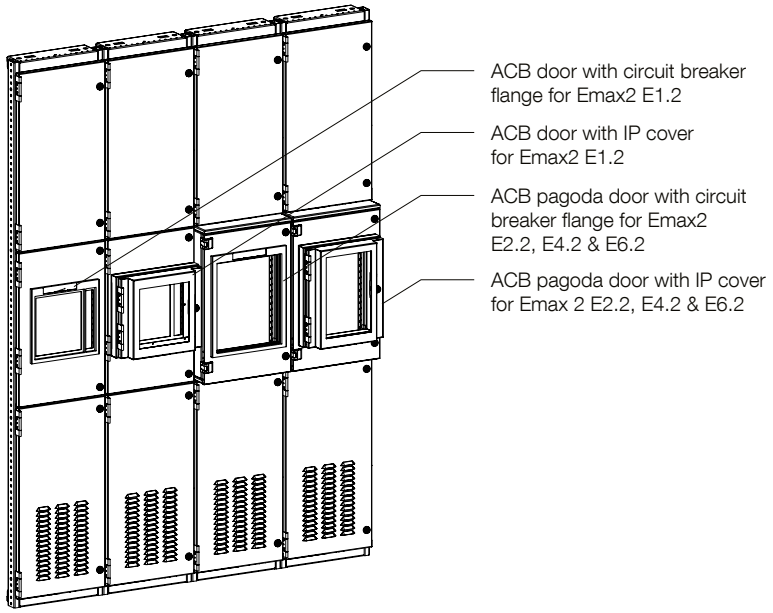


Figure 2-22 Air circuit breaker sections (example)

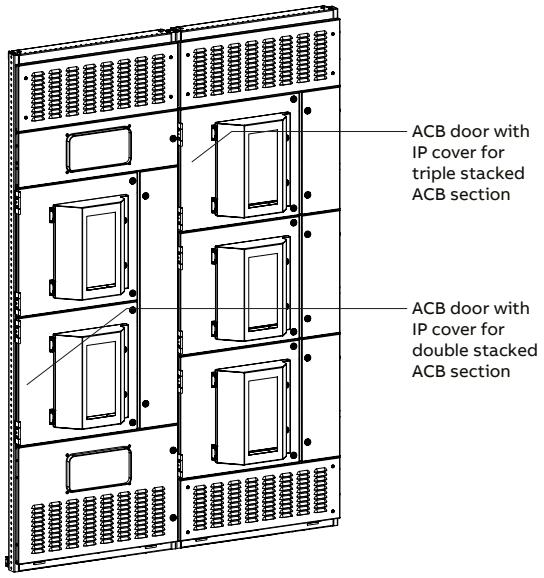


Figure 2-23 MNS Rear stacked sections (example)

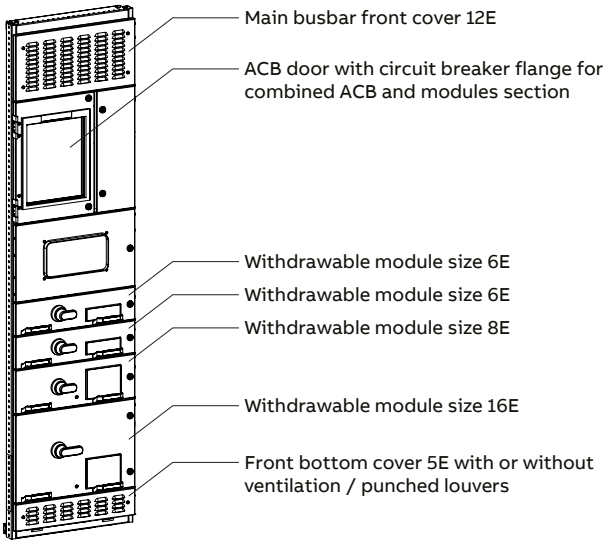


Figure 2-24 MNS Rear combined ACB and withdrawable module section (example)

2.8 The busbar system

The basic mechanical design comprises:

- The main busbar
- The multifunctional wall
- The distribution bars
- The power contact

2.8.1 The main busbar

The MNS main busbar system is arranged in the rear of the switchgear. The main busbar system is fully 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.

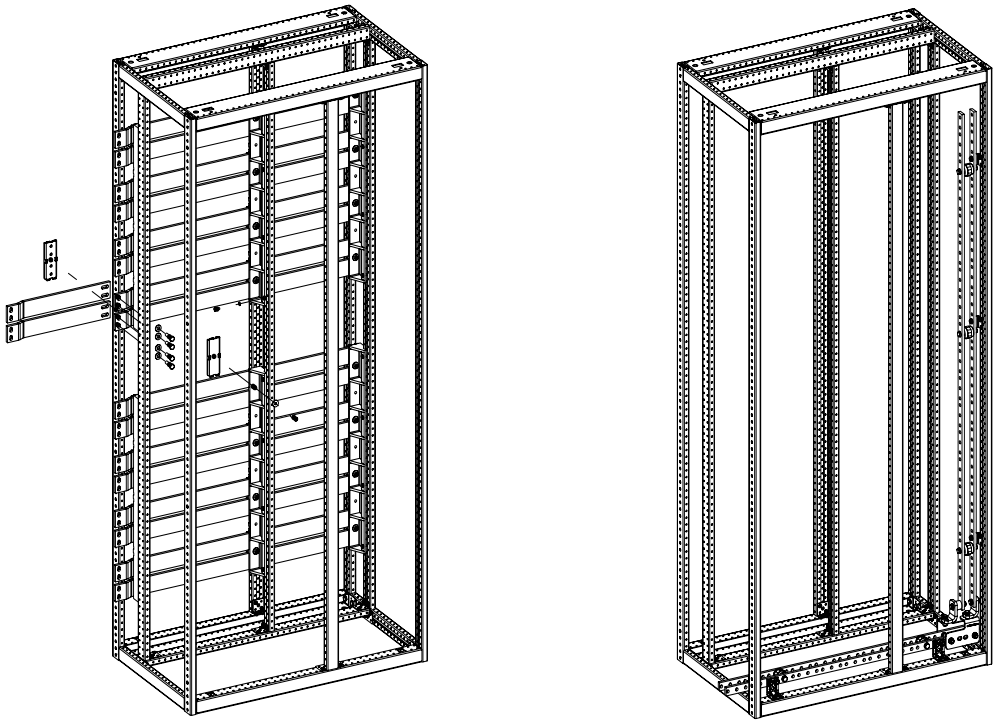


Figure 2-25 Main busbar arrangement (left), N/PEN front distribution (right)

MNS provides the option to configure the main bus in either upper or lower position or both, this enables separate, parallel or coupled operation. Conductor sizes are rated based upon project requirements. Protective earth and neutral bars run horizontally within the front of the switchboard just above the base. The PE bar is fastened to the frame to assure electrical continuity. Within the cable compartment it runs vertically and located on the front right hand side of the compartment.

For applications where a 50% or 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 at the rear (see left pictue of Figure 2-25).

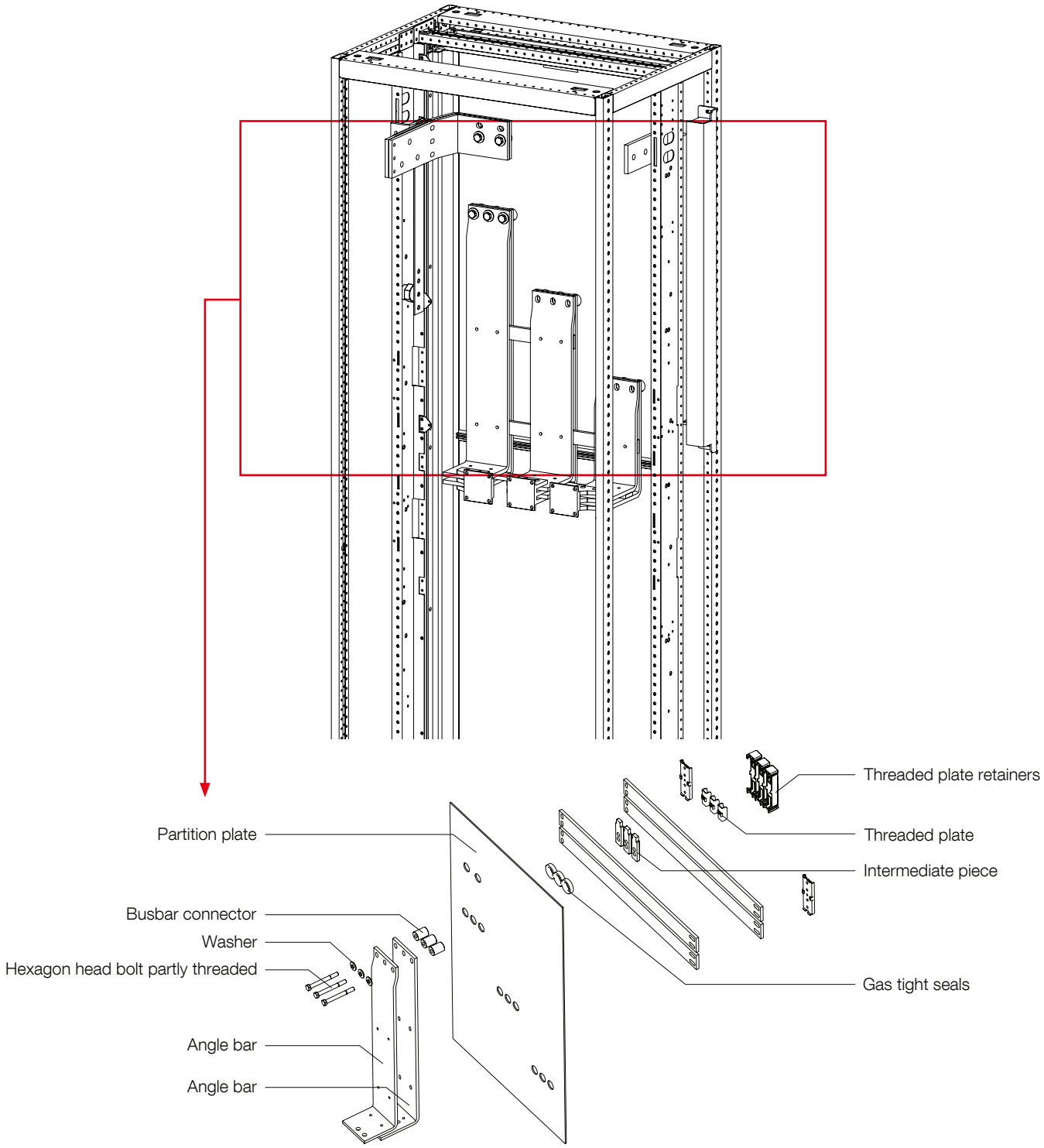


Figure 2-26 ACB copper connetion to main busbar

2.8.2 MNS Rear main busbar system

In MNS Rear the main busbar system is located 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 of a maintenance free construction as a result of utilizing thread locking ESLOK screws together with conical spring washers.

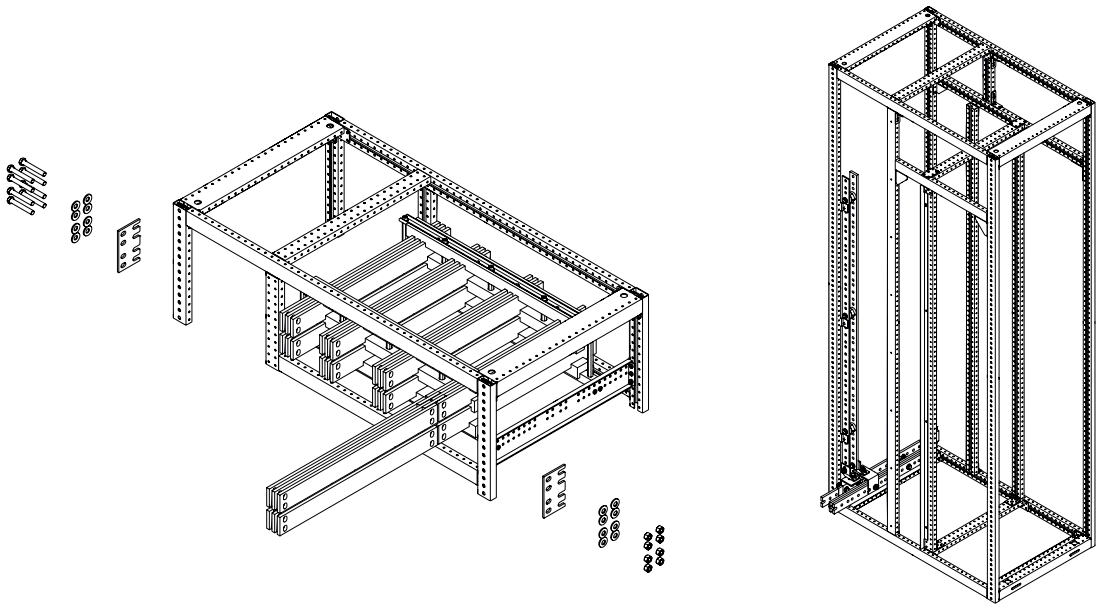


Figure 2-27 MNS Rear main busbar arrangement (left), PE/N/PEN rear distribution (right)

With MNS Rear switchgear, the main busbar is located at the top front position of the switchgear. Conductor sizes are rated based upon project requirements. Protective earth and neutral bars run horizontally within the rear of the switchgear just above the base. The PE bar is fastened to the frame to assure electrical continuity. Within the cable compartment it runs vertically and located at the rear of the compartment.

In MNS Rear switchgear, for applications where a 3 pole with 50% neutral (or PEN) of main busbar ≥ 6300A or 4 pole with 100% neutral size for all main busbar ratings is required due to unbalance or harmonic distortion, the neutral (or PEN) conductor is arranged within the busbar compartment running in parallel with the phase busbars at the top (see picture above of MNS Rear main busbar arrangement).

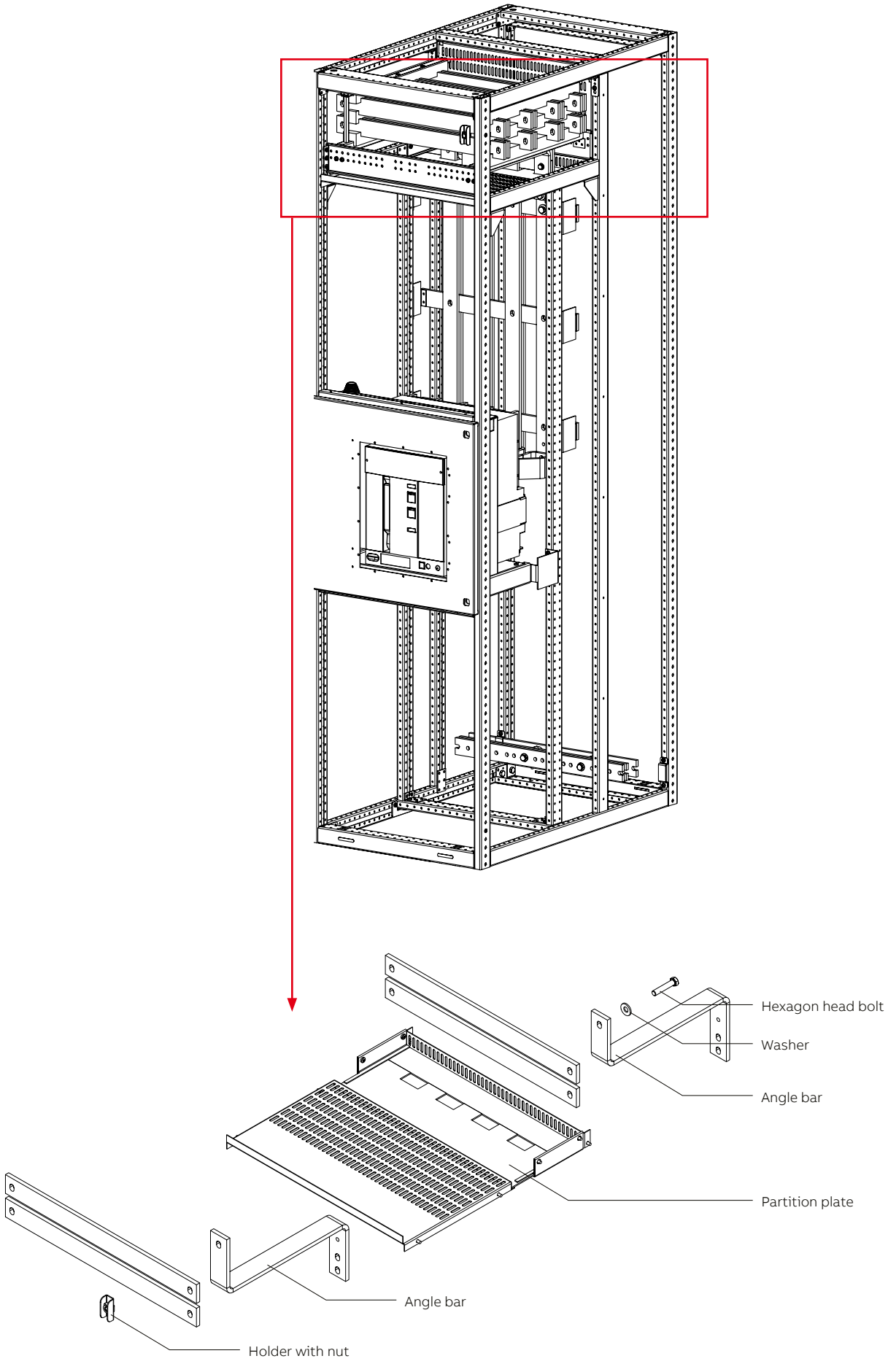


Figure 2-28 MNS Rear ACB copper connection to main busbar

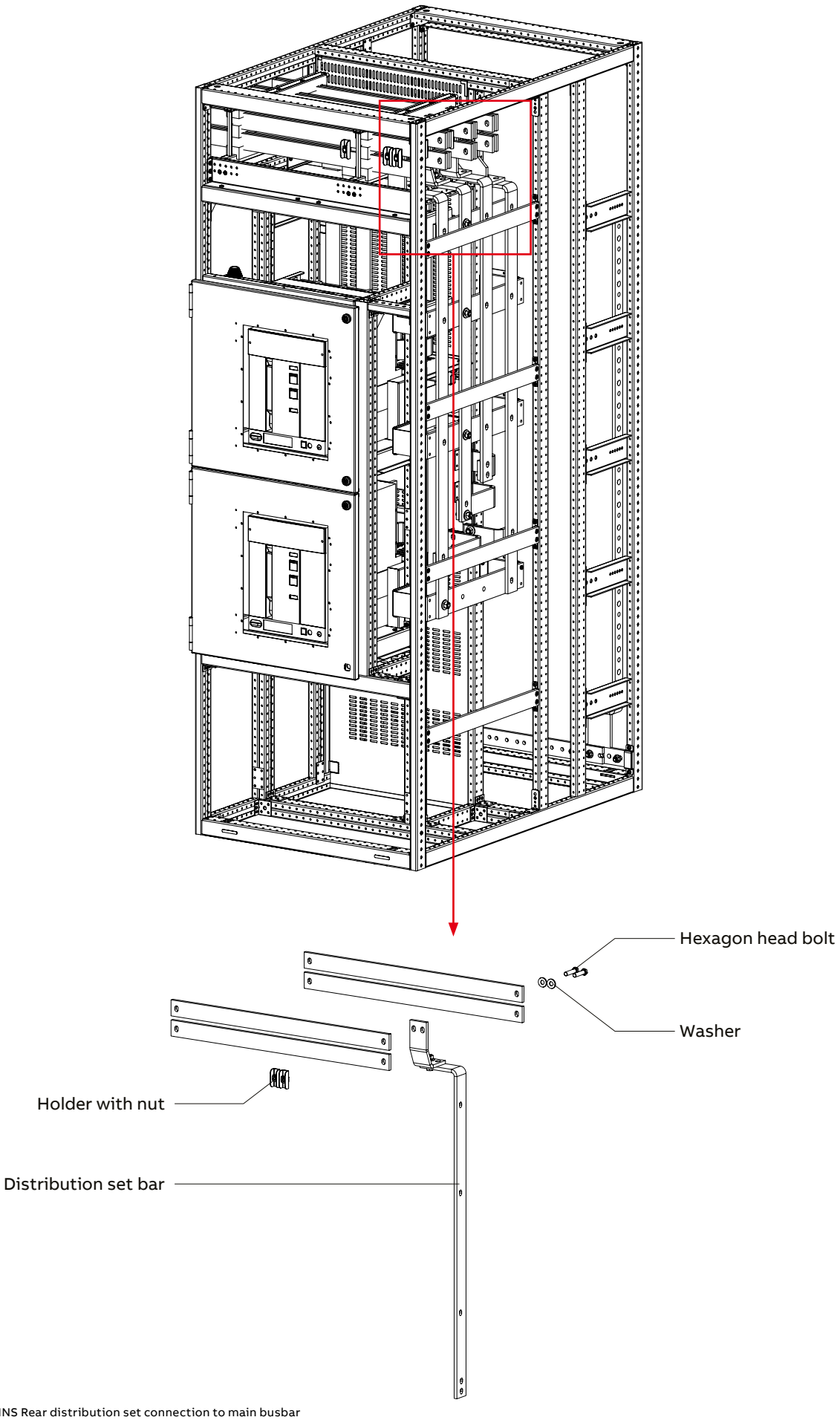


Figure 2-29 MNS Rear distribution set connection to main busbar

2.8.3 The multifunction separation wall

The multifunction wall (MFSW) with the embedded distribution bars is a unique MNS design. It constitutes a complete barrier between the main busbars and the equipment compartment. The distribution bars are fully phase segregated and insulated. This design makes it virtually impossible for an arc to pass between distribution bar phases or between main busbars and equipment compartment. The insulation material is CFC and halogen free, flame-retardant and self-extinguishing.

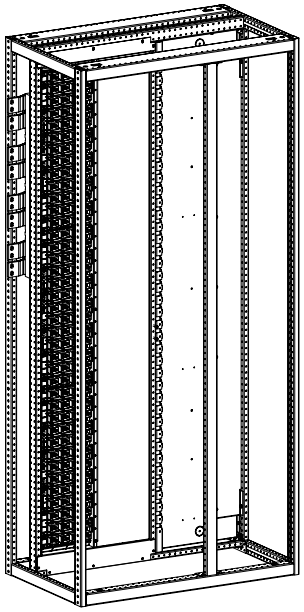


Figure 2-30
MFSW location in front access section located to the left

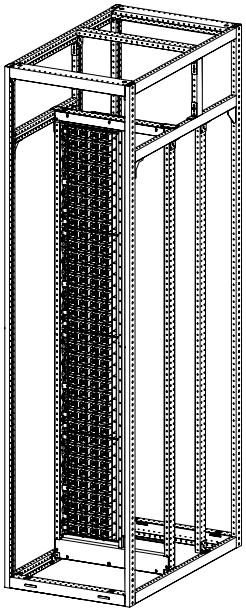


Figure 2-31
MFSW location in rear access section

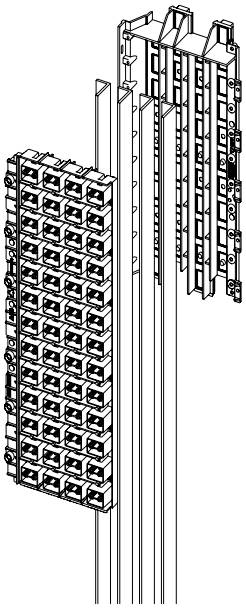


Figure 2-32
Exploded view with front and rear MFSW components and the distribution bars

2.8.4 The distribution bar system

The vertical distribution bars provide the connection from the main busbars to the modules. This connection is gas tight to ensure arc fault containment standards are met.

The distribution bars are L-shaped for improved rigidity and silver plated as standard.

Options exist for increased ratings and are project dependant.

Sectionalising of the distribution bars within a single outgoing section is also an option.

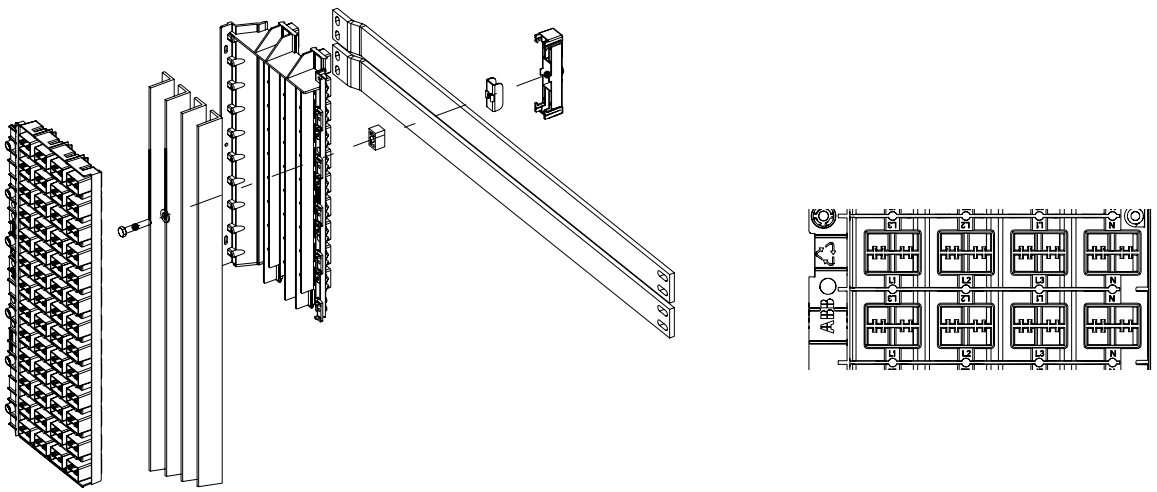


Figure 2-33 Distribution bars. The right hand side shows a detailed view

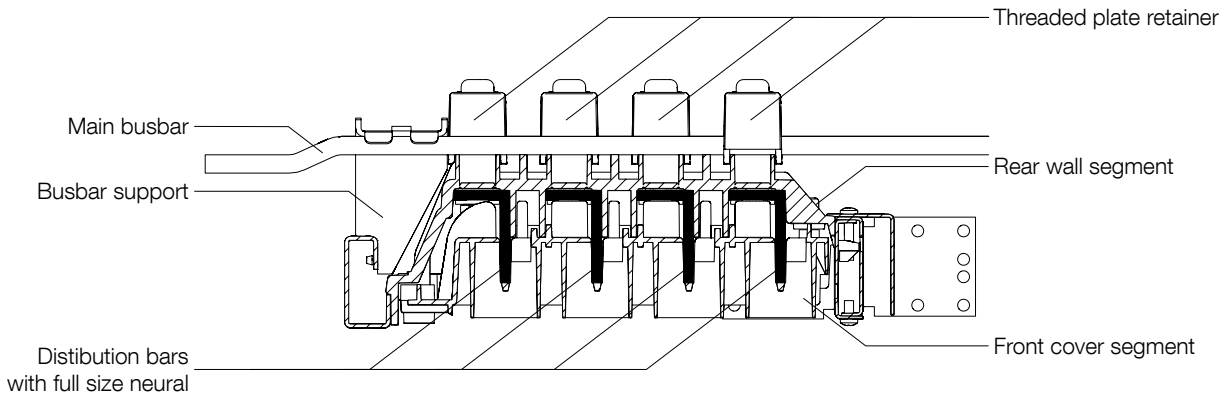


Figure 2-34 Top view of distribution bars

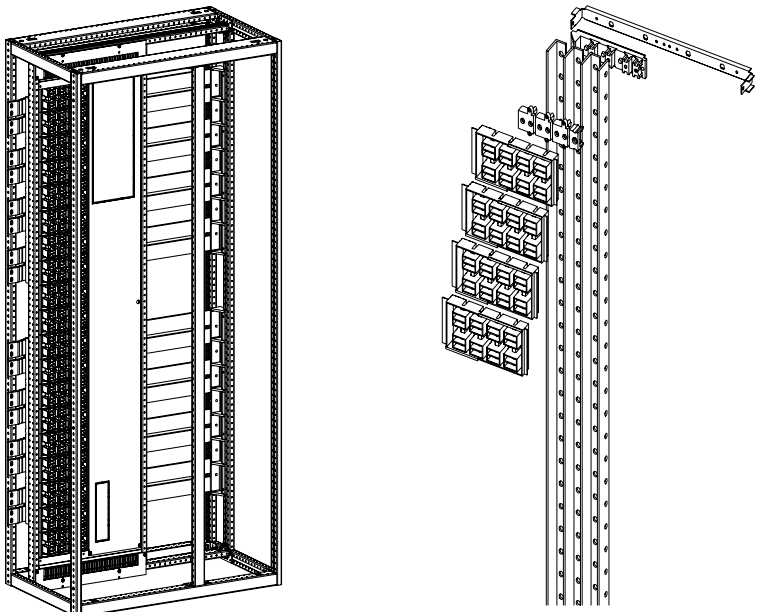


Figure 2-35 Metal separation wall MSW

Figure 2-35 shows the left half of the section with the metal separation wall. The right hand graphic details the 'open type' of busbar construction.

2.8.4.1 MNS Rear distribution bar system

For MNS Rear switchgear, the vertical distribution bars provide the connection from the main busbars to the modules. This connection achieves a protection degree IP2X.

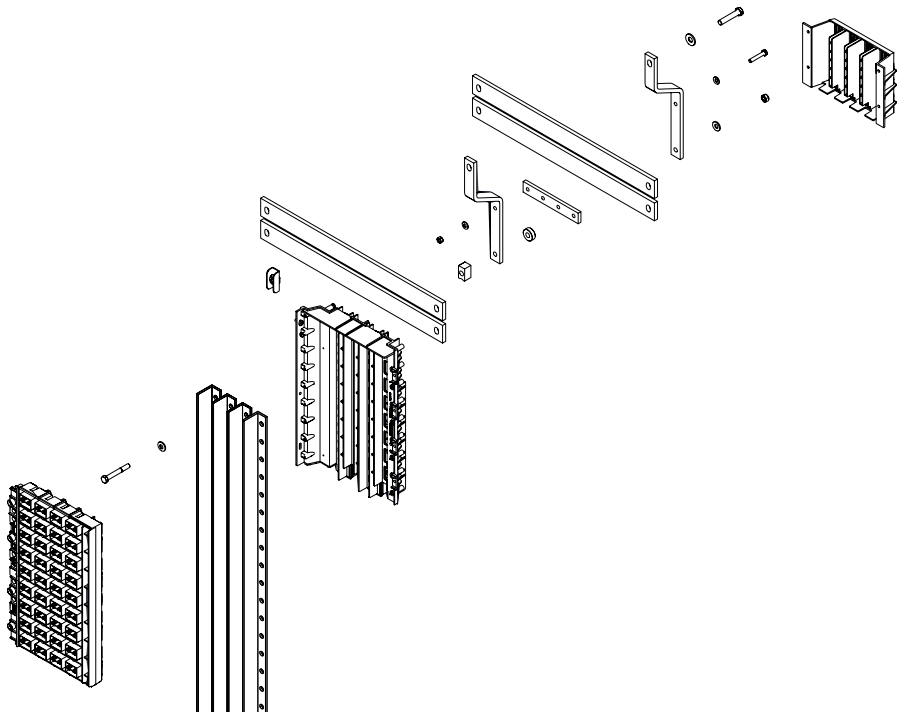


Figure 2-36 MNS Rear distribution bars with standard type MFSW

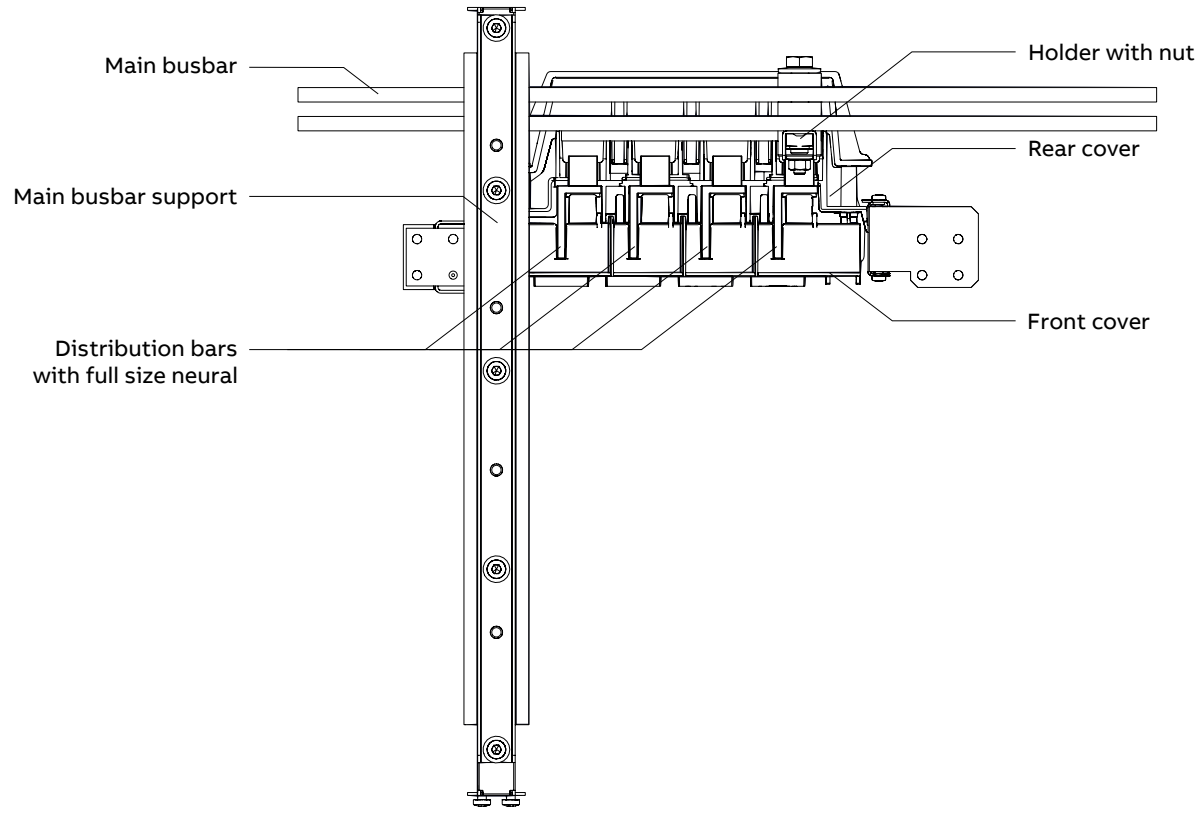


Figure 2-37 Top view of MNS Rear distribution bars with standard type MFSW

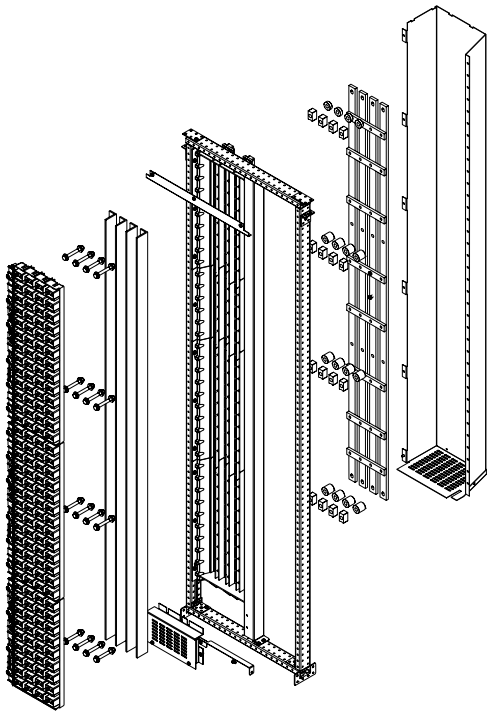


Figure 2-38 MNS Rear distribution bars with optimized type MFSW

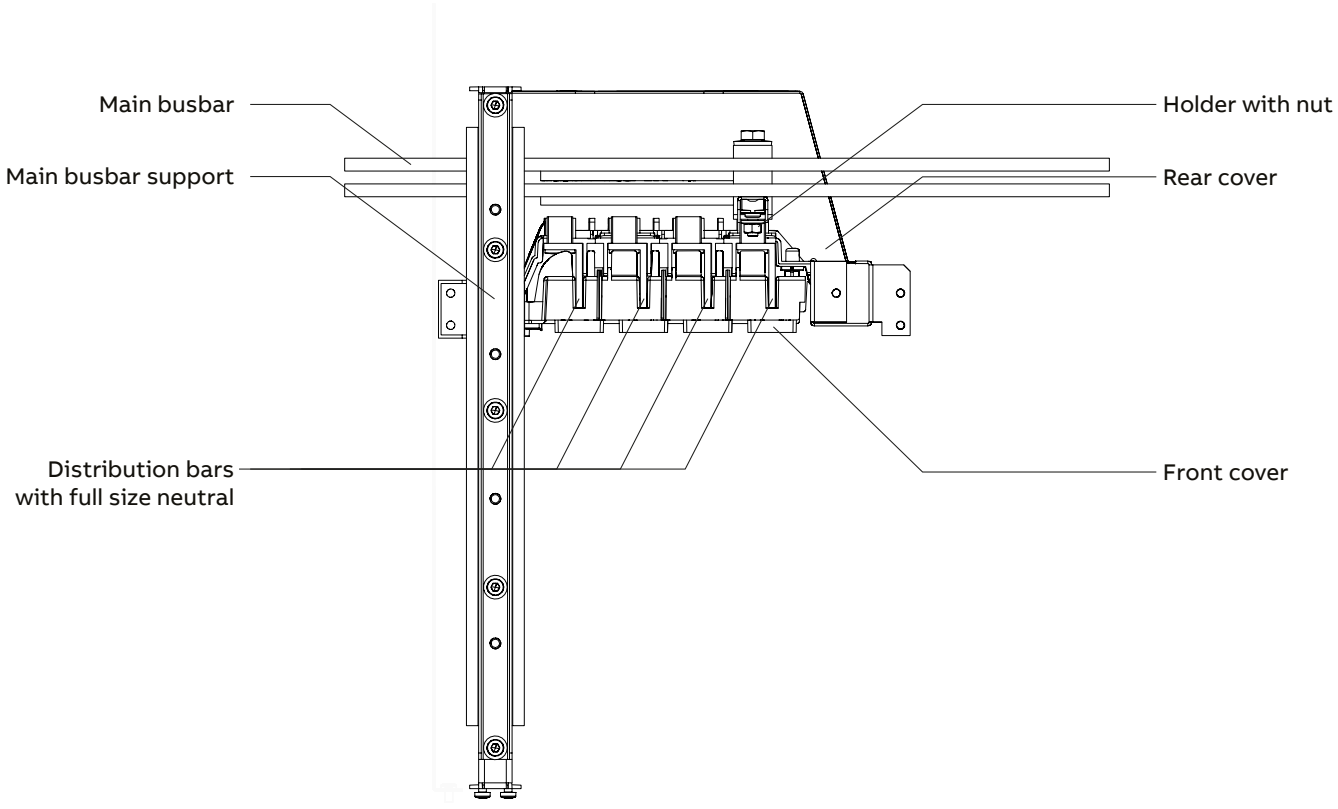


Figure 2-39 Top view of MNS Rear distribution bars with optimized type MFSW

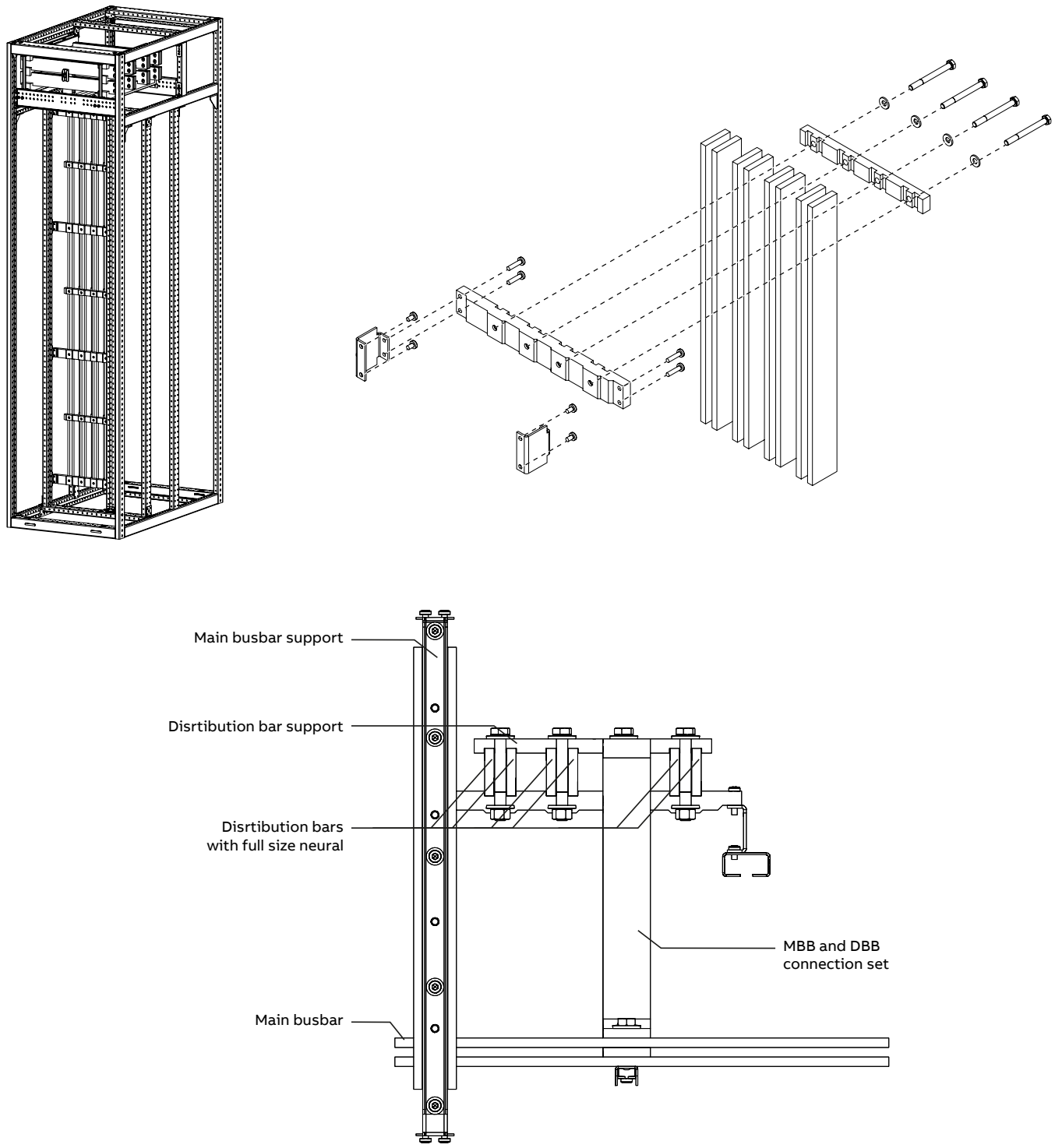


Figure 2-40 MNS Rear fixed distribution bars system

2.8.4.2 Fixed type distribution bars system

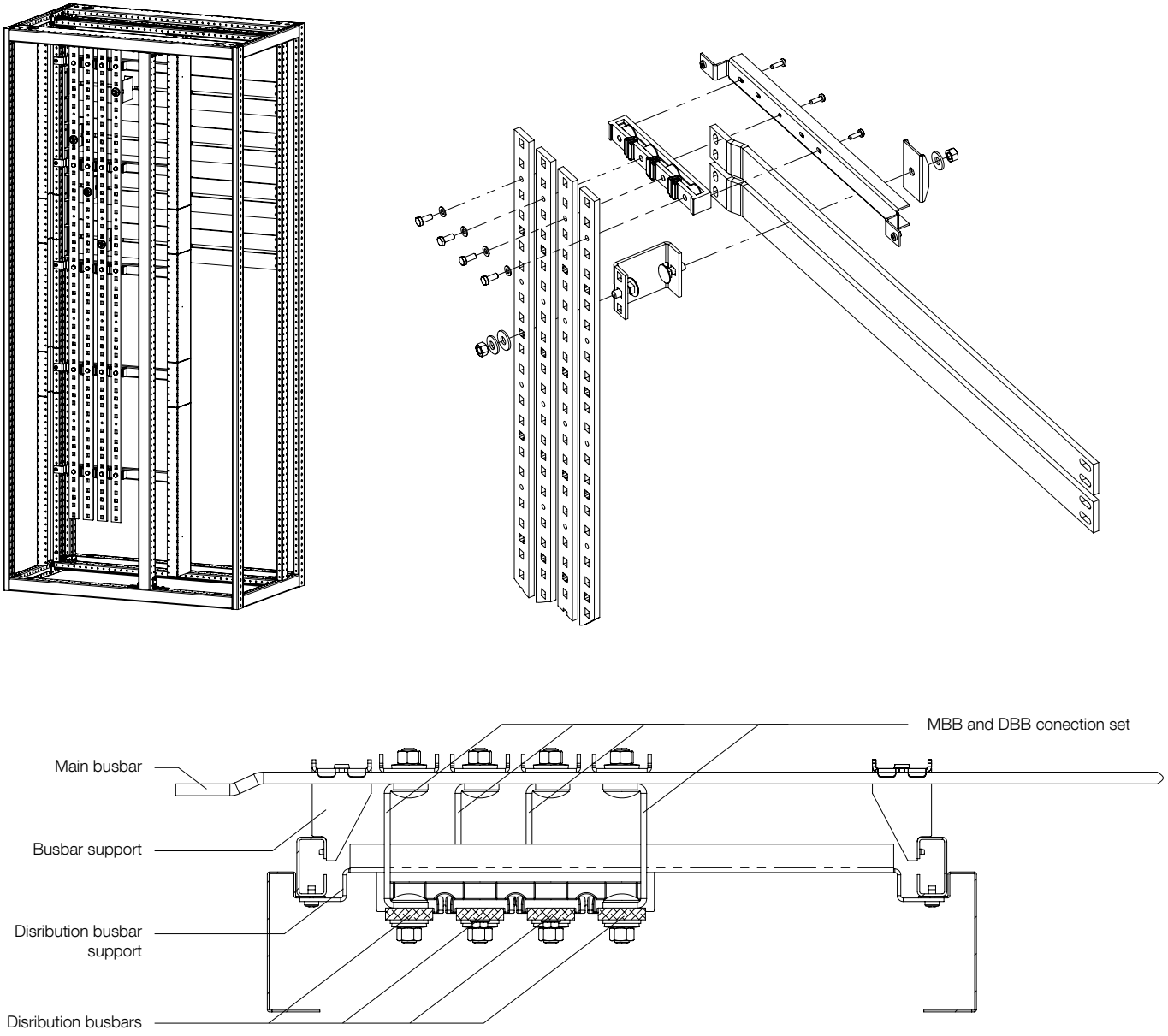


Figure 2-41 Fixed distribution bar system

2.8.5 The power contact

Utilised with plug-in and withdrawable type moduels the distribution bar is realized using the precision engineered MNS power contacts. The power contact is characterised by a turn able bearing, thus decoupling cable stress and electrical contact. Consequently any cable bending forces do not affect the stability of the power contact (see Figure 2-31).
The mechanical stabilisation 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 independently verified in order to provide a life cycle up to 1000 insertions, exceeding the requirements of IEC 61439-1.

To ensure product quality, each power contact is engraved with marking code, which details:
- contact coating,
- conductor cross section in mm^2,
- serial number of production,
- year of production,
- calendar day of production,
- contact force,
- manufacturing country acc. ISO 3166.

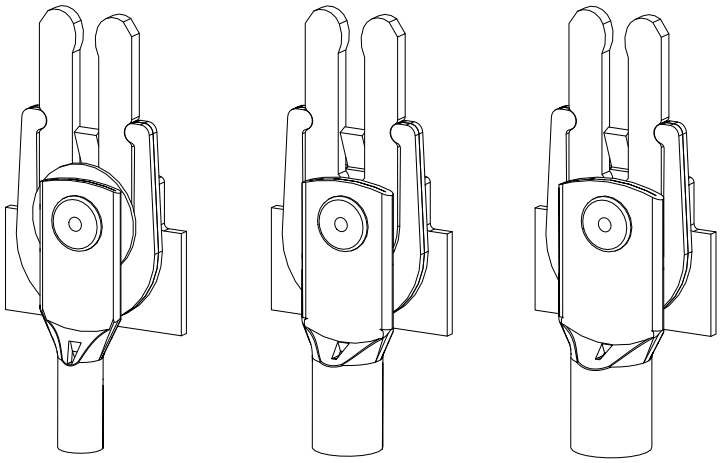


Figure 2-42 Power contacts used in MNS switchgear for different cable cross-sections

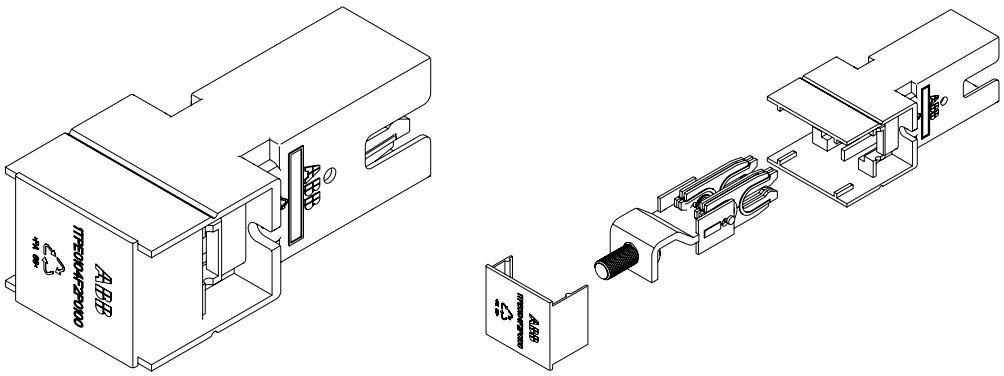


Figure 2-43 Sotax contacts are used for higher current application

For maintenance on the main contact please refer to section 7.5

2.9 Section and functional units

A previously described the MNS platform is of a modular construction enabling flexible configuration of the assembly to be project requirements, the modular assembly comprises:

- Sections
- Functional units

As section is a full height construction based upon the “C” profile frame construction. A functional unit is a subassembly contained within the section.

The MNS system enables the following solutions to be configured, as defined in IEC 61439-2:

- F – F ixed connections, connected / disconnected by means of a tool.
- D – Disconnectable connected / disconnected by manual operation, no tool required.
- W – Withdrawable connected / disconnected by bringing the functional unit into the isolated position, no tool is required for MNS solutions.

The MNS universal section design enables the different types of modules to be combined in the same section.
The figure below details the scalability of the system from Fixed to Withdrawable and operational aspects associated with the different functional unit designs.

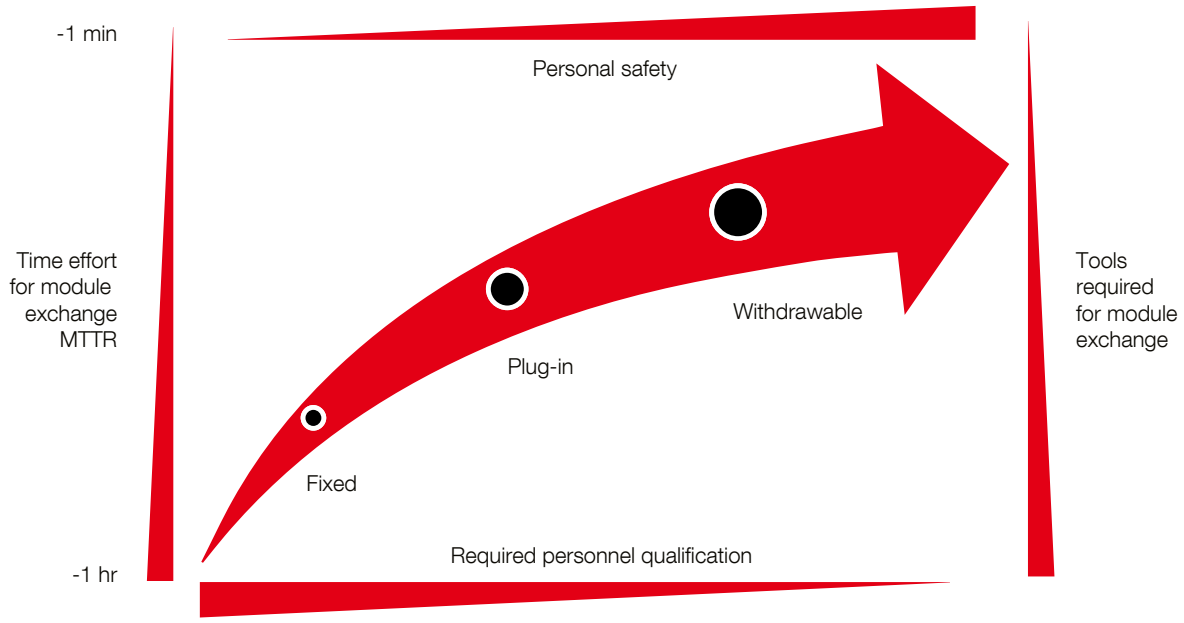


Figure 2-44 Characteristics of functional unit design

2.9.1 ACB (Air Circuit Breakers) sections

The ACB sections are directly connected to the busbars. Designs are available for both fixed and withdrawable ACB's. ACB sections can be configured for either top or bottom entry, depending on this the position of the auxiliary recess and surge protection device varies as shown below.

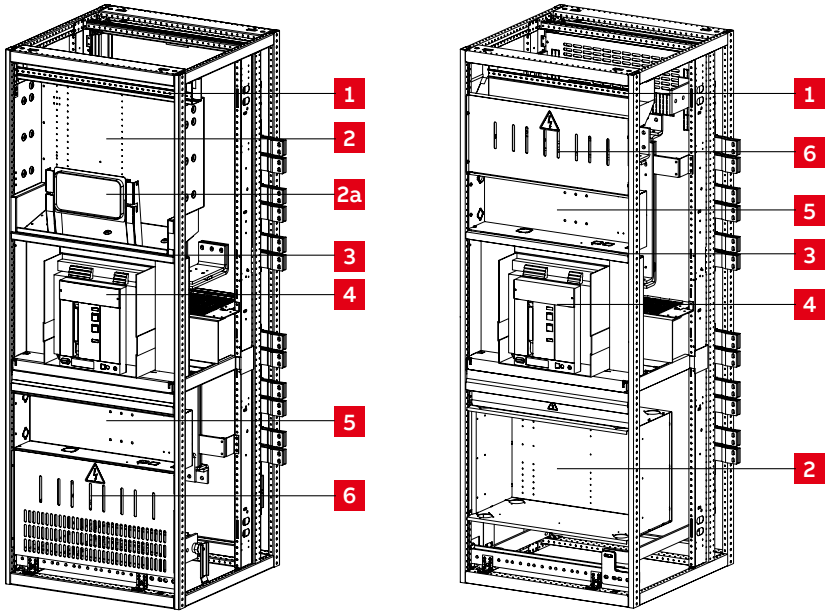


Figure 2-45 ACB section bottom entry configuration (left), top entry configuration (right)

No	Description
1	Horizontal wiring duct for internal / external cabling (top and bottom cable entry with different type of wiring duct)
2	Auxiliary recess with optional instrument panel 2a (instrument panel possible only for cable bottom entry section)
3	ACB compartment
4	ACB – Air Circuit Breaker
5	SPD compartment (optional, possible for top and bottom cable entry)
6	IP20 touch protection

MNS provides an option where it is possible to configure up to two earthing in a single ACB section, to meet operational safety procedures. Please refer to project specific documentation.

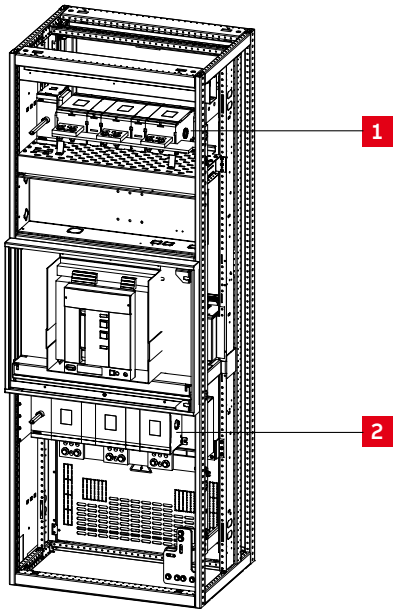


Figure 2-46 Positions for optional earthing switch solutions
1 Position shown for upper earthing switch
2 Position shown for lower earthing switch

SPD compartment description

The Surge Protection Device (SPD) is provided as an optional feature with the ACB section design integration with MNS.

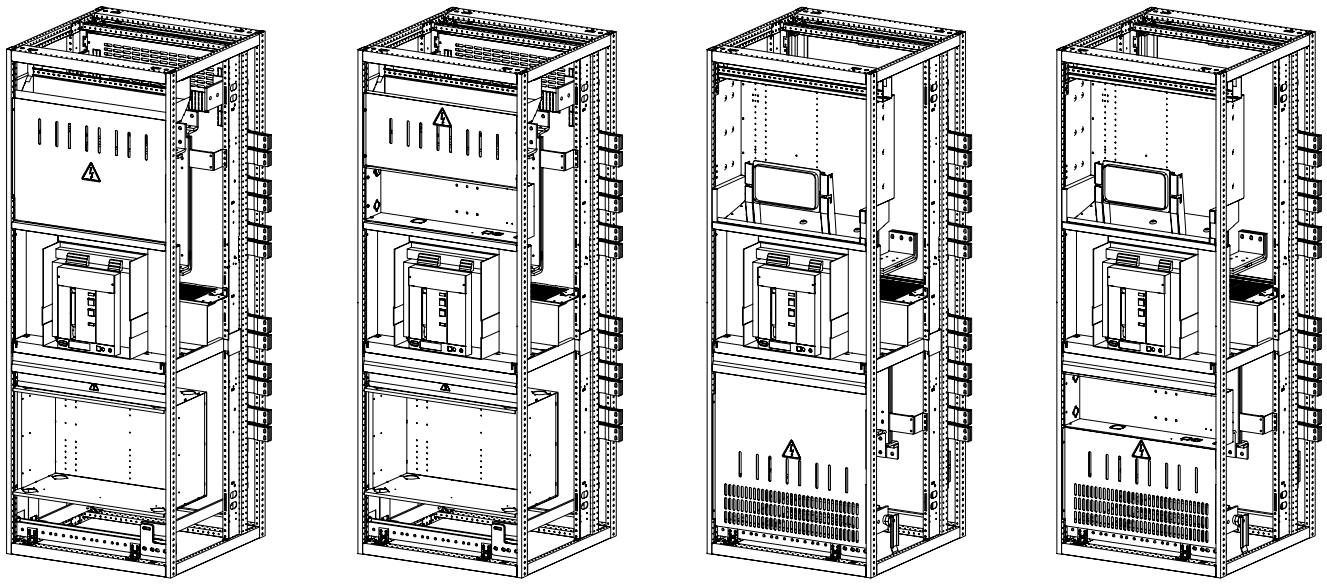


Figure 2-47 Sections with cable top entry (left) and bottom entry (right)

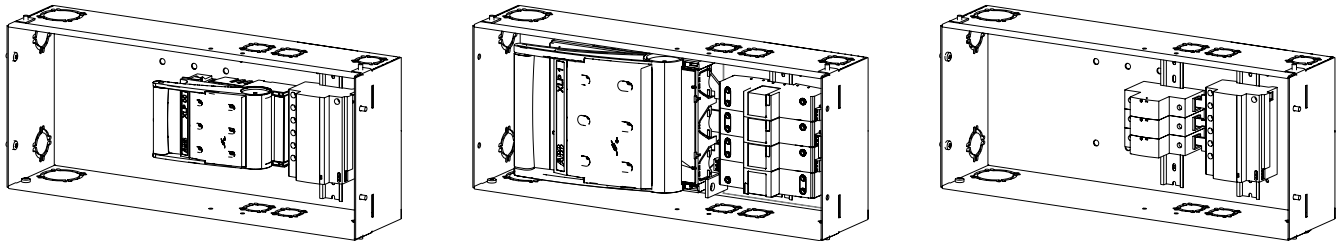


Figure 2-48 SPD with fuse backup protection XLP0 (left), XLP1 (middle) and MCB backup protection (right)

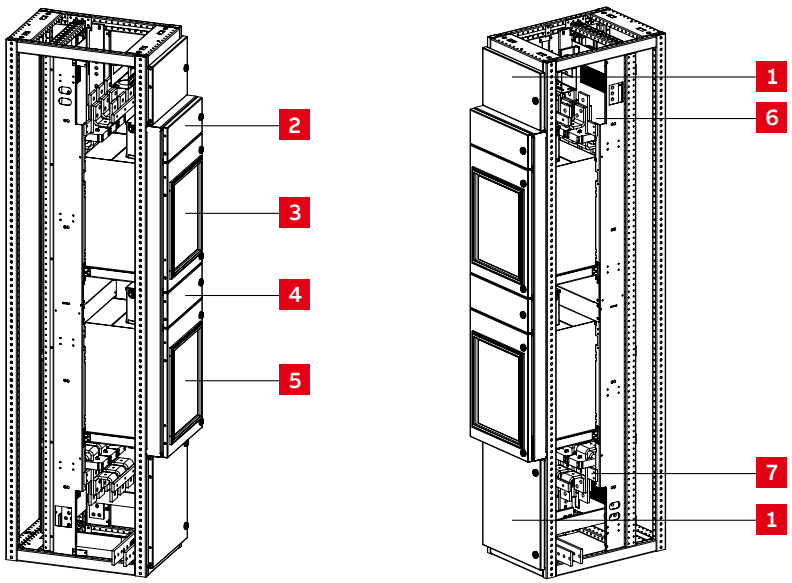


Figure 2-49 MNS Front access switchgear with double stacked ACBs

No	Description	No	Description
1	Ventilation area	5	Lower ACB
2	Measuring recess upper ACB	6	Upper ACB cable connection
3	Upper ACB	7	Lower ACB cable connection
4	Measuring recess lower ACB		

MNS Rear ACB sections are directly connected to main busbars. ACB section can be configured for either top or bottom entry. The position of auxiliary recess and surge protective device (SPD) compartment are showed below. SPD compartment is provided as an option to accommodate SPD or other devices within ACB section.

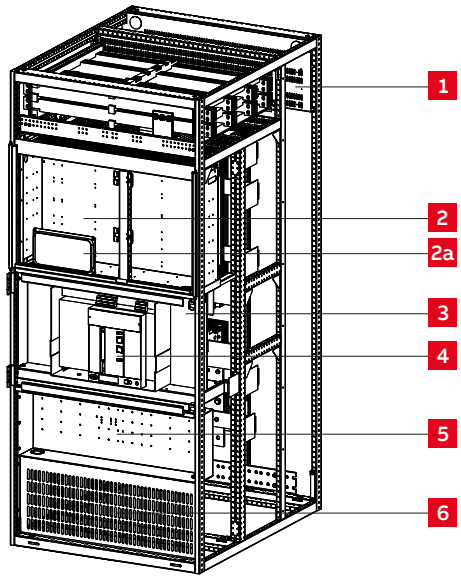


Figure 2-50 MNS Rear ACB section configuration

No	Description	No	Description
1	Horizontal wiring duct for internal/ external cabling (top and bottom cable entry with different type of wiring duct)	4	ACB – Air Circuit Breaker
2	Auxiliary recess with optional instrument panel 2a (instrument panel possible only for cable bottom entry section)	5	SPD compartment (optional, possible for top and bottom cable entry)
3	ACB compartment	6	IP20 touch protection

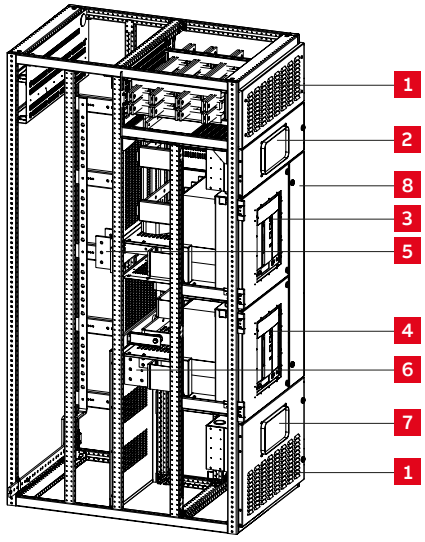


Figure 2-51 MNS Rear access double stacked ACB

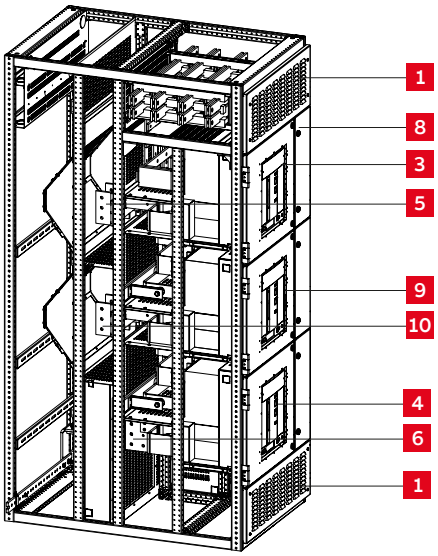


Figure 2-52 MNS Rear access triple stacked ACB

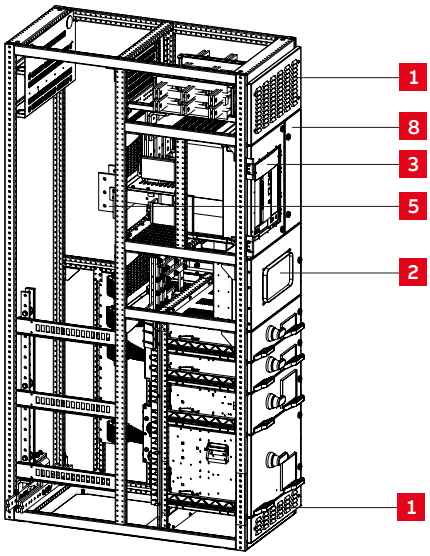


Figure 2-53 MNS Rear access combined ACB and withdrawable modules

No	Description	No	Description	No	Description
1	Ventilation	5	Upper ACB cable connection	9	Central ACB
2	Measuring recess upper ACB	6	Lower ACB cable connection	10	Central ACB cable connection
3	Upper ACB	7	Measuring recess lower ACB		
4	Lower ACB	8	Side auxiliary recess		

2.9.2 Switch-disconnector sections

The Switch-disconnector is directly connected to the busbar. The fixed design is available for either top or bottom entry. In addition to the main breaker, MNS provides an option where it is possible to configure an earthing switch to meet operational safety procedures. Please refer to project specific documentation.

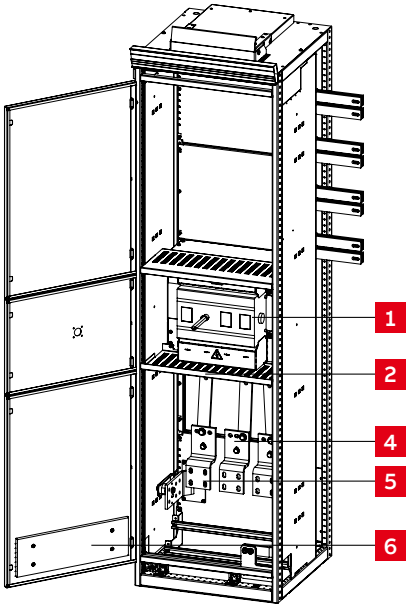


Figure 2-54 Switch-disconnector

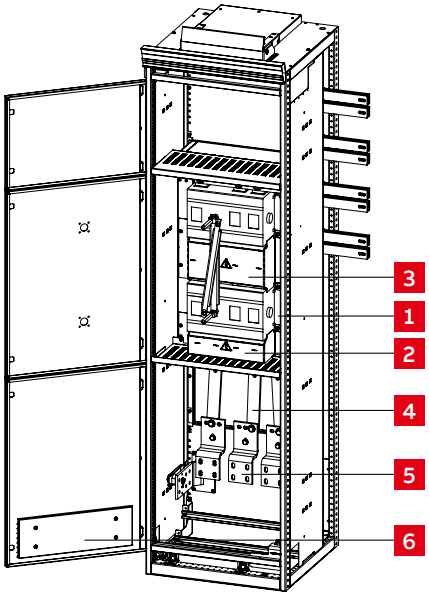


Figure 2-55 Switch-disconnector with earthing switch

No	Description
1	Switch-disconnector compartment
2	Switch-disconnector
3	Earthing switch
4	IP20 touch protection
5	Cable connection
6	Ventilation area

2.9.3 Fixed modules in MNS

Fixed modules are available with the following options

- Fixed module width is 400/600mm
- Standard sizes are 8E, 12E, 16E, 24E, 36E, 40E, 56E & full size
- Form 4a as standard, please refer to project documentation

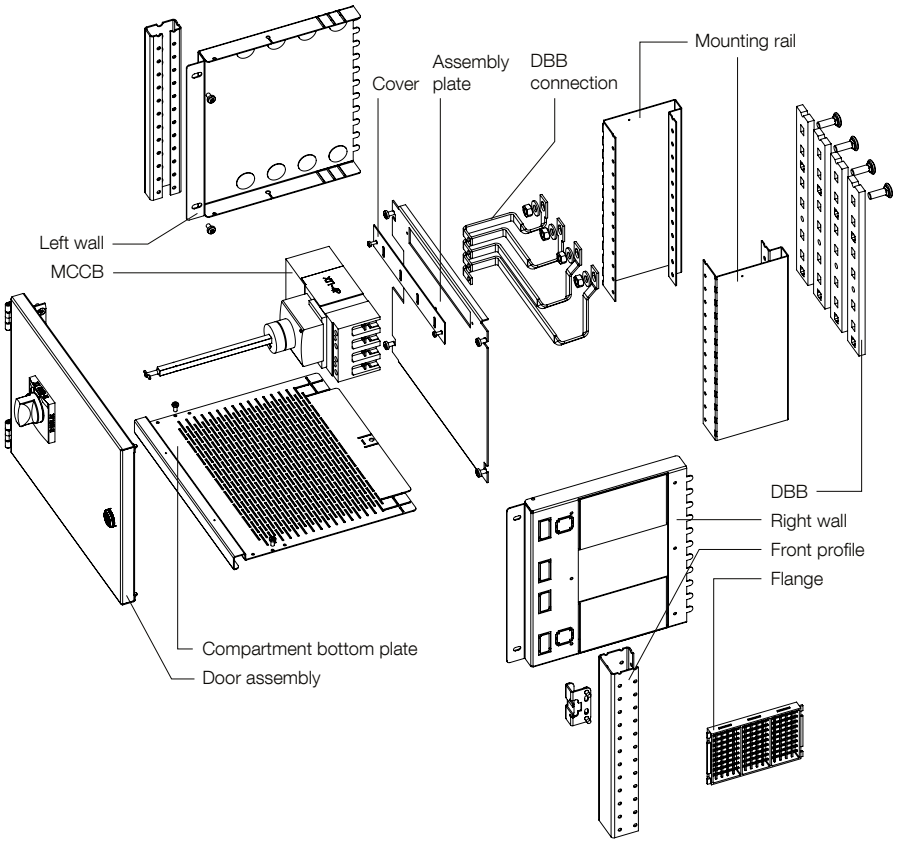


Figure 2-56 Fixed module size 12E

Fixed module construction and connection to distribution busbars

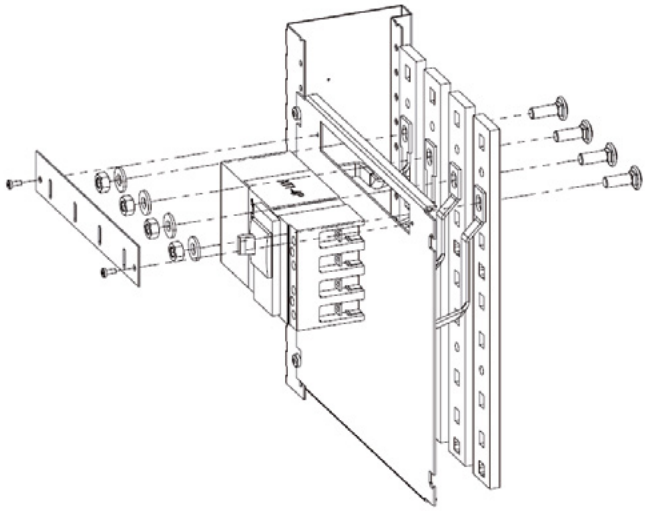


Figure 2-57 DBB connection with busbars

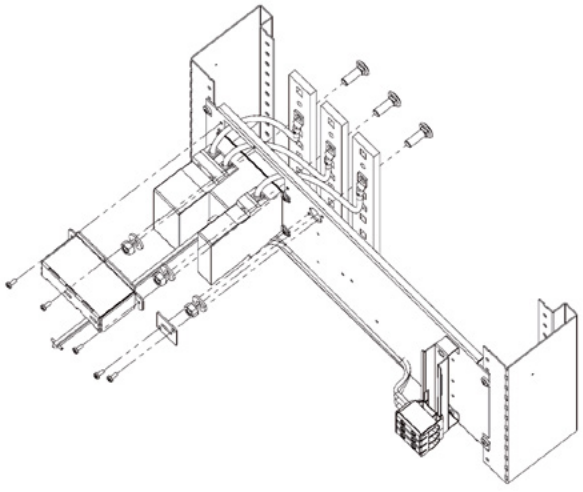


Figure 2-58 DBB connection with cables

2.9.4 Fixed modules in MNS Rear

Fixed modules in MNS Rear are available with the following options

- Fixed module width is 600mm
- Standard sizes are 6E, 8E, 12E, 16E
- Form 3b as standard, please refer to project documentation

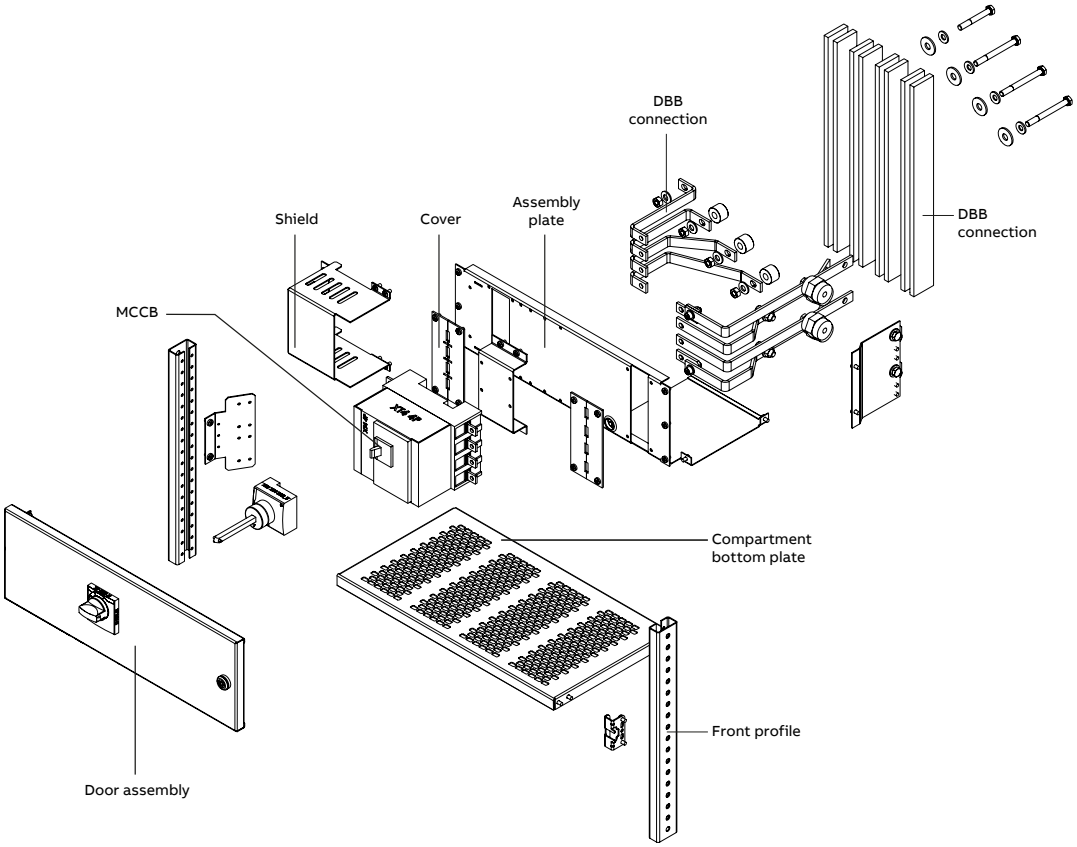


Figure 2-59 MNS Rear fixed module size 8E

Fixed module construction and connection to distribution busbars

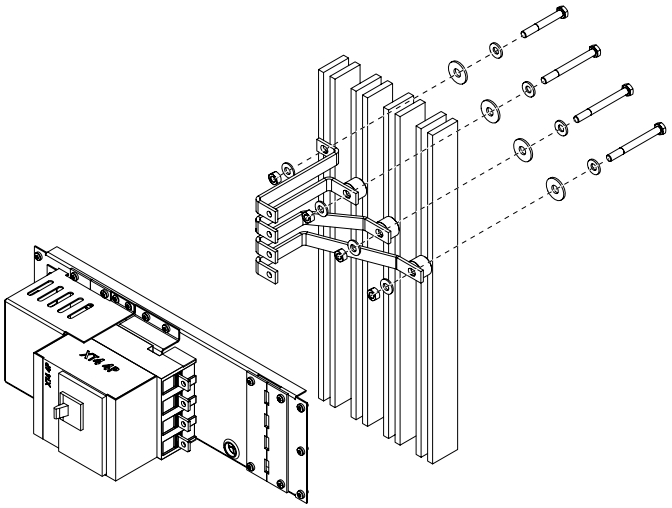


Figure 2-60 MNS Rear fixed DBB connection with busbars

Fixed module can also be connected to distribution busbars with cables.

2.9.5 Compact modules in MNS

Compact modules are provide energy distribution functionality with moulded case circuit breakers. Operation is inside or behind door, options are available for power monitoring and MNS Digital integration.

The MNS compact modules are defined as disconnectable, as they require a tool for removal and are a 'Plug-in' type of module. The modules utilise the MNS power contact for connection to the MFSW. The outgoing section for the compact modules differs slightly in with respect to the fact that two sets of distribution bars are utilised in the outgoing and two cable compartments are present one on either side of the equipment compartment, see figure 2-61.

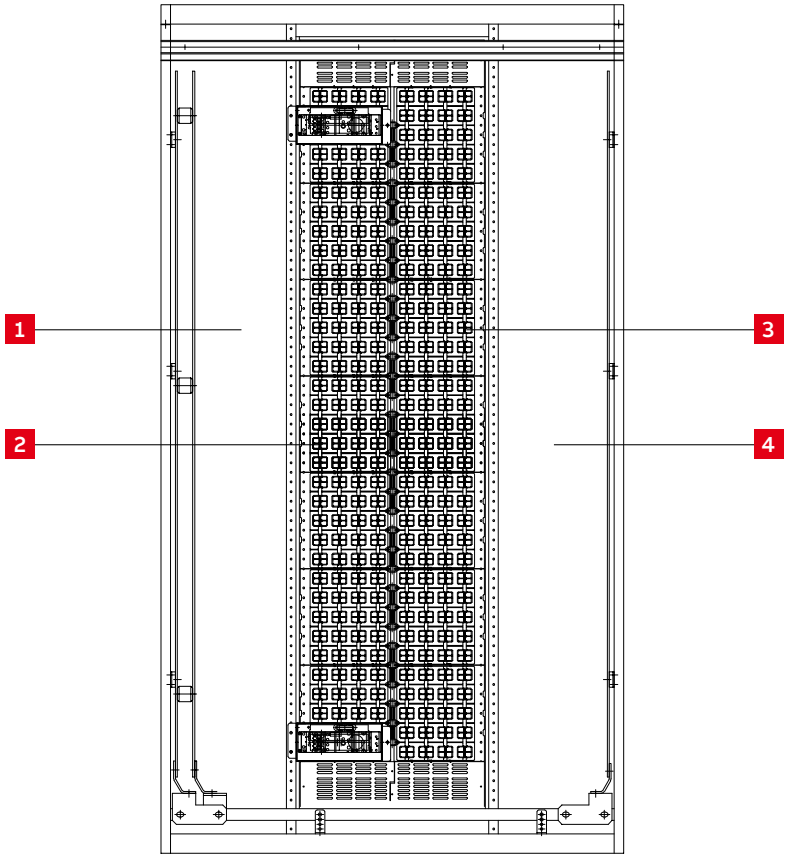


Figure 2-61 Multi-Function Separation Wall (MFSW) in section

No	Description
1	Left cable compartment
2	Left multi-function separator
3	Right multi-function separator
4	Right cable compartment

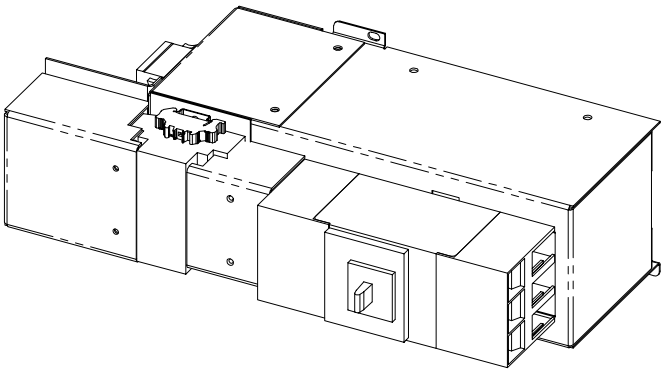
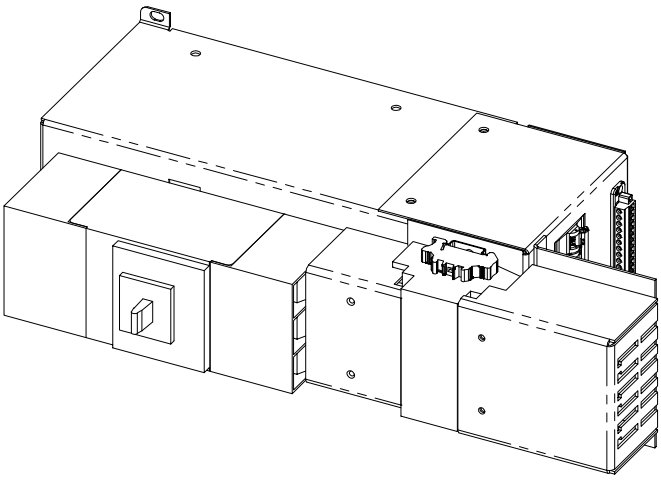


Figure 2-62 Compact module left side mounting



Compact module right side mounting

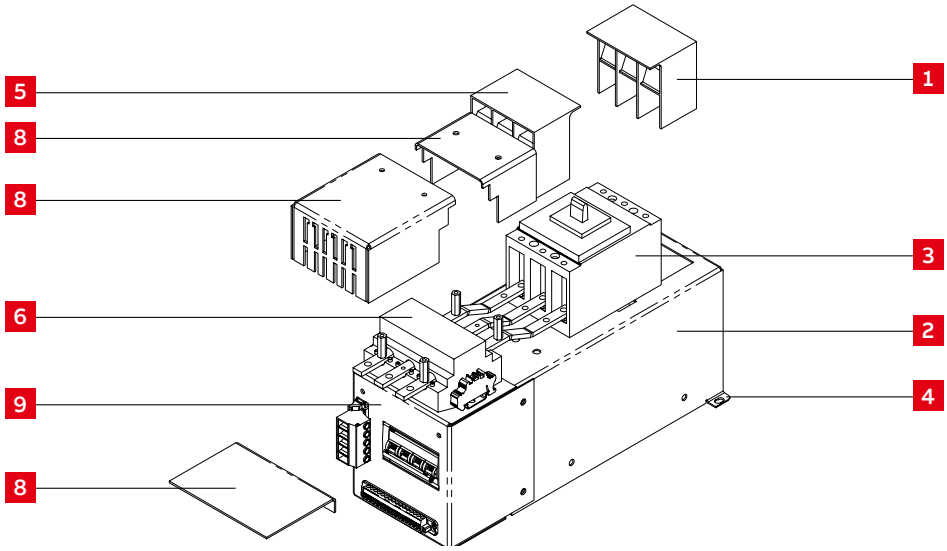


Figure 2-63 Exploded view

No	Description	No	Description
1	Incoming MCCB connection cover	6	Current Transformer (option)
2	Module base & main contact mounting (not visible)	7	Connection bars
3	MCCB	8	Protection covers
4	Fixing point lower	9	Auxiliary area
5	Outgoing MCCB connection cover		

Prior to removal of Compact modules. The module shall be isolated. Following this power and control cables may be disconnected.

2.9.6 Plug-in modules in MNS

Plug-in modules can be configured for energy distribution or motor starting applications with either fuses or moulded case breakers. Operation can be inside, behind individual or shared doors, or outside. Options are available for control and monitoring with MNS Digital integration.

Disconnectable modules or Plug-in modules (up to 630 A) are connected to the distribution bars by means of the main contact and require tools for removal. There are four different module variants that may be configured for the MNS platform.

- Compact
- Plug-in
- Slimline XR
- Power factor correction (RPC – Reactive Power Compensation)

All plug-in modules require a tool to connect / disconnect the modules and all variants utilise main contacts to connect to the distribution bars via the MFSW.

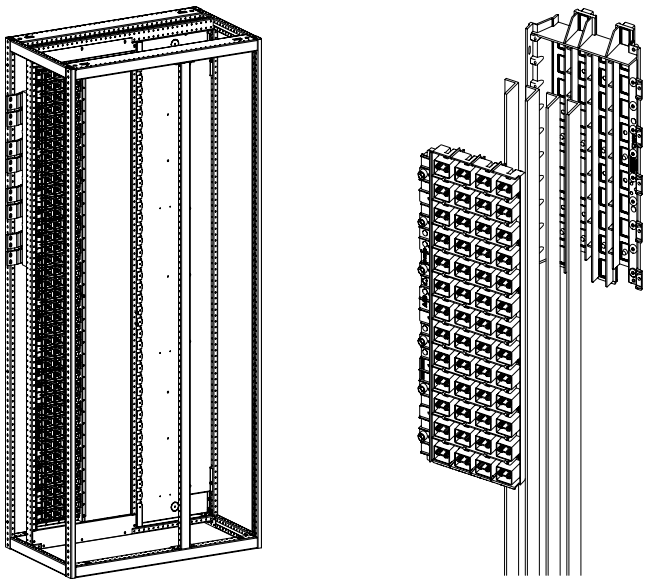


Figure 2-64 Multi-Function Separation Wall (MFSW) in section

Above shows the left half of the section with the multifunction wall and embedded distribution bars. The right hand side shows a detailed view.

Plug-in modules
Sizes 6E, 8E, 12E, 24E and 36E are available as standard sizes.

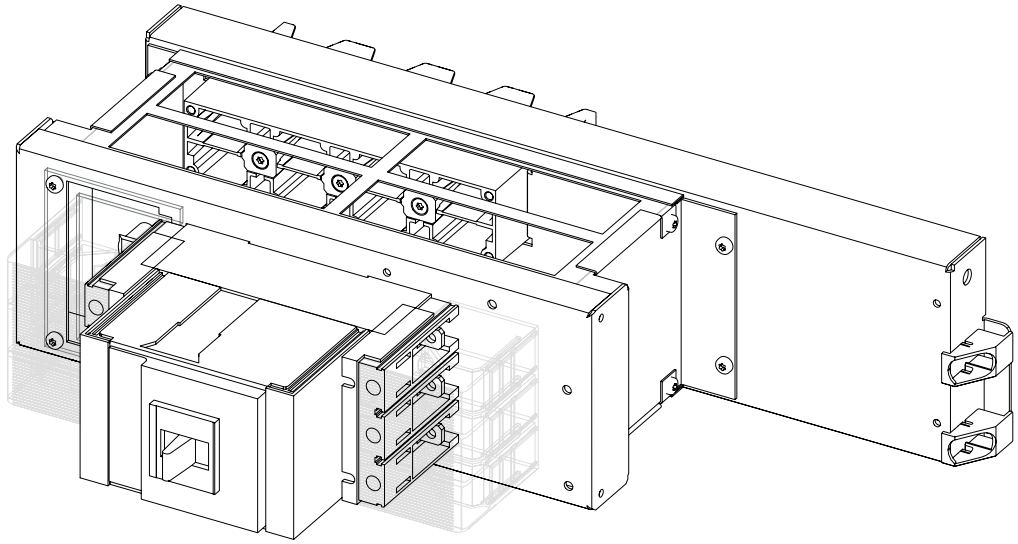


Figure 2-65 Basic plug-in energy distribution module

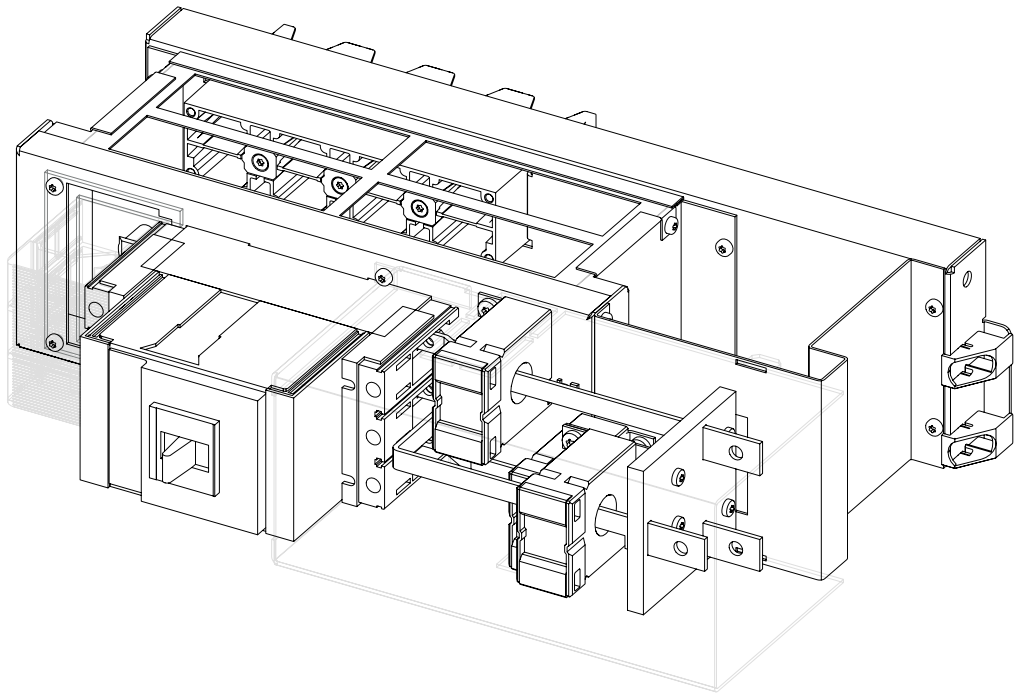
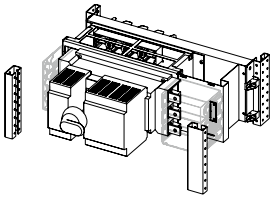
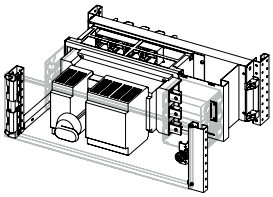
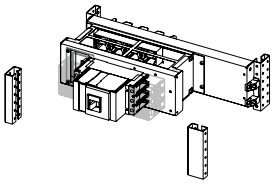
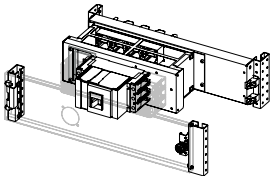
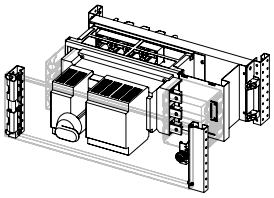
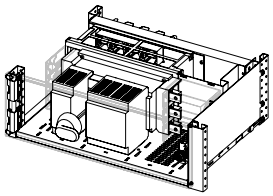
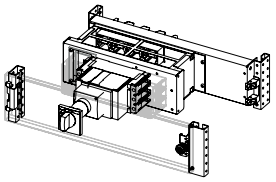
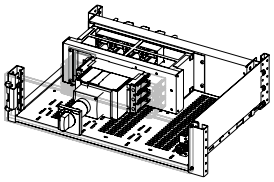


Figure 2-66 Energy distribution module with optional CT´s

The basic design consists of a sheet steel plates where the SCPD and the MNS main contacts are mounted. Modules may be configured on the 25 mm grid up to a height of 1800 mm, options are available for 400 mm or 600 mm module widths. Plug-in modules may be configured for internal or external operation and options for Form 2 and Form 4 separation are possible. Please refer to the relevant project documentation.

Prior to removal of Compact modules. The module shall be isolated.
Following this power and control cables may be disconnected.

	Fuse switch	Fuse switch	MCCB	MCCB
	Form 4a	**Form 4a**	**Form 4a**	**Form 4a**
Internal operation	• door sizes selectable up to full section height • without compartment bottom plate	• individual door for each module • without compartment bottom plate utilizing door rail	• door sizes selectable up to full section height • without compartment bottom plate	• individual door for each module • without compartment bottom plate utilizing door rail
				
External operation	• individual door for each module • without compartment bottom plate utilizing door rail	• individual door for each module • with compartment bottom plate	• individual door for each module • door rail utilised	• individual door for each module • compartment bottom plate and side wall options shown
				

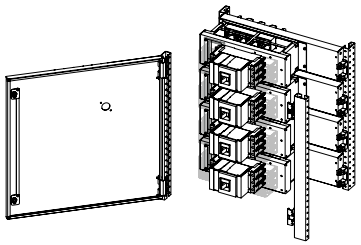
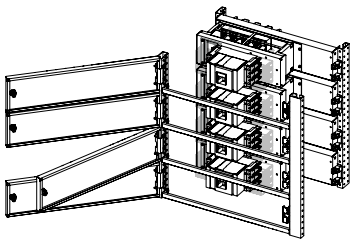
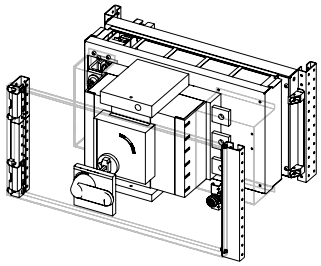
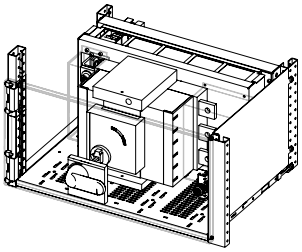
	MCCB	MCCB
	Form 4a	**Form 4a**
Internal operation	• common door for 4 × MCCB • door otpions upto 72E	• individual door for 4 × MCCB • without compartment bottom utilizing door rail
		
External operation	• Individual door	• Individual door • compartment bottom plate and side wall options shown
		

Table 2-03 Form of separation for plug-in modules

Note: Forms of separation can vary dependent upon project requirements. Please refer to project specific documentation.

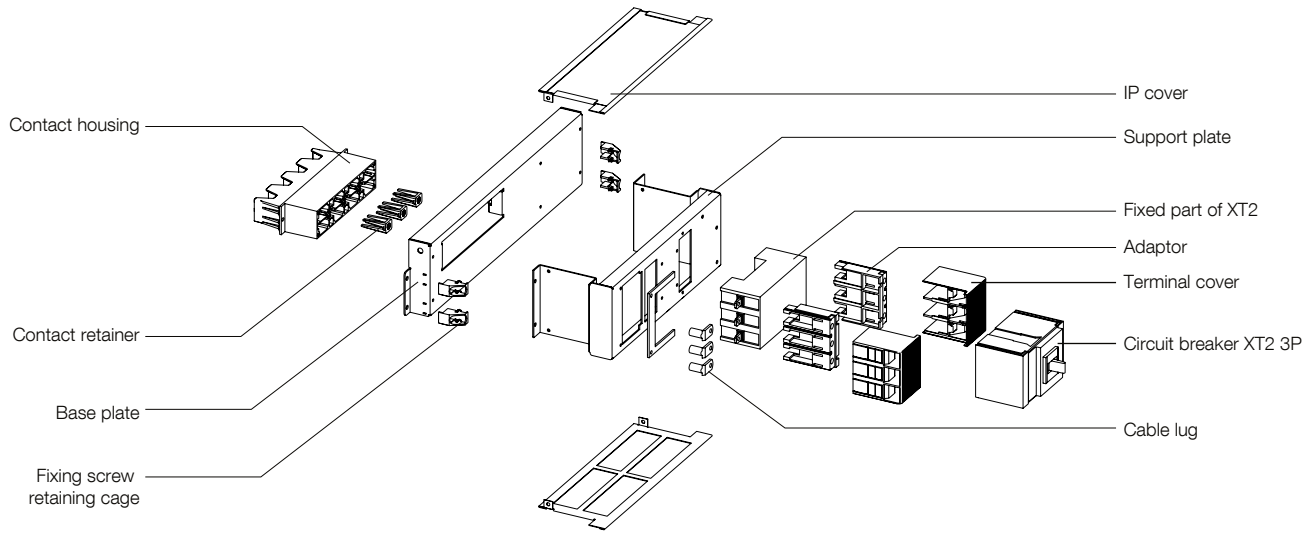


Figure 2-67 Exploded view of plug-in module cable connection to main contacts

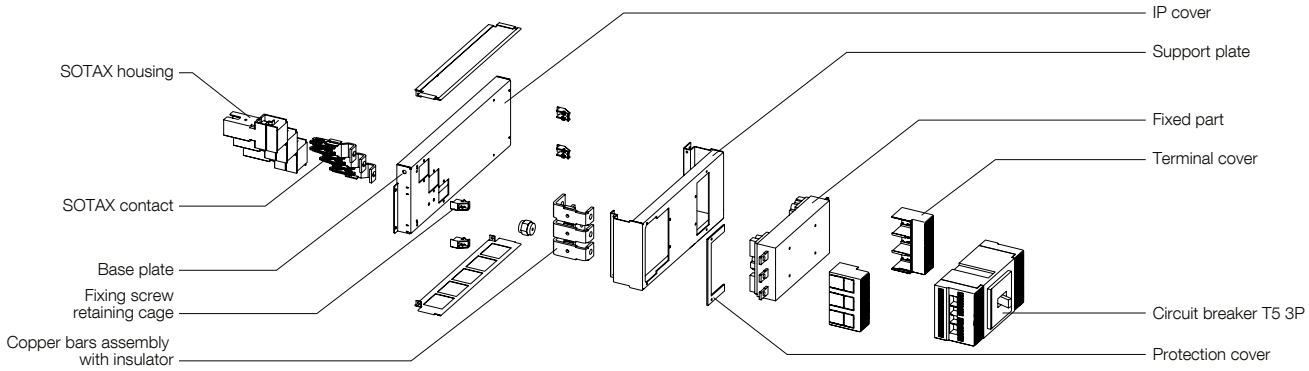


Figure 2-68 Exploded view of plug-in module with copper connection to main contacts

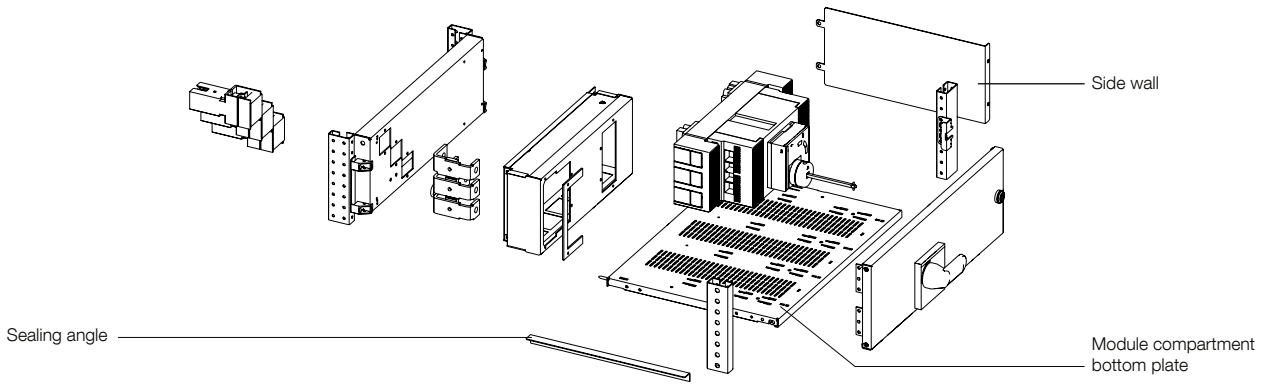


Figure 2-69 Exploded view of plug-in module with optional separation components

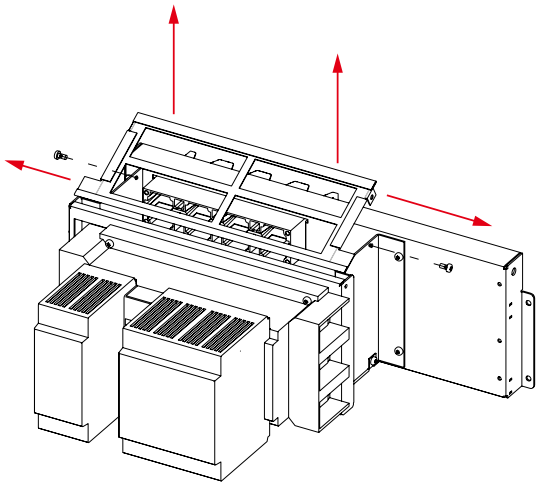


Figure 2-70 IP cover clip for all modules up to 250 A. To remove undo screws on left and right side and flip cover up, same is applicable for lower cover. Re-fitting is the reverse procedure.

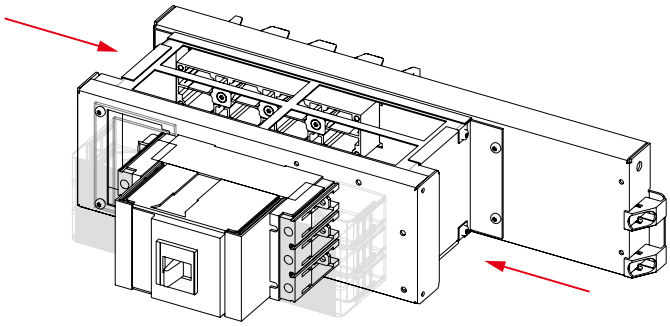


Figure 2-71 Ergonomic design for improve module handling. The module support plate is designed with handles on both sides.

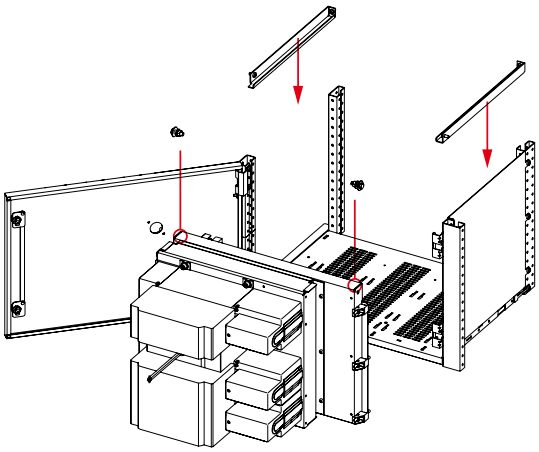
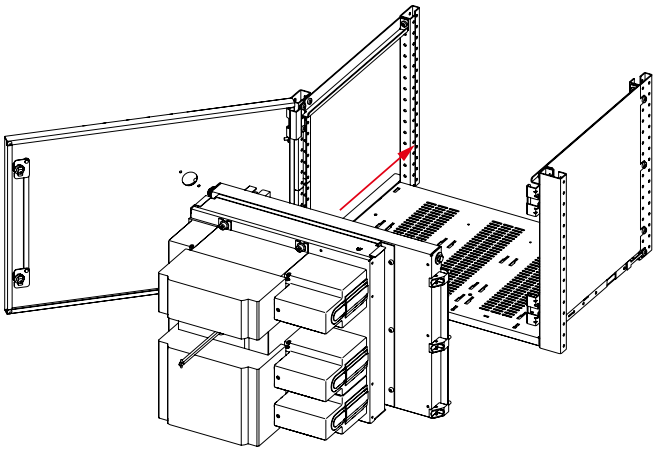


Figure 2-72 Module location guides and rails for larger modules. Larger modules can be equipped with location guides fixed to the top of the base plate. Guide rails are then mounted in the section.



Once the location guides are aligned onto the guide rail the modules can be easily inserted in to the section then fixed in place.

Fixing of the plug-in modules to the section

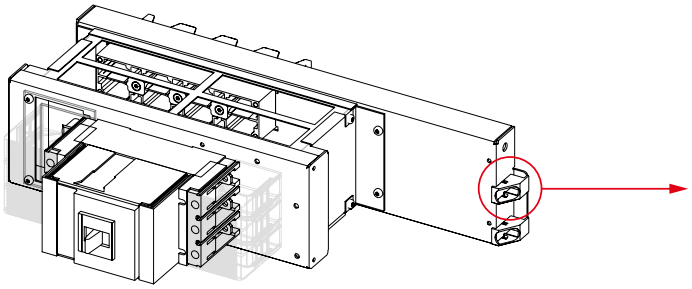


Figure 2-73 Fixing of the plug-in modules to the section

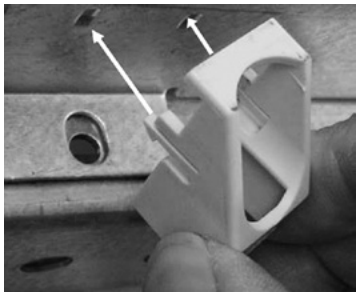


Figure 2-74 Detail of captive screw holder

Captive screw holders are utilised with the plug-in modules to ensure the highest level of safety when mounting or removing the module. The screw is placed in the holder, and the holder is ‘clicked’ into position which is secured by locating lugs.
The captive screw holders ensures that the screws remain with the module, during mounting and removal. The screw holders are utlised on the left and right hand side of the modules.

2.9.7 Slimline XR modules

The Slimline XR switch disconnector is a 600 mm wide enclosed energy distribution module suitable for NH or BS fuses. It is connected to the distribution bars directly via its internal main contact or using main contact extension module. Utilising the direct connection method it is possible to reduce the section depth of the assembly.

Form of separation is possible up to Form 4a, please refer to the relevant project documentation.

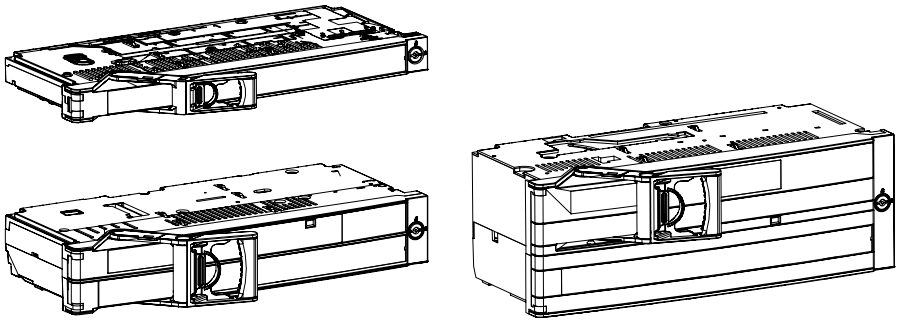


Figure 2-75 SlimLine XR Seiries

Removal of Slimline XR modules with connected load is not permitted, the load shall be isolated and disconnected prior to removal.

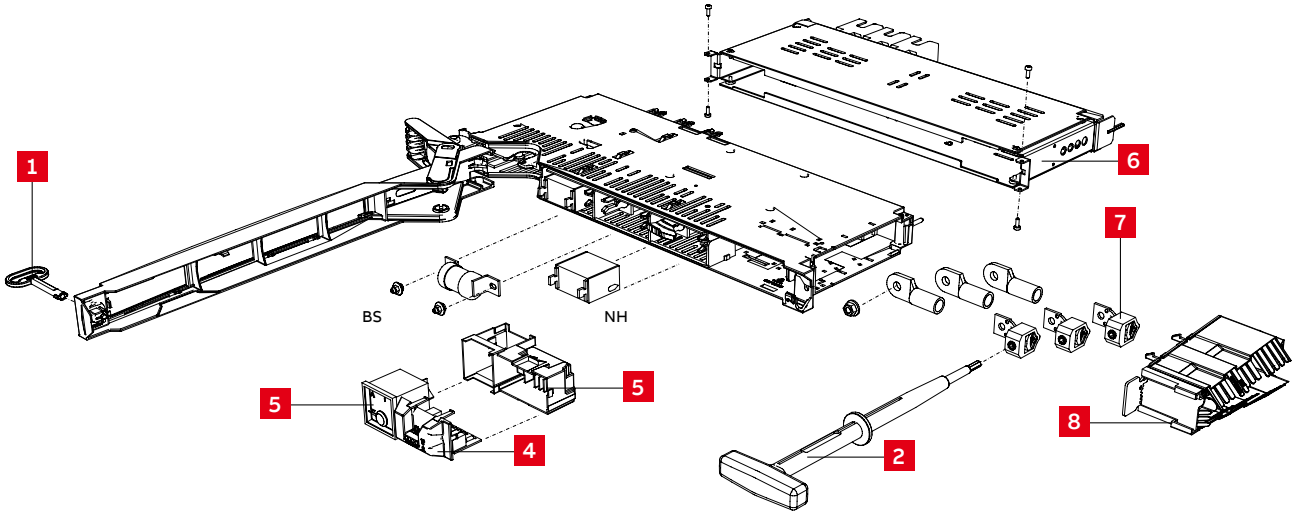


Figure 2-76 Exploded view and optinal accessories of XR00

No	Description	No	Description
1	Front cover key	5	Ameter bracket
2	Cable terminal key	6	Contact extension
3	Ameter	7	Cable clamp
4	Electronic fuse monitoring, EFM	8	Cable terminal shroud

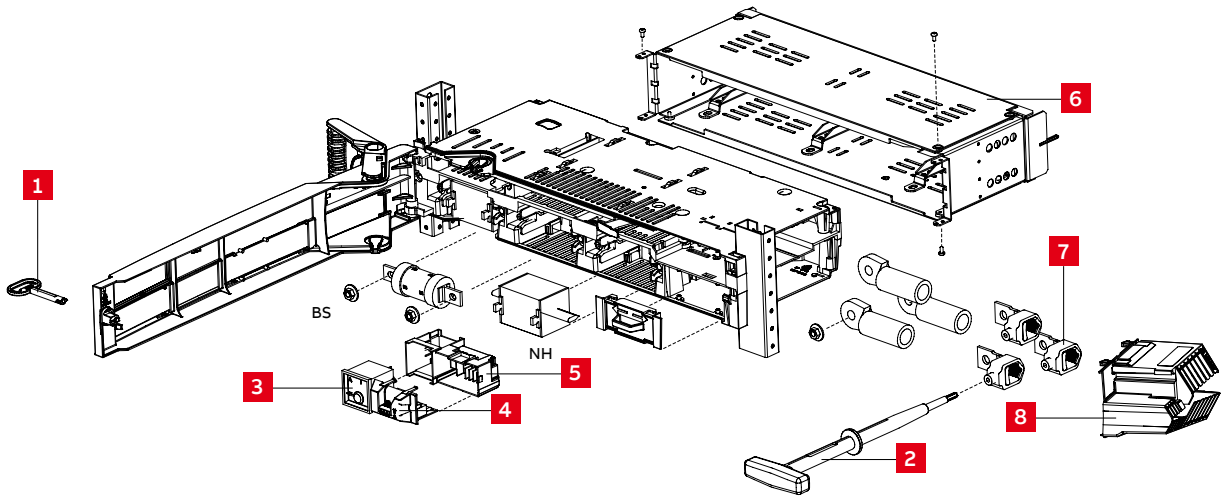


Figure 2-77 Exploded view and optinal accessories of XR1

No	Description	No	Description
1	Front cover key	5	Ammeter bracket
2	Cable terminal key	6	Contact extension
3	Ammeter	7	Cable clamp
4	Electronic fuse monitoring, EFM	8	Cable terminal shroud

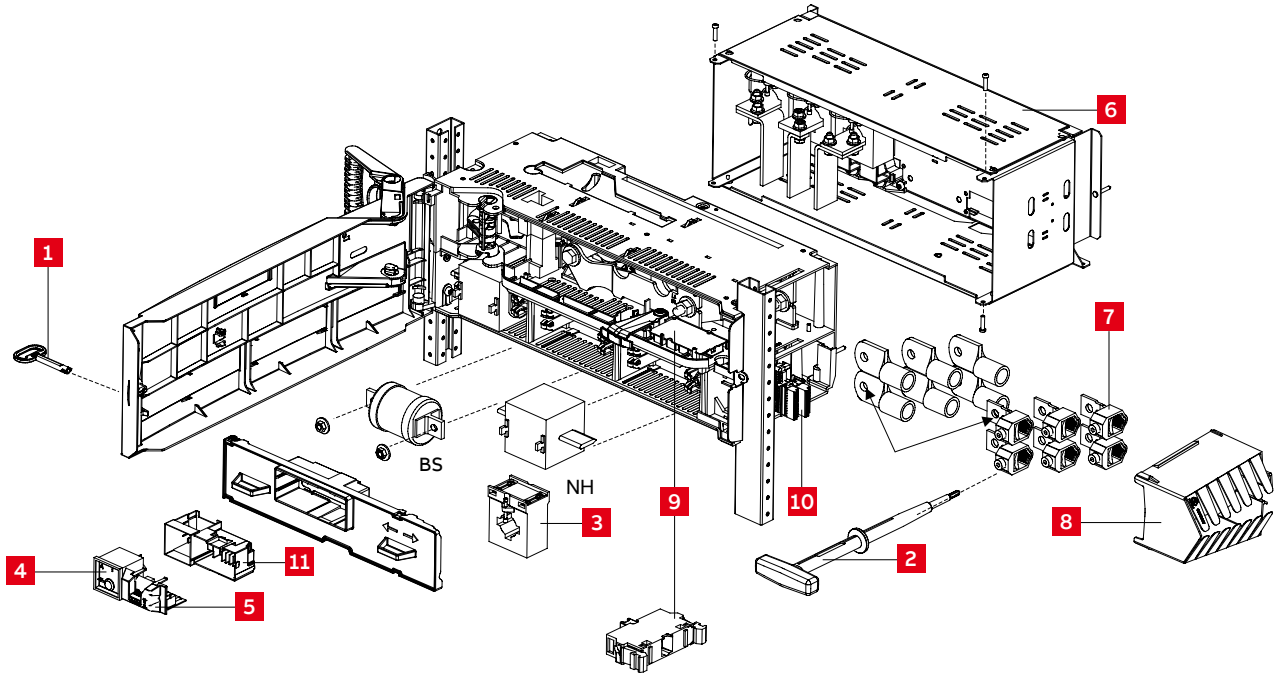


Figure 2-78 Exploded view and optinal accessories of XR2-3

No	Description	No	Description
1	Front cover key	7	Double cable clamp
2	Cable terminal key	8	Cable terminal shroud
3	Current transformer	9	Auxiliary switch
4	Ammeter	10	Multi plugs
5	Ammeter bracket	11	Ameter bracket
6	Contact extension		

2.9.8 Power Factor Compensation modules

The reactive power compensation modules are 600 mm wide modules connected to the distribution bars via the MNS main contacts. Multiple modules may be configured in a single section with a full sized door. Options exist for natural or forced ventilation and integration with MNS Digital, please refer to the relevant project documentation.

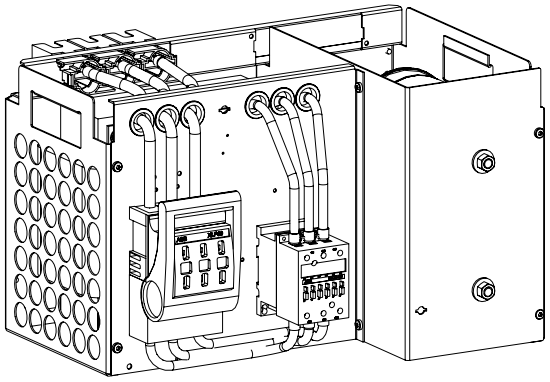


Figure 2-79 Reactive power compenstation module (RPC module)

2.9.9 Withdrawable modules in MNS

Withdrawable modules can be configured for energy distribution or motor starting applications with either fuses or moulded case breakers. Operation outside only via a single handle . Options are available for control and monitoring with MNS Digital integration.

Withdrawable modules can be inserted and withdrawn from the assembly without the use of tool. Connection to the distribution bars via the MFSW for the full size modules utilises the main contact. The small modules utilise the condaptor to enable 2 or 4 modules on single level within the assembly. The Withdrawable functionality consists of:

- the withdrawable module
- the frame-mounted module compartment

Standardized sizes are 8E/4, 8E/2, 4E, 6E, 8E, 12E, 16E, 20E and 24E (E = 25 mm).

One 600 mm wide equipment compartment can contain in one level:

- up to 4 small modules size 8E/4
- up to 2 small modules size 8E/2
- 1 widthdrawable module size 4E to 24 E

Empty space in the sections must be closed with front covers for the small modules and doors for the full width modules.

Withdrawable modules size 8E/4 and 8E/2

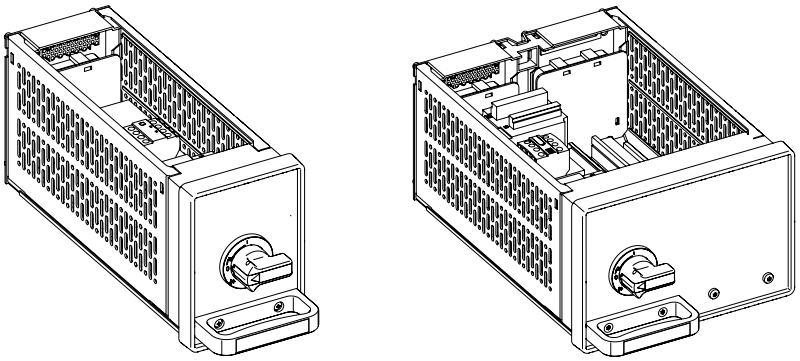


Figure 2-80 Examples of 8E/4 and 8E/2 modules

Withdrawable modules and compartments size 8E/4 and 8E/2 consists of:

- Compartment bottom plate
- Withdrawable module condapter
- Guide rails
- Front posts

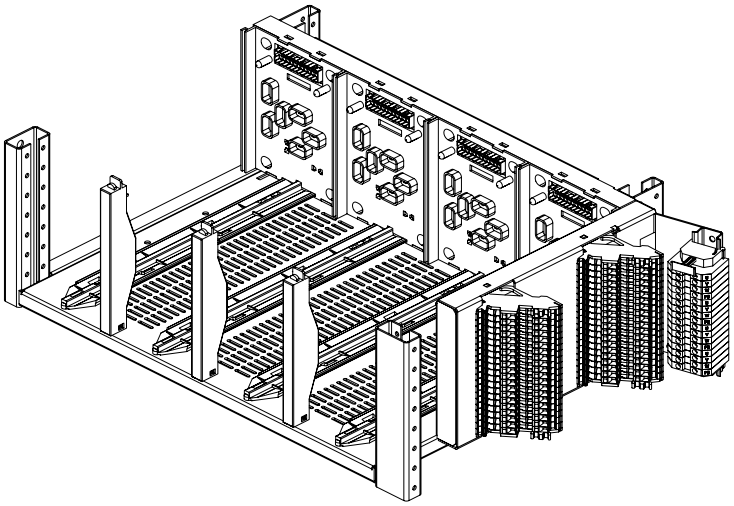


Figure 2-81 Withdrawable module compartment for 4 units size 8E/4

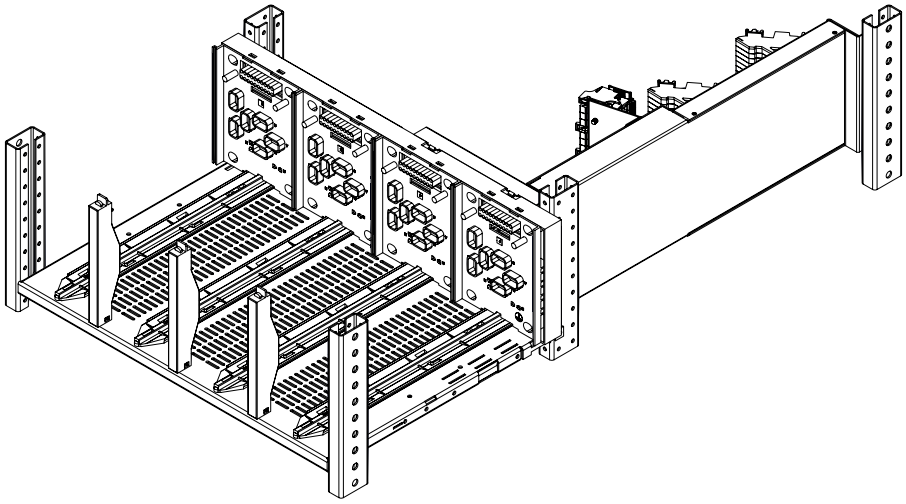


Figure 2-82 MNS Rear withdrawable module compartment for 4 units size 8E/4

The withdrawable module condapter is the connecting component between distribution bars and the withdrawable modules size 8E/2 and 8E/4.

The condapter consists of:
- Main contacts and conductor bars for the incoming feeder connection of the withdrawable modules.
- Outgoing contacts with connection to the power terminals (in the cable compartment).
- Power terminals including the PE terminals.
- Control terminals
  - 8E/4 module, one control plug 8, 16 or 20 pole
  - 8E/2 module, one control plug 16 or 20 pole
  - 8E/2 module, two control plugs 32 or 40 pole

Note: It is not allowed to mix 8E/4 and 8E/2 Modules on the same level

The front panel for withdrawable modules size 8E/4 and 8E/2 is fixed to the withdrawable modules and made of insulating material. It also serves as instrument panel for measuring, operating and indicating devices.

Withdrawable module size 4E - 24E

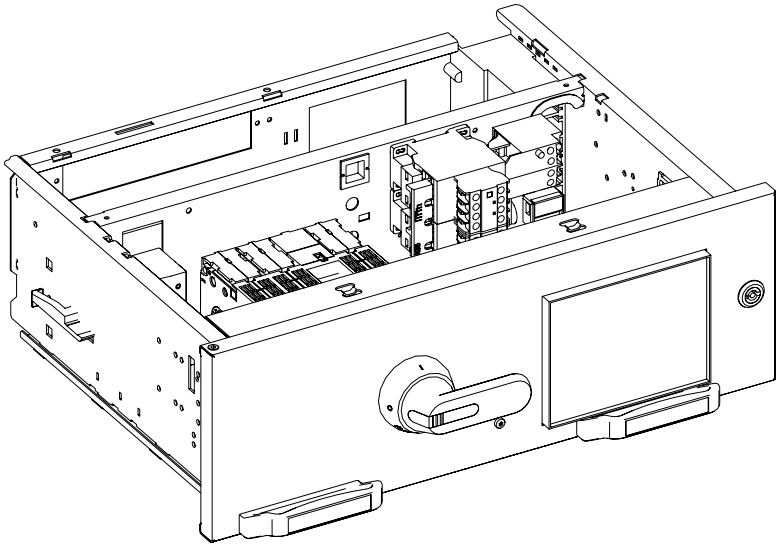


Figure 2-83 Examples of full withdrawable modules

Withdrawable module and compartments size 4E ... 24E

Withdrawable module compartments size 4E … 24E consist of:

- Compartment bottom plate with roller guide rails
- Sheet metal side wall with the outgoing control plug
  - for 4E size 10 or 20 pole
  - for 6E size 8, 10, 16, 20, 24 or 48 pole
  - for 8E to 24E size 8, 16, 20 or 32 pole
- Outgoing cable connection unit

Withdrawable module feeder connection to the distribution bar system is achieved directly via the power contact of the withdrawable module. Outgoing cables are connected via main power contact to the outgoing cable connection unit (main circuit) and via terminal blocks (auxiliary circuit). The outgoing cable connection units are fastened directly to the frame.

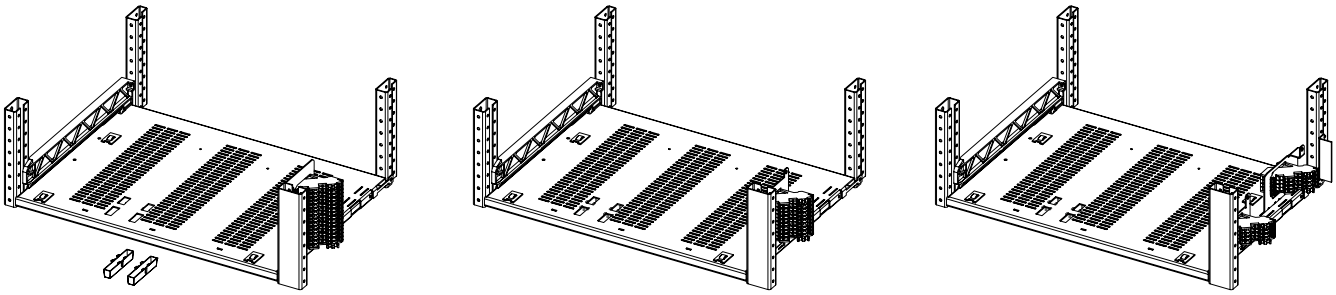


Figure 2-84 Withdrawable module compartment for units size 4E ... 24E

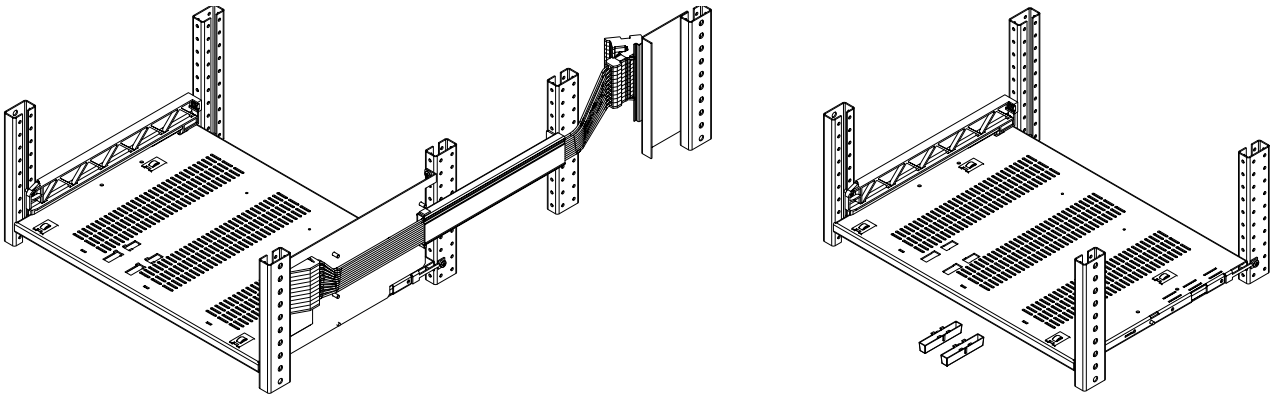


Figure 2-85 MNS Rear withdrawable module compartment for unit size 4E...24E (right), with control plug system (left)

03

Packing, storage and transportation

Packing, storage and transportation

3.1 General

MNS switchgear is shipped either in single section or in shipping units not exceeding 3 m in length depending on the type of equipment installed and on the space available for handling the switchgear at the erection site.

Maximum size of a shipping unit (length × width × height) in mm:
- Unpacked 3600 x 1500 x 2300
- Packed in crate 3700 x 1700 x 2590 (see also “3.1.1 Container shipment”)

The movable part of the ACB and MCCB of more than 1000A must be removed from the switchgear and transported separately from the section. It is not allowed to transport the movable part within the section. Fixed installed ACB’s are transported within the switchgear.
The ACB requires special attention during transport and handling. Please refer to the SACE Emax2 “Installation, operation and maintenance instruction manual for the installer and the user” manuals 1SDH000999R0002 and 1SDH001000R0002, Chapter 2: Transport and checking on receipt.

Remove all ACBs from sections and transport them separately!

Module type		Protection circuit	Type	Module size
Withdrawable modules	Motor starters	Fuse	TOL / EOL / UMC100 / M10X	8E4 up to 24E
		Circuit breaker	TOL / EOL / UMC100 / M10X	
	Energy distirbution	Fuse	Load breaker	8E4 up to 24E
			Contactor feeder	
		Circuit breaker	MMS / MCCB	
			Contactor feeder	
Plugin modules	Motor starters	Fuses	Soft starter	16E up to 36E
			VSD	
		Circuit breaker	VSD	
	Energy distribution	Fuse	SlimLine	2E up to 8E
		Circuit breaker	MMS / MCCB	6E up to 24E
			Contactor feeder	
	Reactive power compensation	Fuse	–	14E
Fixed modules	Motor starters	Fuse	TOL / EOL / UMC100 / M10X	8E up to 80E
			Soft starter	
			VSD	
		Circuit breaker	TOL / EOL / UMC100 / M10X	
	Energy distribution	Fuse	Load breaker	8E up to 28E
		Circuit breaker	MCCB	

Table 3-01 General overview of standard module solutions (customer specific solutions not mentioned)

If no special instructions are given by the customer, packing is carried out based on ABB shipping guidelines and a suitable method of shipping is selected. Approximate weights for calculation are listed in below tables.

All weights for incoming feeders configured as below:
- Section weights are defined based on IP30-IP40 internal protection with bottom plate
- Section weight for EQ400 / EQ600 contains 200 mm main busbar area
- Section weight for EQ800 contains 400 mm main busbar area
- Section weights are defined with all possible CTs (measuring and protection), REF relay and SPD
- Section weights do not contain internal devices (except CTs, REF, SPD) and wiring
- Section weights do not contain side walls and main busbar end covers

All weights for couplers configured as below:
- Coupler weights do not contain internal devices (except CTs and REF) and wiring
- Coupler weights do not contain side walls and main busbar end cover
- The type of coupler with CTs utilizes different angle set (with more copper) to create place for CTs. If you use coupler without CTs, the overall weight might be significantly lower.

Approximate weight of one front access section without ACB

Type of section	Type of ACB	Section width [mm]	Weight of ACB [kg]	Standard (EQ400,EQ600)	High current (EQ800)
Incoming feeder, 3 pole	E1.2 – upto 1600 A	400	20	250	–
Incoming feeder, 3 pole	E2.2 – upto 2000 A	400	53	300	–
Incoming feeder, 3 pole	E2.2 – upto 2500 A	600	53	350	–
Incoming feeder, 3 pole	E4.2 – upto 2500 A	800	67	400	700
Incoming feeder, 3 pole	E4.2 – upto 4000 A	800	67	500	700
Incoming feeder, 3 pole	E6.2 – upto 6300 A	1000 – 1200	129	750	1000
Coupler, 3 pole	E1.2 – upto 1600 A	400	20	250	–
Coupler, 3 pole	E2.2 – upto 2500 A	600	53	350	–
Coupler, 3 pole	E4.2 – upto 4000 A	800	67	500	700
Coupler, 3 pole	E6.2 – upto 6300 A	1200	129	750	1000
Incoming feeder, 4 pole	E1.2 – upto 1600 A	600	23	300	–
Incoming feeder, 4 pole	E2.2 – upto 2000 A	600	60	350	–
Incoming feeder, 4 pole	E2.2 – upto 2500 A	800	60	400	–
Incoming feeder, 4 pole	E4.2 – upto 2500 A	1000	81	500	800
Incoming feeder, 4 pole	E4.2 – upto 4000 A	1000	81	600	800
Incoming feeder, 4 pole	E6.2 – upto 6300 A	1200	143	900	1200
Coupler, 4 pole	E1.2 – upto 1600 A	600	23	300	–
Coupler, 4 pole	E2.2 – upto 2500 A	800	60	500	–
Coupler, 4 pole	E4.2 – upto 4000 A	1000	81	600	800
Coupler, 4 pole	E6.2 – upto 6300 A	1200	143	900	1200
Empty module section	–	1000	–	300	–

Table 3-02 Approximate weights per 3 and 4 pole ACB sections (incomming feeders and couplers)

All weights for MNS Rear ACB sections configured as below:
- Section weights are defined based on IP30-IP40 protection with bottom plate
- Section weights for main busbar compartment of depth 600 mm
- Section weights for main busbar compartment of depth 800 mm and height 250 mm
- Section weights for main busbar compartment of depth 800 mm and height 450mm
- Section weights are defined with 4 measuring CTs + 3 protective CTs for single ACB section, 3 measuring CTs for each ACB unit in stacked section. If the CT quantity is fewer, the overall weight might be lower
- Section weights for incomer / feeder are defined with IO set for busway from top. For IO set with cable, the overall weight might be lower
- Section weights for stacked section are defined with IO set for cable connection
- Section weights do not contain internal devices (except CTs) and wiring
- Section weights do not contain side walls and main busbar end covers
- For combined ACB and withdrawable modules section, section weight does not contain modules.

Approximate weight of one MNS Rear section

Type of section	Type of ACB	Section width [mm]	Weight of ACB see table 3-02	Section with ACB fixed part [kg]		
				main busbar compartment of depth 600mm	main busbar compartment of depth 800mm and height 250mm	main busbar compartment of depth 800mm and height 450mm
Incomer / feeder, 3 pole	E1.2 – up to 1600 A	400	–	315	330	370
Incomer / feeder, 3 pole	E1.2 – up to 1600 A	600	–	355	385	435
Incomer / feeder, 3 pole	E2.2 – up to 2000 A	400	–	325	350	390

Approximate weight of one MNS Rear section

Type of section	Type of ACB	Section width [mm]	Weight of ACB see table 3-02	Section with ACB fixed part [kg]		
				main busbar compartment of depth 600mm	main busbar compartment of depth 800mm and height 250mm	main busbar compartment of depth 800mm and height 450mm
Incomer / feeder, 3 pole	E2.2 – up to 2500 A	600	–	445	475	530
Incomer / feeder, 3 pole	E4.2 – up to 3200 A	600	–	535	570	630
Incomer / feeder, 3 pole	E4.2 – up to 4000 A	800	–	795	800	875
Incomer / feeder, 3 pole	E6.2 – up to 4000 A	1000	–	815	845	965
Incomer / feeder, 3 pole	E6.2 – up to 5000 A	1000	–	–	1025	1125
Incomer / feeder, 3 pole	E6.2 – up to 6300 A	1200	–	–	–	1380
Coupler, 3 pole	E1.2 – up to 1600 A	600	–	360	–	–
Coupler, 3 pole	E2.2 – up to 2500 A	600	–	460	–	–
Coupler, 3 pole	E4.2 – up to 3200 A	800	–	610	640	–
Coupler, 3 pole	E4.2 – up to 4000 A	1000	–	970	960	1035
Coupler, 3 pole	E6.2 – up to 4000 A	1200	–	965	1005	1105
Coupler, 3 pole	E6.2 – up to 5000 A	1200	–	–	1200	1295
Coupler, 3 pole	E6.2 – up to 6300 A	1200	–	–	–	1510
Incomer / feeder, 4 pole	E1.2 – up to 1600 A	600	–	405	465	510
Incomer / feeder, 4 pole	E2.2 – up to 2500 A	600	–	510	610	655
Incomer / feeder, 4 pole	E4.2 – up to 3200 A	800	–	660	705	755
Incomer / feeder, 4 pole	E4.2 – up to 4000 A	1000	–	1030	1035	1100
Incomer / feeder, 4 pole	E6.2 – up to 4000 A	1200	–	935	995	1080
Incomer / feeder, 4 pole	E6.2 – up to 5000 A	1200	–	–	1245	1320
Incomer / feeder, 4 pole	E6.2 – up to 6300 A	1200	–	–	–	1580
Coupler, 4 pole	E1.2 – up to 1600 A	600	–	410	–	–
Coupler, 4 pole	E2.2 – up to 2500 A	600	–	535	–	–
Coupler, 4 pole	E4.2 – up to 3200 A	800	–	705	765	–
Coupler, 4 pole	E4.2 – up to 4000 A	1000	–	1170	1180	1280
Coupler, 4 pole	E6.2 – up to 4000 A	1200	–	1125	1185	1265
Coupler, 4 pole	E6.2 – up to 5000 A	1200	–	–	1460	1580
Coupler, 4 pole	E6.2 – up to 6300 A	1200	–	–	–	1885
Double stacked ACB, 3 pole	E1.2 – up to 1600 A	600	–	530	580	595
Double stacked ACB, 3 pole	E2.2 – up to 2000 A	600	–	580	630	645
Double stacked ACB, 3 pole	E2.2 – up to 2500 A	800	–	730	790	815
Double stacked ACB, 3 pole	E4.2 – up to 4000 A	800	–	–	885	920
Triple stacked ACB, 3 pole	E1.2 – up to 1250 A	600	–	585	630	645
Triple stacked ACB, 3 pole	E2.2 – up to 1250 A	600	–	625	665	680
Triple stacked ACB, 3 pole	E1.2 – up to 1600 A	600	–	–	715	735
Triple stacked ACB, 3 pole	E2.2 – up to 1600 A	600	–	–	760	780
Combined ACB and withdrawable modules, 3 pole	E1.2 – up to 1600 A	600	–	430	465	490
Combined ACB and withdrawable modules, 3 pole	E2.2 – up to 2000 A	600	–	450	485	510
Double stacked ACB, 4 pole	E1.2 – up to 1600 A	800	–	635	710	770
Double stacked ACB, 4 pole	E2.2 – up to 2500 A	800	–	790	860	925
Double stacked ACB, 4 pole	E4.2 – up to 4000 A	1000	–	–	1060	1155
Triple stacked ACB, 4 pole	E1.2 – up to 1250 A	800	–	700	755	815
Triple stacked ACB, 4 pole	E2.2 – up to 1250 A	800	–	750	805	865
Triple stacked ACB, 4 pole	E1.2 – up to 1600 A	800	–	–	865	930
Triple stacked ACB, 4 pole	E2.2 – up to 1600 A	800	–	–	925	990
Combined ACB and withdrawable modules, 4 pole	E1.2 – up to 1600 A	800	–	520	575	645
Combined ACB and withdrawable modules, 4 pole	E2.2 – up to 2000 A	800	–	545	600	675
Empty withdrawable module section, 3 pole	–	600	–	310	315	320
Empty withdrawable module section, 4 pole	–	600	–	340	350	390
Empty fixed module section, 3 pole	–	600	–	330	360	–
Empty fixed module section, 4 pole	–	600	–	350	385	–

Table 3-03 Approximate weights per 3 or 4 pole MNS Rear ACB sections

Approximate weight of module acc. size		
Module type	**Module size**	Approximate weight [kg]
Withdrawable modules	8E / 4	4
	8E / 2	7
	4E	8
	6E	14
	8E	18
	12E	25
	16E	35
	24E	65
Plugin modules	6E	8
	8E	15
	12E	16
	16E	31
	24E	36
Fixed modules	6E	18
	8E	18
	12E	26
	16E	35

Table 3-04 Approximate weights of modules per size (customer specific solutions not mentioned)

Module size and weight highly depends on customer requirements and specification.
Above mentioned values are only informative should detailed clarification be required please contact your local ABB representative.

For easy and safe operation, withdrawable modules above or equal 12E are equipped with additional side handles.

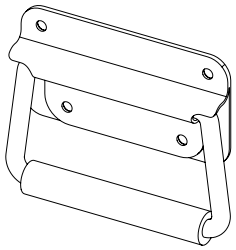


Figure 3-01 Module side handle

3.1.1 Container shipment

If container shipment transport is needed, consider the final packed dimension based on height of the HIGH CUBE CONTAINER internal dimension.

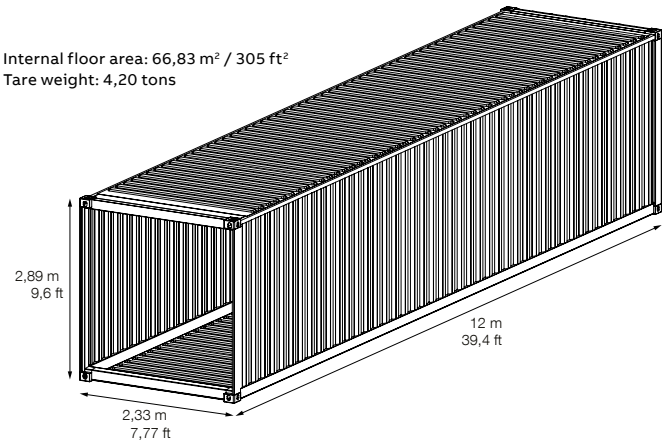


Figure 3-02 Inner dimensions of 40' high cube container

3.2 Recommended packing methods

The sections are protected by suitable packaging during transport and possible intermediate storage.

3.2.1 The packing for normal road transport

Transport frame consisting of:

- standardized or euro pallet
- plastic strips
- plastic film
- edge protection

The section are to be placed on standardized pallet. The sections are to be wrapped by plastic film and fixed with the cuplastic strips to the pallets. Edges of transport section are protected by standardized edge protection.

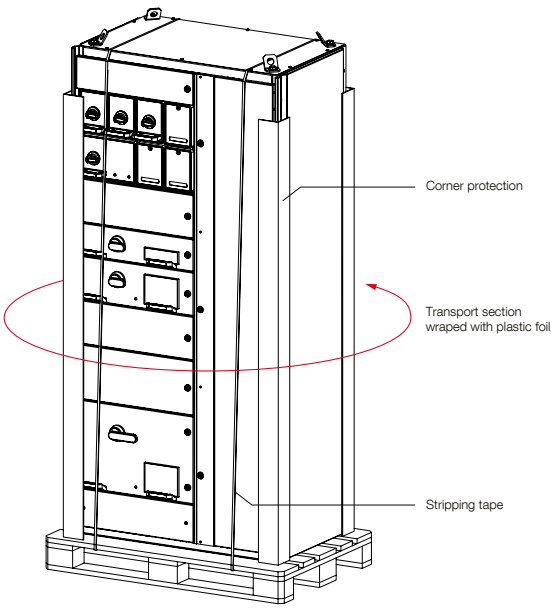


Figure 3-03 Packing for normal road transport

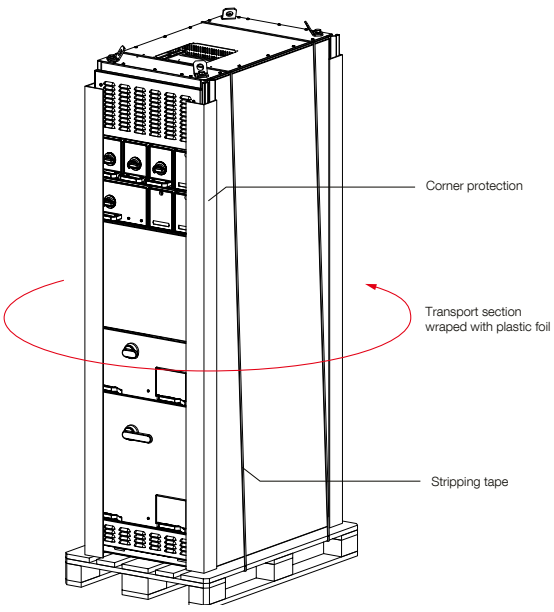


Figure 3-04 Packing for MNS Rear switchgear

Standardized pallets are suitable for handling by forklit trucks. To protect them against moisture, the switchgear sections shall be encased in a foil. A protective drying agent (such as silicagel) shall be provided between the foil and the switchgear. This shall last for 12 or 24 months.

3.2.2 The seaworthy packing

The export/seaworthy packaging (for sea transport and truck or train transport outside continental Europe) comprises:

1. Bottom
- Wooden beams (100 × 100 mm), bottom panel – boards (thickness 40 mm)
- Box packing length up to 800 mm – 2 × wooden beams
- Box packing length up to 1700 mm – 3 × wooden beams
- Box packing length up to 2500 mm – 4 × wooden beams
- Box packing length up to 3300 mm – 5 × wooden beams
- Box packing length up to 3800 mm – 6 × wooden beams

2. Side walls
- Support beams 23 × 100 mm
- Side wall panels OSB 3 (thickness 12 mm)

3. Top
- Support beams 23 × 100 mm
- Top wall panel OSB 3 (thickness 12 mm)
- “Kartonplast” between Support beams and top wall panel

4. Additions
- Inner AL foil with drying agent

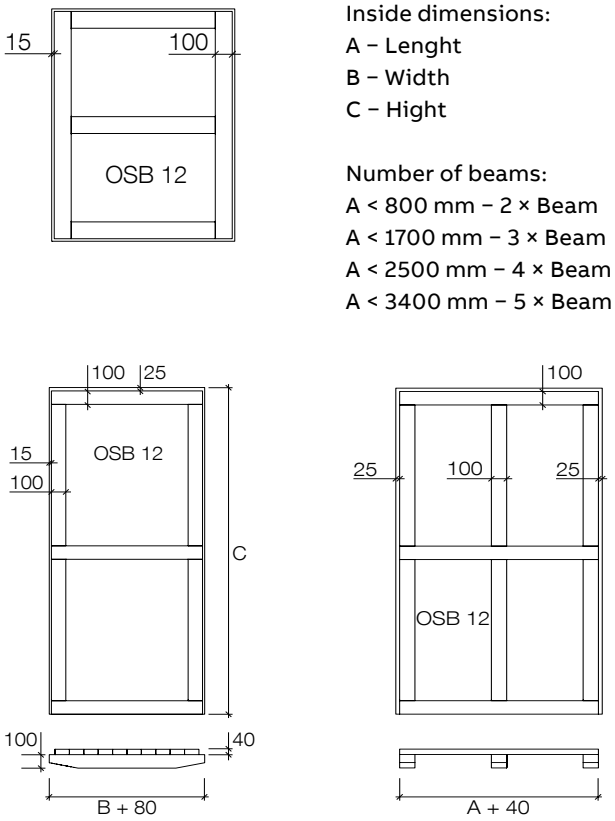
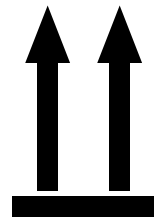
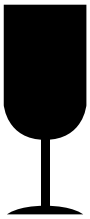


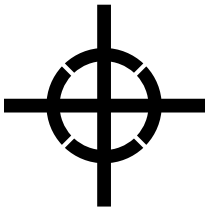
Figure 3-05 Wooden parts dimensions



Do not incline

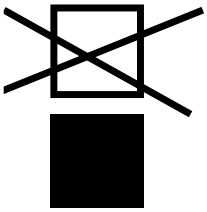


Fragile

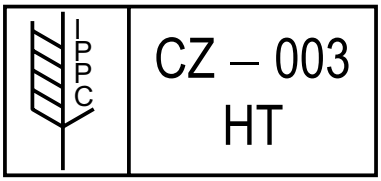


Gravity center

Marking for ropes



Do not stack

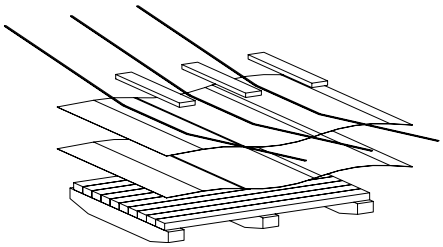


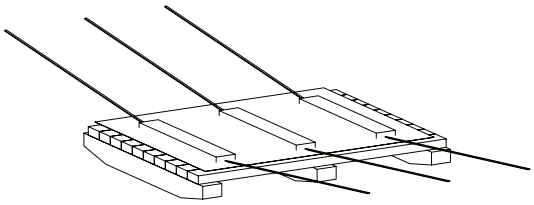
HT IPPC

Figure 3-06 Transport marking

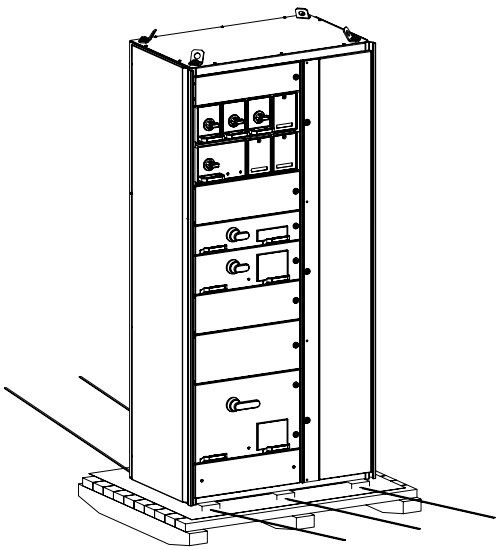
All sawn wood shall be thermal treated according ISPM 15 standard.

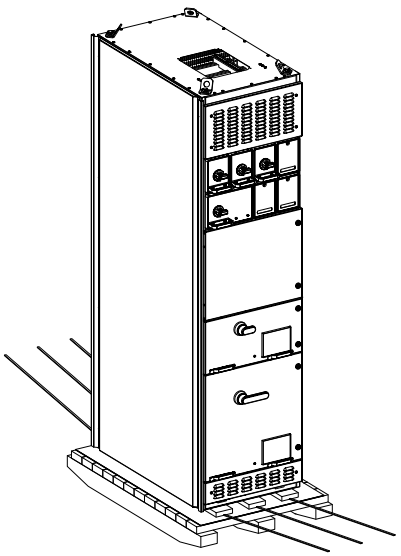
1. On the base a 2 mm miralon layer is placed and aluminium foil on top of it. Wooden boards and strips are placed on top of this AL foil.





2. Switchgear shipping section is placed on those wooden boards. For MNS Rear switchgear (right).





3. Overhanging parts and sharp edges are covered by miralon to protect additional packing.

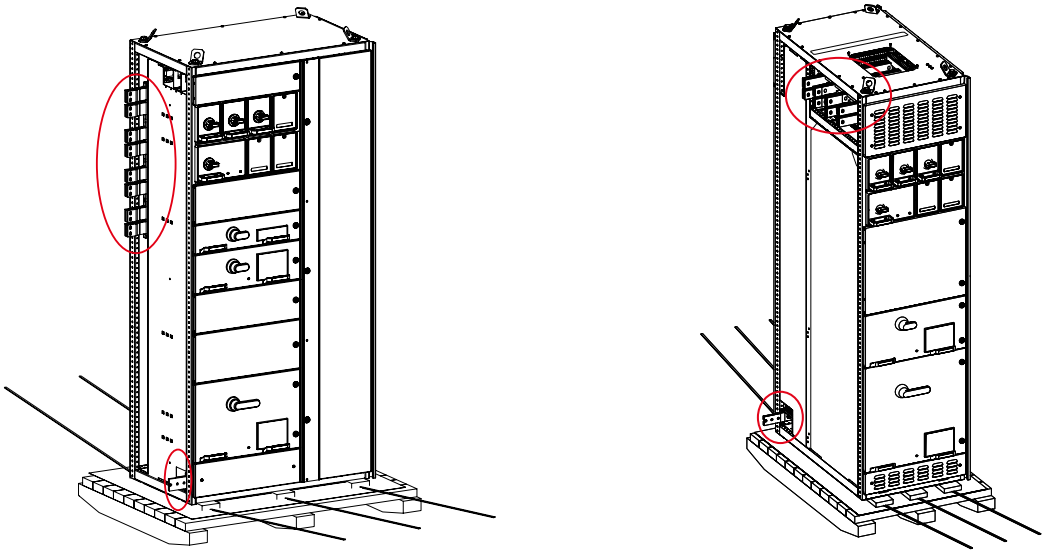
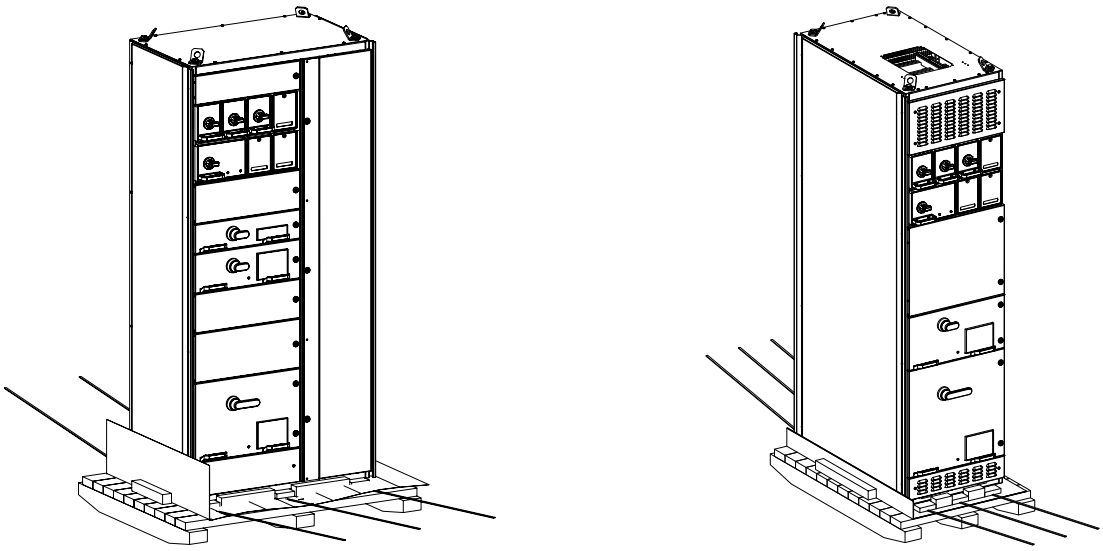


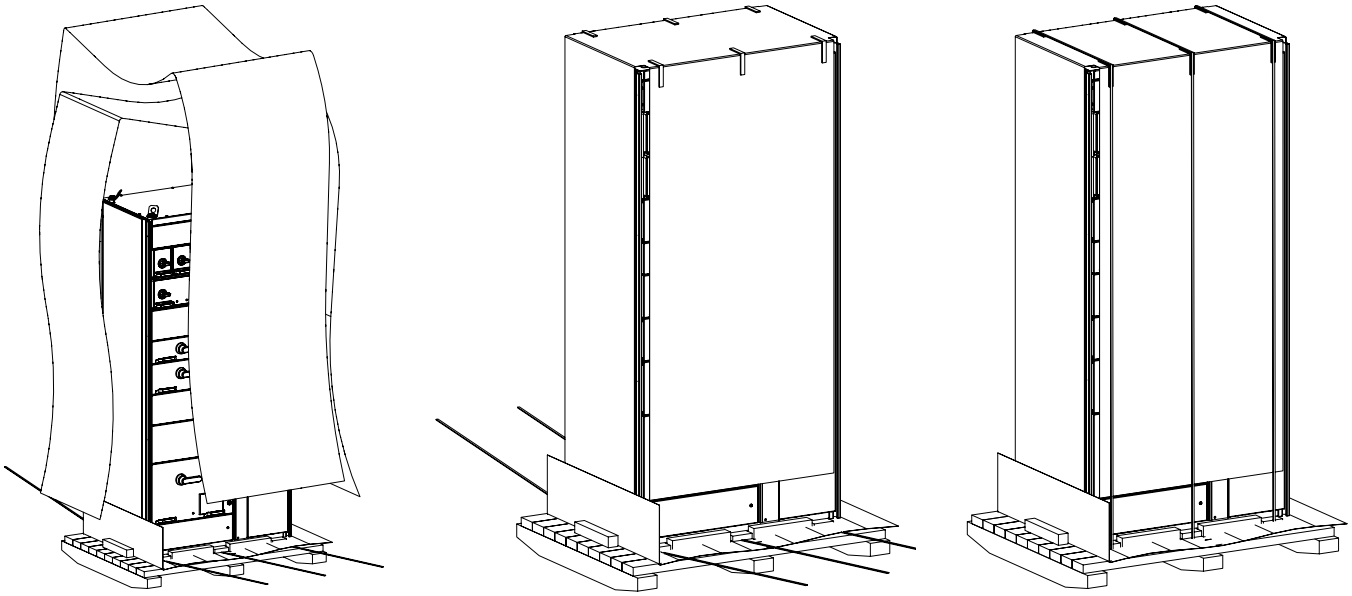
Figure 3-07 Seaworthy packing procedure, steps 1, 2 & 3 (left), for MNS Rear switchgear (right)

4. Unit is secured by placing wooden beams 5 × 5 cm right around the unit and secured to bottom platform against shifting. For MNS Rear switchgear (right).



When two shipping sections placed back to back into one wooden box fiber board 3,5 mm shall be used in between sections.

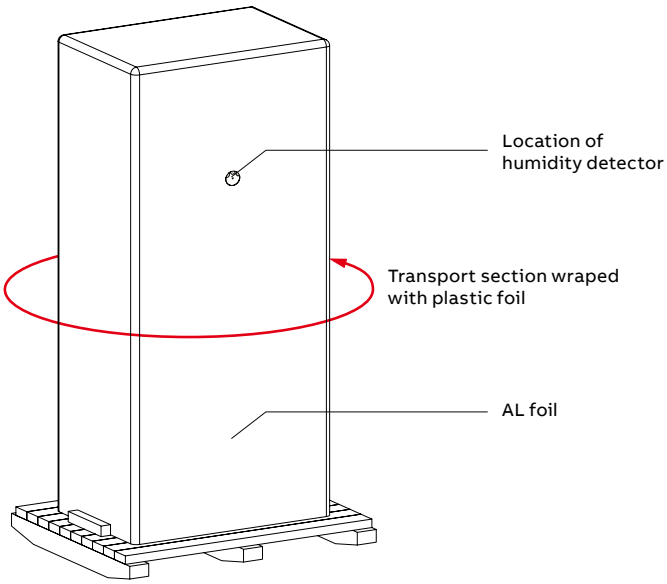
5. Miralon 2 mm is placed all over the shipping section and is stripped by tape. The tape is supported by plastic edge protection.



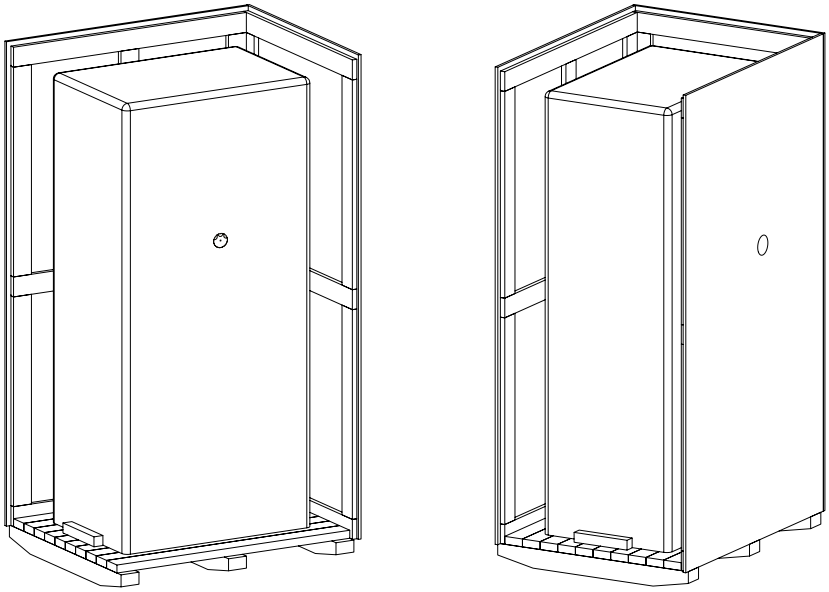
A drying agent is required for seaworthy packing. A single packet 32 DIN is required per 3 m^2 box.

Figure 3-08 Seaworthy packing procedure, steps 4 & 5

6. The shipping section is sealed in AL foil and the air is extracted. The unit is then wrapped by plastic film to strengthen the wrap.



7. Wooden box assembly and execution of aperture for humidity detector verification.



8. Shipping unit preparation from the top by wooden beams 5 × 5 cm against movement.

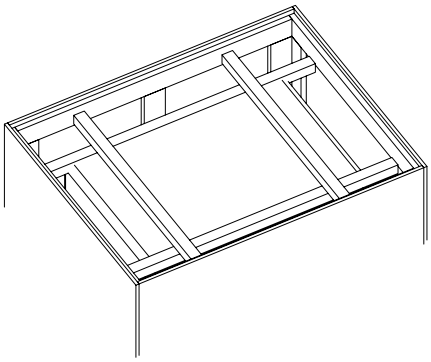
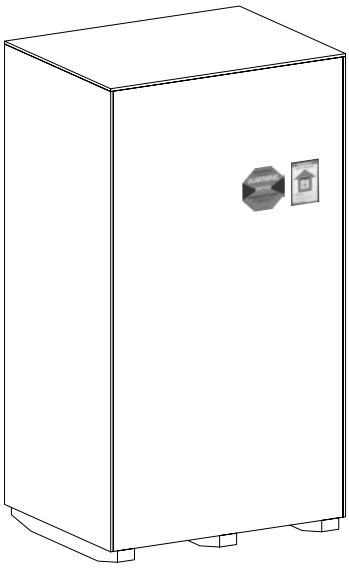


Figure 3-09 Seaworthy packing procedure, steps 6, 7 & 8

9. Location of crash and turnover protection (shockwatch label and tilt watch)



10. PE foil UV resistant shall be utilised on the top of the packing

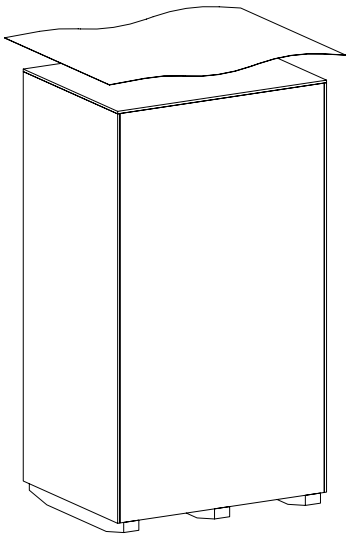


Figure 3-10 Seaworthy packing procedure, steps 9 & 10

The switchgear shall be wrapped with foil after upholstering sharp edges and corners. The joints of the foil shall be sealed.

A protective drying agent according DIN 55474 shall be utilised between the foil and the switchgear. No direct contact of this protective drying agent with the switchgear is allowed.

Only remove the packaging after delivery of the switchgear to site.
Only remove the transport frames from the section bases at the place of erection.

3.2.3 Horizontal transportation

In situations where that the structural conditions on site, e.g. height of door frame < 2200 mm, does enable the MNS sections to enter the e-room in standing (vertical) position, all individual sections may be transported horizontally.

As the vertical profiles do not support the complete weight of the section in the horizontal position, a reinforcement on the frame structure necessary. Therefore, following points are mandatory.

- Maximum width of section transport section is 1400 mm and the maximum weight of 800 kg shall not been exceeded. See also Table 3-02.
- Heavy weight devices shall be disassembled, as the weight-loading is not foreseen for horizontal transportation.
- Withdrawable breaker (Sace Emax) shall be transported in separate boxes.
- Also withdrawable modules shall be withdrawn and transported separately.
- See also in chapter ”3.2.4 Packaging of switchgear components”
- As the sections will be moved “from horizontal to vertical position” on site manually, special safety measures has to be taken to have less weight as possible.
- To avoid the deformation of vertical MNS profiles as well also the door hinge, a provisory transportation brace shall be mounted before the section is moved to the horizontal position.
- For horizontal transportation a longer euro pallet is required with 2.1 m length.
- All wires and cables for interconnections, between different transport sections, shall be fixed accordingly to avoid damages on cabling or enclosures.
- After the erection of the sections on site, all doors has to checked on their functionality and adjusted.

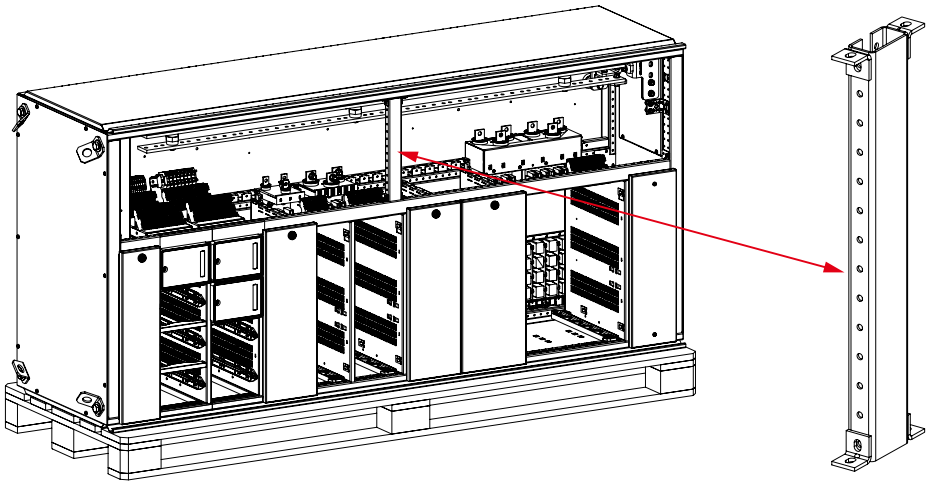


Figure 3-11 Reinforcement for horizontal transport

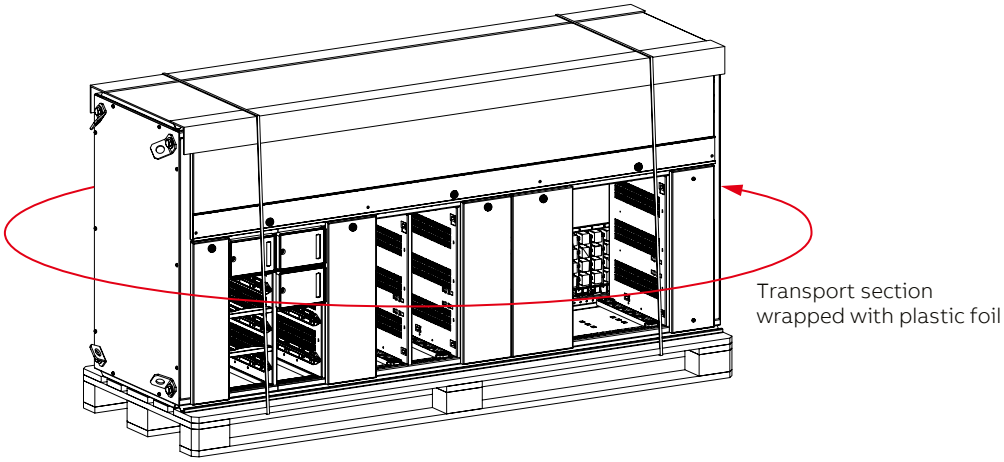


Figure 3-12 Example of horizontal transport

Horizontal transportation is not suitable for MNS Rear switchgear.

3.2.4 Packaging of switchgear components

The following devices and materials have to be delivered separately packed with the switchgear independent from the kind of transport:

- withdrawable air circuit breakers,
- withdrawable moulded case circuit breakers with a nominal current of more than 1000 A,
- transformers and reactors with a weight of more than 25 kg, in the case of floor mounted units of more than 100 kg,
- precision instruments of high value for measuring and indication,
- fluorescent tubes,
- modules with single phase control power transformers of more than 2 kg,
- spare withdrawable and P-/R-modules,
- top stripe holders,
- withdrawable modules with weight ≥ 30 kg,
- raised roof plates incl. mounting angles.

If possible the original packaging material of the manufacturer should be reused for packaging.

Modules as spare parts or as supplementary parts for the switchgear shall be marked with the necessary technical data for the use (module location, type, order number). The fuses remain in the modules. Information concerning the procurement of standard boxes can be obtained from the ABB shipping department.

The quality of the internal packaging depends on the type of goods to be packaged and shall be selected by the ABB shipping department.

Materials to be used:
Padding (chips made of expanded polystyrene), corrugated cardboard, foil, expanded polystyrene board, cardboards.

Any special shipping requirements of the switchgear shipment shall be specified in the ordering phase.

3.3 Handling of switchgear components

3.3.1 Circuit breaker

Circuit breaker shall be handled in the following way:

- Fixed circuit breaker shall be braced additionally.
- All withdrawable air circuit breakers and withdrawable moulded case circuit breaker with a weight ≥40 kg shall be removed and packed separately.
- Heavy busbar constructions have to be supported during transport in an adequate way. It is necessary to attach a caution label demanding the removal of the used transport fixing material during switchgear erection.

If possible the original packaging material should be reused for packing the circuit breaker.

The bracing shall be removed prior to commissioning.

Separately shipped circuit breakers are to be mounted in accordance with the mounting instructions enclosed.

3.3.2 Withdrawable modules

Withdrawable modules have to be secured for shipping by their own mechanical interlock operated by the switch handle (ON, OFF or TEST position). In addition, the withdrawable modules may be secured by a latch-type lock which works independently from the mechanical interlock and which may be operated by 5 mm double bit key or a cylinder type safety key.

Modules shall be secured with handles in the “OFF“ position.
Necessary switch positions prior to commissioning: Module handle must be in position “OFF”.

3.4 Unloading and transport at site

The loads must be lowered onto a flat surface by either a crane or fork lift truck.

3.4.1 Ground transport

- By fork-lift truck (see Figure 3-13).
- By lifting and conveying devices.
- In an emergency, with rollers (min. 3 pieces). For roller transport the wooden cross-beams must be removed (only for sections with transverse sections up to 1200 kg, see Figure 3-14).
- Switchgear sections could be transported in the vertical or horizontal position (see also chapeter 3.2.3)
- Tilting and canting must be avoided (see Figure 3-15).
- Single sections (sections without withdrawable modules, circuit breaker sections without circuit breakers) may be briefly tilted into the horizontal position if the height of the doorway to the place of erection does not permit vertical transport. In this case the section sections must be supported over a wide area.

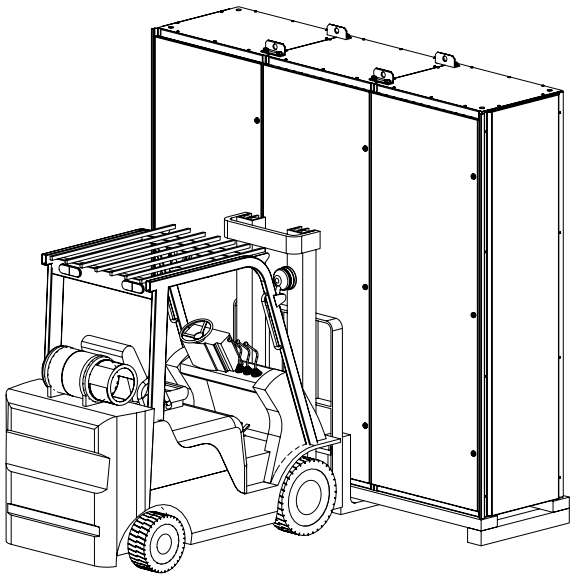


Figure 3-13 Fork-lift transport

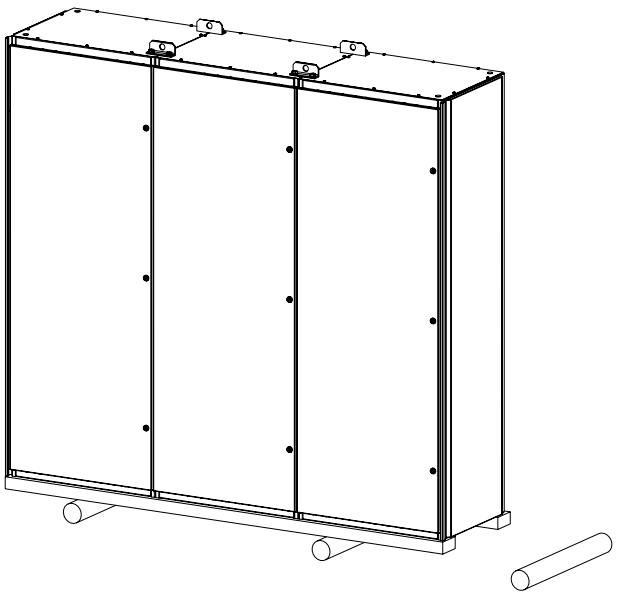


Figure 3-14 Roller transport (only for weight of transport units up to 1200 kg)

Sections may easily tip over when transported with a hand-pulled truck. Therefore the distance between the wooden cross beam or the pallet and the ground should not be more than 3 mm (see Figure 3-15).

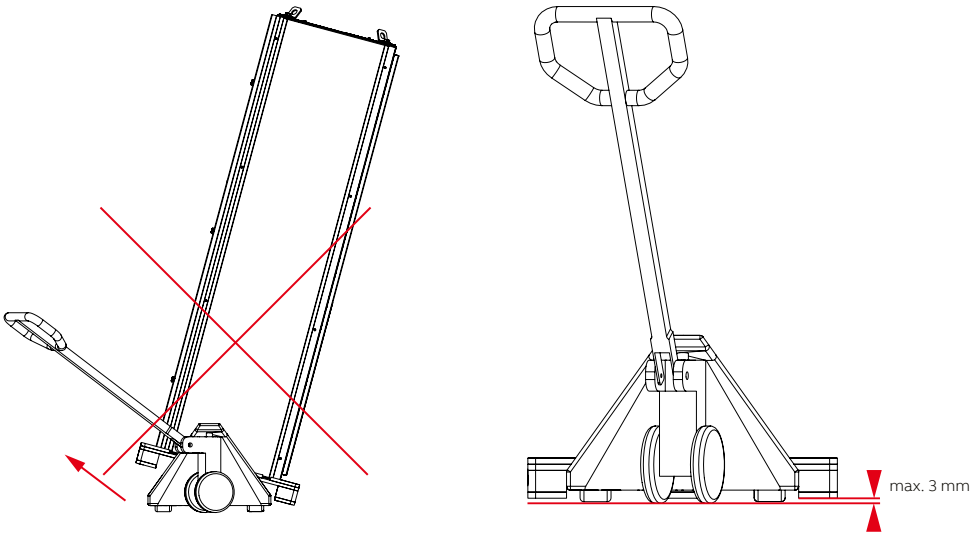


Figure 3-15 Transport with a hand-pulled truck

When using motor operated lifting truck or hand-pulled truck always check the position of gravity center mark. Note, marking of transport section with gravity center is always requried for seaworthy transport, otherwise the marking is optional.

3.4.2 Transport by crane

All lifting operations involving lifting equipment must be properly planned by a competent person; appropriately supervised; and carried out in a safe manner.
Cranes and lifting accessories such as slings must be of adequate strength, tested and subject to the required examinations and inspections.
All crane operators, and people involved in lifting loads and directing lifting operations, must be trained and competent.

- Accessories of switchgears like top stripe holder (see Figure 2-17), pressure relieve flaps (see Figure 4-12) or raised roof plates (see views in chapter 4.16.1) of switchgears with IP31 to IP43, must be disassembled for lifting transportation, otherwise lifting fittings would be in collision with listed components. In addition, for transportation with L-profile all types of flat roofs (IP30, IP40 and IP54) must be removed as well.
- For the transport by crane the shipping units are equipped with single, double lifting angles (see Figure 3-17 and 3-18) or customized lifting L-profiles (see Figure 3-19) to allow usage of four legs sling.
- Fastening of any lifting device directly to the frame sections is not permitted.
- Selection of right four leg sling with legs construction of hemp ropes, polyamide ropes, steel wire ropes, chains shall be decided by trained and competent lifting operator.
- Lifting capability of four legs sling at legs angle at crane hook “α” (angle depend of length of sling leg, lifting angle distance, shipping unit width – see Figure 3-16) must be equal or bigger than mass of transported shipping unit.
- The sling legs angle at the crane hook “α” must not be larger than 120° (see Figure 3-16).
- Ensure safety of personnel during crane transportation.
- Ensure even balance of the load. Attachment points shall be distributed in same plan around and above the center of gravity, load distribution per leg shall be equal. In case not symmetrical construction (see Figure 3-17 and 3-18) maximum outer section width is 800mm and weight of such section shall be lower than 20% of the mass of whole shipping unit.
- Control rotation of load.
- Avoid any shock loading.
- The lifting angles may be removed after the switchgear has been erected.
- The lifting L- profile shall be removed after the switchgear has been erected due to interference with roof accessories (top stripe holder).
- The fastening holes for the lifting angles are to be closed with plugs if removing the lifting angles to maintain IP level of the switchgear (see "4.13 Fastening of shipping sections").

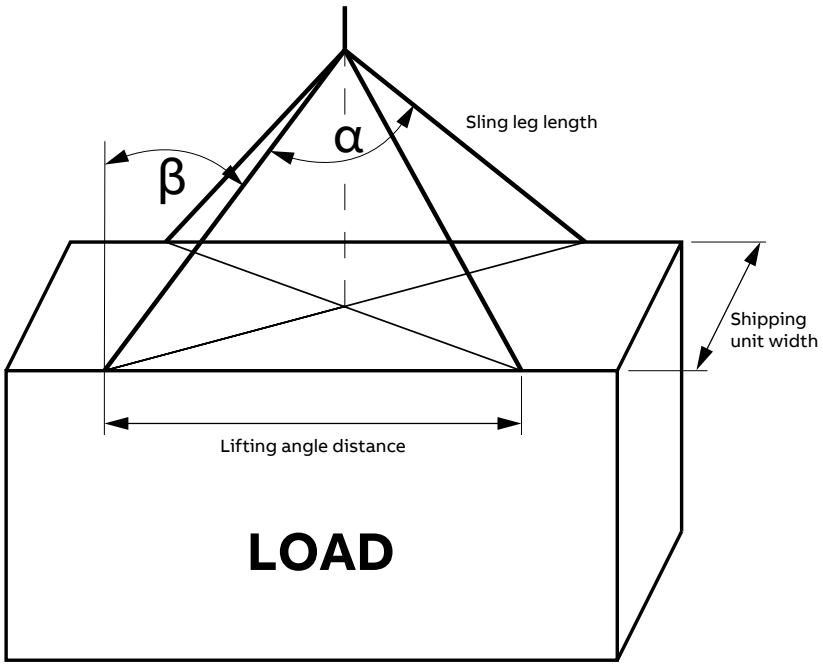


Figure 3-16 Four legs sling arrangement and legs angle at crane hook definition

Shipping units arranged of up to three connected sections, length up to 2,8 m and mass up to 3000 kg shall be raised by means of single lifting angles according to Figure 3-17.

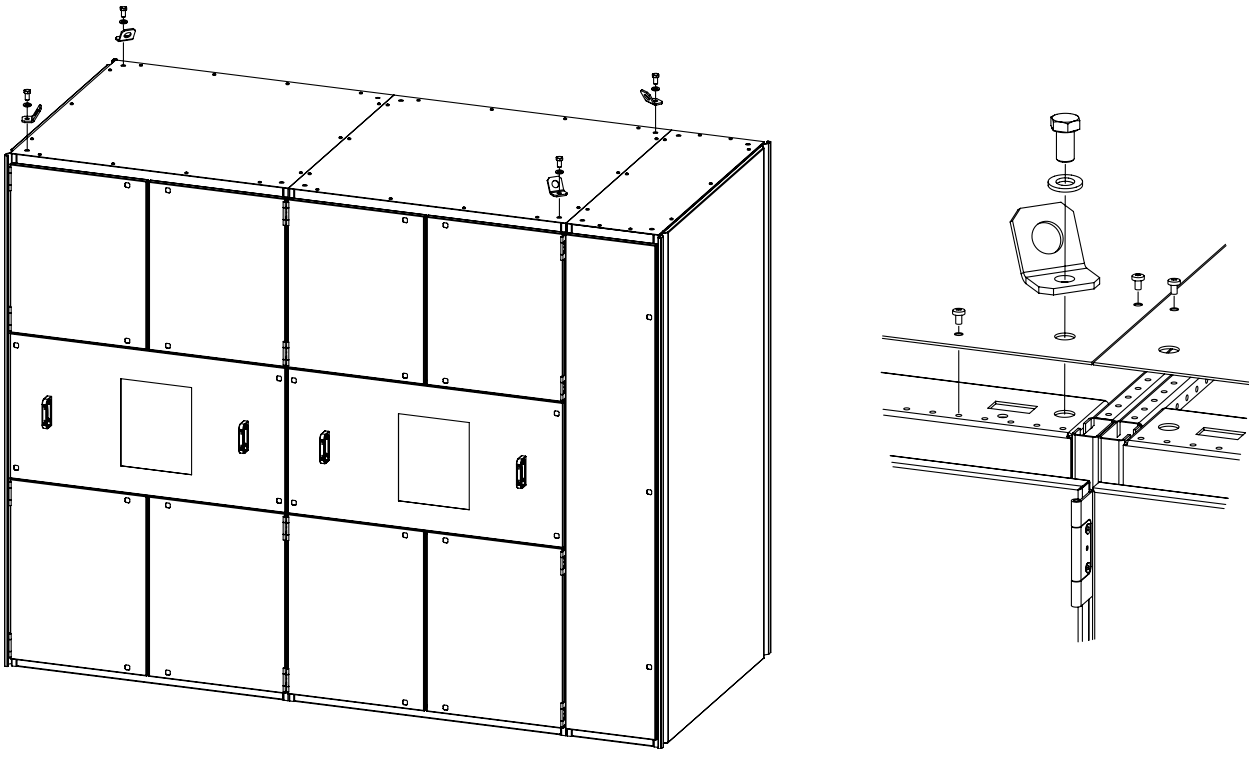


Figure 3-17 Arrangement of single lifting angles

Shipping units arranged of multiple connected sections, length up to 3,2 m and mass up to 3200 kg shall be raised by means of double lifting angles according to Figure 3-18.

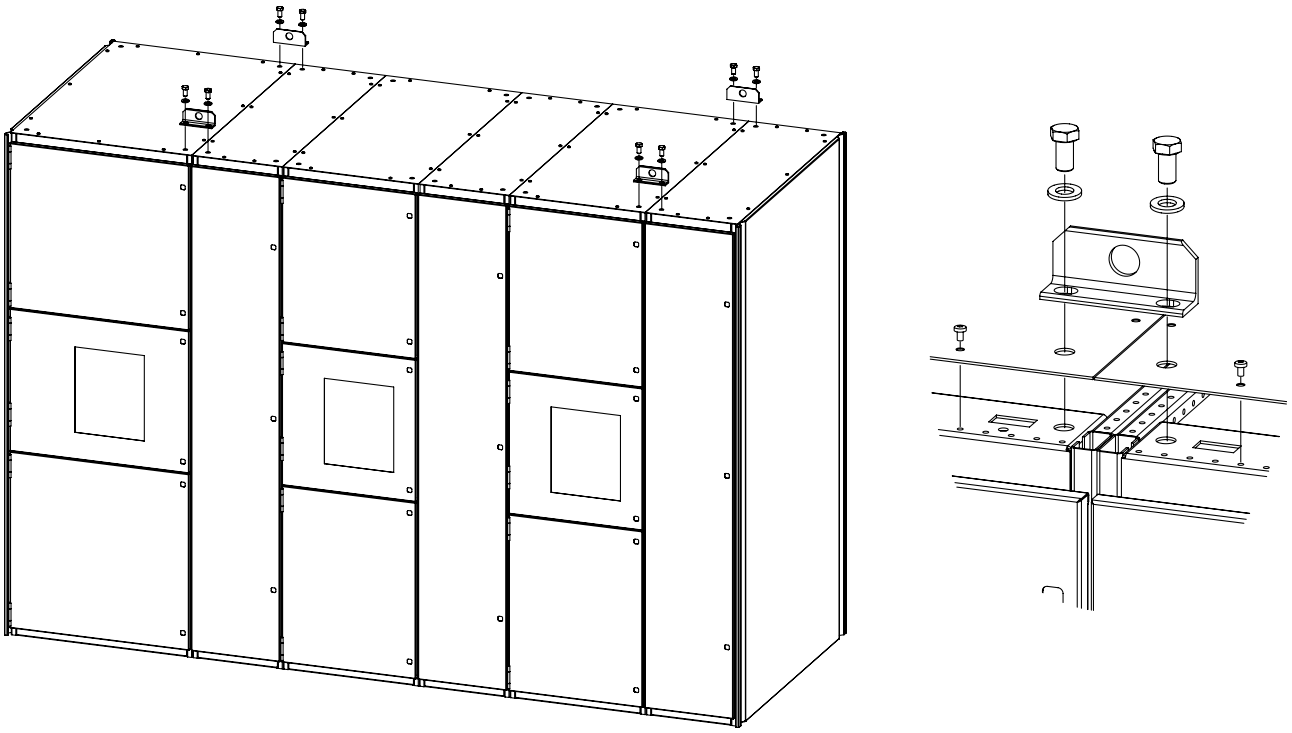


Figure 3-18 Arrangement of double lifting angles

Shipping units arranged of multiple connected sections, length up to 3,6m and mass up to 3900 kg shall be raised by means of customized L – profile according to Figure 3-19.

L – profile, made of non-alloy steel, must be bolted to shipping unit using standard lifting bolts at all mounting points of each section.

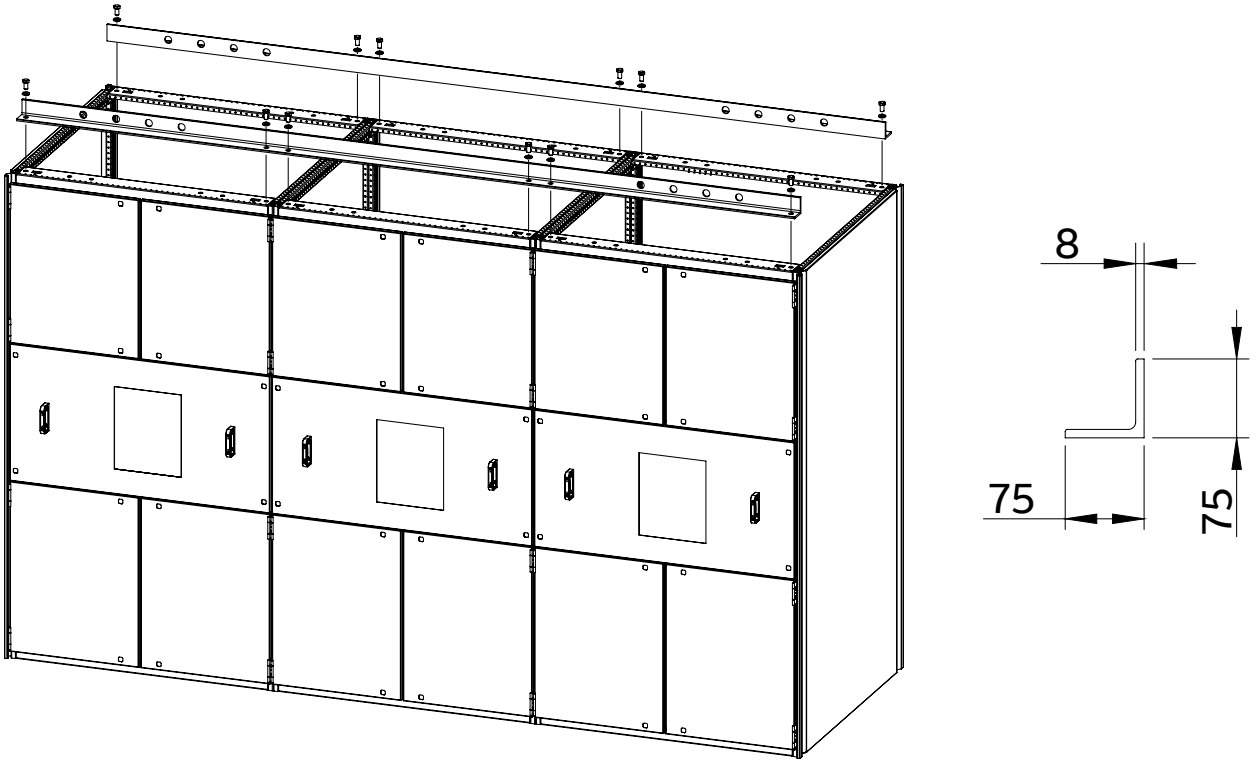


Figure 3-19 Arrangement of lifting by L – profile and L-profile details (dimensions in mm)

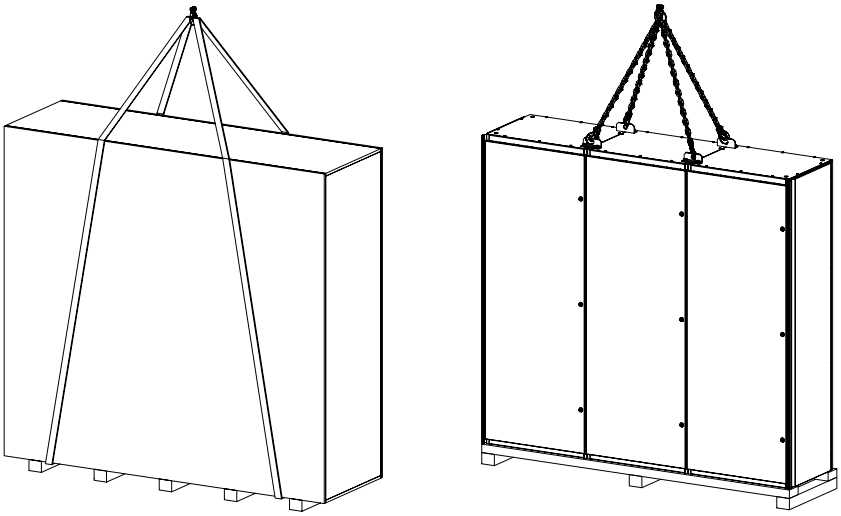


Figure 3-20 Crane transport packed sections (left side picture), crane transport unpacked sections (right side picture)

The sign detailing the tilting danger must not be removed before all sections have been secured to the foundation. Do NOT place the switchgear down on one edge, there is a danger of considerable mechanical damage.

3.4.3 Transport by truck

The loading of the sections can be undertaken with a fork lift from the side of the truck. In case of collocate sections an additional spacer between the sections is necessary (see Figure 3-21).

To protect the edges of the sections paperboard angles has to be attached. 32 mm wide steel straps must be strapped around the arrangement and the loading platform. The number of these steel straps depends upon the size of the switchboard.

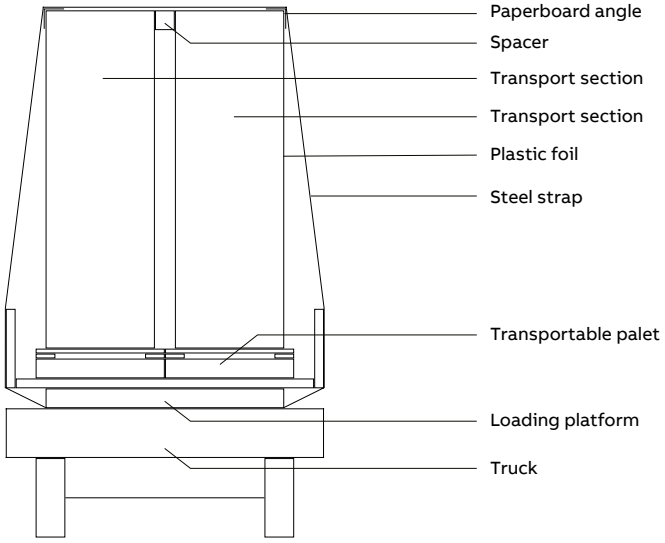


Figure 3-21 Transport by truck

3.5 Intermediate storage

The ambient temperature for storage and transport should not exceed below –50°C however, care should be taken to observe the any storage limits with respect to any electronic components and plastic materials.

Outdoor storage is not allowed!

The nature and duration of intermediate storage are dependent on the type of packaging.

Sections in standard packaging:
- Store indoor after arrival where no condensation can occur.
- Unpack immediately.
- Open the doors for several hours to acclimatize the equipment.
- Cover the sections with plastic sheeting for any subsequent storage periods.
- Check regularly for condensation forming under the sheeting prior to the start of installation.

Sections with export/seaworthy packaging (acc. “3.2.2 The seaworthy packing”):
- Moisture protection is only guaranteed if the packaging is undamaged.
- Storage period of maximum 12 months if wrapped in heat sealed PE sheeting and the packaging is undamaged.
- For duration of transport and storage from 12 months up to maximum 24 months and/or if the possibility to check the status of the drying agent is needed, the following can be used instead of heat-sealed PE-sheeting:
  - Heat-sealed aluminium-compound foil with integrated hygroscope which provides moisture protection for at least 24 months.
  - The hygroscope is visible from the outside through a opening in the transport box.
- When the storage period is exceeded, the drying agent must be replaced and the plastic sheeting has to be resealed.

3.5.1 Storage of spare modules
- Storage is only allowed in dry rooms.
- The modules have to be stored in undamaged original packing.
- Do not expose the modules to large temperature variations.
- Store the boxes with the top side to the top.
- Do not store modules with sizes ≥ 16E one on top of the other.

3.6 Enviromental conditions of transport, storage and installation

A special agreement shall be made between the assembly manufacturer and the user if the conditions during transport, storage and installation differ from those defined in IEC 61349-1.

Environmental conditions like ambient temperature and humidity, pollution degree and altitude must be specified during project phase. Acc. IEC 61439-1 the standard environmental conditions are:

Ambient air temperature
The air temperature does not exceed +40°C and it´s average over a period of 24 hours does not exceed +35°C. The lower limit of the ambient air temperature is -5°C.

Humidity conditions
The relative humidity of the air does not exceed 50% at a maximum temperature of +40°C. Higher relative humidity may be permitted at lower temperatures, for example 90 % at +20 °C.

Pollution degree
The pollution degree of the place for transport, storage and installation does not exceed pollution degree 3.

Altitude
The altitude of the place for transport, storage and installation does not exceed 2000 m above sea level.

04

Erection and installation

Erection and installation

4.1 Warranty aspects

MNS power switchgear assemblies have a mean lifetime of 30 years providing the assembly is correctly installed and maintained in line with the requirements defined in this manual.
It must be noted that the MNS switchgear assembly utilises a diverse range of products to meet the requirements of our customers. Individual lifetimes and maintenance practices need to be recognized for these components.

Erection and installation process includes transportation of heavy loads and maneuvering the sections in tight spaces. All safety precautions must be taken during this process not limited to the ones suggested in this instruction.

ABB recommends during erection and installation the use of ABB personnel or ABB certified specialists to oversee activities to ensure warranty conditions are not compromised. Failure to comply with these instructions may void the warranty terms of the product.

4.2 Delivery checks

Check the consignment on arrival at site for:
- completeness,
- transport damage (if found, determine the extent, cause and originator).

When damage is detected it must be proceeded as follows:
- immediately document visible damage in the consignment note,
- report hidden damage within acceptance period.

4.3 Switchgear room and placement requirements

To prevent damage being caused by moisture and ingress of dust following tasks (only examples) must be carried out before erection of the switchgear:
- Walls and ceilings plastered, painting completed.
- Doors and windows installed.
- Openings in the floor, wall and ceiling for cables, conductors pipes, bars and ventilation in accordance with the construction drawings provided.
- Supporting brackets, beams, enclosures and foundation frames assembled.
- If necessary, assemble braces appropriate to the basic dimensions of the switchgear installation with crosstruts corresponding to the section divisions.

Figure 4-01 Example of switchgear room layout

ABB recommends the following minimum requirements for switchrooms where MNS is to be installed

- Clear access and space for installation, operation, maintenance and emergency situations. Clearances may vary depending to local regulations, Table 4-05 and Figure 4-02 to Figure 4-07 shows the minimum requirement as per ABB MNS design guidelines.
- Available climate control to ensure the design mean ambient temperature is not exceeded.
- Positive pressured room or with air locks to limit the exposure to dust or other environmental contaminents.
- First aid / Emergency kit for electrical work (content may vary depending on National standards).
- Dedicated location to house lifting devices of air circuit breakers.
- Foundation appropriate to carry the switchboard as well as for routing the cables. MNS Switchboards can be installed directly on to a concrete floor, supports of false floor (UPN / HALFEN / UNISTRUT Profiles).
- Roof adequate to support cable ducts and busducts (if applicable).
- Smoke/Fire detection systems.
- Adequate lighting for operation and maintenance.

Ingress protection	**Dimension 1** Section to side wall, for **right** mounted door	**Dimension 1** Section to side wall, for **left** mounted door	**Dimension 2** Section to side wall	**Dimension 3** Section to rear wall	**Dimension 4** Section to ceiling
Expanded metal mesh roof plate					
IP30 – IP40	80	150	150	80	500
Raised roof plate (RRP)					
IP31 – IP41	115 (80 + 35 RRP overlap)	150	150	175 (80 + 95 RRP overlap)	500
IP32 – IP42	115 (80 + 35 RRP overlap)	150	150	175 (80 + 95 RRP overlap)	500
IP43	335 (80 + 255 RRP overlap)	335 (80 + 255 RRP overlap)	335 (80 + 255 RRP overlap)	355 (80 + 255 RRP overlap)	500
Pressure relief roof plate (roof with flap)					
IP31 – IP41	80	150	150	80	500
IP32 – IP42	80	150	150	80	500
IP43	80	150	150	80	500
Solid metal sheet roof plate					
IP54	80	150	150	80	500

Table 4-01 Section minimum clearances (all dimensions in mm)

Please measure the minimum distances from rear and side walls, **NOT** from frame!

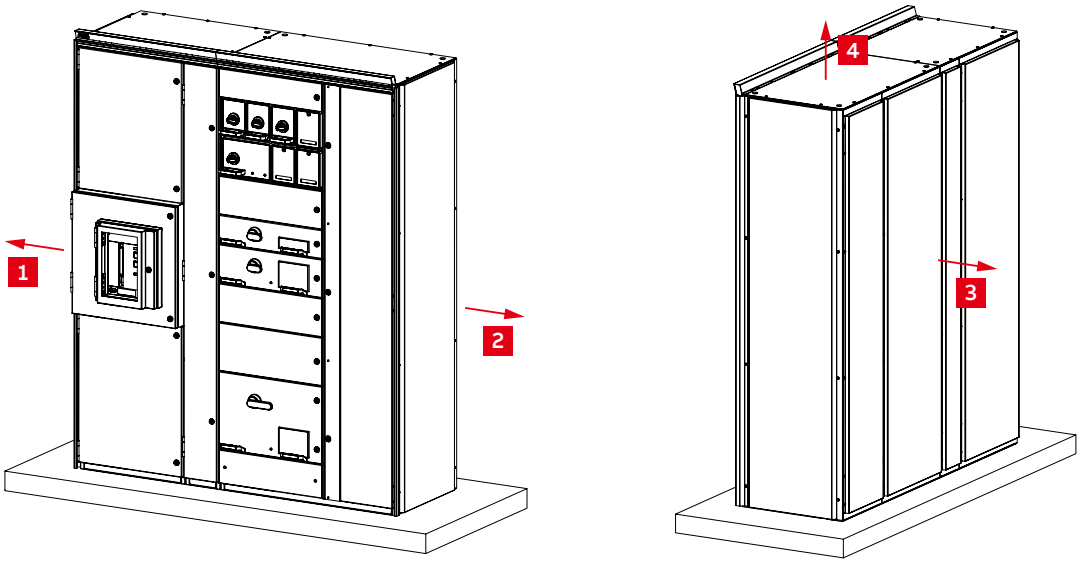


Figure 4-02 Section minimum clearances

Note
The IP43 roof is to protect from water spray at an angle of 60°.
It may be possible to reduce the minimum clearances required subject to agreement with the manufacturer and end user.

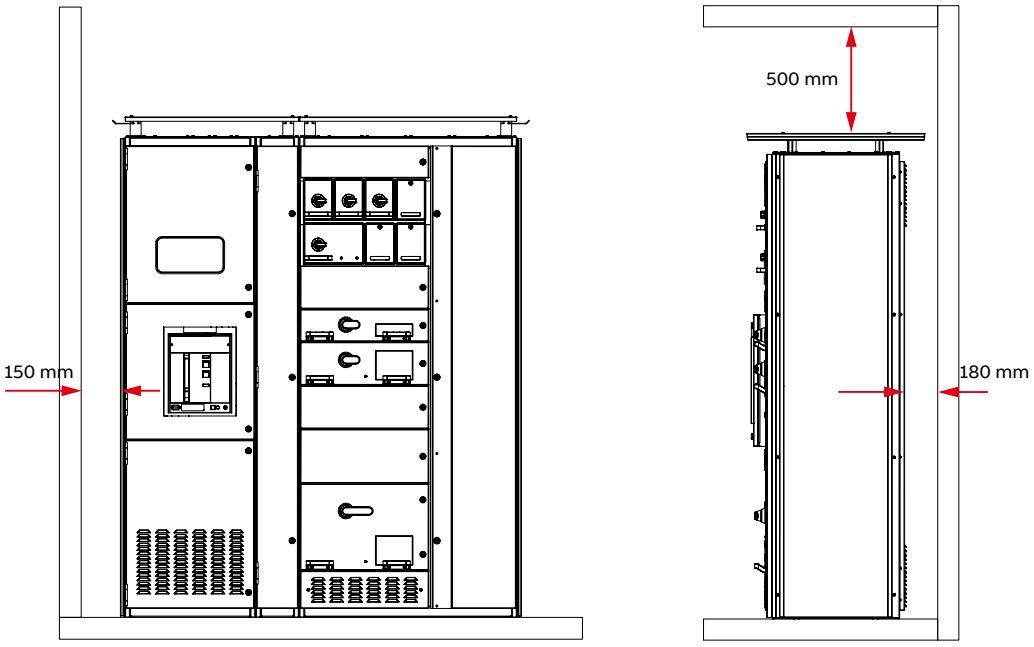


Figure 4-03 Section minimum clearances for raised roof plate IPx1/IPx2 with left mounted doors

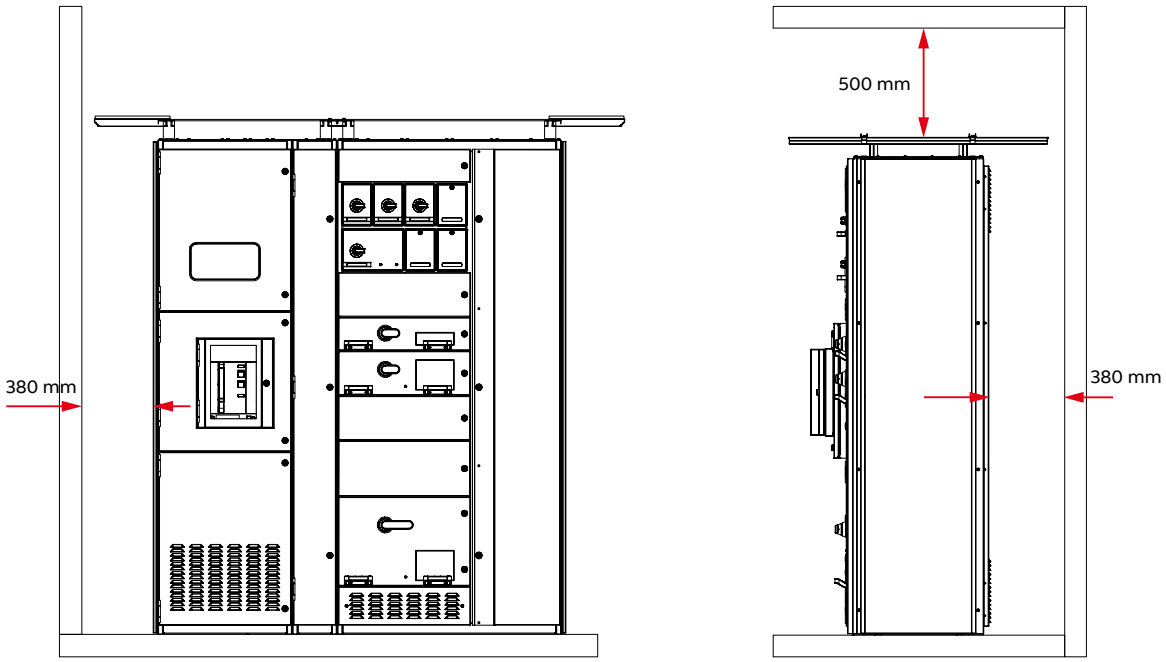


Figure 4-04 Section minimum clearances for raised roof plate IP43 with left mounted doors

Note:
When the IP 43 raised roof is utilised.
It may be optimised during installation on site, in order to locate the assembly to locate the assembly 80 mm from the wall

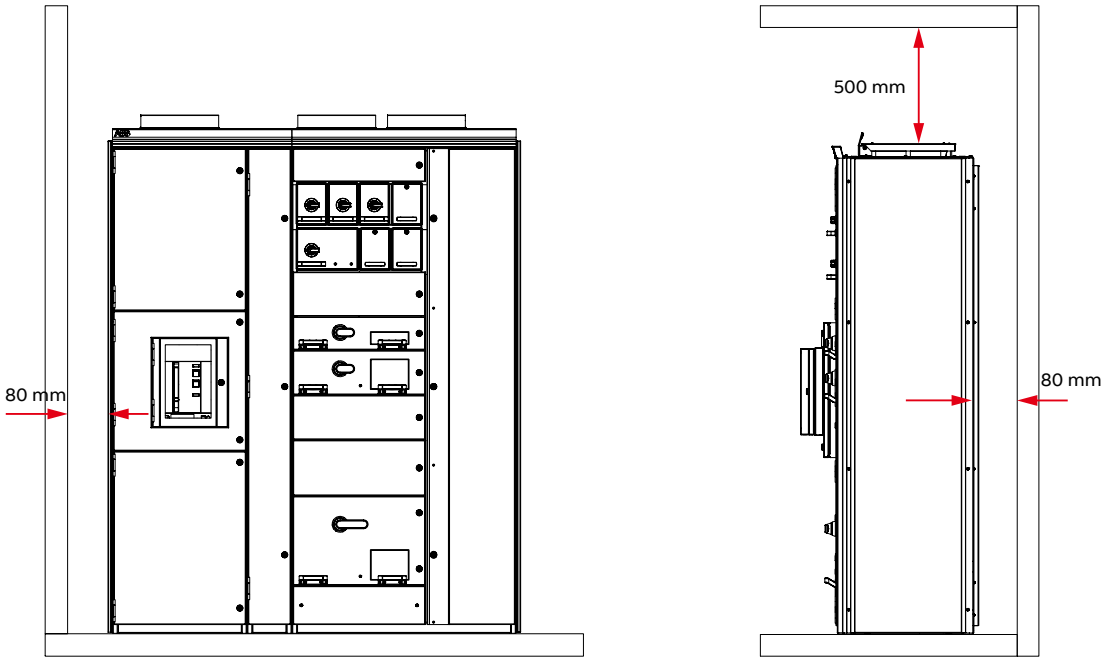


Figure 4-05 Section minimum clearances for pressure relief roof (flap roof) with right mounted doors

4.4 Escape routes

Operating aisle widths are complied with minimum aisle width in general ≥ 700 mm, if operating elements protrude into the aisle, the walking clearance must be ≥ 600 mm.

Escape route widths are complied with minimum aisle width ≥ 700 mm, doors closing in the direction of escape need not be accounted for, doors closing in the opposite direction of the direction of escape must maintain a minimum aisle width of 500 mm. In the case of switchgear systems on both sides of the aisle, open doors only have to be expected on one side. With the MNS system the switchgear sections are available with the door hinges on the right or left-hand side, the minimum aisle widths are sufficient. Escape routes within the switchgear room must not exceed 40 m in length. It must be possible to open the doors of the switchgear room from inside without any tools (use panic locks if necessary).

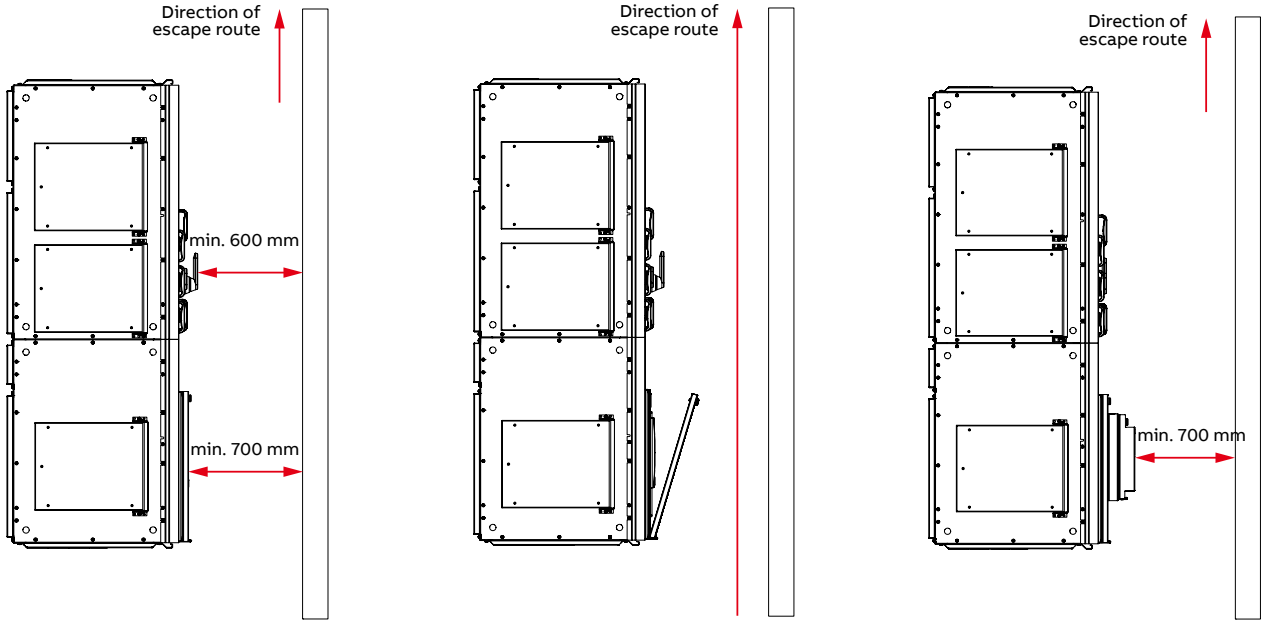


Figure 4-06 Front access section minimum clearances for escape routes

IP cover: Impact to emergency escape paths

If the IP cover and/or pagoda cover are utilised in the ACB section, as per IEC 60364 the distance for an evacuation route must consider the circuit breaker in its fully withdrawn position. Accordingly the IP cover size must be considered for calculation of switchgear room arrangement dimensions. This also applies to the pagoda dimensions.

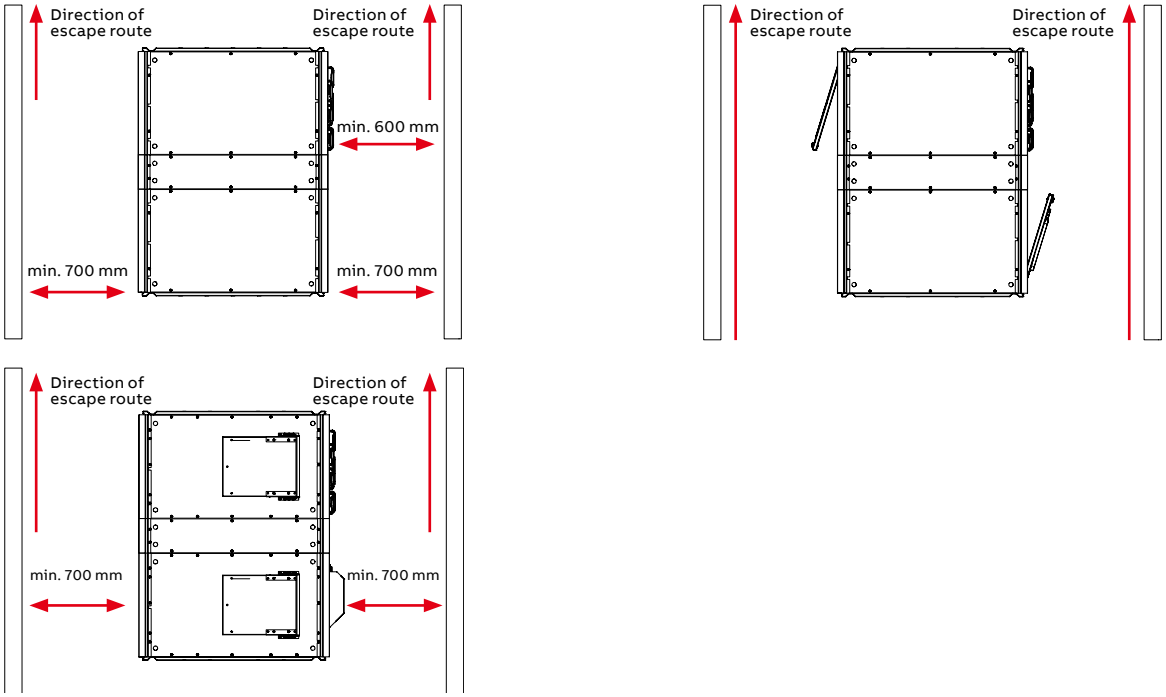
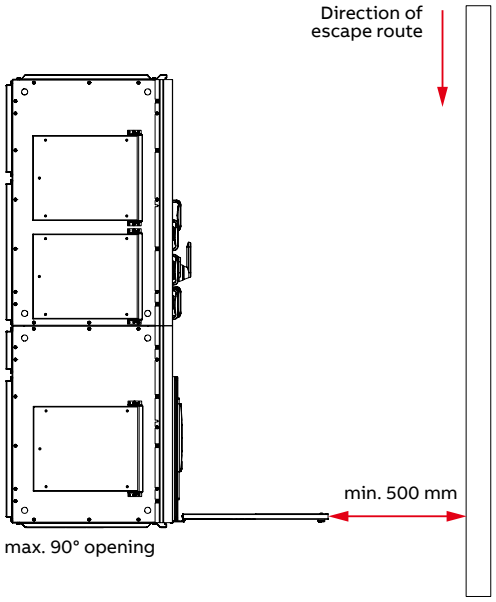
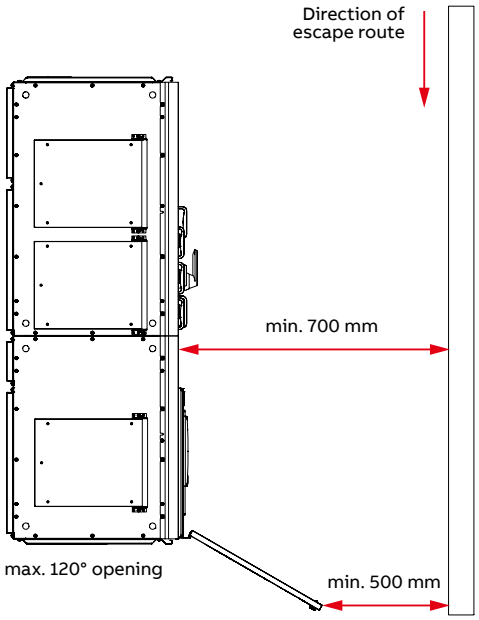
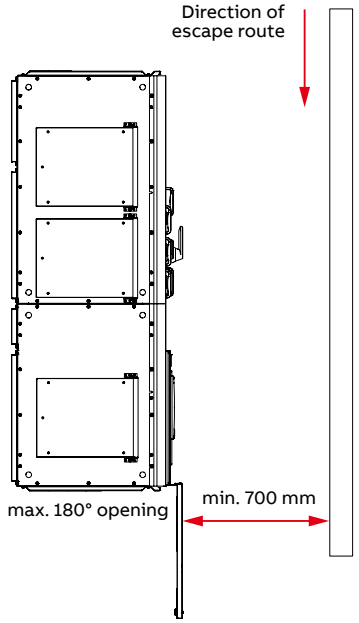


Figure 4-07 MNS Rear access section minimum clearances for escape routes



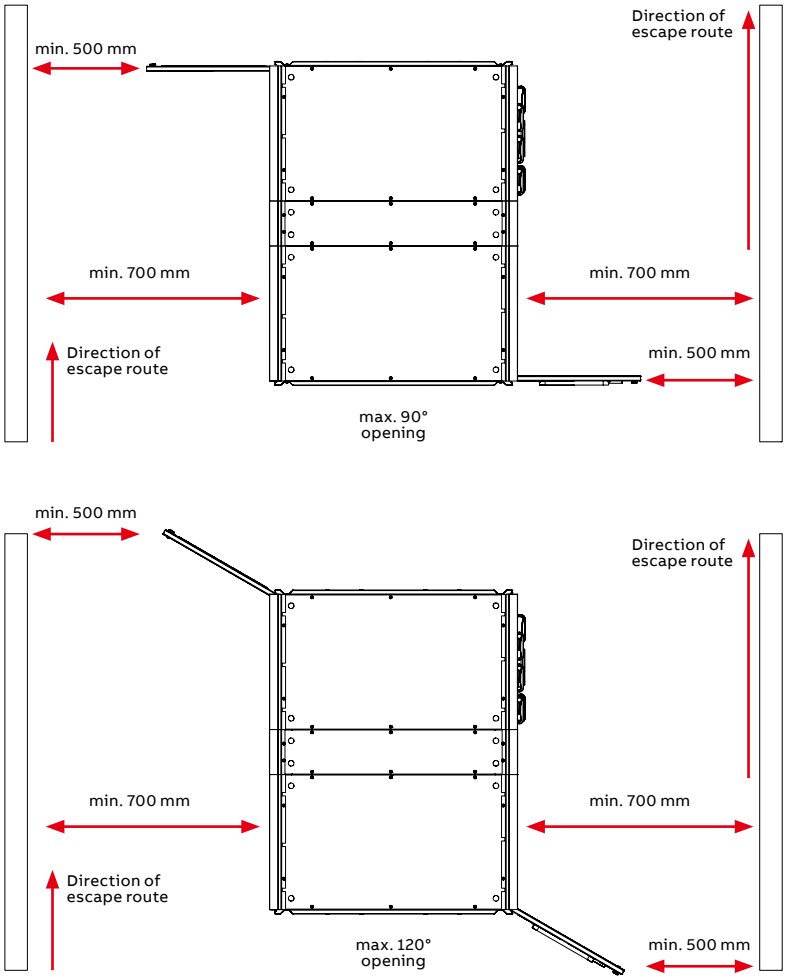


In case of 120° degree opening, don´t forget to adhere the minimum operationg ailse especially when sections whit narrow width are installed (e.g. 400 mm).



In case of 180° degree opening, the escape aisle is equal to minimum operating aisle width.

Figure 4-08 The difference of front access assemblies minimum clearances according escape route direction



In case of 120° degree opening, don´t forget to adhere the minimum operationg ailse especially when sections whit narrow width are installed (e.g. 400 mm).

Figure 4-09 The difference of MNS Rear access assemblies minimum clearances according escape route direction

When calculating escape routes, always consider direction of escape route and the worst case of switchgear with opened doors.

4.5 Front access section foot print

When calculating the section foot print, additional dimensions needs to be considered. Please refer to the table below.

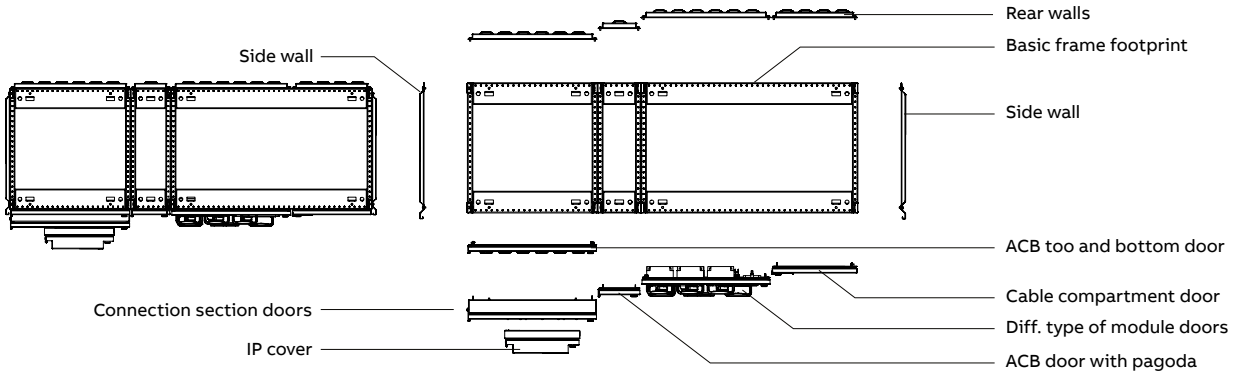


Figure 4-10 Example of section foot print extension parts

Segment	Description	Dimensions
Walls	Rear wall closed	25 mm
	Rear wall with ventilation louvers	28 mm
	Rear wall with punched louvers	34 mm
	Side wall (left or right)	20 mm
ACB door	Top door (without electrical equipment)	27 mm
	ACB door	27 mm
	ACB door with pagoda	90 mm
	ACB door with IP cover	135 mm
	ACB door with pagoda & IP cover	200 mm
	Bottom door	27 mm
	Bottom door with ventilation louvers	28 mm
	Bottom door with punched louvers	34 mm
Module door	Top model door 6E	27 mm
	Small module cover (8E4, 8E2)	23 mm
	Small module cover with handle (8E4, 8E2)	75 mm
	Module door empty (≥ 4E)	27 mm
	Module door with handle (≥ 4E)	85 mm
	Module cover 7E	27 mm
	Module cover 7E with ventilation louvers	28 mm
	Module cover 7E with punched louvers	34 mm
SlimLine	Slimline module ON, folded handle	90 mm
	Slimline module OFF, folded handle	70 mm
	Slimline module ON or OFF, unfolded handle	170 mm

Table 4-02 Additional dimensions to calculate exact section footprint

4.5.1 MNS Rear access section foot print

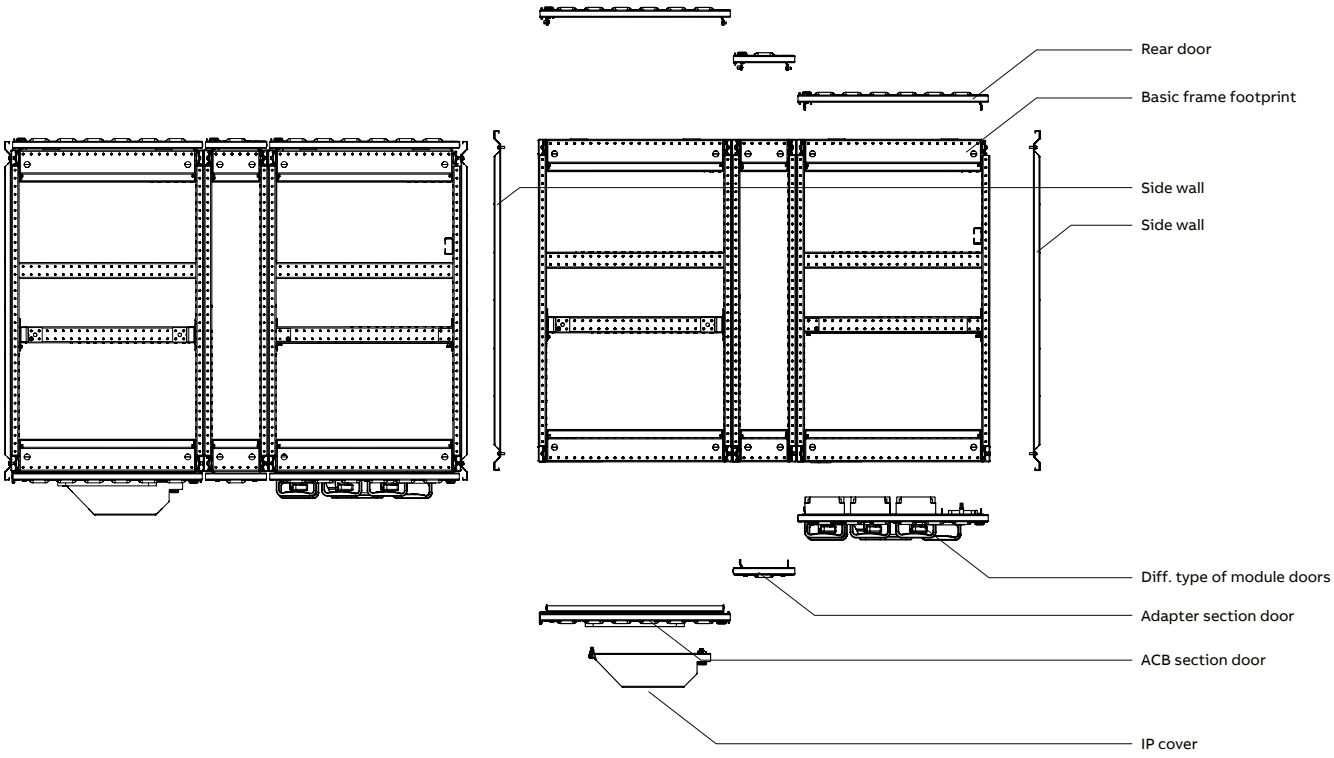


Figure 4-11 Example of section foot print extension parts

Segment	Description	Dimensions
Side wall	Side wall (left or right)	20 mm
Rear door	Rear door 12E / 77E without ventilation	27 mm
	Rear door 12E / 77E with ventilation louvers	30 mm
	Rear door 12E / 77E with punched louvers	36 mm
Main busbar front cover	Front cover 12E / 20E without ventilation	27 mm
	Front cover 12E / 20E with ventilation louvers	30 mm
	Front cover 12E / 20E with punched louvers	36 mm
ACB section door	Top door 21E / 25E without instrument panel	27 mm
	Top door 21E / 25E with instrument panel	45.5 mm
	ACB door 23E	27 mm
	ACB door 23E with IP cover	136 mm
	Bottom door 21E / 25E / 29E without ventilation	27 mm
	Bottom door 21E / 25E / 29E with ventilation louvers	30 mm
	Bottom door 21E / 25E / 29E with punched louvers	36 mm
Stacked section door (including combined ACB and withdrawable modules)	Auxiliary recess door 10E / 14E without instrument panel	27 mm
	Auxiliary recess door 10E / 14E with instrument panel	45.5 mm
	ACB door 22E/23E	27 mm
	ACB door 22E/23E with IP cover	136 mm
	Side auxiliary recess door 22E/46E	27 mm
	Side cover 37E / 41E	27 mm
	Bottom door 13E / 21E without instrument panel	27 mm
	Bottom door 13E / 21E with instrument panel	45.5 mm
	Front cover 3E / 11E without ventilation	27 mm
	Front cover 11E with ventilation louvers	30 mm
	Front cover 11E with punched louvers	36 mm

Segment	Description	Dimensions
Module section door	Small module cover (8E/4, 8E/2)	23 mm
	Small module cover with handle (8E/4, 8E/2)	75 mm
	Module door empty (≥ 4E)	27 mm
	Module door with handle (≥ 4E)	85 mm
	Front cover 5E without ventilation	27 mm
	Front cover 5E with ventilation louvers	30 mm
	Front cover 5E with punched louvers	36 mm

Table 4-03 Additional dimensions to calculate exact MNS Rear section footprint

4.6 Section height

When calculation the section foot height, additional dimensions must be added to get the correct hight.

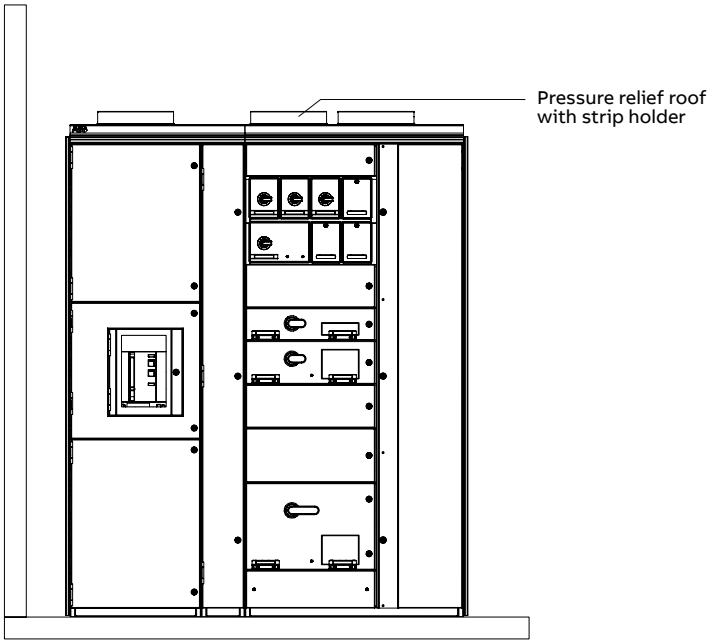


Figure 4-12 Example of section hight extension parts

Segment	Description	Dimensions
Roofs	Mesh roof with strip holder	50 mm
	Raised roof with strip holder	110 mm
	Pressure relief roof with strip holder	110 mm
	Closed roof with strip holder	50 mm

Table 4-04 Additional dimensions to calculate exact section hight

4.7 Section length

For IP 41 and above sealing tape must be added between sections. To calculate the correct lenght of switchgear, add 1 mm to each sealed section.

Example:

- Total lenght of 3 sections with section width 400 mm and left and right side wall is:
- 20 mm + 1 mm + 400 mm + 1 mm + 400 mm + 1 mm + 400 mm + 1 mm + 20 mm = 1244 mm.

It´s very important to add 1 mm per section to overall length for longer switchgear.
It´s necessary to calculate with 1 mm per section if predrilling of concrete floor is required.

4.8 Floor cut outs

4.8.1 Front access floor cut outs

Where floor cut-outs are required at site, the measurements shall be taken according to the following dimensions. Please consider the differences for the W1 dimensions:

- ACB Section W1 = 75 mm
- Outgoing Section W1 = 50 mm

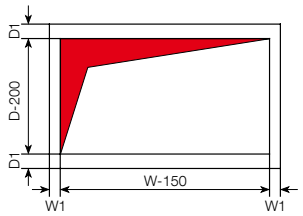
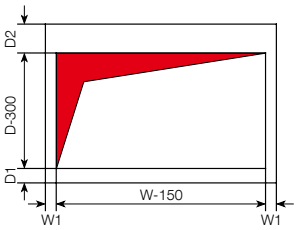
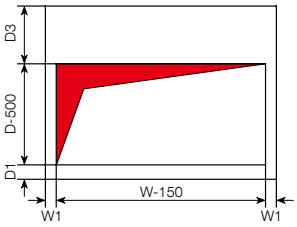
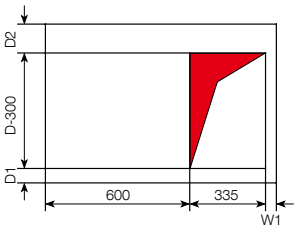
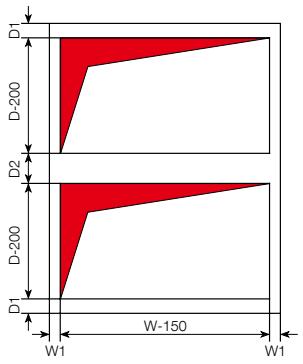
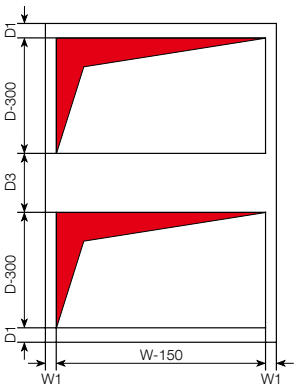
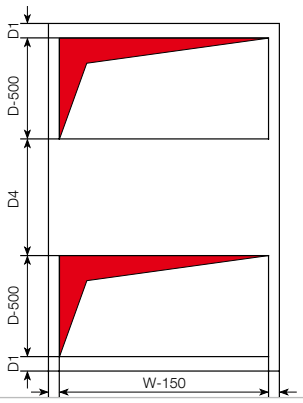
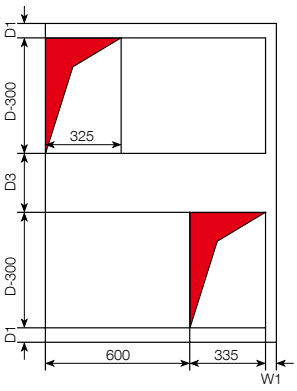
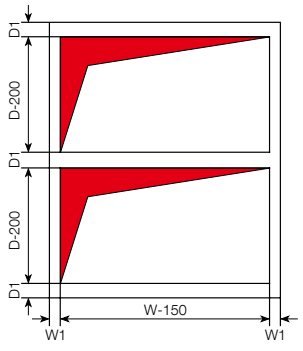
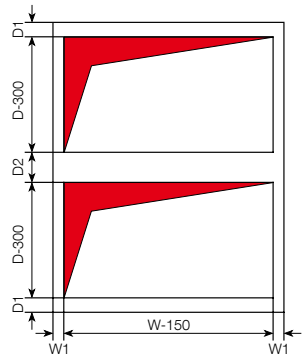
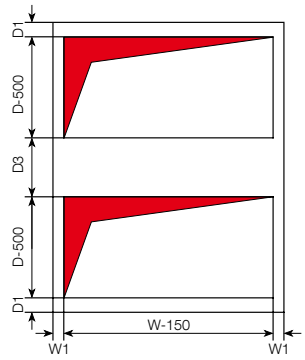
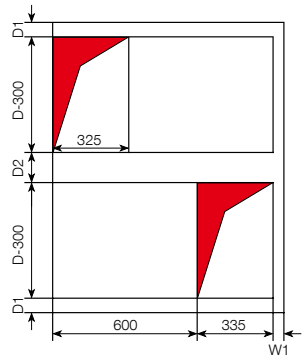
	Section without busbar compartment	Section with busbar compartment BBA = 200 mm	Section with busbar compartment BBA = 400 mm	Section with cable and busbar compartment (BBA = 200 mm); cable entry only to the cable compartment
Standard section				
Back to back section				
Duplex section				

Table 4-05 Floor cut-outs for standard, back to back and duplex sections
All dimensions are in mm

Legend
D1 = 100 mm / D2 = 200 mm / D3 = 400 mm / D4 = 800 mm
W = frame width of the section / D = frame depth of the section

4.8.2 Rear access floor cut outs

Where floor cut-outs are required at site, the measurements shall be taken according to the following dimensions.

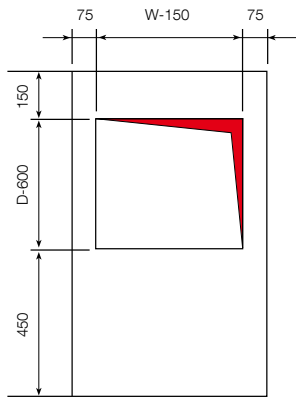
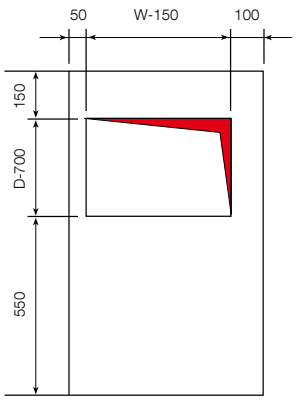
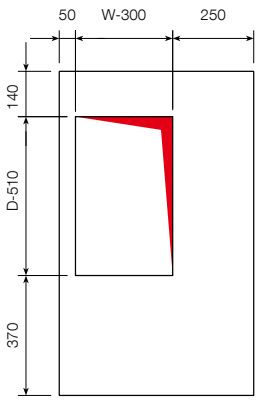
MNS Rear Access ACB section	MNS Rear Access outgoing module section and combined ACB and withdrawable modules section	MNS Rear access double stacked and triple stacked ACB sections
		

Figure 4-13 Floor cutouts for MNS Rear sections
All dimensions are in mm

Legend
W = frame width of the section / D = frame depth of the section

4.9 Preparation for installation

Tools & equipment required

- crane or forklift for moving the switchboard sections to switchroom,
- lever or suitable alternative for lifting the switchboard section,
- shaft or bar for moving individual sections to final location,
- concrete drill or welding equipment (if required),
- cordless hand tools for fixing sections together,
- torque wrench with extension set,
- colored permanent marker for marking torqued bolts,
- bolts / screws suitable for concrete fixing,
- general hand tools,
- equipment suitable for checking the level of the switchboard (1 m long level, surveyor equipment, etc.),
- PRESTOJACK levelling shims or equivalent (e.g. 1 mm thick square galvanised shims).

Switchroom

- the switchroom floor should be pre-marked and drilled (if necessary) on the fixing locations before the switchboard sections are moved in for installation,
- it is recommended to heat the room to avoid sudden changes in temperature, high humidity and condensation,
- the route of the switchboard sections manuevre should be identified and pathways shall be cleared.

Front access switchboard

- the switchboard shipping sections should be identified as per project documentation,
- busbar partition plates (see Figure 4-14) shall be removed,
- check the loose items within the switchboard required for securing of busbars, section fastening and operation.

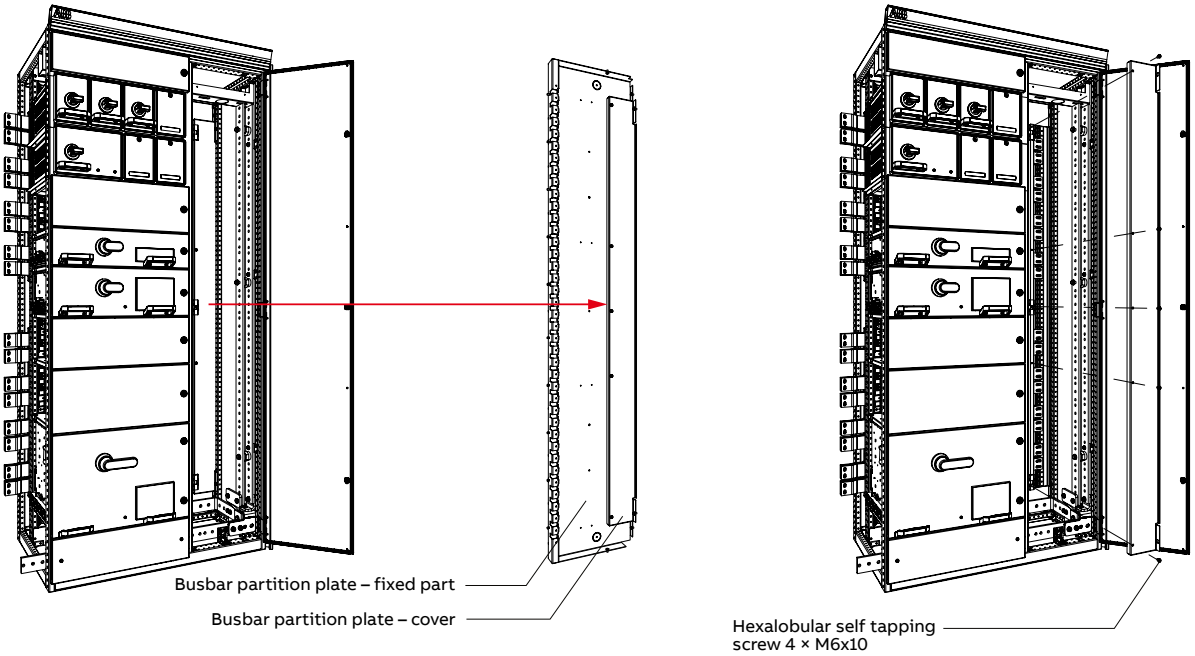


Figure 4-14 Busbar partition plate and fixing hole locations

Rear access switchboard

- the switchboard shipping sections should be identified as per project documentation,
- top stripe holders, roof plate, main busbar compartment front cover and main busbar rear partition wall (see Figure 4-15) shall be removed,
- check the loose items within the switchboard required for securing of busbars, section fastening and operation.

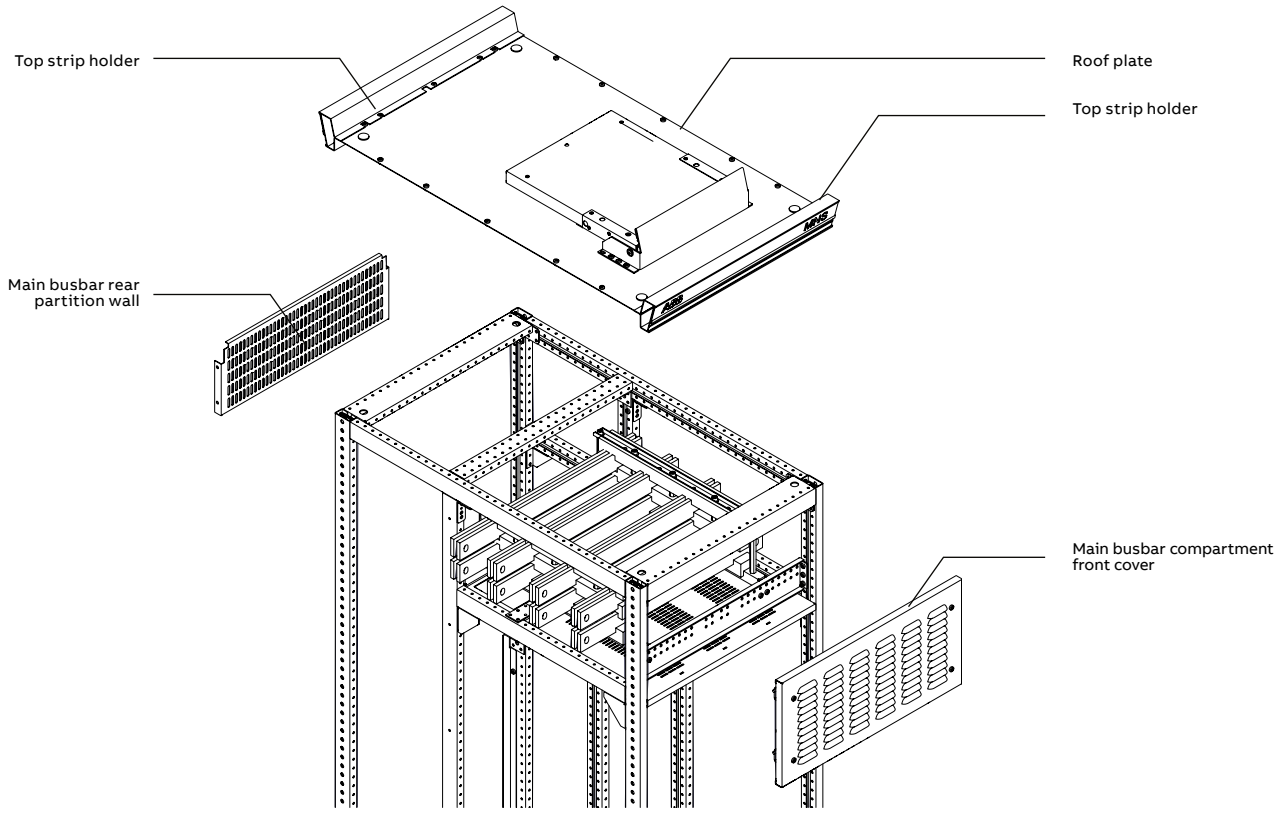
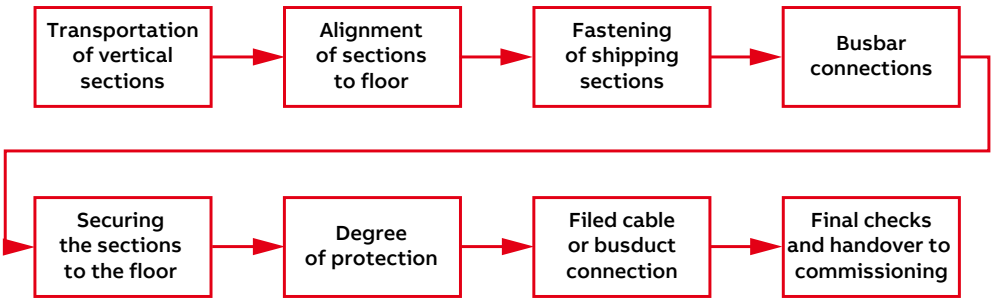


Figure 4-15 Rear access busbar partition plate and fixing hole locations

4.10 Work flow



4.11 Transportation of vertical sections

For further information see chapter 3. PACKING, STORAGE & TRANSPORT

4.12 Alignment of sections to floor

Once all the switchboard sections are in place, the levelling of the entire switchboard shall be checked with a spirit level, 1 m long surveyors rod or suitable surveyor equipment. The horizontal tolerance of the frame must not exceed ±1 mm over a length of 1 m.

The frame must not ondulate (2 / 1000 according to DIN ISO 1101)
Sections which are out of tolerance shall be corrected using galvanised steel sheet shims or with PRESTOJACK levelling shims.

4.13 Fastening of shipping sections

Shipping sections must be secured at the points shown on Figure 4-16 below. Fastening components are provided with the switchboard.

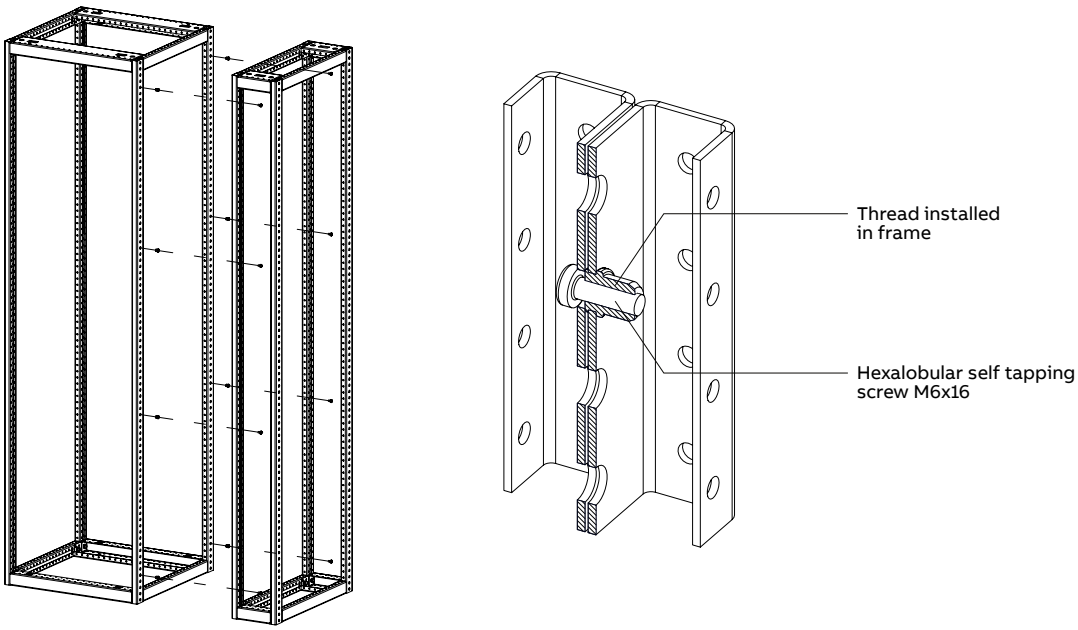


Figure 4-16 Connection points (threads installed in frame) with detail of connection

The lifting angles shall be removed and the hole plug GMN 775502P0018 shall be utilized to seal the holes. Alternatively the screws and washers can be re-used to close the lifting hole.

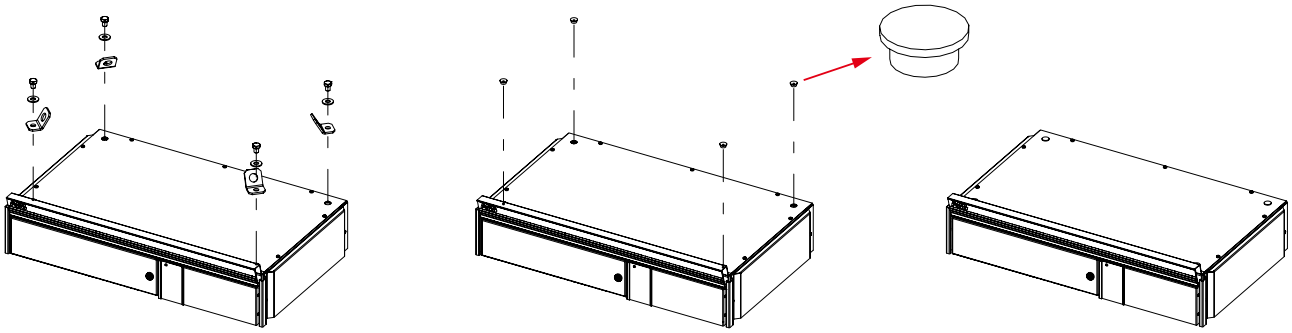


Figure 4-17 Lifting holes plug

4.14 Front access busbar connection between sections

Busbars can be secured on the levelled switchboard sections as per Figure 4-18 below. The fastening of the busbars shall be undertaken with a calibrated torque wrench as per the torque values in Table 4-09.

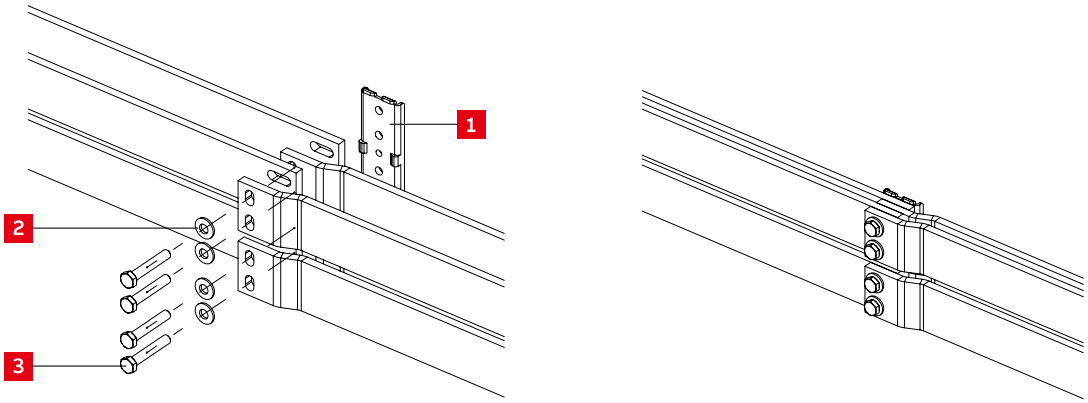


Figure 4-18 Example of busbar conection – main busbar connection

Ident.-no	Material	Additional information
1	Supporting plate	for 30 mm busbar for 40 mm busbar for 60 mm busbar
2	Conical spring washer acc. DIN 6796 of spring steel, corrsosion protected	
3	Hexagon head bolt partly threaded with ESLOK, ISO 4014	M10×35 for 2× … × 10 busbar M10×60 for 4× … × 10 busbar
4	Nuts of property class ≥8, corrosion protected acc. DIN 43673-1	
5	Plain washer in acc. DIN 7349	Must be used on aluminium side
6	Cupal plate	The usage of Cupal plate in between Cu-Al bar is needed to avoid chemical reaction decreasing the joint conductivity

Table 4-06 Main busbar connection material

Note:
For aluminium busbar connections, jointing areas should be first cleaned with a wire brush and then treated with Penentrox-(TM) A-13 to ensure effective electrical connection.

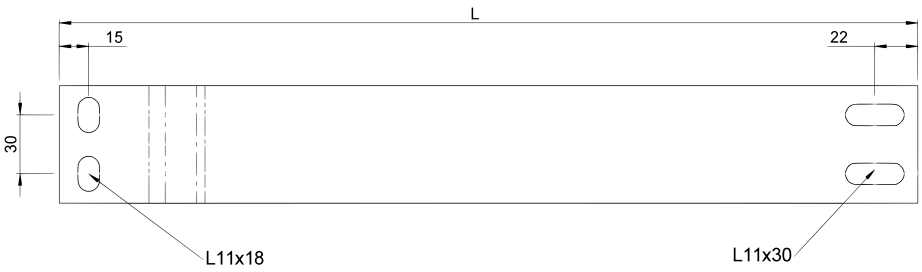


Figure 4-19 Generic busbar dimension in mm

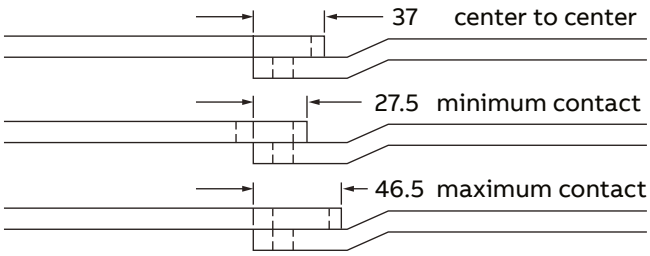


Figure 4-20 Main busbar overlapping ranges in mm

Note:
The MNS busbar system uses a combination of vertical and horizontal holes to cater for tolerances during installation. The contact surface for main bus bar overlap ranges from 27.5 mm to 46.5 mm as shown above.

Only ESLOK-coated screws together with one conical spring washer each are to be used. The connecting points for the busbars are accessible through partition wall between the cable and busbar compartments. This partition wall shall be closed after the bars have been connected. Elongated holes at the ends of the bars ensure adequate adjustment withiin the tolerances set. If the erection is properly carried out the holes will match up as required.

Drilling is not permissible, due to the resulting chips. Contact surfaces do not need a special pretreatment. In case of dirt, the contact surfaces should be cleaned with a soft cloth. Do not use a metal brush or chemical liquids. In case of double busbar systems the bars should be deburred or slightly phased (on both sides 45° $^{+0}$ with 1 $^{+1}$ mm). For tightening torques refer to Table 4-09: Torque values of busbar & PE/PEN connections.

4.14.1 Busbar connection options

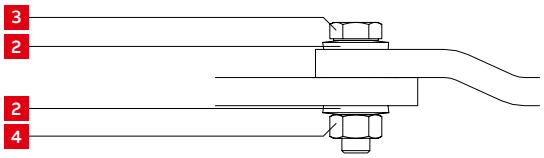


Figure 4-21 Copper to copper

2 Conical spring washer
3 Bolt
4 Nut

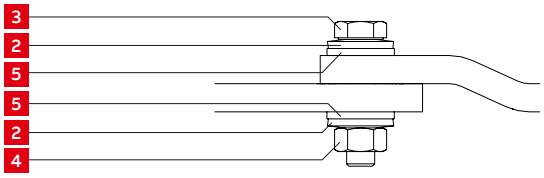


Figure 4-22 Aluminium to aluminium

2 Conical spring washer
3 Bolt
4 Nut
5 Plain washer aluminium side

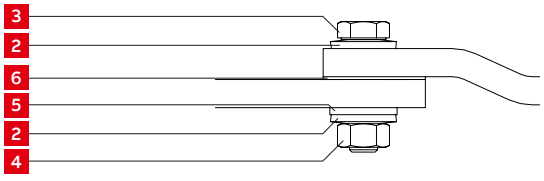


Figure 4-23 Copper to aluminium

2 Conical spring washer
3 Bolt
4 Nut
5 Plain washer aluminium side
6 Cupal plate to avoid chemical reaction

Note: For aluminium busbar connections, jointing areas should be first cleaned with a wire brush and then treated with Penentrox- (™) A-13 to ensure effective electrical connection.

4.14.2 Rear access busbar connections between sections

MNS Rear busbars can be secured on the levelled switchgear sections as per Figure 4-24. The fastening of busbars shall be undertaken with a calibrated torque wrench as per the torque values in Table 4-09.

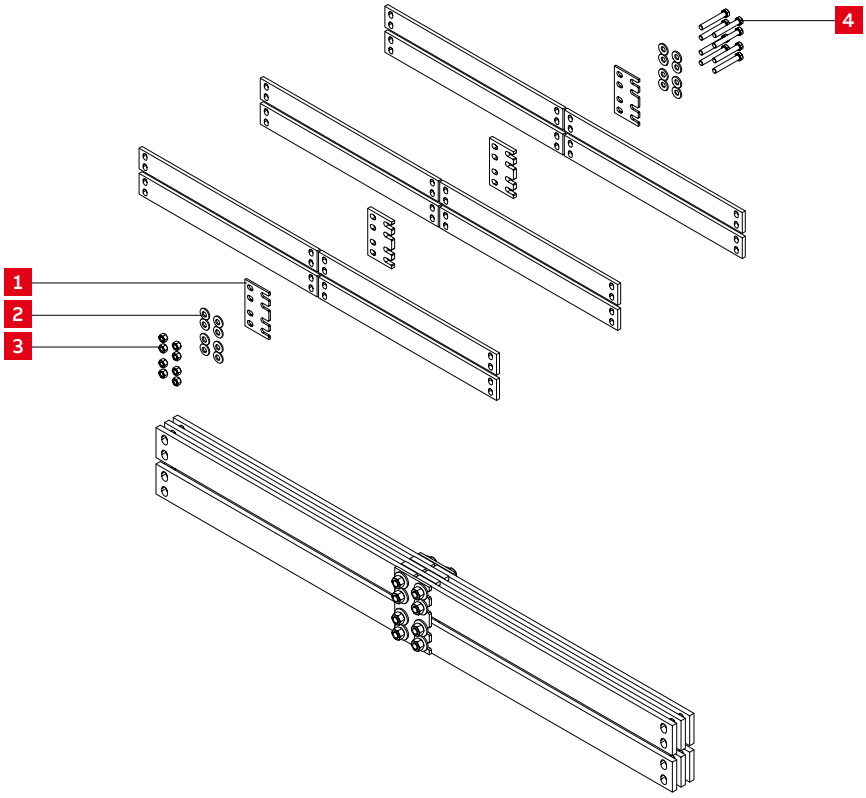


Figure 4-24 Example of MNS Rear busbar connection – main busbar connection

Ident.-no	Material	Additional information
1	Connection set	for 2x20x10 main busbar for 2x30x10 main busbar for 2x50x10 main busbar for 4x30x10 main busbar for 4x50x10 main busbar for 6x40x10 main busbar for 6x60x10 main busbar
2	Conical spring washer acc. DIN 6796 of spring steel, corrosion protected	M12
3	Nuts of property class ≥8, corrosion protected acc. ISO 4032	M12
4	Hexagon head bolt partly threaded with ESLOK, DIN 933	M12×40 for 2× … × 10 main busbar M12×60 for 4× … × 10 main busbar M12×80 for 6× … × 10 main busbar

Table 4-07 MNS Rear main busbar connection material

For MNS Rear switchgear, only ESLOK-coated screws together with one conical spring washer each are to be used. The connecting points for the busbars are accessible through the roof plate, main busbar compartment front cover and main busbar rear partition wall. These parts should be closed after the bars have been connected. Elongated holes at the ends of the main busbars and connection sets ensure adequate adjustment within the tolerances set. If the erection is properly carried out the holes will match up as required.

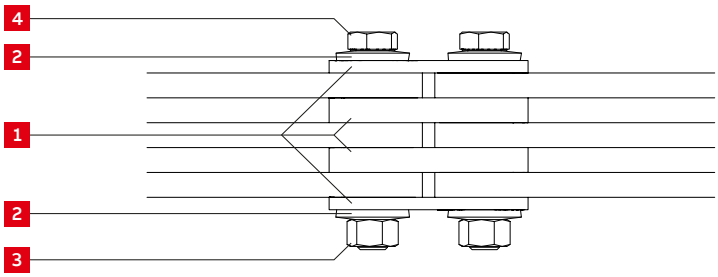


Figure 4-25 MNS Rear main busbar connection

4.14.3 Example of front access ACB incoming connections

For tightening torques refer to Table 4-09: Torque values of busbar & PE/PEN connections

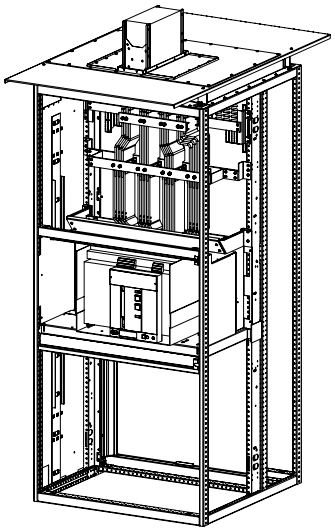


Figure 4-26 Example of busbar conection – busduct connection

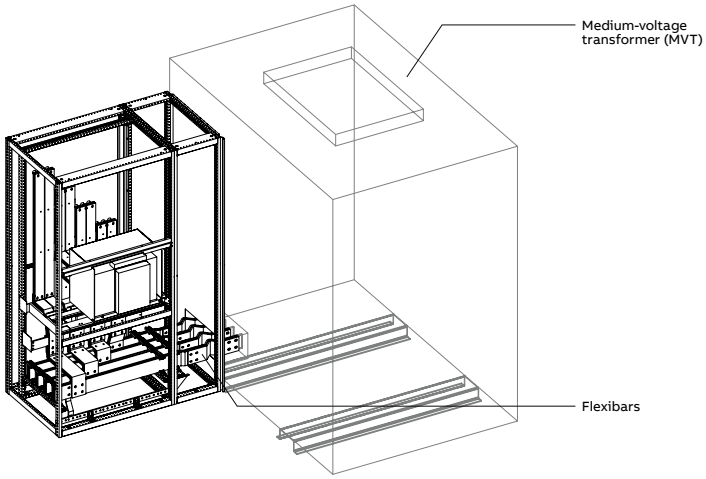


Figure 4-27 Example of section hight extension parts

When using busbar to medium-voltage transformer connection, it´s recommended to use flexibars. Flexibars have ability to compensate inequalities in transformer placement and damp transformer vibrations.

For aluminium busbar connections, jointing areas should be first cleaned with a wire brush and then treated with Penentrox(TM) A-13 to ensure effective electrical connection.

The protective conductor (PE or PEN) shall be connected to the PE/PEN bar. Additional connections to the central earthing system can be made at any point of the perforated PE/PEN bar. Local regulations must be complied with. See Figure 4-28.

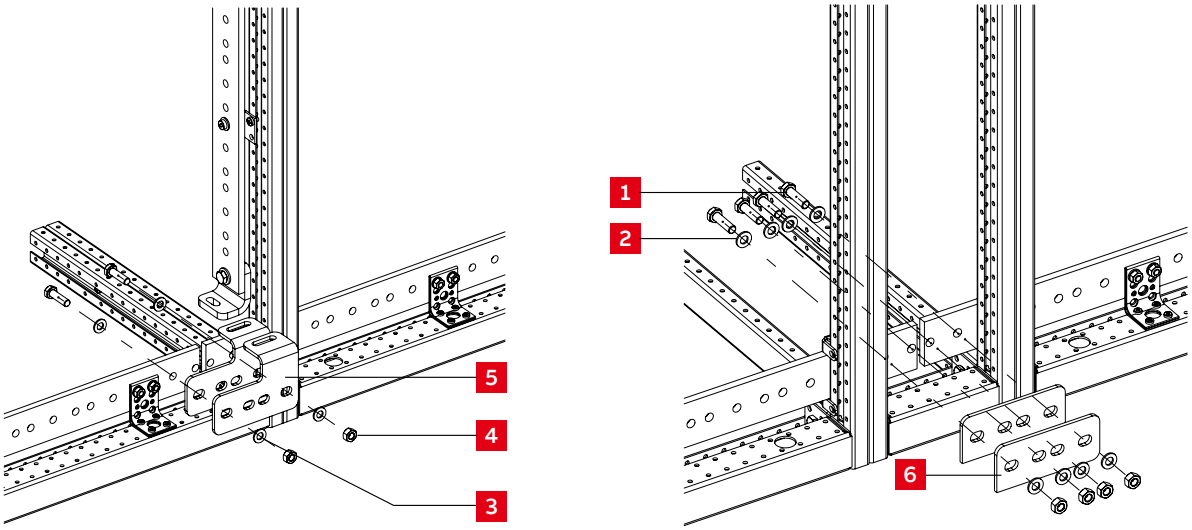


Figure 4-28 PE / PEN busbar connection

Ident.-no	Material	Additional information
1	Hexagon head bolt with ESLOK, DIN 933	M10x45 for bars 40x05 M10x55 for bars 40x10 and 60x10
2	Conical spring washer M10	
3	Conical spring washer M10	
4	Hexagon nut M10, ISO 4032	
5	Front connection set (2 layouts)	For bars 30x05 and 30x10 use only 1 layout
6	Front connection set (2 layouts)	For bars 30x05 and 30x10 use only 1 layout

Table 4-08 PE/PEN bar connection material

Screw type	Dimensions	Tightening torques	
		Nominal set value [Nm]	Max. value [Nm]
Hex socket head cap screw DIN 912, with ESLOK	M6	6,8	8
Hex head bolts DIN 931, with ESLOK	M8	17	20
Hex head screw DIN 933, with ESLOK	M10	34	40
Hex socket head cap screw ISO 4762 (DIN 912)	M12	60	70
Hex head bolts ISO 4014 (DIN 931)	M16	119	140
Hex head screws ISO 4017 (DIN 933)	M20	380	440

Table 4-09 Torque values of busbar & PE/PEN connections

Do not exceed max. tightening torques.
The testing torque is the set value of the tightening torque wrench minus 15%.

4.14.4 Example of rear access ACB incoming connections

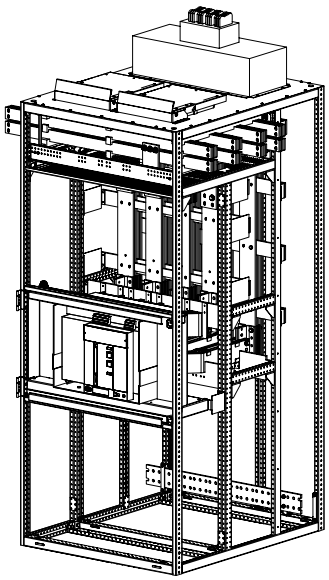


Figure 4-29 Example of busbar connection – busduct connection for MNS Rear switchgear

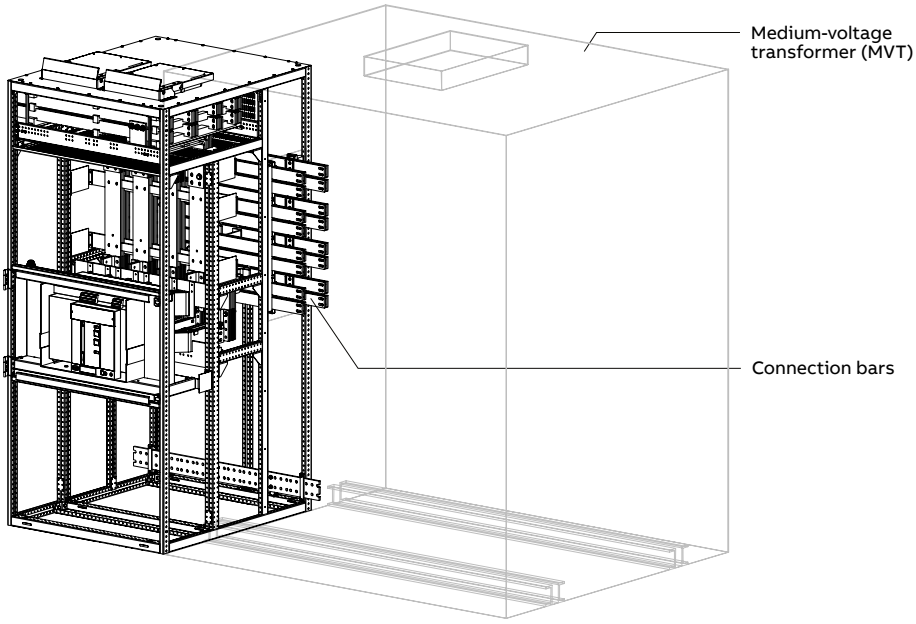


Figure 4-30 Example of busbar connection of MNS Rear switchgear to medium-voltage transformer

MNS Rear PE/PEN bar connection see Figure 4-29

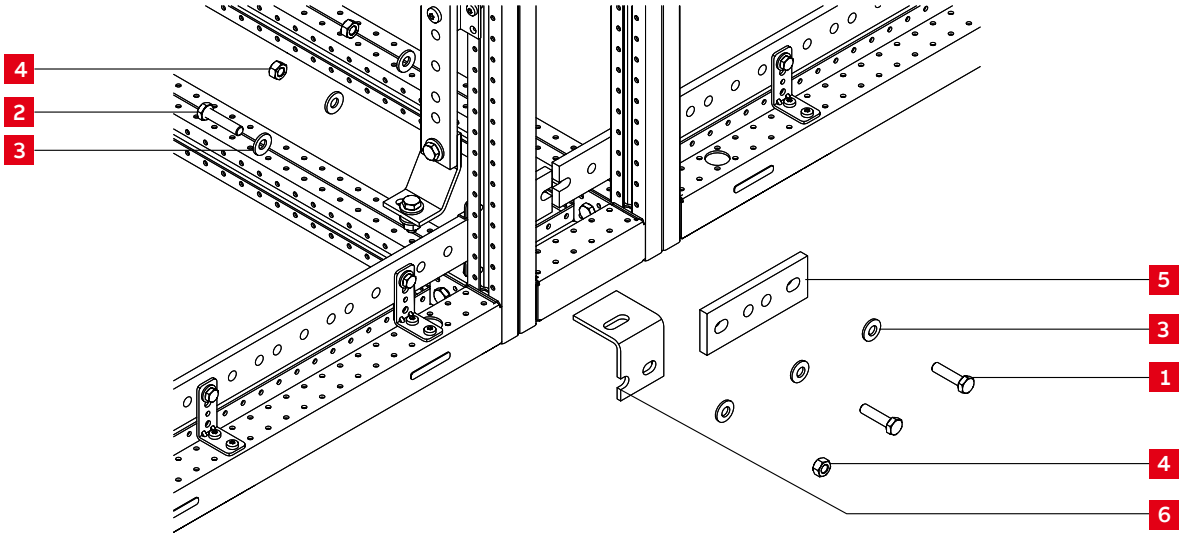


Figure 4-31 MNS Rear PE/PEN bar connection

Ident.-no	Material	Additional information
1	Hexagon head bolt ISO 4017 (DIN 933), with ESLOK	M10x40 for bars 1x…x10 (Horizontal PE/PEN bars) M10x60 for bars 2x…x10 (Horizontal PE/PEN bars)
2	Hexagon head bolt ISO 4017 (DIN 933), with ESLOK	M10x35 for bars 1x…x10 (with vertical PE/PEN bars) M10x45 for bars 2x…x10 (with vertical PE/PEN bars)
3	Conical spring washer M10, DIN 6796	–
4	Hexagon nut M10, ISO 4032	–
5	Connection bar for horizontal PE/PEN bar	Same dimension as horizontal PE/PEN bar
6	Connection bar for vertical PE/PEN bar	Dimension 60x5

Table 4-10 MNS Rear PE/PEN bar connection material

4.14.5 Screw connections with threadlocking WSH-ESLOK

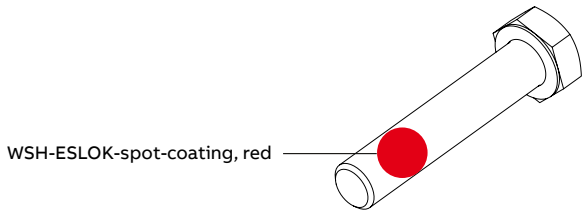


Figure 4-32 Bolt with WSH-ESLOK spot coating

For busbar screw connections ≥ M6 and frame screw connections ≥ M8, screws coated with WSH-ESLOK threadlocking compound (spot-coating) must be used.

The WSH-ESLOK-threadlocking effects by an abrasive resitant red polyamide-spot-coating and ensures an active clamped threadlocking. By the elasticity of the polyamide no rigid compound develops, so that the coating material will not be destroyed after a necessary release of the screw connection. Because of this, the screw coated with WSH-ESLOK can be reused several times (up to max. 10 × screw in and screw off). After the first screw in with a compressed air screw driver or electric screw driver the subsequent torque controlled tightening at a later time is possible without further ado, i. e. after the adjustment of the unit.

After the whole screw in, the elastic polyamide fills out completely the clearance between internal thread and external thread and achieves a high compressive load per unit area between the flanks of thread of screw and nut. This causes a high resistance against dynamic strength to the release direction.

Screws with WSH-ESLOK-coating can be stored max. 12 months at room temperature (max. 30°C).

4.14.6 Screw connections with threadlocking LOCTITE 270 or LOCTITE 263

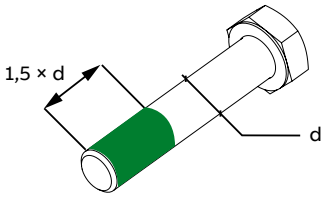


Figure 4-33 Bolt with LOCTITE spot coating

If, according to the parts list, a screw with threadlocking which is not stocked has to be used, a non-coatedscrew of otherwise the same type is to be coated with the threadlocking material LOCTITE 270/263 in accordance to the coating specification prior to assembly.

Coating specification

- The thread must not be greasy. If it is, degrease with industrial cleaner.
- Fill the gaps between the threads starting with the 2nd gap over a length of min. 1,5 × d (i. e. 12 mm for M 8, 15 mm for M10) with LOCTITE 270/263. Coating is carried out by dripping the compound onto the thread at one side along the specified length, and then turning the screw to spread the coating material. Keep the receptacles always closed after use and don't return excess coating material into the original container (risk of curing).
- The screws coated with LOCTITE 270/263 must be used immediately after coating and be tightened with the correct tightening torque. The curing of the coating starts just 5 minutes after assembly. After this period no further adjustments or settings are possible. A subsequent tightening or release of the screw is not admissible. One up to two hours after assembly, the screw is adequately locked against dynamic stresses. The joint reaches final strength after 8 up to 12 hours at the latest at room temperature (20°C).

A reuse is not permitted. If a screw coated with LOCTITE 270/263 was released out of the thread, the cured adhesive surface must be completely removed out of the thread. For the renewed assembly a new screw has to be used absolutely.

LOCTITE 270/263 is an anaerobic, single component adhesive threadlocking material, which develops high strength. The product cures rapid at room temperature when confined in the absence of air between close fitting metal surfaces.
The product can be stored max.12 months at a room temperature of + 8°C … + 21°C, if it is dry located in unopened original containers.

4.14.7 Insulated busbar installation (optional)

Where the switchboard is supplied with a heat shrink insulated busbar system, the busbar joints must be either taped with insulation tape (e.g. 3M SCOTH 2228 and / or 3M SCOTCHFIL ELECTRICAL INSULATION PUTTY) or provided with the protective cover, see Figure 4-34.

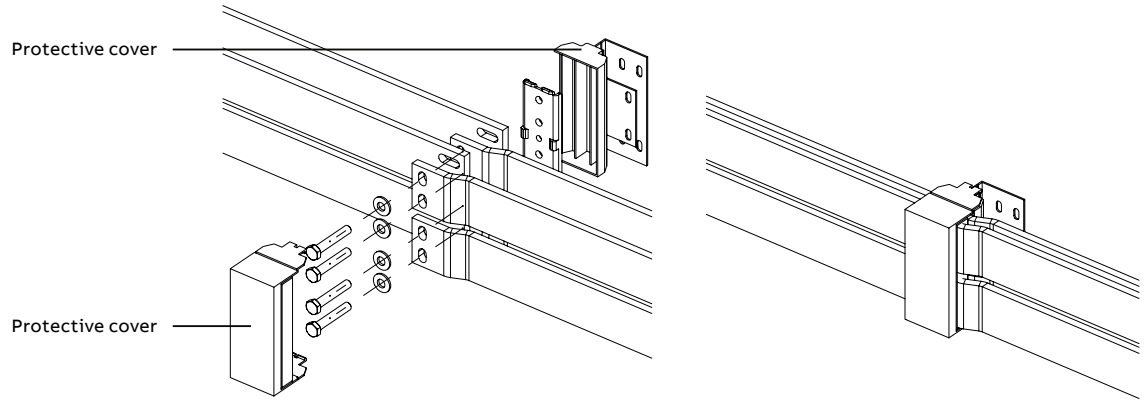


Figure 4-34 Isolated busbar connection cover

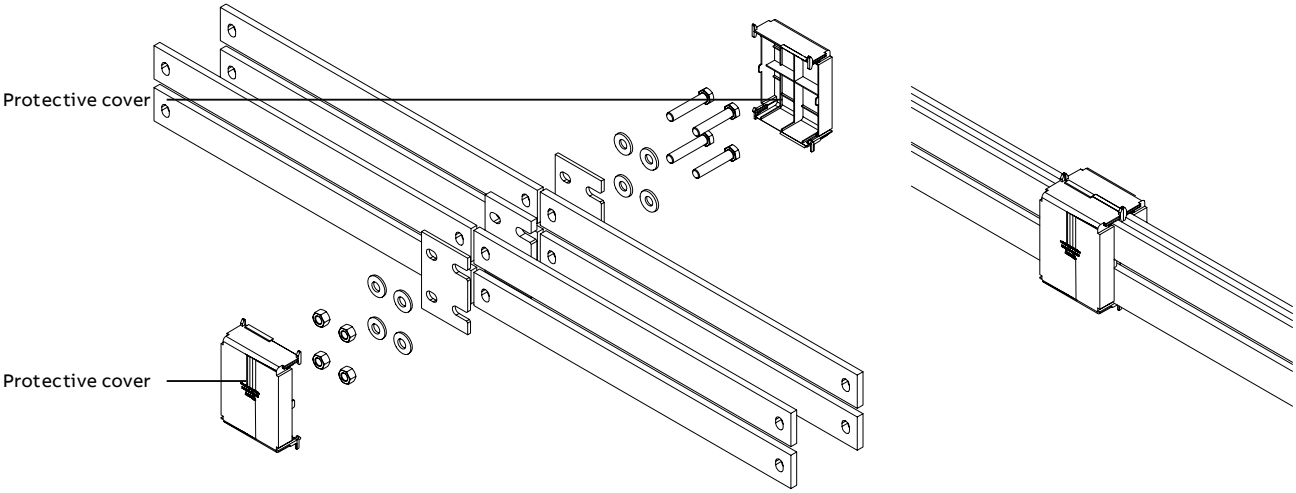
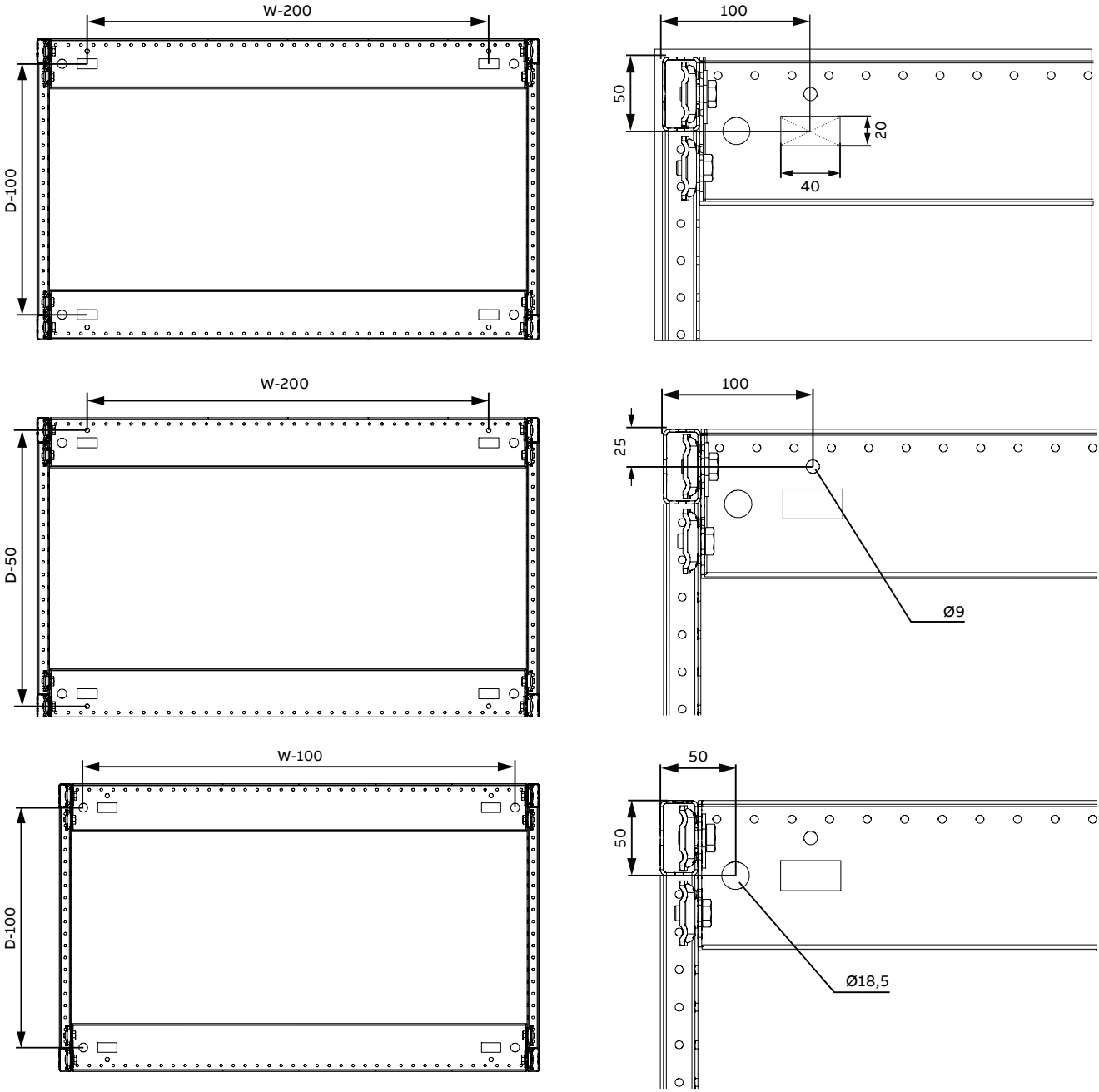


Figure 4-35 MNS Rear isolated busbar connection cover

4.15 Securing the section to the floor

MNS sections can be fixed on variety of switchroom foundation alternatives. Each foundation type requires precautions to be taken to ensure the switchboard is fixed correctly. As per common industrial usage the following foundation alternatives have been utilized with MNS Switchboards:

- Direct fixing of the switchboard or base frame to false floor,
- Direct fixing of the switchboard or base frame to UPN channel,
- Direct fixing of the switchboard or base frame to concrete floor,
- Direct fixing of the switchboard to HALFEN profile,
- Direct fixing of the switchboard to UNISTRUT profiles.



Legend
W = frame width of the section / D = frame depth of the section
All dimensions are in mm.

Figure 4-36 Detail dimensions of mounting holes

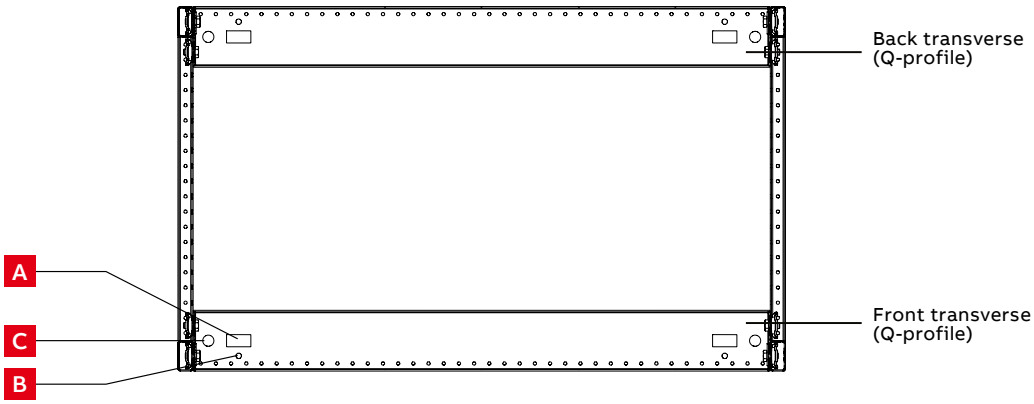


Figure 4-37 Typical installation mounting holes A, B and C

In earthquake free environments fixing of the assembly at the front traverse section only is fully acceptable for all forms of fixing.

Position	Section with bottom plate	Type of foundation / earthquake free environment		
		Concrete floor	HALFEN profile	UNISTRUT profile
Section placed back to wall	Yes	Only front transvers, opening B, fix switchgear on the left- and right hand corner and max. at a distance of 1200mm between the fixing points	Only front transvers, opening A, fix switchgear on the left- and right hand corner and max. at a distance of 1200mm between the fixing points	Only front transvers, opening C, fix switchgear on the left- and right hand corner and max. at a distance of 1200mm between the fixing points
	No			
Section placed in open space	Without dependency			

4.15.1 Direct fixing of the switchgear to false floor

When utilizing false floors as a foundation the following points must be considered:

- The tolerances of the false floor to be same as the base frame
- The floor must be firm, so that the tolerances are not exceeded by settling of the floor, especially when using insulation layers and adhesives
- The false floor shall have a carrying capacity of p = 20 kN / m2 (compression load from top to bottom)
  Care should be taken to ensure that the base sections of each section rests evenly on the supports
- Take into account the bending radius of the cables and adequate accessibility, a minimum floor height of 500 mm is recommended

4.15.2 Direct fixing of the switchgear to UPN channel

For welding the switchboard to the floor, the weld seams at the front and rear of each section should not be less than 20 mm. Then a reliable earth connection is provided. All welding must be protected against corrosion by a coat of zinc paint.

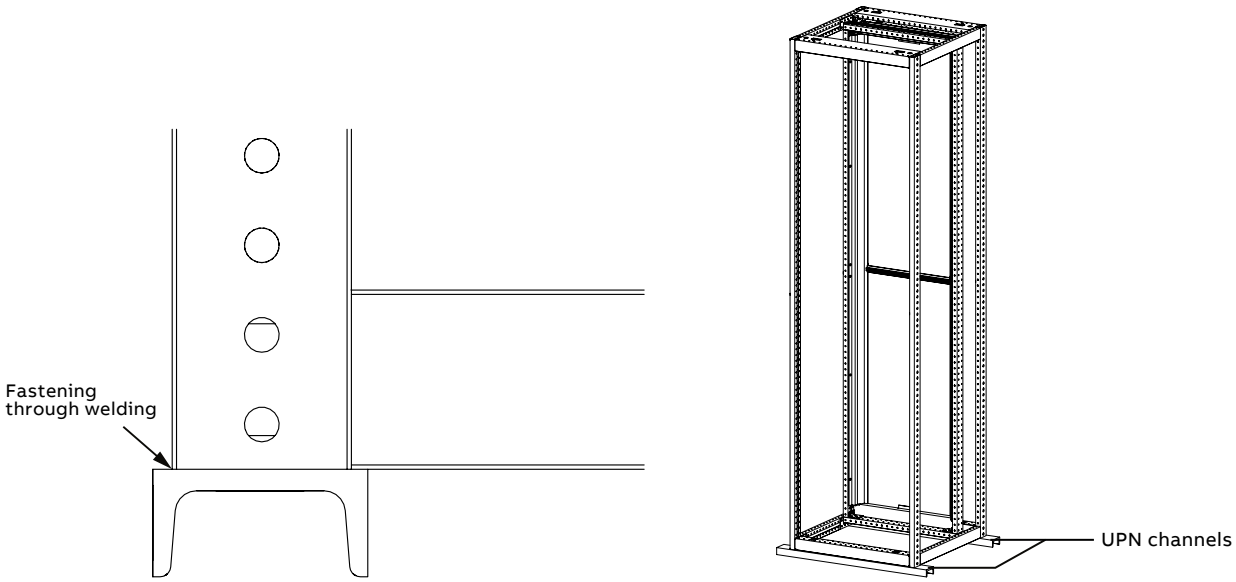


Figure 4-38 Weld seam position

4.15.3 Direct fixing of the switchgear to concrete floor

When utilizing a base frame for the switchboard installation, the holes must be drilled on site prior to moving the sections to the final destination.

The screwed connection to concrete is carried out through the holes available at the transverse section, preferred type B. Steel anchor bolts or metal straddling dowels (M8) to be used. The installer must check the location of the holes as per the general arrangement drawing of the switchboard. See Figure 4-37 for the typical fixing locations and recommended fixing points.

Mounting procedure to the concrete floor

- Produce drilled holes and clean them with air pump.
- Sink an anchor bolt on the concrete floor directly under the transverse profile hole.
- The switchboard is placed on top of the anchor bolt via the holes.
- Shim the switchboard to make sure the switchboard is levelled.
- Then tighten the anchor bolt to secure the switchboard to the floor.

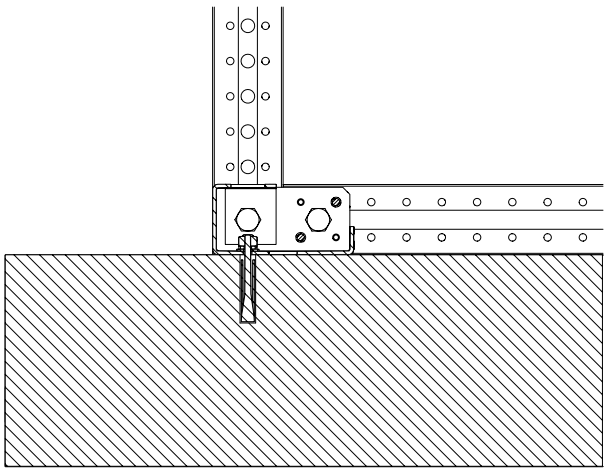


Figure 4-39 Fastening to foundation – concrete floors

4.15.4 Direct fixing of the switchgear to HALFEN / UNISTRUT channels

The switchboard can also be mounted on channels (HALFEN / UNISTRUT). It is recommended to follow the instructions of the manufacturer as well as the installation limits described previously. As general practice prior to moving the sections to their dedicated locations, the fixing apparatus of the profiles should be located as per drawings to ensure the switchboard can be fastened correctly.

- **UNISTRUT channels** allows to create false floor with huge amount of different fixing options
- **HALFEN channels** are mostly used directly in concrete floor. Allows fixing procedure without drilling holes.

Mounting procedure to HALFEN channel

- Check the tolerance over the lenght of the HALFEN channels.
- Channels must be spaced directly under the transverse profile, correct opening see Table 4-08.
- The switchboard will sit on top of the HALFEN channels.
- Place a switchgear on the channels and start levelling.
- Insert the special type of HALFEN bolt into the channel.
- Rectangular type of opening enables this foolowing the location of the switchgear on the channel.
- Place a nut and washer on the HALFEN bolt and start to tighten.
- Follow HALFEN instructions for proper tightening torque.

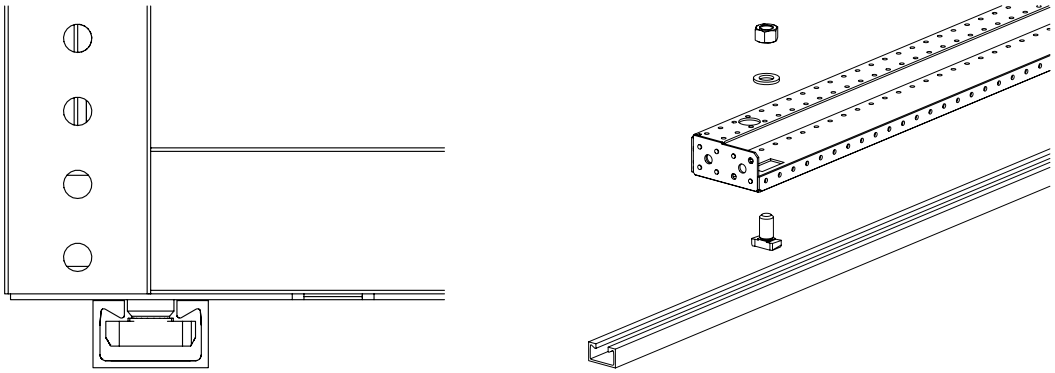


Figure 4-40 Fastening to foundation – HALFEN channel

Mounting procedure to UNISTRUT floor

- Check the flatness of the UNISTRUT channels or anchor the UNISTRUT channel directly to the floor
- Channel must be spaced directly under the transverse profile, correct opening see Table 4-08.
- The switchboard will sit on top of the UNISTRUT channels.
- Place spring nut into the UNISTRUT channel.
- Place the switchgear on the top of channels and start levelling.
- Place a bolt with washer into the UNISTRUT spring nut and start to tighten.
- Follow UNISTRUT instructions for proper tighting torque.

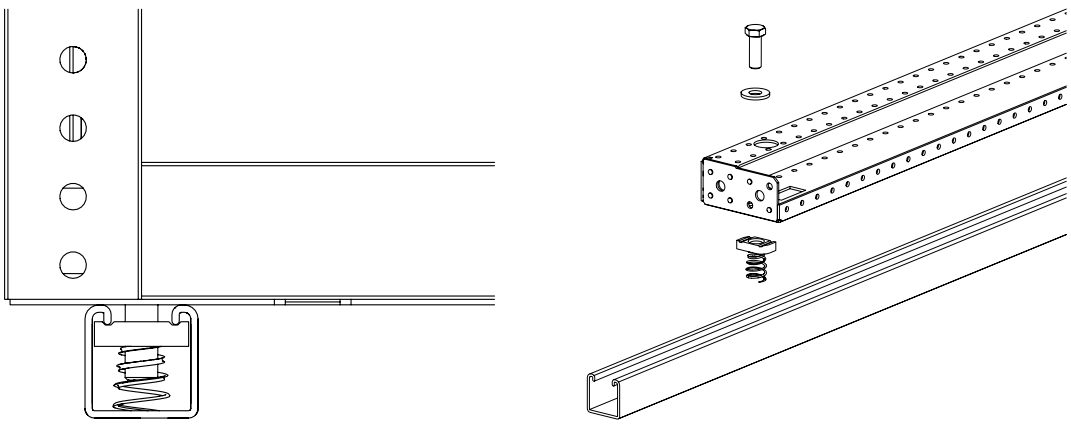


Figure 4-41 Fastening to foundation – UNISTRUT channel

NOTE ! : When utilising HALFEN / UNISTRUT profiles the following should be observed.

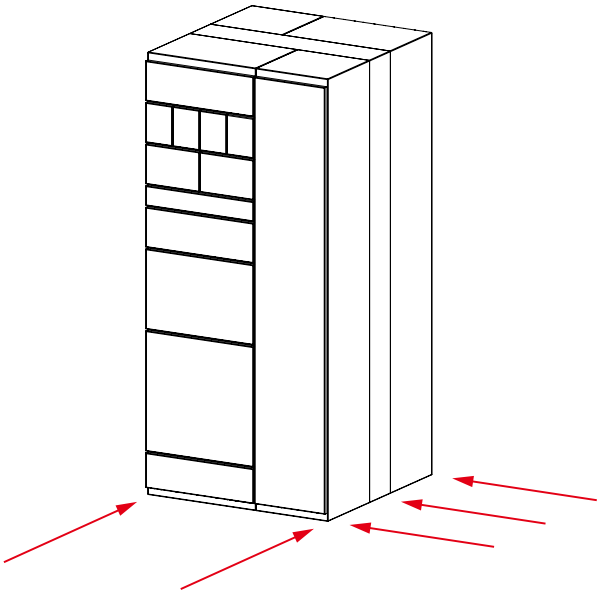


Figure 4-42 HALFEN / UNISTRUT positions for Duplex

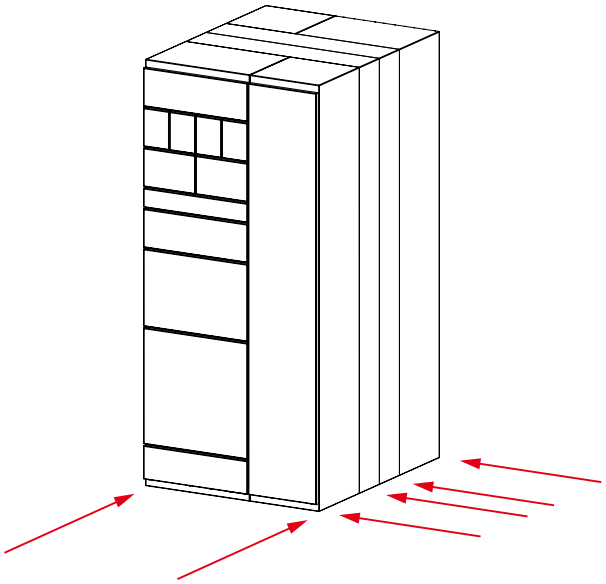


Figure 4- 43 HALFEN / UNISTRUT positions for Back to Back

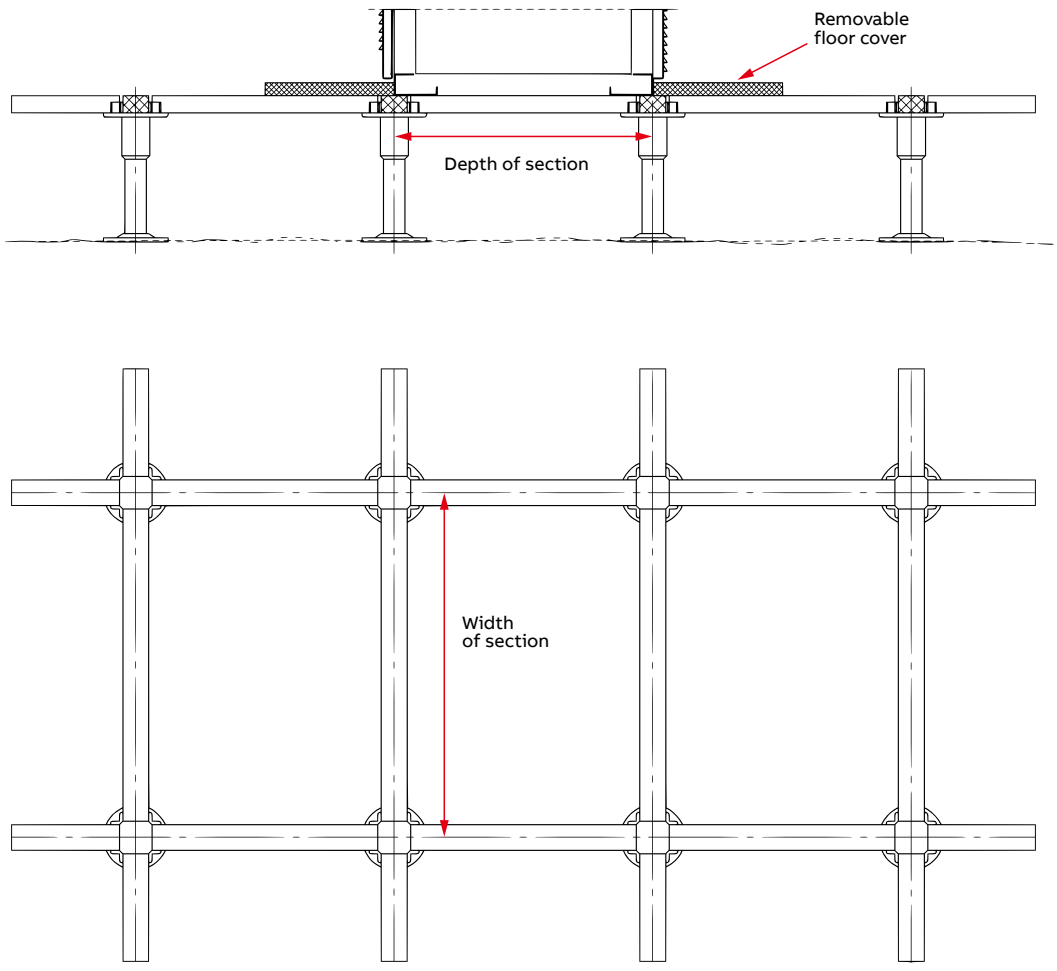


Figure 4-44 Installation on false floors

Care should be taken to ensure that the base of each section rests evenly on the supports. Taking into account the bending radius of the cables and adequate accessibility, a minimum floor height of 500 mm is recommended.

4.16 Securing the section to the floor in special environment conditions

In case of special environment conditions e.g. earthquake hazard, each section must be fixed in four points. Placing the switchgear next to the wall with 80 mm distance, prevents the access the rear transverse fixing points. The following table details possible front access solutions.

Position	Section with bottom plate	Type of foundation		
		Concrete floor	**HALFEN profile**	**UNISTRUT profile**
Section placed back to wall	Yes	Front transverse, opening B, fix switchgear on the left- and right hand corner and max. at a distance of 1200 mm between the fixing points, additional angle peg type LS, fix 2 times per section to wall	Front transverse, opening A, fix switchgear on the left- and right hand corner and max. at a distance of 1200 mm between the fixing points, additional angle peg type LS, fix 2 times per section to wall	Front transverse, opening C, fix switchgear on the left- and right hand corner and max. at a distance of 1200 mm between the fixing points, additional angle peg type LS, fix 2 times per section to wall
	No	Front transverse, opening B, fix switchgear on the left- and right hand corner and max. at a distance of 1200 mm between the fixing points, additional standard angle peg, fix 2 times per section to floor	Front transverse, opening A, fix switchgear on the left- and right hand corner and max. at a distance of 1200 mm between the fixing points, additional standard angle peg, fix 2 times per section to floor	Front transverse, opening C, fix switchgear on the left- and right hand corner and max. at a distance of 1200 mm between the fixing points, additional standard angle peg, fix 2 times per section to floor
Section placed in open space	Without dependency	Both front and back transvers, opening B, fix 4 times per section	Both front and back transvers, opening A, fix 4 times per section	Both front and back transvers,opening C, fix 4 times per section

Table 4-11 Recommendation of section foundaton fixing in earthquake environment

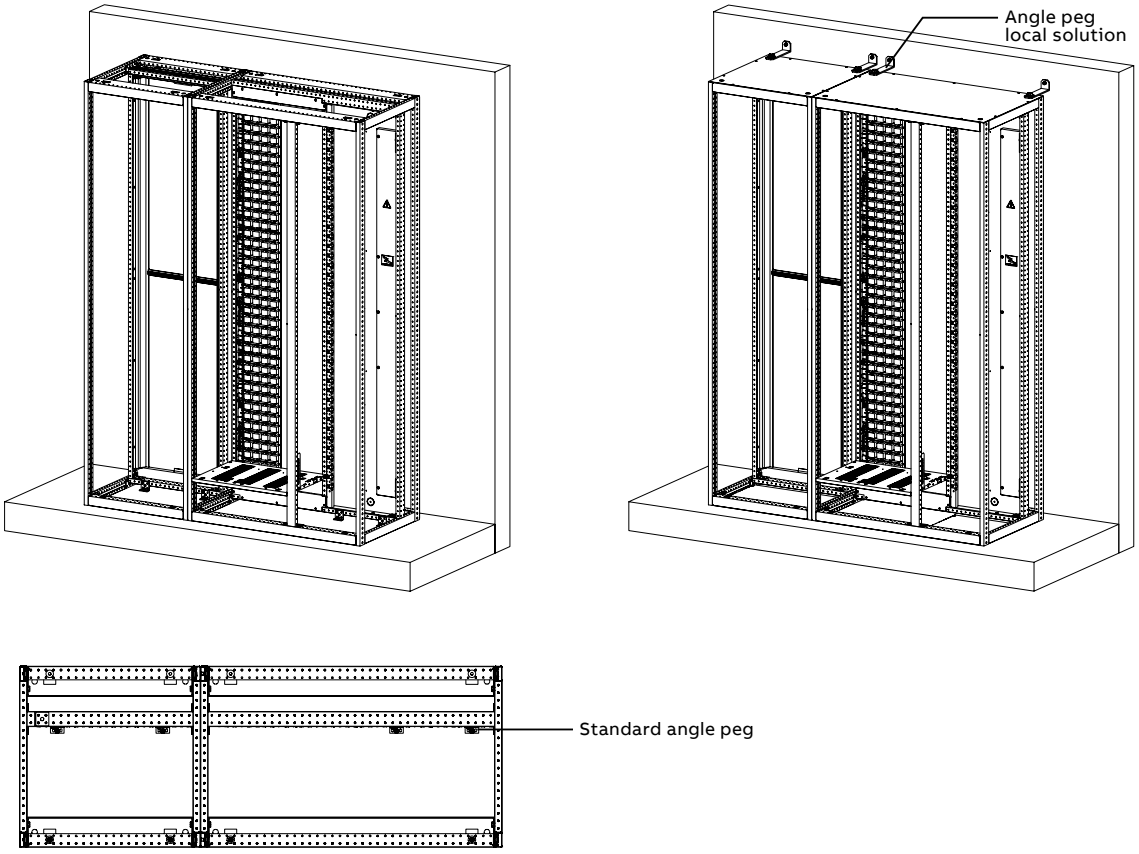


Figure 4-45 Fastening to foundation – concrete floors / each section fixed in 4 points front access design

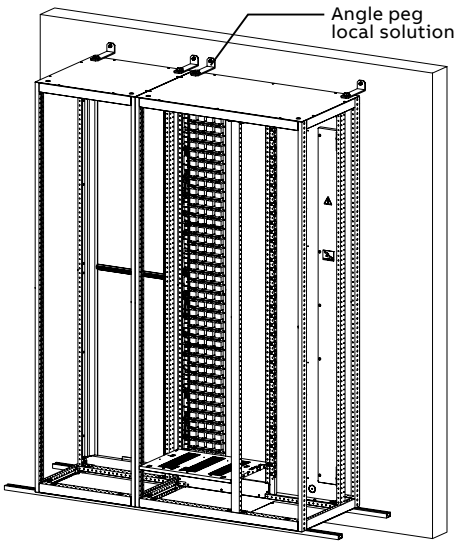


Figure 4-46 Fastening to foundation – HALFEN channel / each section fixed in 4 points

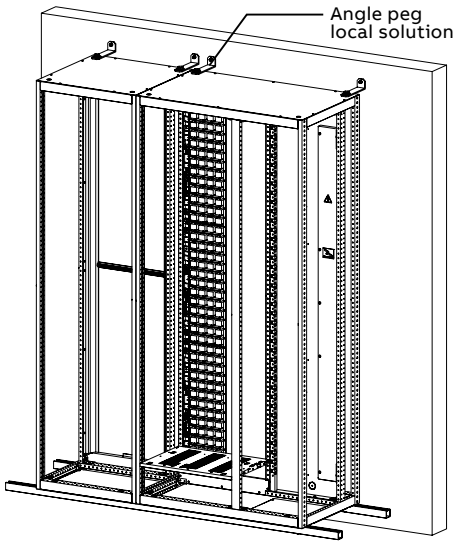


Figure 4-47 Fastening to foundation – UNISTRUT channel / each section fixed in 4 points

4.16.1 Degree of protection

Depending on the degree of protection measures are required to be taken at the erection site to seal the sections.

- For degrees of protection (IP X2 or IP 5X the bottom plate covers (flanges) shall be sealed, if not already done at the manufacturers site. To seal the bottom plate covers the self adhesive tape 15 x 2 mm shall be used which has to be applied after cleaning (see below) on the inside bending of the flanges with an overlapping distance of 3 mm to the bending.

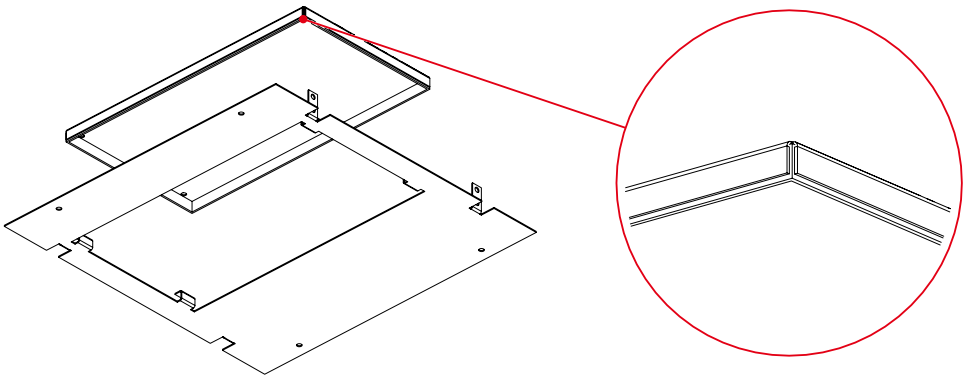


Figure 4-48 Bottom plate sealing

- For degrees of protection (IP X1 to IP X4 a sealing of the frames between the sections (section/section) at the transport division is necessary. Therefore the following measures have to be taken:
  - The connection sides of the affected frame sections have to be cleaned with Terokal R cleaner using an oil- and grease-free piece of cloth.
  - After drying of the cleaner the self-adhesive sealing tape 15 x 2 mm has to be applied to the C-sections at a distance of 3 mm from the outer edge. In addition the corner sealing is required.
  - Sealing material is supplied with the section. Use glands for cable entrances.

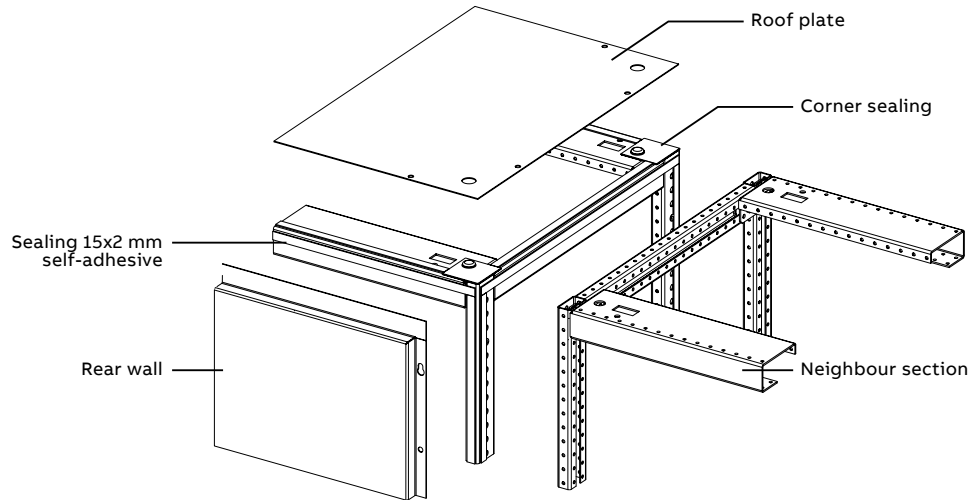
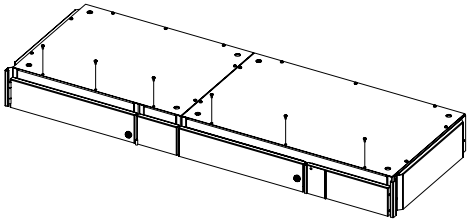


Figure 4-49 Frame sealing

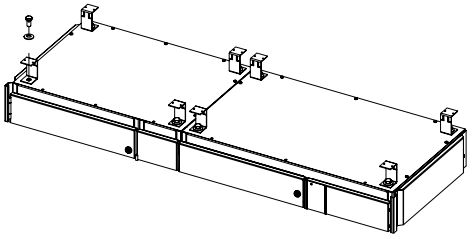
The cleaner Terokal R is inflamable. Follow the use instructions of the manufacturer.
Self adhesive sealing tape 15 x 2 mm GSIN 100021P0010

Raised roof plate IPx1/x2 installation steps with section **bottom entry**.
Raised roof plates shall be installed on site, all components are supplied as part of the project.

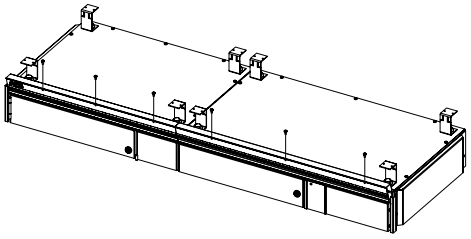
Please take care when installing the roof plates not to allow components to fall into the assembly.



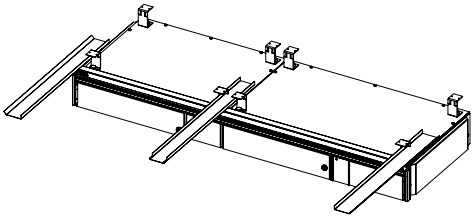
1 Demount front self tapping screw M6x10 and transporting angles from the metal mesh roof plate.



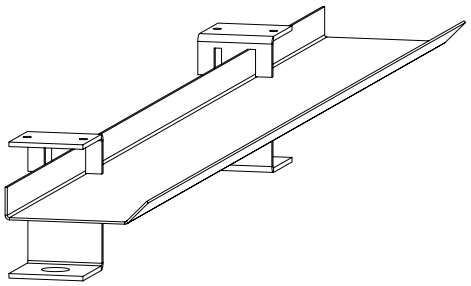
2 Mount the roof plate supports. Use the nut M16×30 and spring washer A16 from transporting angles. **Do not fully tighten.**



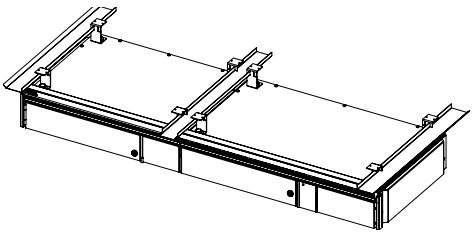
3 Mount the strip holders. Use self tapping screw M6x12.



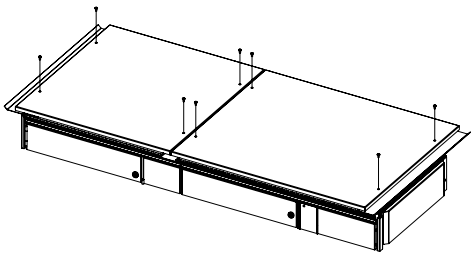
4 Slide the middle and end (left and right) gutters.



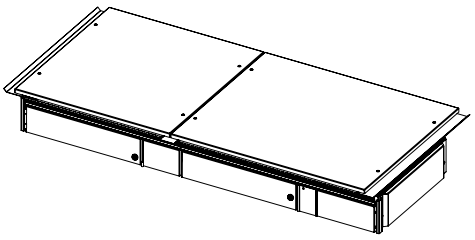
5 Detail of end gutter.



6 Once the gutters are correctly located, tighten the screws M16×30.

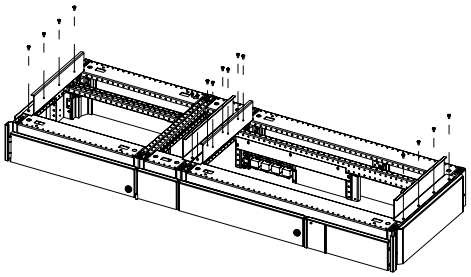


7 Mount the closed roof plates. Use self tapping screw M6x30 to fix the roof plates (4 pieces per section).

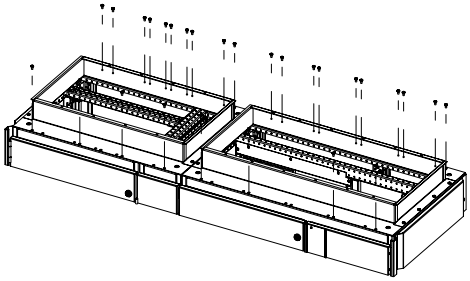


8 Raised roof plate IPx1 / x2 for section bottom entry.

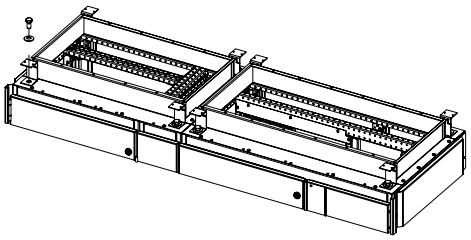
Raised roof plate IPx1/x2 installation steps with section **top entry**.



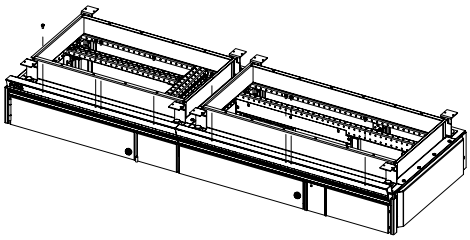
1 Demount transporting angles and start with mounting roof side plates.
Fix with self tapping screws M6x10 (8 pieces per section).



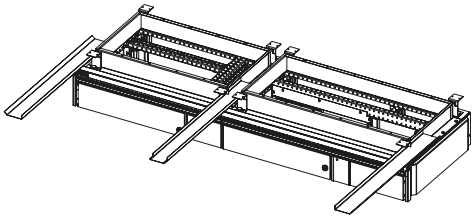
2 Continue with mounting the front and rear plates.
Fix with self tapping screws M6x10 (14 pieces per section).
Fix the side panels with the front and rear panels with rivets 3,2 x 7,5 (8 pieces per section)



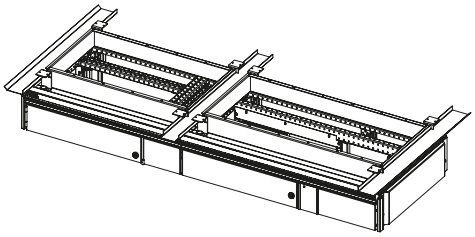
3 Mount the roof plate supports. Use the nut M16×30 and spring washer A16 from transporting angles. **Do not fully tighten.**



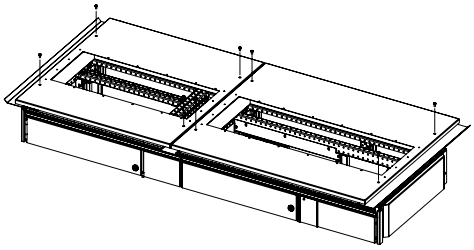
4 Mount the strip holders. Use self tapping screw M6x12.



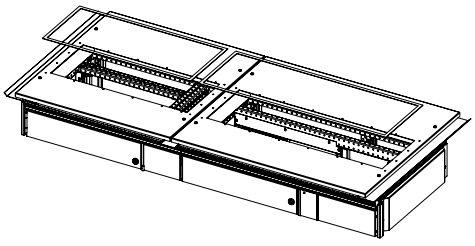
5 Slide the middle and end (left and right) gutters. For detail see the mounting instruction for section with bottom entry.



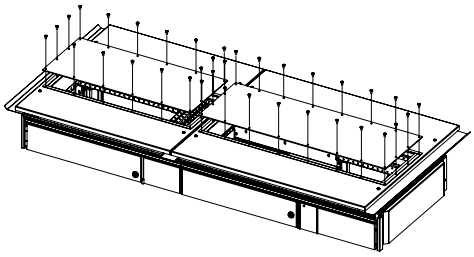
6 Once the gutters are correctly located, tighten the screws M16×30.



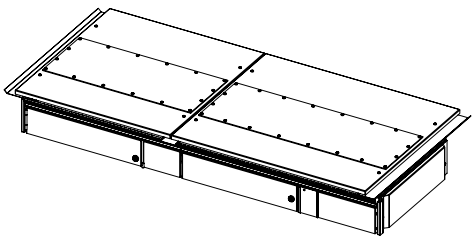
7 Place the roof plates with top entry cut outs. Use hexalobular self tapping screw M6x30 to fix the roof plates (4 pieces pre section).



8 Clean and hare 15×2 mm self-adhesive sealing under the cover plate.

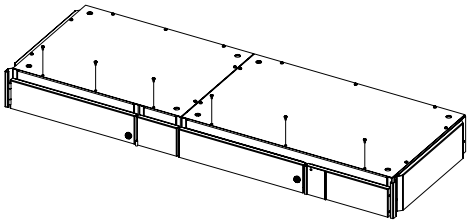


9 Mount the cover plate with prepared holes and glands for cable entrance.
Fix with self tapping screw M6x12 (16 pieces per section).

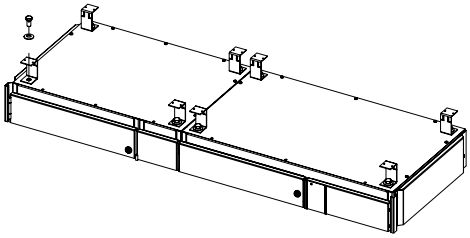


10 Raised roof plate IPx1 / x2 for section top entry.

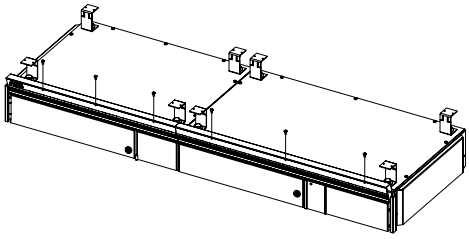
Raised roof plate IP43 installation steps with section **bottom entry**.



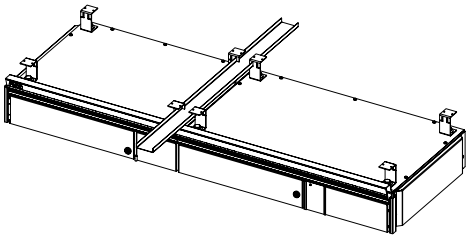
1 Demount front self tapping screw M6x10 and transporting angles from the metal mesh roof plate.



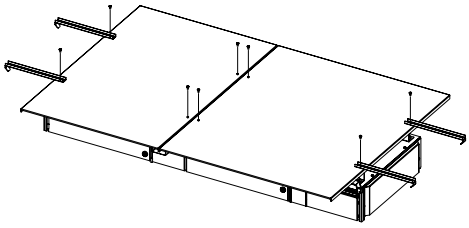
2 Mount the roof plate supports. Use the nut M16×30 and spring washer A16 from transporting angles. **Do not fully tighten.**



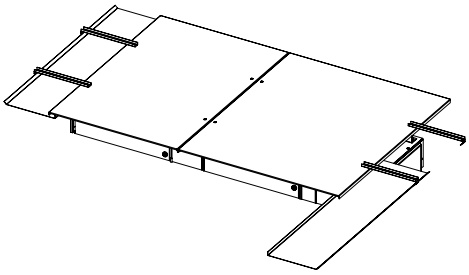
3 Mount the strip holders. Use self tapping screw M6x12.



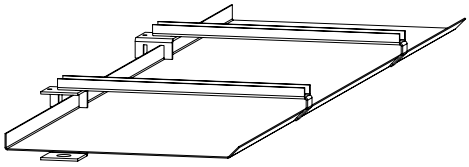
4 Slide the middle gutters. Once the gutters are correctly located, tighten the screws M16×30.



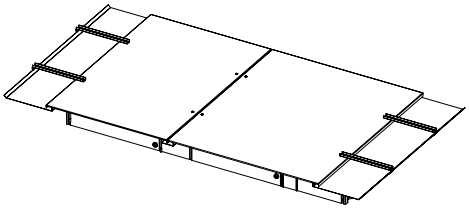
5 Mount the closed roof plates with gutter support.
Use self tapping screw M6x30 to fix the roof plates (4 pieces per section).



6 Slide the end gutters. Once the gutters are correctly located, tighten the screws M16×30.

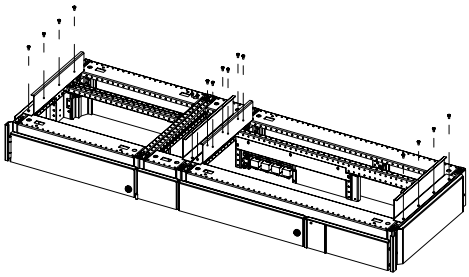


7 Detail of end gutter.

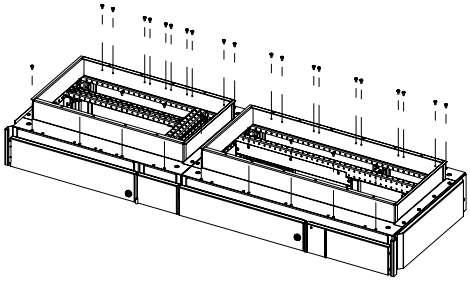


8 Raised roof plate IP43 for section bottom entry.

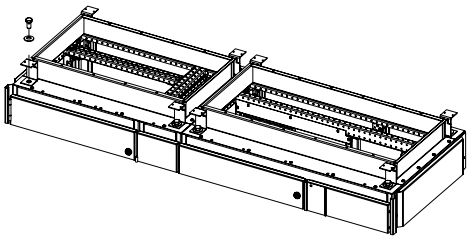
Raised roof plate IP43 installation steps with section **top entry**.



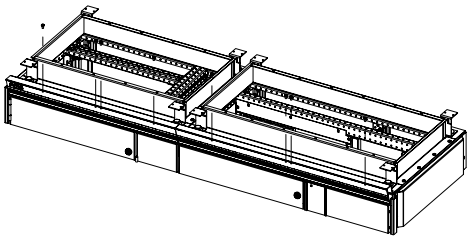
1 Demount transporting angles and start with mounting roof side plates.
Fix with self tapping screws M6x10 (8 pieces per section).



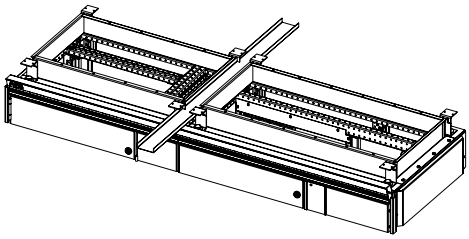
2 Continue with mounting the front and rear plates.
Fix with self tapping screws M6x10 (14 pieces per section).
Fix the side panels with the front and rear panels with rivets 3,2 x 7,5 (8 pieces per section)



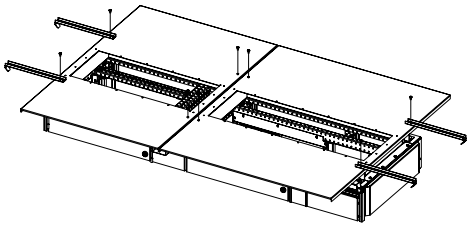
3 Mount the roof plate supports. Use the nut M16×30 and spring washer A16 from transporting angles. **Do not fully tighten.**



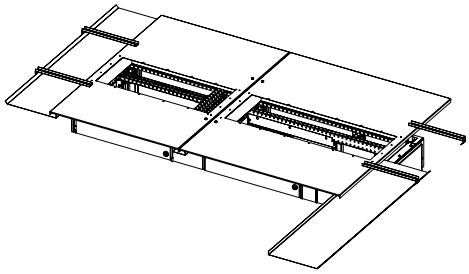
4 Mount the strip holders. Use self tapping screw M6x12.



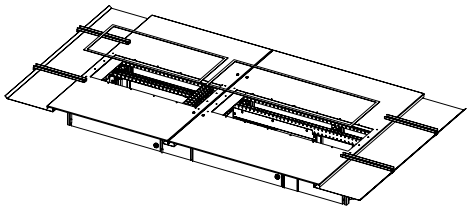
5 Slide the middle. Once the gutters are correctly located, tighten the screws M16×30.



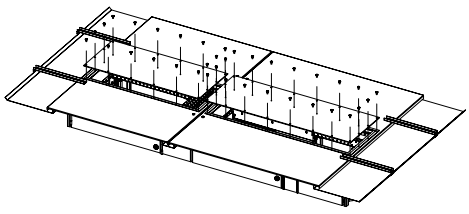
6 Place the roof plates with cut outs with gutter support.
Use self tapping screw M6x30 to fix the roof plates (4 pieces per section).



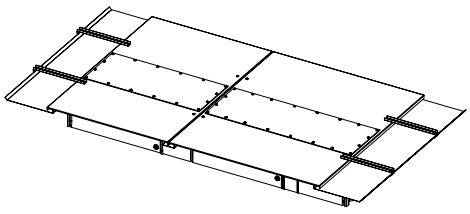
7 Slide the end gutters. Once the gutters are correctly located, tighten the screws M16×30.



8 Clean and apply the 15×2 mm self-adhesive sealing under the cover plate.



9 Mount the cover plate with prepared holes and glands for cable entrances.
Fix with self tapping screw M6x12 (16 pieces per section).



10 Raised roof plate IP43 for section top entry.

Danger sign “KEEP OFF“ for raised roofs

It is required to attach the supplied labels „Keep off“ due to the risks associated when accessing the roof. The roof plate is not designed to be load bearing. Do not place any heavy objects on the roof plate during assembly, as this will result in deformation of the roof plate. This could result in water accumulation and corrosion.

Figure 4-50 Danger sign “KEEP OFF”

4.16.2 Field cable or busduct installation – incoming / outgoing full size sections front access construction

- Full size sections are equipped with cable connections as well as cable supports.
- If required, use suitable glands as per local regulations.
- The cables must be torqued as per the Table 4-12
- For section busduct connections, qualified supervisor must be present during installation to ensure compliance to the manufacturer’s guidelines.
- Busduct assemblies must be supported adequately to ensure no weight is supported by the section.

Screw type	Dimensions	Tightening torques	
		Nominal set value [Nm]	Max. value [Nm]
Hex socket head cap screw DIN 912, with ESLOK	M6	6,8	8
Hex head bolts DIN 931, with ESLOK	M8	17	20
Hex head screw DIN 933, with ESLOK	M10	34	40
Hex socket head cap screw ISO 4762 (DIN 912)	M12	60	70
Hex head bolts ISO 4014 (DIN 931)	M16	119	140
Hex head screws ISO 4017 (DIN 933)	M20	380	440

Table 4-12 Torque values of busbar & PE/PEN connections

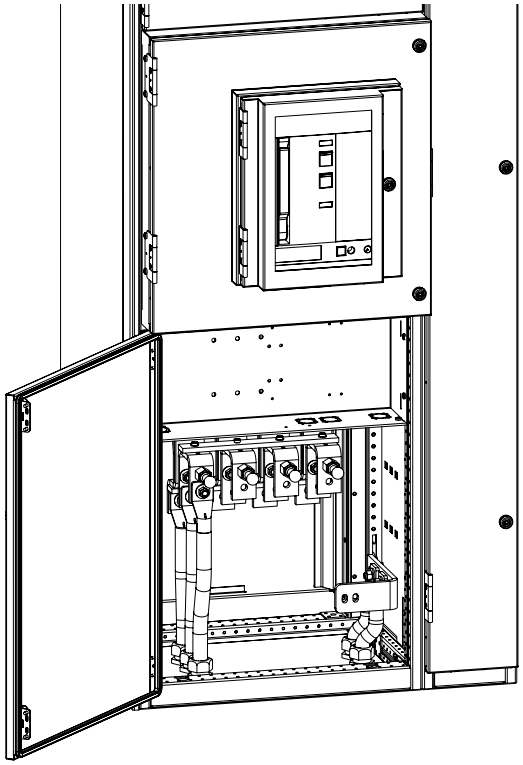


Figure 4-51 Example of cable connection in incoming / outgoing ACB unit

Minimum amount of main cables

To comply with cross section for current ratings the minimum amount of external I/O main cables shall be utilised. MNS standardized solutions are 300 mm², 500 mm² and 630 mm² for other please contact ABB local representative.

<table>
<tr><th rowspan="3">Type
of Emax2</th><th colspan="6">Minimum recommended amount of cables</th></tr>
<tr><th colspan="2">per 25% PE</th><th colspan="2">per 50% PEN/N</th><th colspan="2">per one phase or 100% N</th></tr>
<tr><th>300 mm²</th><th>500/630 mm²</th><th>300 mm²</th><th>500/630 mm²</th><th>300 mm²</th><th>500/630 mm²</th></tr>
<tr><td>E1.2 630 A</td><td rowspan="4">1</td><td rowspan="13">1</td><td rowspan="4">2</td><td>1</td><td rowspan="4">4</td><td rowspan="3">2</td></tr>
<tr><td>E1.2 800 A</td><td rowspan="3">2</td></tr>
<tr><td>E1.2 1000 A</td></tr>
<tr><td>E1.2 1250 A</td><td>3</td></tr>
<tr><td>E1.2 1600 A</td><td rowspan="12">2</td><td rowspan="3">3</td><td rowspan="6">2</td><td rowspan="3">6</td><td rowspan="3">4</td></tr>
<tr><td>E2.2 1600 A</td></tr>
<tr><td>E2.2 2000 A</td></tr>
<tr><td>E 2.2 800 A</td><td rowspan="3">2</td><td>1</td><td rowspan="3">4</td><td rowspan="2">2</td></tr>
<tr><td>E2.2 1000 A</td><td rowspan="3">2</td></tr>
<tr><td>E2.2 1250 A</td><td>3</td></tr>
<tr><td>E2.2 1600 A</td><td>3</td><td>6</td><td rowspan="2">4</td></tr>
<tr><td>E2.2 2000 A</td><td rowspan="4">4</td><td rowspan="4">8</td></tr>
<tr><td>E2.2 2500 A</td><td>2</td><td>3</td><td>6</td></tr>
<tr><td>E4.2 2000 A</td><td>1</td><td>2</td><td>4</td></tr>
<tr><td>E4.2 2500 A</td><td rowspan="2">2</td><td>3</td><td>6</td></tr>
<tr><td>E4.2 3200 A</td><td rowspan="3">3</td><td rowspan="3">6</td><td>4</td><td rowspan="3">12</td><td>7</td></tr>
<tr><td>E4.2 4000 A</td><td rowspan="2">3</td><td>5</td><td rowspan="2">8</td></tr>
<tr><td>E6.2 4000 A</td></tr>
<tr><td>E6.2 5000 A</td><td>4</td><td>8</td><td>6</td><td>16</td><td>11</td></tr>
<tr><td>E6.2 6300 A</td><td>6</td><td>4</td><td>12</td><td>7</td><td>24</td><td>12</td></tr>
</table>

Table 4-13 Minimum recommended amount of cables

Connection point for main cables is designed for cable lugs acc. DIN 46235:

- For 300 mm² cables the hole in the copper connection is Ø14 mm for screws M12.
- For 500/630 mm² cables the hole in the copper connection is Ø22 mm for screws M20. This option depends upon the ACB solution supplied.

Location of external main cable connection point
For external main cables connection cable units are designed according connection type.

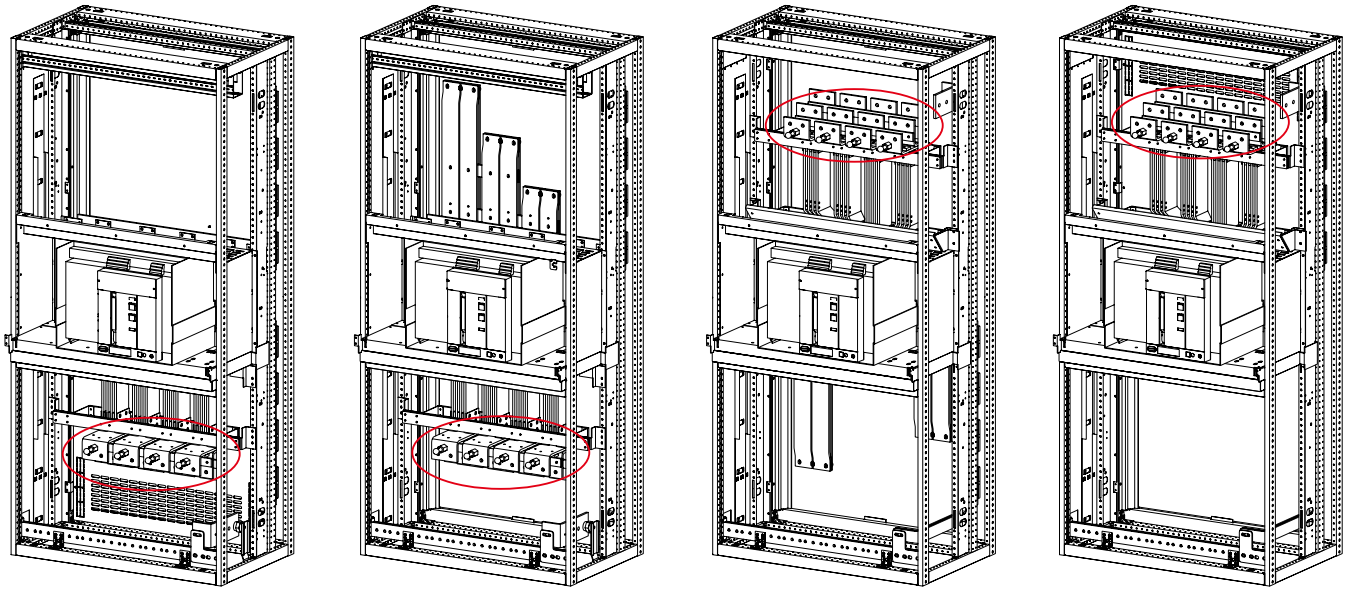


Figure 4-52 Location of cable bars acc. connection types

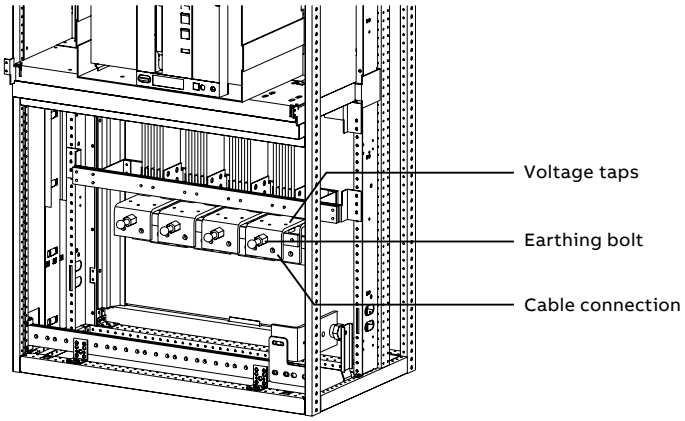


Figure 4-53 Main cable connections

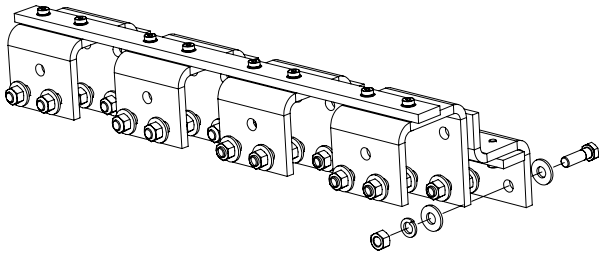


Figure 4-54 Cable connection unit with fixing material (1 spring lock washer and 2 plain washers)

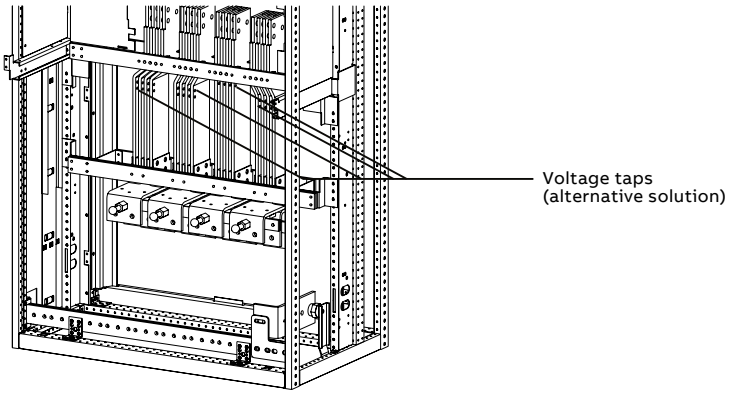


Figure 4-55 Main cable connections high performance sections

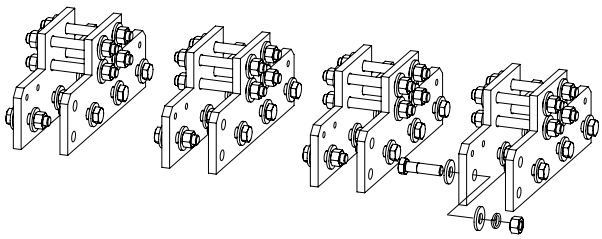


Figure 4-56 Cable connection unit with connection material for high performance sections (1 spring lock washer and 2 plain washers)

Location of control cables for ACB sections
For external control cables there are two wiring ducts situated in section. The vertical on the right side and the horizontal on the top of the section. The vertical wiring duct on the right side consists of three plastic tubes with external diameter 25 mm.

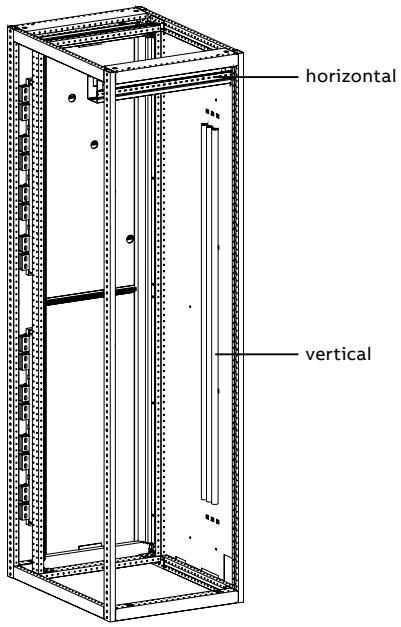


Figure 4-57 Position of vertical and horizontal wiring duct for customer external cables

Important:
It might be required to separate control and serial communication cables. Consider this requirement before using all tubes for control cabling.

Extra length of control cables
With installation of control cables into auxiliary recces always consider extra length of this cables because of auxiliary compartment operation movement. Minimum recommendation is 0,5 m.

Field cable or busduct installation – incoming / outgoing full size sections rear access configuration

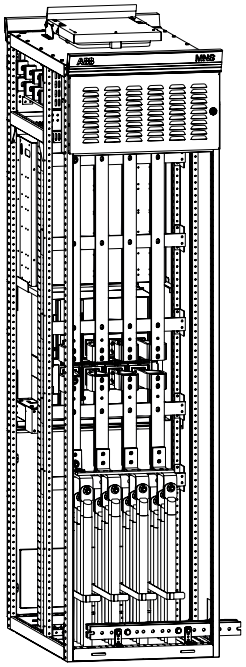


Figure 4-58 Example of cable connection in material for incoming / outgoing MNS Rear ACB unit

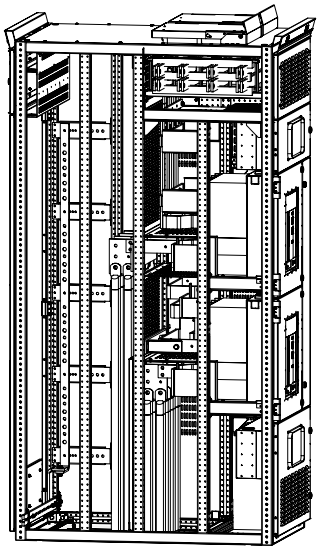


Figure 4-59 Example of cable connection in MNS Rear stacked section

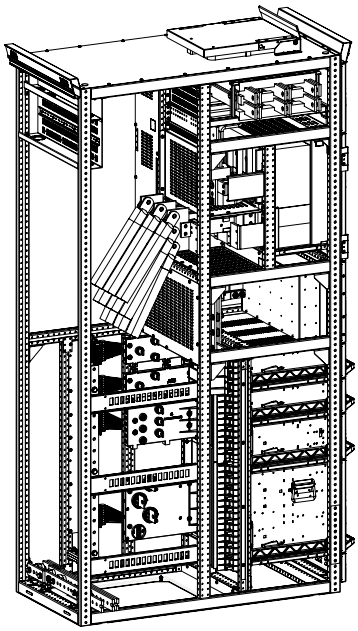


Figure 4-60 Example of cable connection in MNS Rear combined ACB and withdrawable modules section

To comply with cross section for current ratings the minimum amount of external I/O main cables shall be utilized. MNS Rear standardized solutions are 300 mm2. For others refer to project specific documentation.

Type of Emax 2	Maximum cable quantity per phase or 100%N 300 mm²
E1.2 630-1000 A	4
E1.2 1250 A	4
E1.2 1600 A	6
E2.2 800-1250 A	4
E2.2 1600 A	6
E2.2 2000 A	6
E2.2 2500 A	8
E4.2 3200 A	8
E4.2 4000 A	12 (single ACB) or 8 (double stacked ACB)
E6.2 4000 A	12
E6.2 5000 A	18
E6.2 6300 A	24

Table 4-14 Maximum cable quantity per phase or 100%N for MNS Rear ACB solutions

In MNS Rear ACB solutions, connection point for main cables is designed for cable lugs according to DIN 46235:

- For E1.2, E2.2, the hole in the copper connection is Ø13 mm for screws M12.
- For E4.2, E6.2, the hole in the copper connection is Ø17 mm for screws M16.

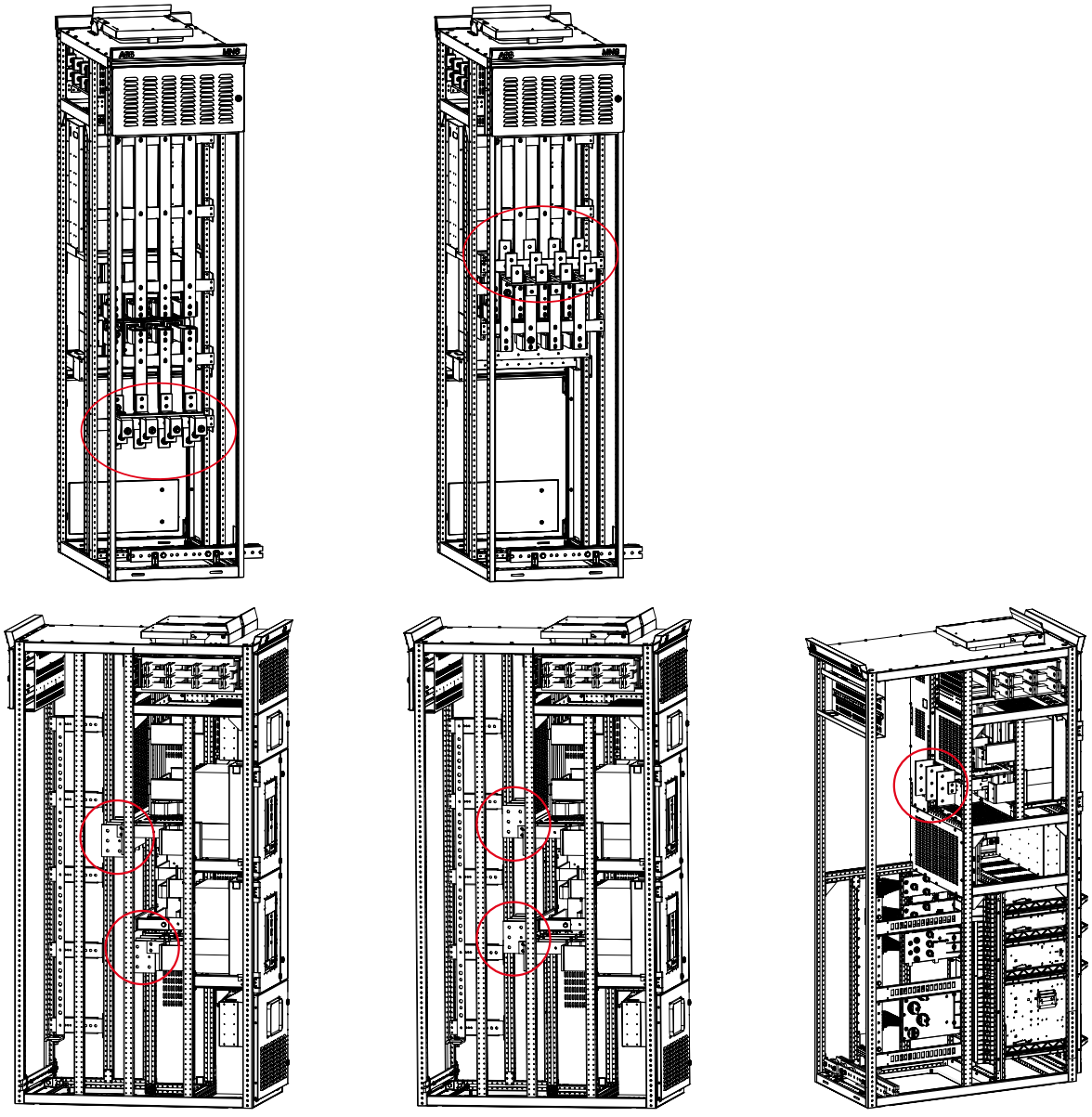


Figure 4-61 Location of MNS Rear cable bars acc. connection types

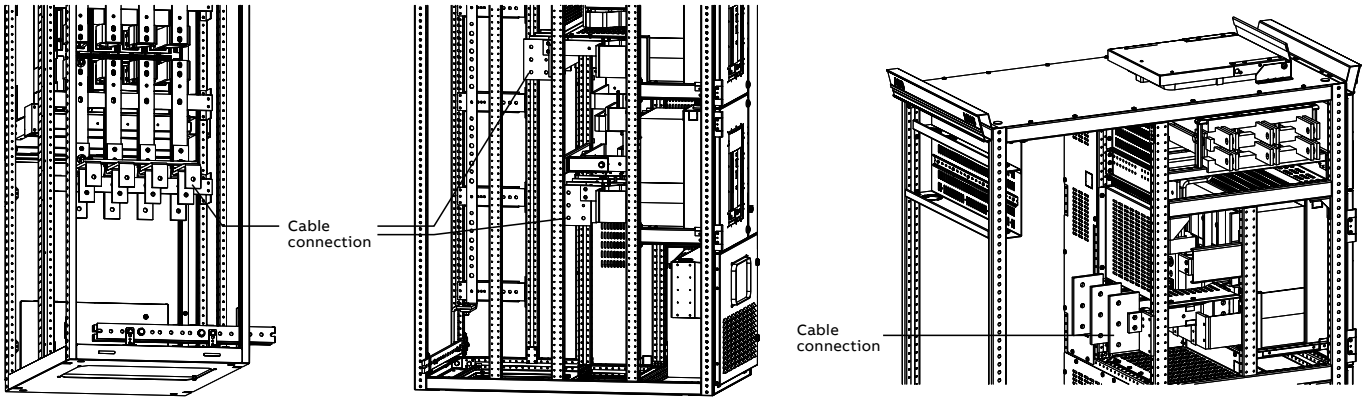


Figure 4-62 MNS Rear cable connections

In MNS Rear switchgear, there is a control wiring duct situated in the section for external control cables. It is installed horizontally at the rear upper part of the section. The control wiring duct has two layers which can be used for control and communication cables.

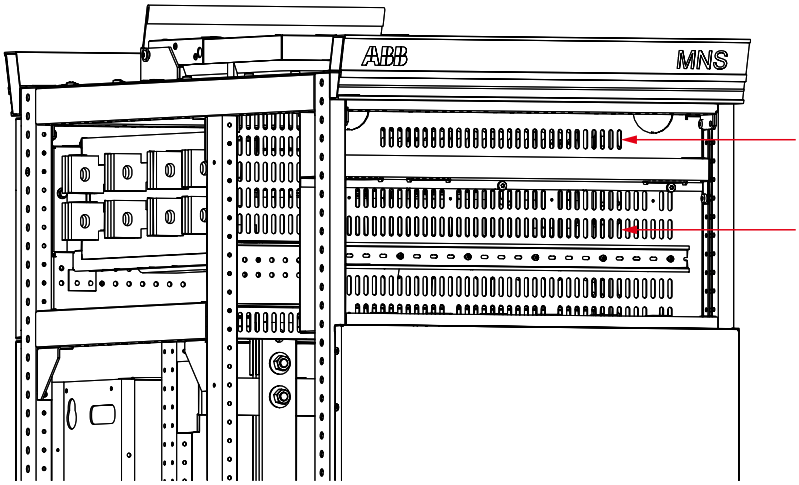


Figure 4-63 Position of MNS Rear control wiring duct for customer external cables. Two wiring ducts are available upper and lower.

Note:
It might be required to separate control and serial communication cables. Consider this requirement before using both layers for control cabling.

4.16.3 Power and control cable installation

- The power and control cable connection to the modules are routed through the cable compartment.
- Cables entering the section must be securly fixed. It shall be also ensured that the integrity of the protection class is maintained.
- Connection material and barriers are supplied with the switchgear separately.
- Cables must be laid neatly and supported throughout its path until its final connection point. Before final connection of the cables at the power terminals they must be supported so that no tension or pressure is exerted on the point of final terminantion.
- Cables for full width withdrawable module size 4E and above are provided with bellows that are used for insulation purposes. Cables must be fitted with bellows before fastening to the cable connection unit. Bellows must be fitted to ensure exposed connections are and secured with a cable tie. See Figure 4-66.
- Connections must be fastened as per table 4-15.

Do not exceed max. tightening torques.
The testing torque is the set value of the tightening torque wrench minus 15%.

Note:
The form of separation and type of functional unit and cable connections can vary in the same section please refer to the project specific documentation.

Module size	Number of poles	I_{nc} [A]	Max. number of cables and cross section per phase [mm²]	Max. tightening torque [Nm]
8E4	3	45	1 x 16	–
8E4	4	45	1 x 10	–
8E2	3	63	1 x 35	–
8E2	4	63	1 x 35	–
8E2	6	63	1 x 16	–
4E	3	63	1 x 25	–
6E	3	250	2 x 120 (M10×30)	40
≥ 8E	3	160	2 x 120 (M10×30)	40
		400	2 x 240 (M12×35)	70
≥ 12E	3	630	2 x 240 (M12×35)	70
≥ 8E	4	160	2 x 120 (M10×30)	40
		250	2 x 120 (M10×30)	40
≥ 16E	4	400	2 x 240 (M12×35)	70
≥ 24E	4	630	2 x 240 (M12×35)	70
= 8E	6	160	2 x 120 (M10×30)	40
= 12E	6	250	2 x 120 (M10×30)	40
≥ 16E	6	160	2 x 120 (M10×30)	40
		400	2 x 240 (M12×35)	70

Table 4-15 Torque values of power cable connections – module section (incomming/outgoing)

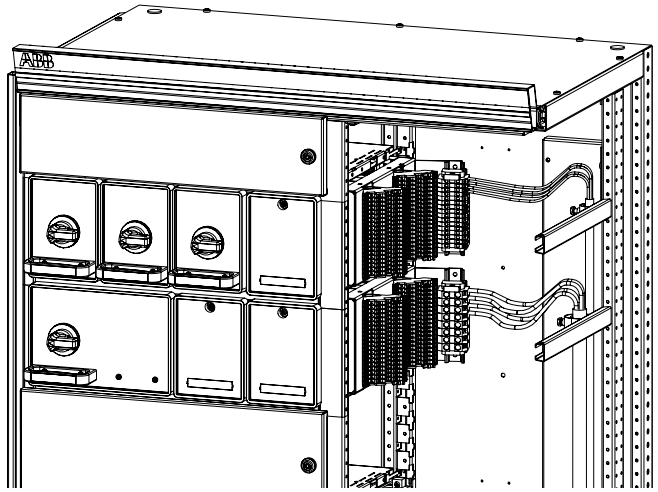


Figure 4-64 Example of cable runs, withdrawable module size 8E/4 and 8E/2

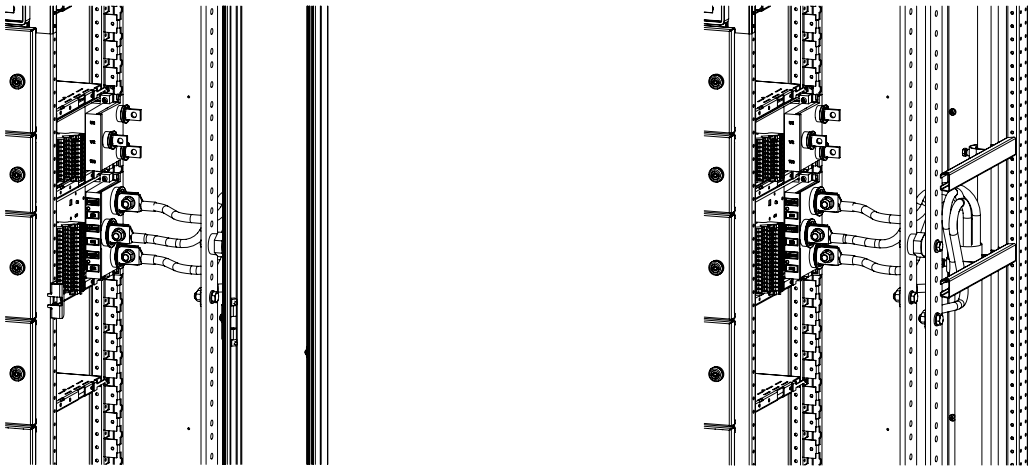


Figure 4-65 Example of cable runs, withdrawable module size ≥ 4E

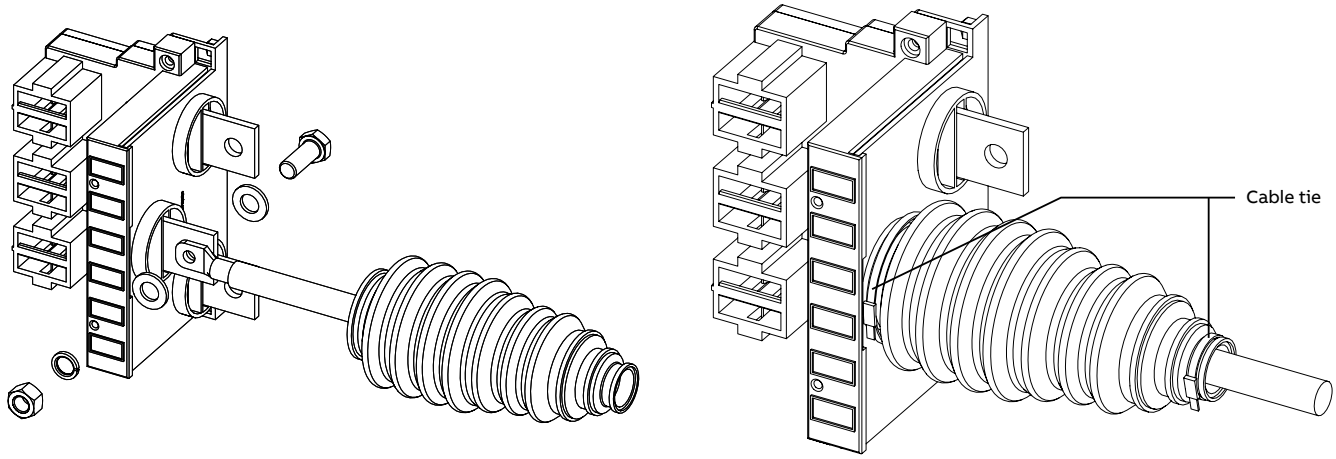


Figure 4-66 Cables provided with bellows for ≥ 4E withdrawable modules and fixing material (1 spring lock washer and 2 plain washers)

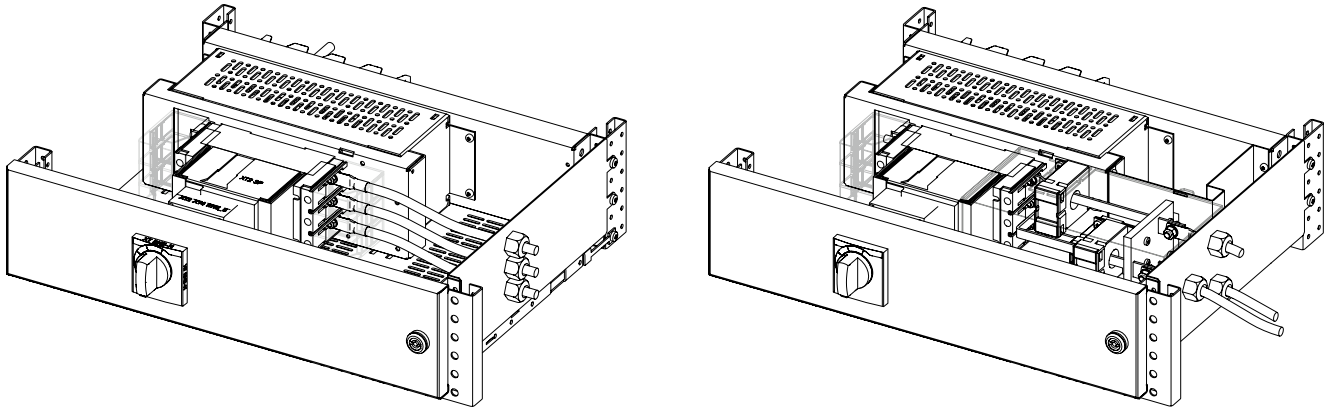


Figure 4-67 Example of plug-in module cable connection

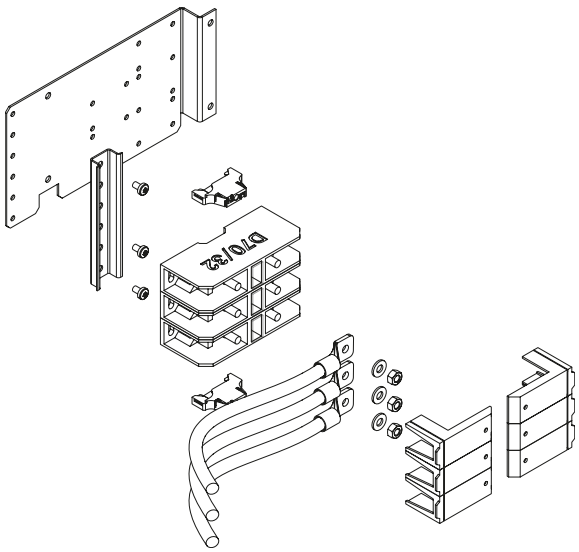


Figure 4-68 Example of MNS Rear fixed module cable connection with terminal blocks

Note: For Fixed type cable connections.

Termination inside the cable compartment is similar to Figure 4-66
Termination inside the module is similar to Figure 4-67

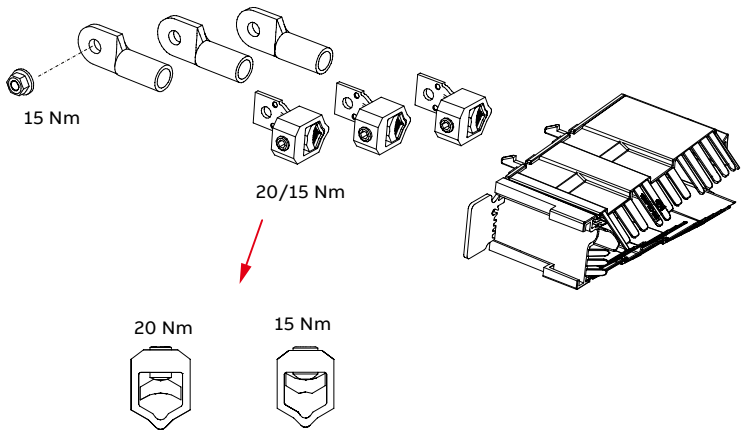
4.16.4 Power cable installation – SlimLine modules

The XR is delivered with bolts as standard for connection of cables with lugs. Cable clamps for Al/Cu -cables are together with cable shorud available as accessories. For more details please refer to title document number 1SEC311001C0201.

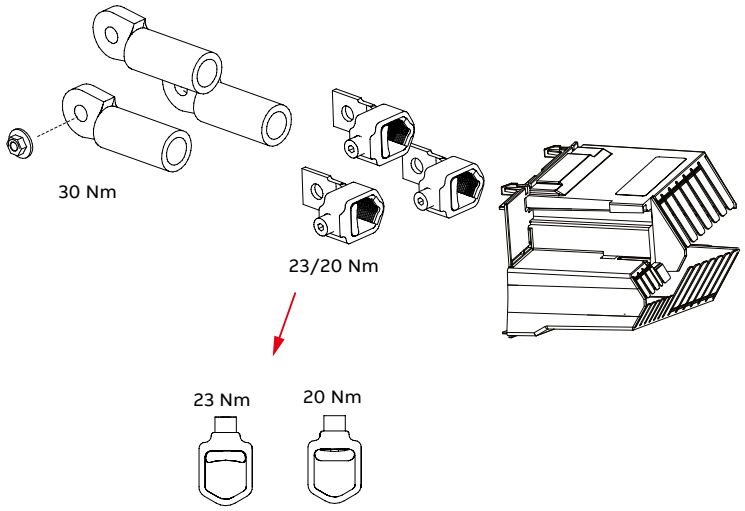
Module size	Type of bolt	Max. tightening torque [Nm]
XR00	M8	15
XR1	M12	30
XR2-3	M12	30

Table 4-16 Torque values of standard power cable connections for SlimLine modules

XR00



XR1



XR2-3

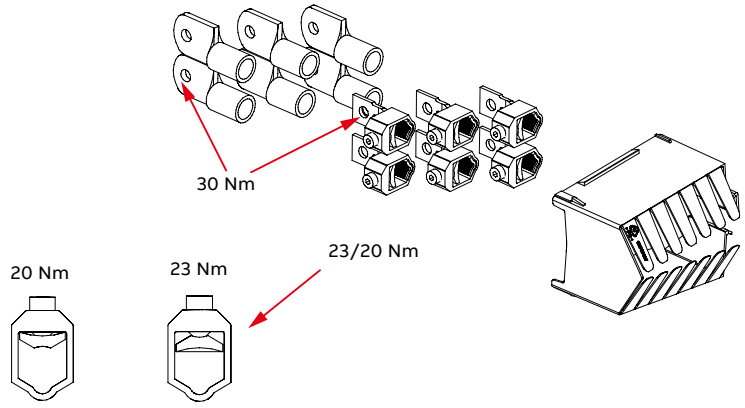


Figure 4-69 SlimLine modules cable connection

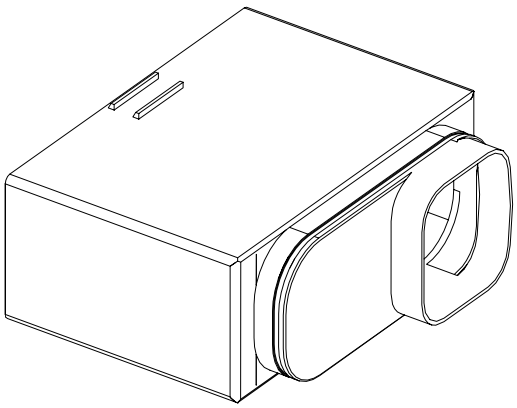


Figure 4-70 Additional cable protection shroud for neutral conductor in SlimLine module

4.16.5 Field cable or busduct installation – protective conductor connections

The green and yellow conductor (colour marking over the entire length) may only be used as protective PE or PEN conductor. It must not be used as a voltage carrying conductor by altering the colours at the ends or employed as regulator earth or as a connector for the shield earth.

The protective conductors shall to be connected as follows:
- Up to 63 A: To the PE terminal of the withdrawable module condapter.
- Up to 100 A: To the vertical section located at front right with a screw M6. For rear access location is at rear left.
- Over 100 A: To the vertical PE connection bar, arranged front right in the cable compartment as screw connection or using a bar mounting terminal. For rear access at the rear left side.

Where the protective conductor connections are screwed on to painted surfaces they shall be secured with serrated contact washers. Any means of locking the screws is permissible for fastening screwed connections to galvanised surfaces. No lock-washers are required for roundhead screws (so-called Taptite screws) when screwed into galvanised parts for the first time.

The protective conductors are connected to the doors by flexible green and yellow copper conductors (cross-section 2,5 mm2). The connection is not required if no live (≤ 50 V AC or ≤ 120 V DC) equipment is mounted to the doors.
The continuous connection of the protective conductor circuits to inactive metal parts of the building (in accordance with IEC 61439-1 clause 10.5.2 or DIN VDE 0100 Part 540) is to be carried out according to the conditions at the site.

Note:
Dependant upon the modules utilised in the switchgear, cable termination my be directly a the SCPD. In these instances please refer to the applicable technical documentation.

Note:
Cable termination varies due to project requirements please refer to the applicable documentation.

4.16.6 Power cable installation – neutral conductor connections

The neutral conductors shall be connected to the insulated neutral bar arranged parallel to the protective conductor bar or to the neutral connection bar, as screw connection or using a bar mounting terminal.
In all cases the connection is to be made at the height of the relevant module and allocation must be clearly distinguishable. In other cases, eg for control cables, cross referencing will be necessary.

Object	Abbreviation acc. to IEC 61439-1/VDE 0660 part 500
Protective earth conductor	PE
Neutral conductor	N
Neutral conductor with protective function	PEN

Table 4-17 PE / N / PEN abbreviation acc. to IEC 61439-1 / VDE 0660 part 500

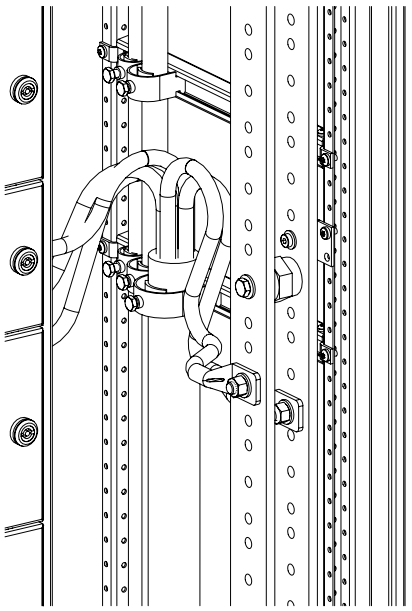


Figure 4-71 Example of front access protection and neutral conductor connection

Power and control cable installation for Rear access switchgear.
Torque values from Table 4-15 shall be observed.

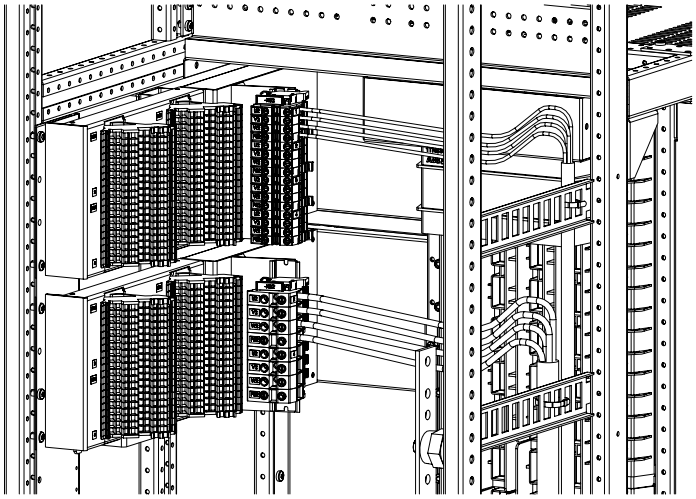


Figure 4-72 Example of MNS Rear cable runs, module sizes 8E/4 and 8E/2

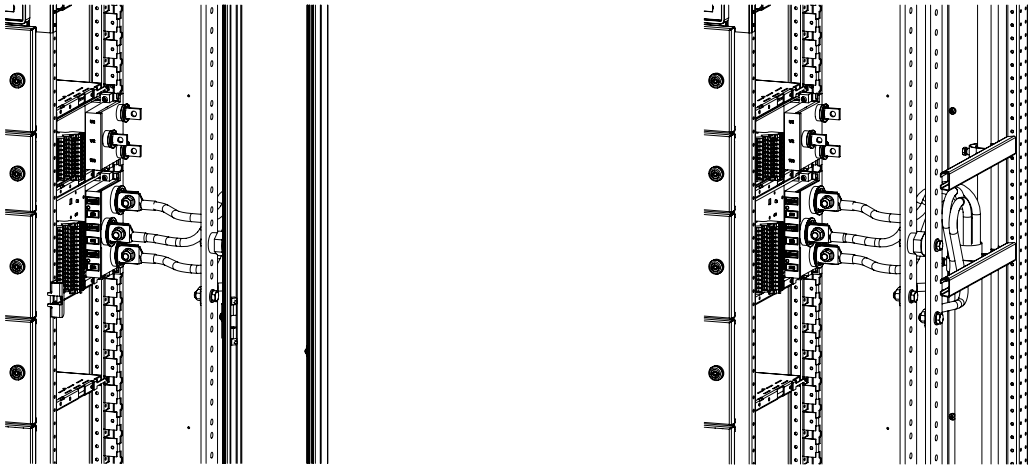


Figure 4-73 Example of cable runs, withdrawable module size ≥ 4E

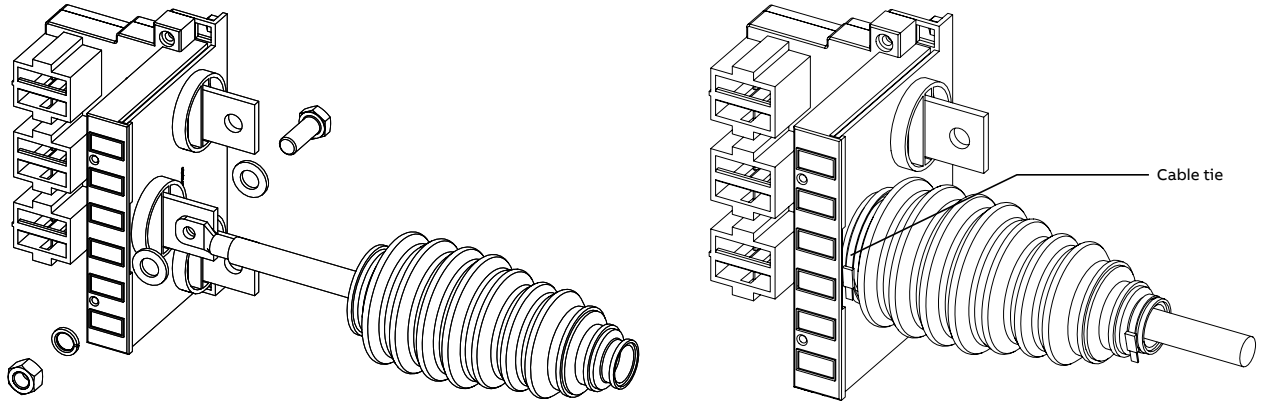


Figure 4-74 MNS Rear cables provided with bellows for ≥ 4E modules and fixing material (1 spring lock washer and 2 plain washers)

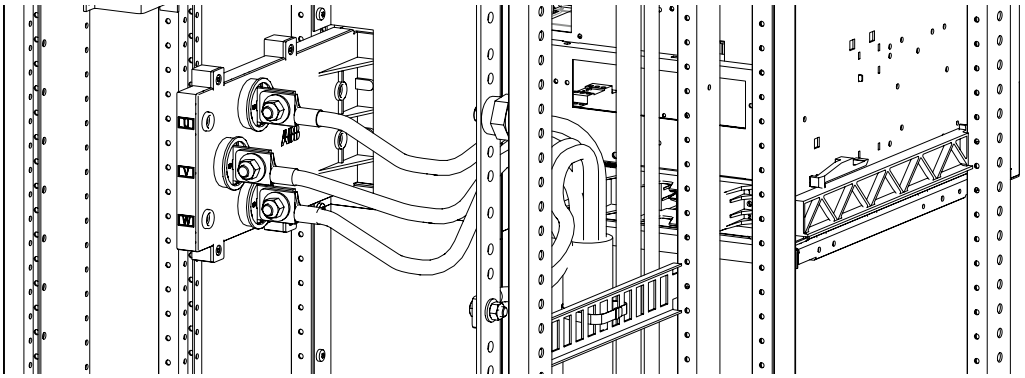


Figure 4-75 Example of MNS Rear cable runs, module size ≥ 4E

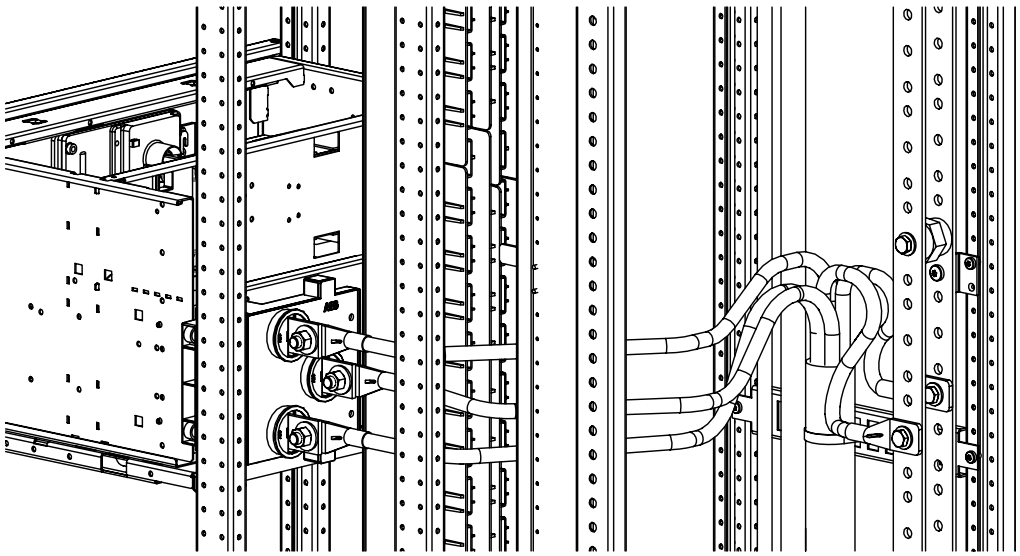


Figure 4-76 Example of MNS Rear cable runs, module size ≥ 6E with optimized CCU

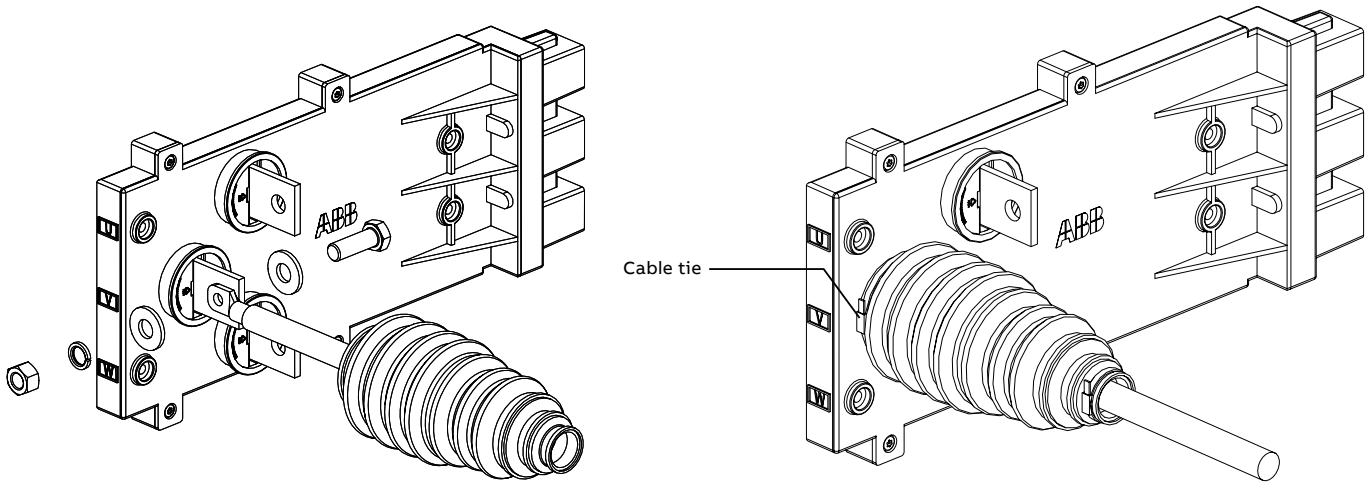


Figure 4-77 MNS Rear cables provided with bellows for ≥ 4E modules and fixing material (1 spring lock washer and 2 plain washers)

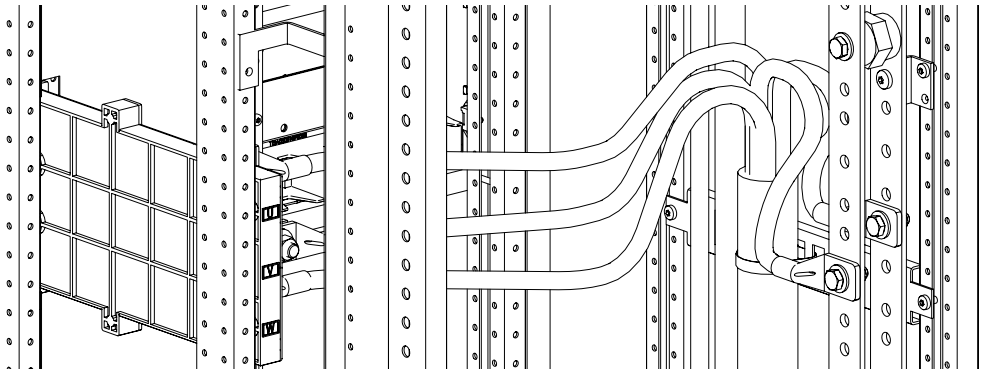


Figure 4-78 Example of MNS Rear access protection and neutral conductor connection

4.16.7 Installation of equipment – functional units

- Ensure all dust exposed areas are cleaned with anti-static cloth. Water filtration vacuum cleaners can be used for large areas first. Blowing air is prohibited as it may distrubite particules to conductive areas and cause a short circuit.
- Install air circuit breakers using the lifting crane. Refer to air circuit breaker's operation manual for further details.
- Install all loose components such as fuses, lighting tube and measuring instruments.
- Plug-in and withdrawable module power contacts shall be greased according to chapter 7.5.
- Withdrawable modules shall be put in disconnected mode, all other modules shall be switched off.
- Remove any foreign parts such as tools, packing material or debris from the switchgear.
- Close the doors

4.16.8 ACB lifting crane feature (typical example features listed below)

- Weight capacity acc. lenght of the arm
- Hand operated suitable for all withdrawable ACB sizes.

Inserting ACB into section

- Utilise the ACB lifting crane to lift the ACB from top to the position.
- Make sure ACB is placed into the fixed part with slightly tilted position.
- The rail of the ACB must be engaged with the fixed part to ensure proper insertion.
- Push the ACB into the fixed part until stop position. From this position the ACB can be racked into correct position.

Removing ACB from section

- Use the ACB crank handle to move the ACB to disconnected position.
- Place the ACB lifting crane arm above the ACB.
- Ensure the ACB is properly fixed to the lifting crane with rope or chain
- Firmly pump the crane to lift ACB.
- Transport ACB to required place.

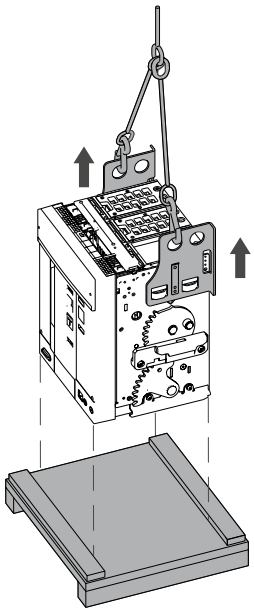


Figure 4-79 Top lifting of ACB withdrawable part

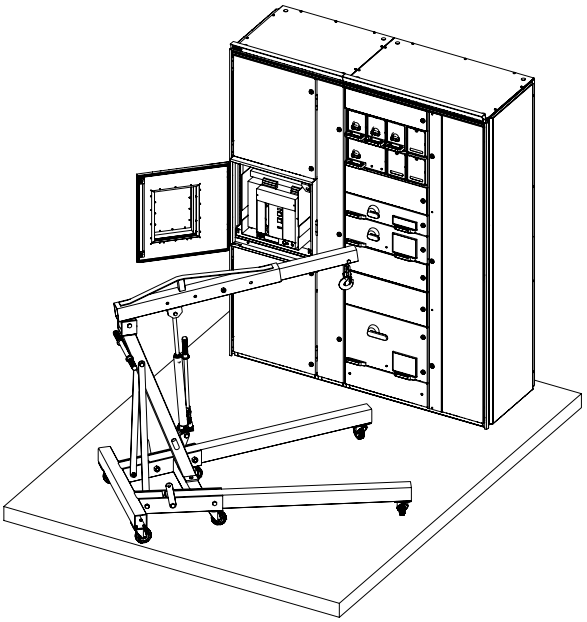


Figure 4-80 Installation of ACB using lifting truck

Do not use hydraulic lifting trolley with rollers on the top. The rollers can cause significant damage of the Emax2 breaker.

Emax 2 requires the use of a top lift crane. Otherwise ACB may be damaged.
See Figure 4-80.

Forklift and hydraulic trolley
As an option, a forklift or a hydraulic trolley can be used to insert and remove a withdrawable ACB from the switchgear. In any case, the weight of the ACB must be considered and the transport surface must be plain to avoid damage to the circuit breaker.
Rollers are not permitted.
ABB offers manual forklift type GP 300 and GP 500. For more information, please contact your local ABB service representative.

4.16.9 Surge Protection Device (SPD) Compartment and check of SPD function

If the SPD compartment with SPD and back-up protection is installed in the ACB section (project dependent), and equipment is being installed, removed or maintained ensure the safety guidelines are followed.

Observe all safety rules for working on electrical equipment!.

Steps to follow to check proper conditions of SPD and back-up protection:
1. Ensure main backup protection MCB/ MCCB is not tripped/open
2. Ensure main backup protection fuses are not blown
3. Ensure SPD end of life indicator is not activated
4. Ensure SPD does not indicate fault state

Hazard of electrical shock!

- The equipment must only be installed and serviced by qualified and skilled personnel.
- Before working on or inside the compartment turn off all power supplying this equipment.
- Always use a properly rated voltage sensing device to confirm power is off and equipment is in dead condition.
- The electrical system or equipment to be worked on must be effectively grounded per all applicable codes.
- Failure to follow these instructions may result in serious injury or death!

05

Commissioning

Commissioning

5.1 Introduction

Prior to commencing on commissioning activities ensure the steps in section 4 are completed.

ABB recommends during commissioning the use of ABB personnel or ABB certified specialists to oversee activities to ensure warranty conditions are not compromised.

The steps described in this section is the minimum requirement of checks and tests required:
- before energizing the switchboard,
- after energizing the switchboard for the first time

in order to perform commissioning steps. Local regulations / client procedures that need to be observed may require additional tests to be conducted.

This section of the service manual only describes the steps that need to be taken for commissioning the switchboard:
- refer to the individual product manuals for electrical protection and control devices installed inside the switchboard for additional commissioning steps and procedures.
- checks of any external cable connection (incoming main and control voltage, outgoing cable to motors and loads, serial communication cables) need to be completed by cable installation provider and confirmed by client/owner.

All safety precautions shall be taken and the switchboard to be commissioned needs to be safeguarded against inadvertently energizing equipment. If the switchboard is energized (or there is energized equipement in the vicinity of the switchboard under commissioning it is required that arc rated PPE clothing is worn for the people involved in commissioning.

Work on an energized switchboard, that exceed operation tasks that are prformed with closed doors, require job risks assessment and must be performed by further authorized personnel that is trained for such tasks.

All checks as described below shall be recorded in a commissioning report document to be handed over to the client after completing the commissioning.

5.2 Commissioning check lists

5.2.1 General commissioning checks according to IEC 61439-2

- Confirm completeness of documentation (general arrangement, electrical drawings and load lists, operation and maintenance manuals) by ABB and product manufacturer for products installed inside of the switchboard.
- Review the test reports of the manufactured switchboard provided by ABB.
- Ensure tools as required for commissioning is available.
- Ensure only calibrated instruments are available, check calibration date.

5.2.2 Commissioning checks on de-energized switchboard

- General visual / mechanical check of switchboard assembly to ensure the steps described in Section 4 are completed:
  - For withdrawable modules in switchboard verify correct mechanical operation by removing/inserting the module using operation handle, remove the module and place in ISOLATE/withdrawal position before perfoming next steps
  - Ensure enclosure is in correct condition, no openings present, door locks are in working condition
  - For plug-in modules ensure that the modules are correctly torqued and that the operating handle when fitted operates in the correct manner.
- Check the earthing system. Ensure proper connection is made to earth.
  Note: Regulations may require to measure the Earth Loop Impedance.
- Check busbar connections at the shipping units using a calibrated torque wrench.
  Note: A microohmmeter may be required to verify the connection.
- Perform insulation resistance test (Min. 500 V DC) on the assembly.
  Note: Prior to performing the test, ensure that all electronic devices are disconnected from the circuit.
- Check the installation of the incoming cables to the switchboard (main supply and, if present, control supply voltage connection from external source)
- Ensure all fuses and switches for the main and control circuits are in OFF position
- Check if all barriers and shrouds have been fitted correctly
- Close all doors

5.2.3 Commissioning checks on energized switchboard

Ensure correct PPE is applied and personnel is trained for the tasks. Only personnel involved in the further tasks are allowed to be in the work area. Hot work permit is required for those tasks.

Check phase rotation using dedicated meter to confirm the correct phase wiring.

For fixed and plug-in type modules please refer to the project documentation and schematics in order operate in a test situation.

Internal control voltage supply

- For internal control voltage supply: check connection of internal control voltage transformer to main busbar.
- Insert the incomer ACB into TEST position
  - Enter the parameter settings for the protection function as per the grading study performed.
  - Check the operation of the incoming circuit breaker assembly in TEST position.
- Ensure all switchboard doors and other openings are closed, energize the switchboard main busbars by inserting the ACB into operation position and switch ON
- Connect consumer in the switchboard to the control voltage supply step by step:
  - Withdrawable
  - Insert the modules and switch into TEST position
  - Apply the protection / control settings as per the grading study performed and perform a functional test in TEST Position

After verifying all assembly operation the user can proceed to performing the further commissioning and tests on equipment which need to be energized following health and safety requirements and apply PPE.

External control voltage supply

- For external control voltage supply: Ensure main switch for control voltage supply is OFF. Switch on the supply voltage at external source and check correct voltage level and phase sequence at the incoming terminals in the switchboard using a calibrated instrument.
- Turn on the main switch for control voltage in the switchboard and check correct control voltage and phase sequence in each switchboar section as applicable.
- For intelligent switchgear system utilizing PLC, gateway, data access point energize the devices and perform system check (see product manuals for detailed commissioning steps).
- Connect consumer in the switchboard to the control voltage supply step by step:
  - ACB
    - Insert ACB into TEST position
    - Enter the parameter settings for the protection function as per the grading study performed.
    - Check the operation of the incoming circuit breaker assembly in TEST position.
  - Withdrawable
    - Insert the modules and switch into TEST position
    - Apply the protection/control settings as per the grading study performed and perform a functional test in TEST Position
- Ensure all switchboard doors and other openings are closed, energise the switchboard main busbars by inserting the ACB into operation position and switch ON

After verifying all assembly operation the user can proceed to performing the further commissioning and tests on equipment which need to be energized following health and safety requirements and apply PPE.

If further tests are to be performed based on contractual or local requlations and client requirements, those tests need to be performed following the test instruction by manufacturer under application of health and safety guidelines.

After completing commissioning of the switchboard and equipment a commissioning report shall be prepared and duly signed by ABB supervisor and client/owner to confirm completeness.

06

Operation

Operation

6.1 Normal service conditions

Assemblies conforming to this Service manual are intended for use under the normal service conditions in indoor installations detailed in IEC 61439-1, chapetr 7.1 Normal service conitions.

When the installation is in operation ensure that:
- the doors and the front covers of the withdrawable modules are closed at all times,
- the withdrawable modules are interlocked,
- the ventilation louvers are not obstructed or clogged

6.1.1 Ambient air temperature

The ambient air temperature does not exceed +40 °C and its average over a period of 24 h does not exceed +35 °C.
The lower limit of the ambient air temperature is –5 °C.

6.1.2 Humidity conditions for indoor installations

The relative humidity of the air does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidity may be permitted at lower temperatures, for example 90 % at +20 °C. Moderate condensation should be borne in mind which may occasionally occur due to variations in temperature.

6.1.3 Pollution degree

The pollution degree refers to the environmental conditions for which the assembly is intended. Unless otherwise stated, assemblies for industrial applications are generally for use in a pollution degree 3 environment. However, other pollution degrees may be considered to apply, depending upon particular applications or the micro-environment.

6.1.4 Altitude

The altitude of the site of installation does not exceed 2 000 m. If this height is exceeded, it must be specified in the original project requirement.

6.2 Special service conditions

For special service conditions refer to IEC 61439-1, chapter 7.2 Special service conditions.

Where any special service conditions exist, the applicable particular requirements shall be complied with or special agreements shall be made between the assembly manufacturer and the user. The user shall inform the assembly manufacturer if such exceptional service conditions exist.

6.3 Opening of doors

All MNS cladding front doors, fixed modules, plug-in modules & large withdrawable modules come complete with MNS standard 5 mm double bit lock.

Other type door locks is available if specified in the original project requirement.

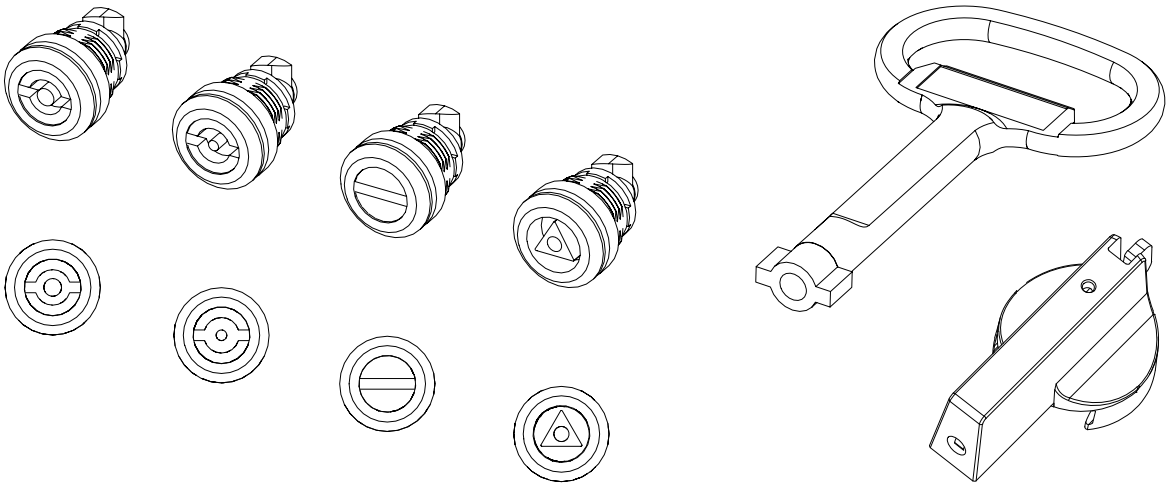


Figure 6-01 Locking alternatives used with MNS standard (left), double bit key and handle with key for slotteted lock (right)

Opening the front cover/doors of any live switchboard is possible to touch live parts.
Site operation procedures must be adhered to.

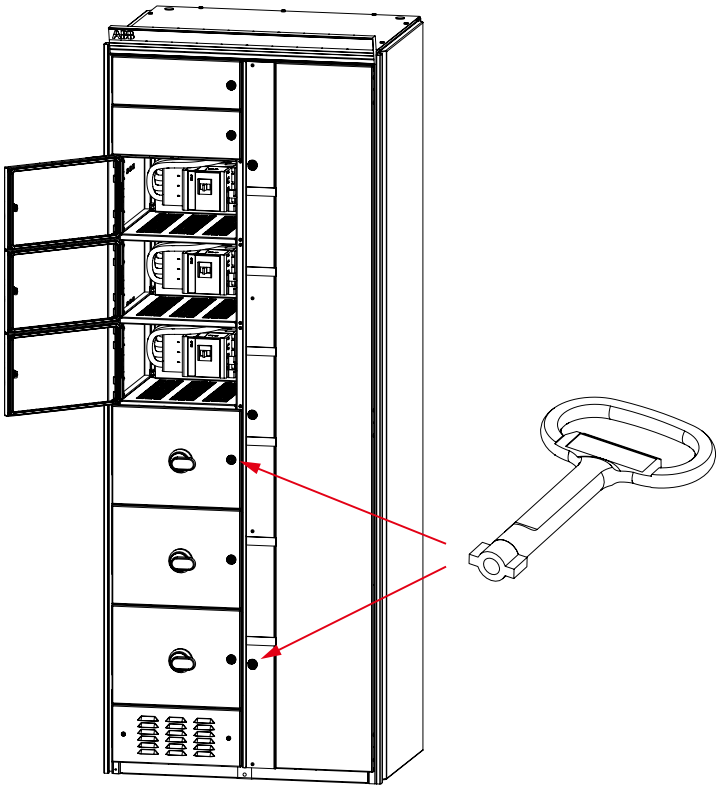


Figure 6-02 Opening of module door with 5 mm double bit key

ACB doors can be open by the designated door key type. In certain project specified condition the ACB is interlocked with the closed ACB, therefor the door cannot be open if the ACB is closed.

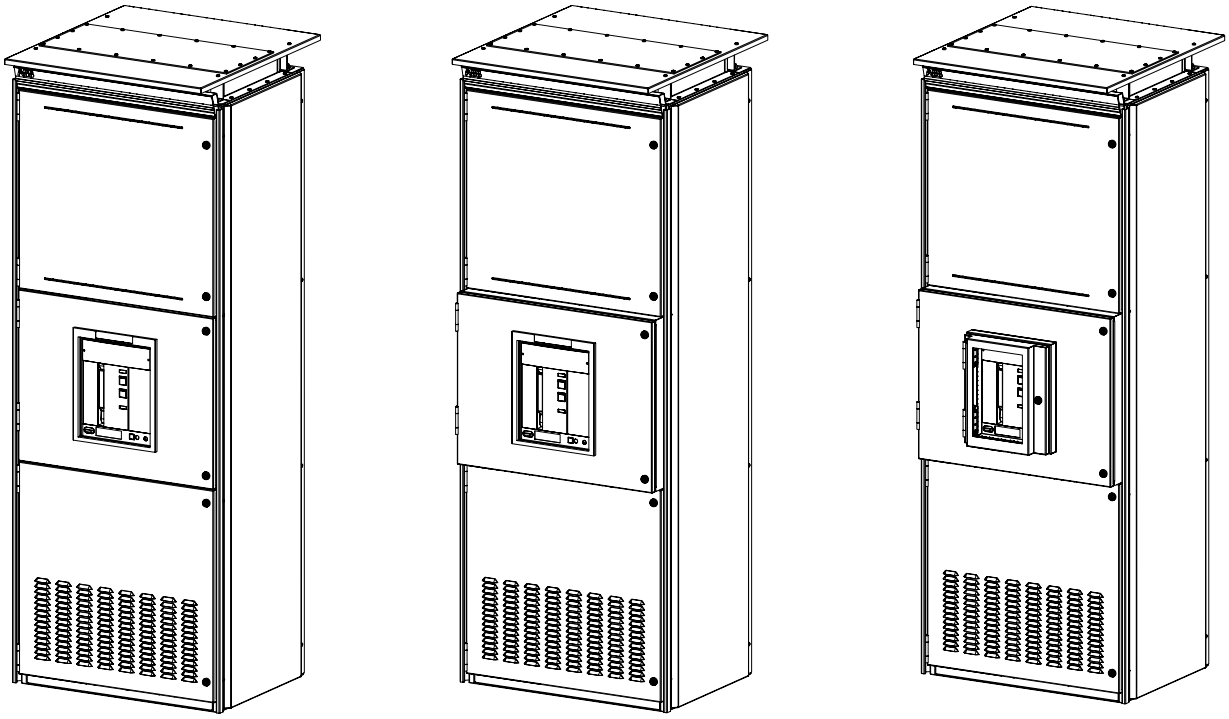


Figure 6-03 Typical ACB door (left) / typical ACB door with pagoda (middle) / typical ACB door with IP cover and pagoda

For ACB sections 1000 mm and 1200 mm wide split door designs may be utilized for the top and bottom door designs. The ACB compartment then utilizes a cover. This cover is secured with four locks and is fitted with handles to make it easy to attach and remove when required.

To safely attach and remove the ACB cover, please follow these steps:
- Use the two handles and insert the cover securely into the four lock shackles
- Hold the cover in position with one hand and close the four locks with the other hand

If the cover must be removed, proceed in reverse order.

6.3.1 IP protection cover

The IP protection cover is designed to protect the ACB front in the section. This IP cover is mounted on the ACB door. The IP protection cover is necessary for section IP ratings IP31 and above.

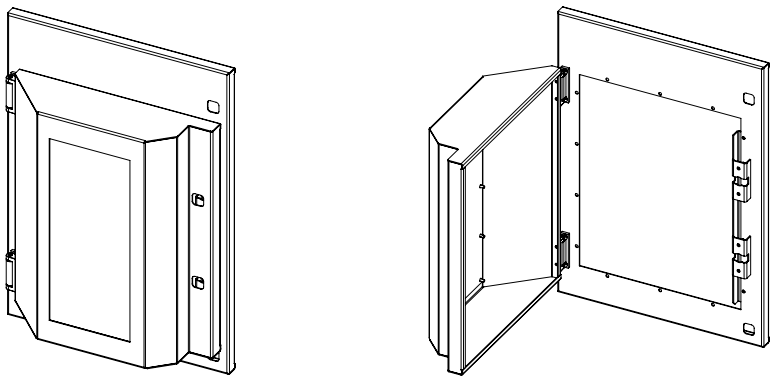


Figure 6-04 IP protection cover

Opening of the IP protection cover, allows the ACB to be moved to the isolated position. To completely remove the ACB, the ACB door must be open.

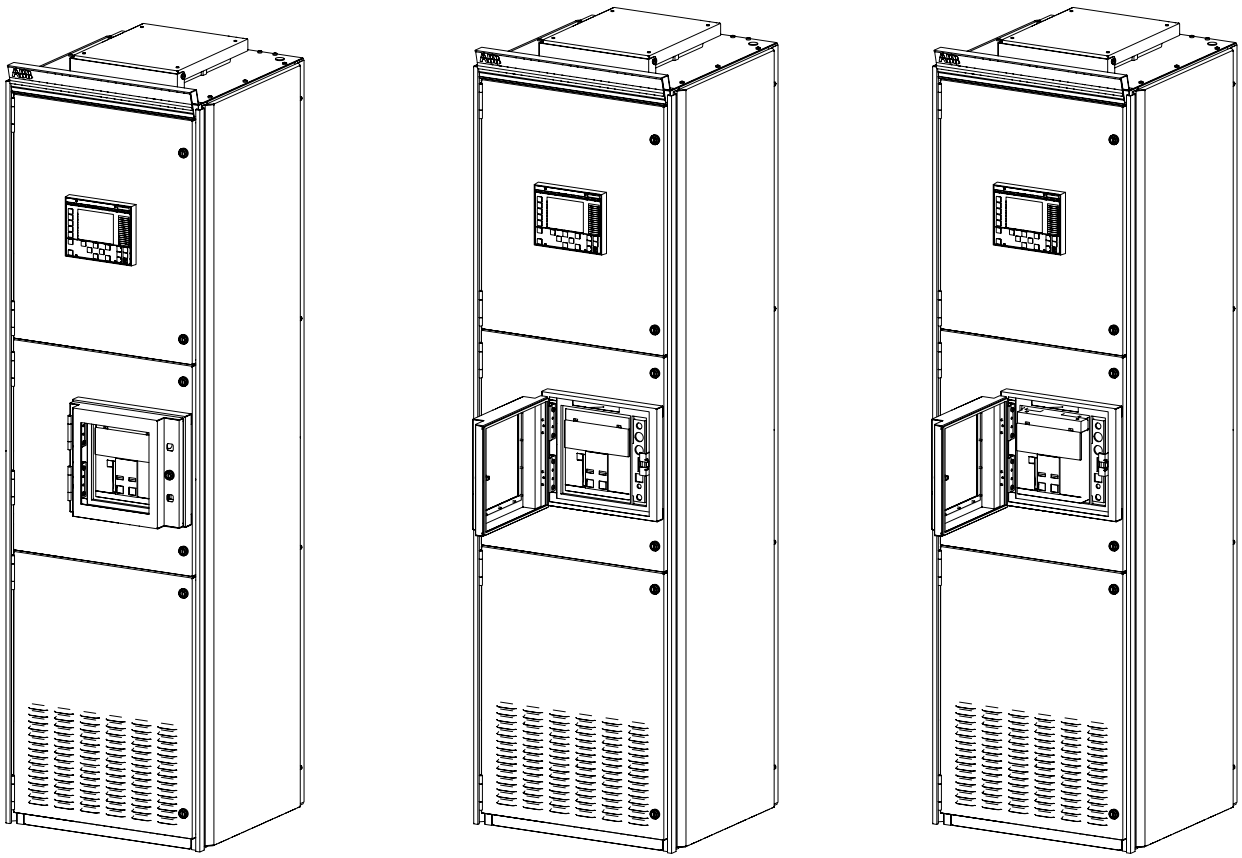


Figure 6-05 IP protection cover (closed / opened / opened with ACB in isolated position)

6.4 ACB operation

For full details of ACB operation please refer to ABB SACE document – 1SDH000999R0002 Installation, operation and maintenance instructions E1.2 and 1SDH001000R0002 Installation, operation and maintenance instructions E2.2 to E6.2

The following are the main components of the circuit breaker

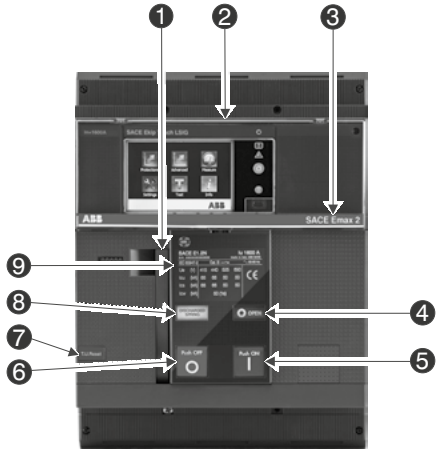
Emax E1.2	
Pos.	**Description**
1	Lever for manually loading the closing springs
2	SACE Ekip protection release
3	Name of the circuit-breaker
4	Open-closed signalling device
5	Closing pushbutton
6	Opening pushbutton
7	Release tripping mechanical signal
8	Spring loaded-unloaded signalling device
9	Electrical sprecifications plate

Emax E2.2 to E6.2	
Pos.	**Description**
1	Lever for manually loading the closing springs
2	SACE Ekip protection release
3	Name of the circuit-breaker
4	Open-closed signalling device
5	Opening pushbutton
6	Release tripping mechanical indication
7	Closing pushbutton
8	Spring loaded-unloaded signalling device
9	Electrical sprecifications plate

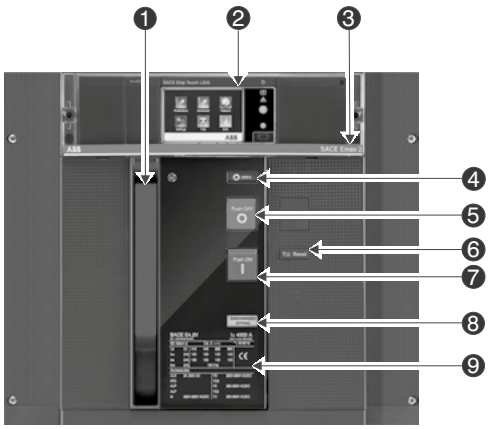
Table 6-01 Main components of the circuit breaker

6.4.1 Description of Emax 2 – Low voltage air circuit-breaker

Emax E1.2

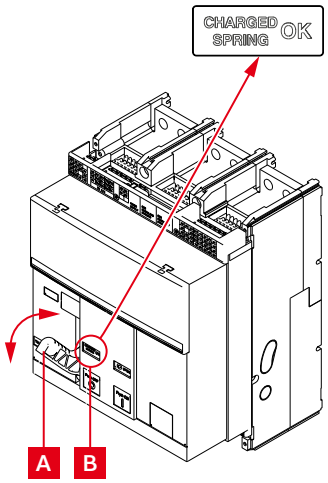


Emax E2.2 to E6.2

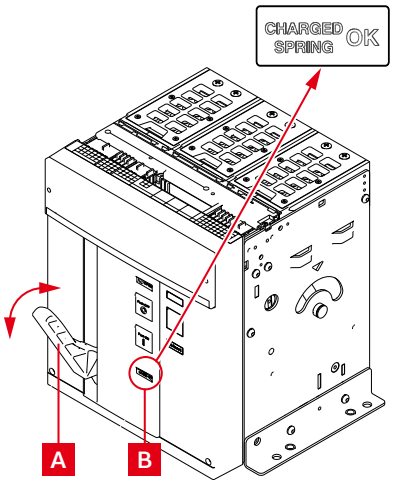


6.4.2 Manual operation

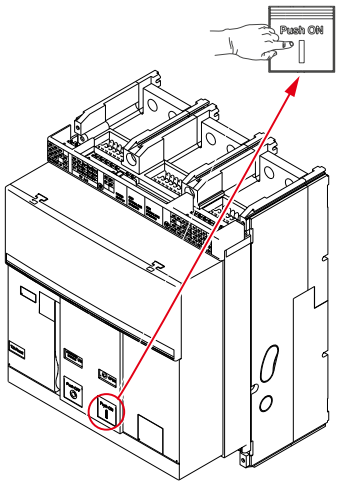
Emax E1.2

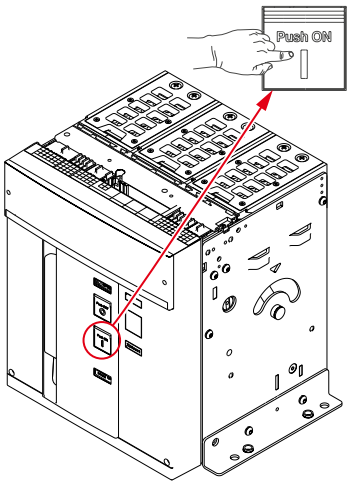


Emax E2.2 to E6.2

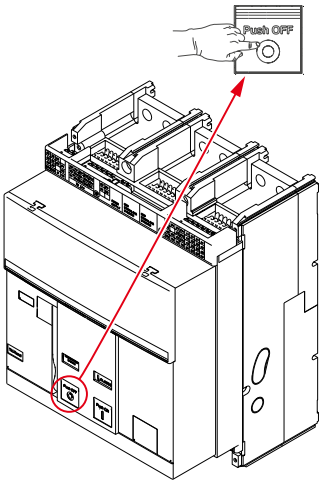


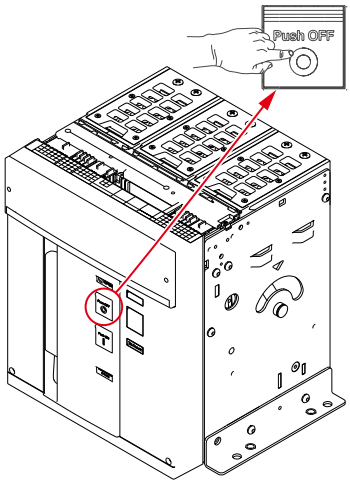
Manual loading of the springs – Pull the lever [A] downwards several times until the springs loaded signalling device [B] is “Yellow – CHARGED SPRING” as indicated.





Manual closing of ACB – Press the closing push-button “I – Push ON” as indicated

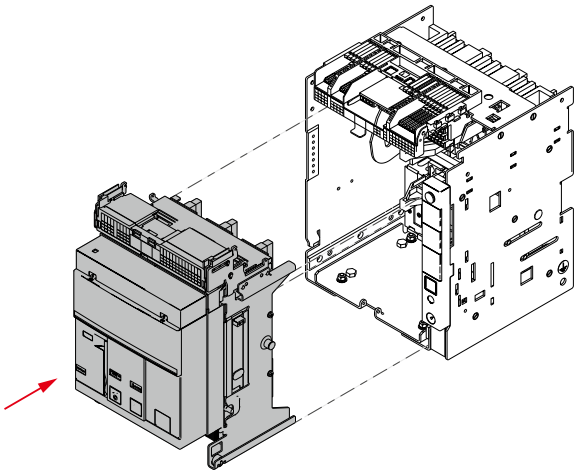




Manual opening of ACB – Press the opening push-button “0 – Push OFF” as indicated

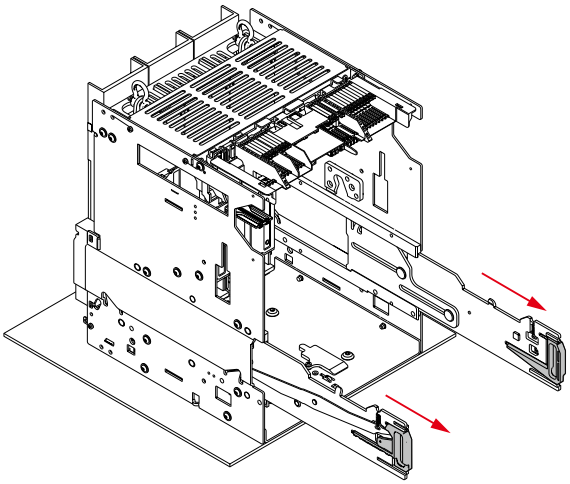
6.4.3 Racking IN/OUT withdrawable ACB

Emax E1.2

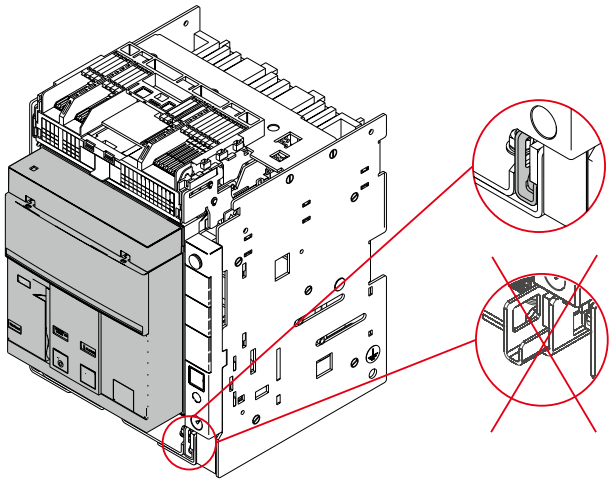


Position the moving part in the fixed part.

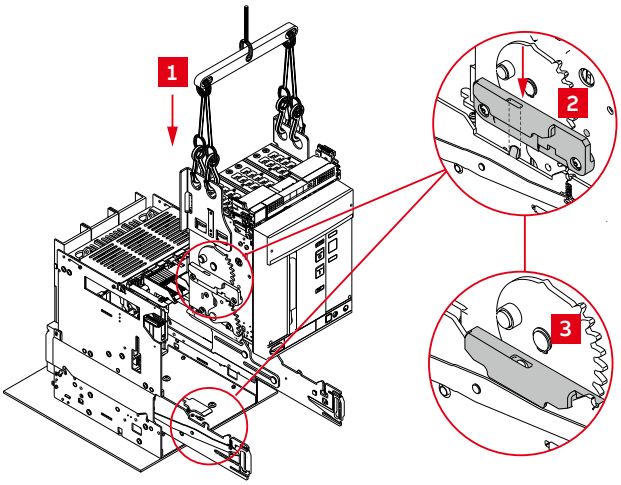
Emax E2.2 to E6.2



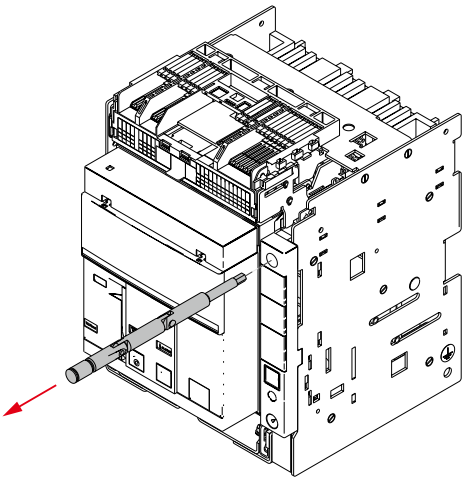
Position the moving part over the guides of the fixed part.



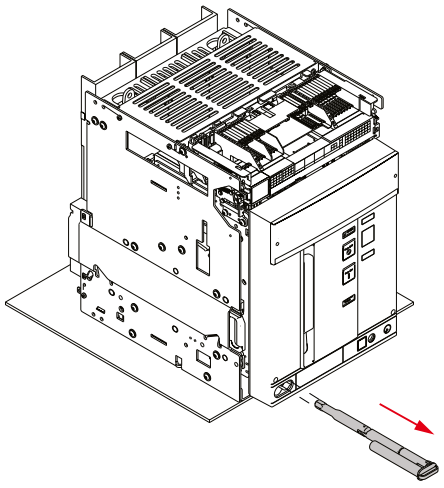
Push until it comes to a stop.



Latch by inserting the hollow part of the side in the ltch of the guide of the fixed part.

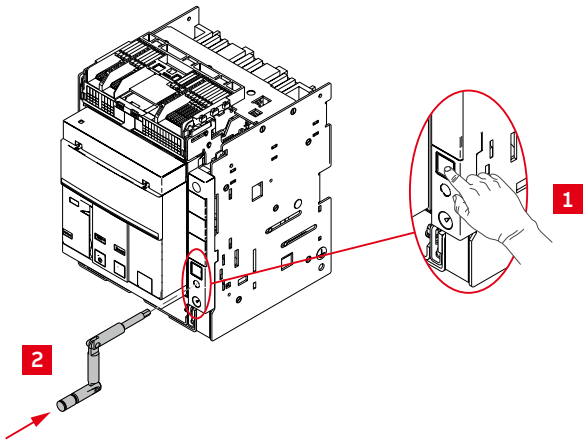


Extract the disconnection crank from its housing.

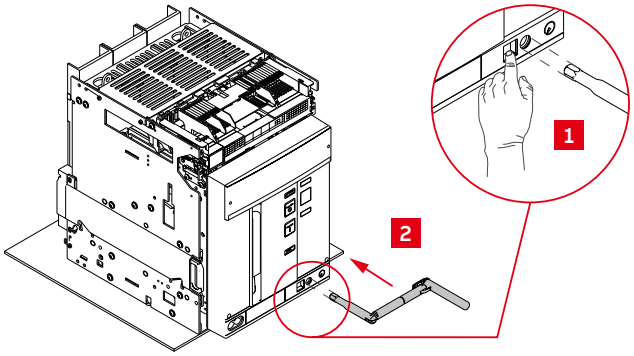


Extract the disconnection crank from its housing.

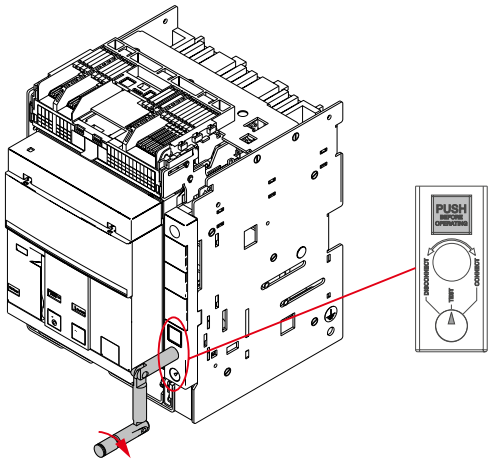
Emax E1.2

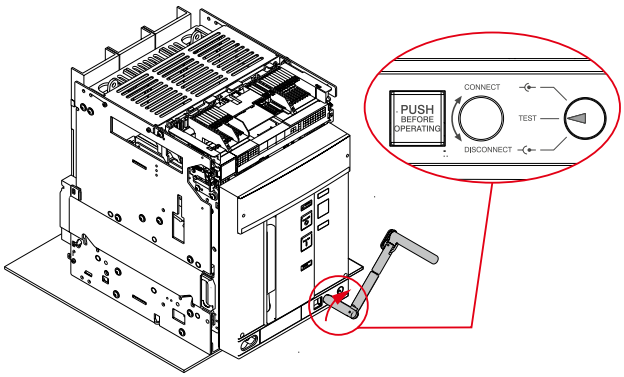


Emax E2.2 to E6.2

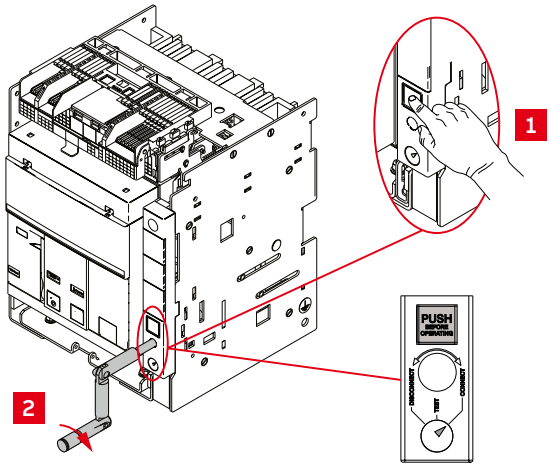


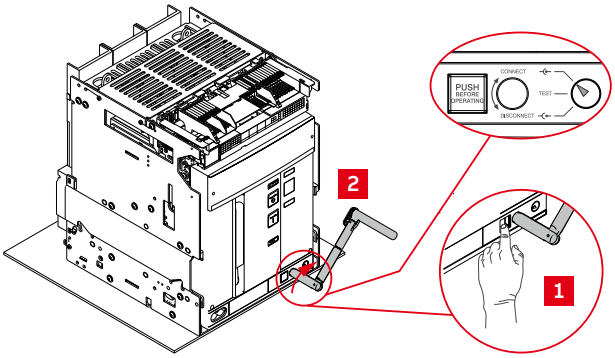
Press the lock push-button and insert the crank in the moving part. In this phase the moving part is still in the **DISCONNECTED** position.





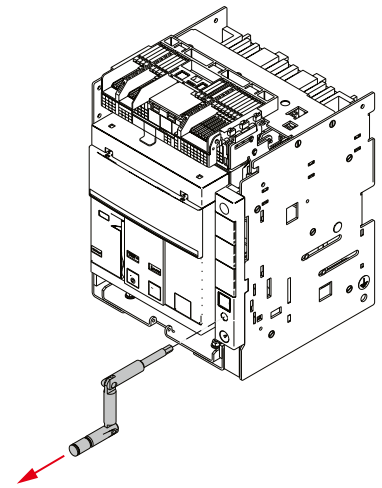
Turn the crank clockwise until the pushbutton comes out and the indicator shows that the circuit-breaker is in **TEST** position.

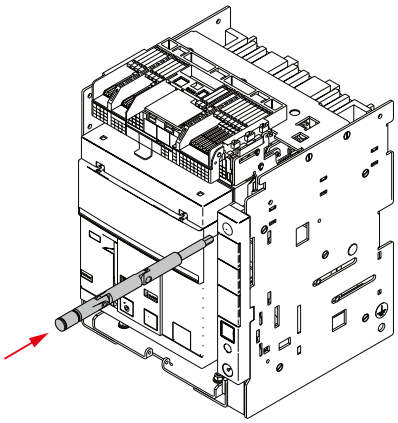




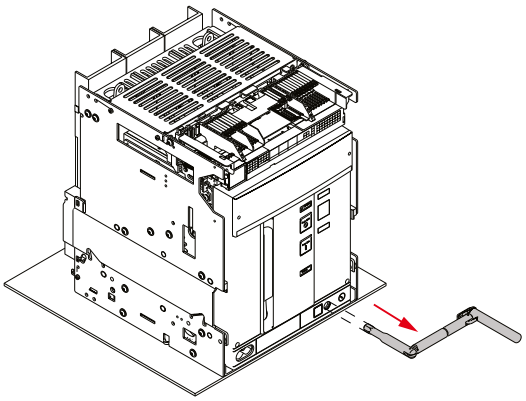
Press the lock button and then rotate the crank clockwise until the button comes out and the indicator shows that the circuit-breaker is in the **CONNECTED** position.

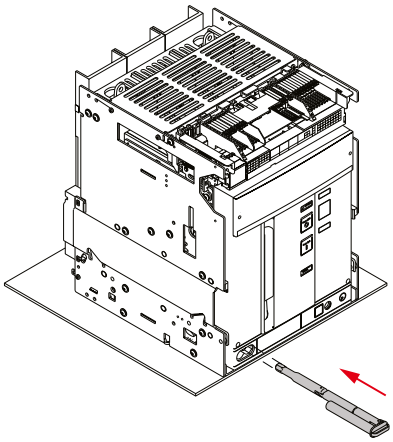
Emax E1.2





Emax E2.2 to E6.2





Extract the crank and replace the crank in its housing. If the crank is not placed in its housing, IP class may be compromised.

6.4.4 ACB auxiliary recess

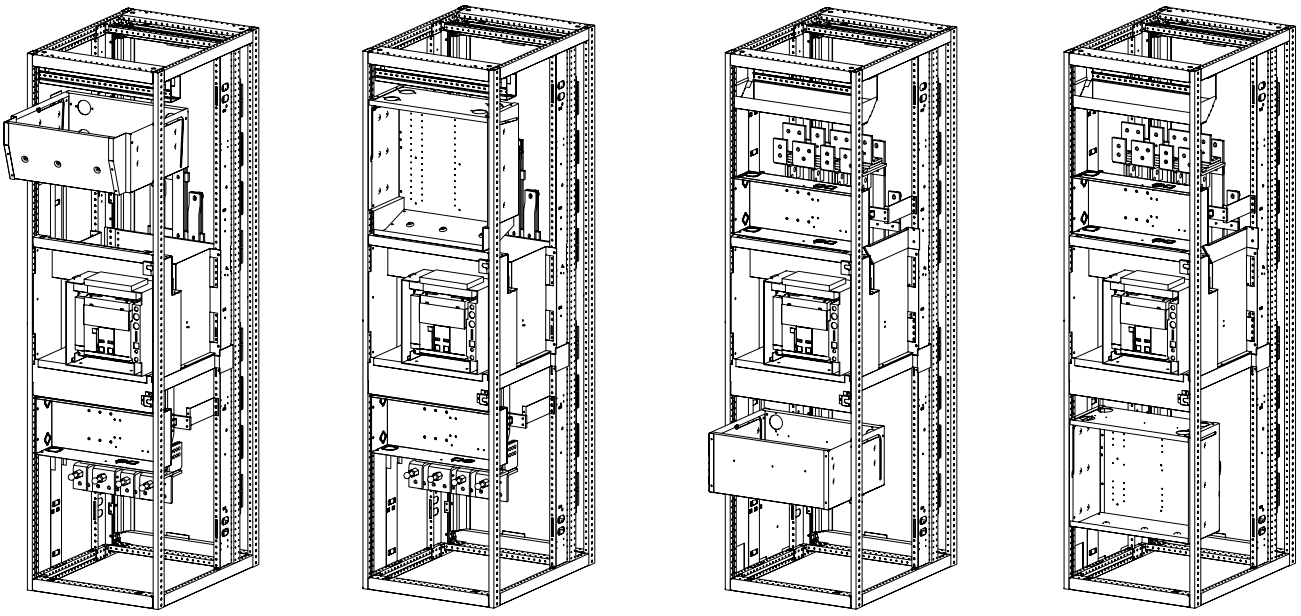


Figure 6-06 Top and bottom auxiliary recess in mounting and standard position

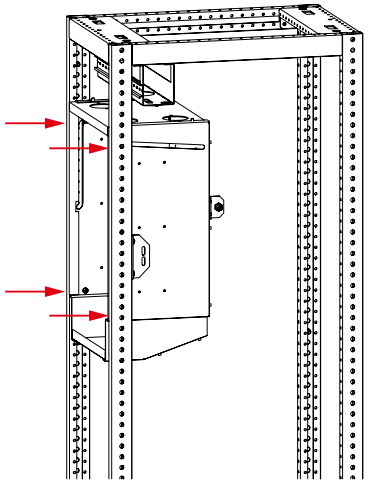
Be careful whilst moving the auxiliary recess. Carelessness may cause trapping of hands!
Be careful whilst moving the auxiliary recess. The fully equipped auxiliary recess can weigh over 80 kg!
Observe all safety rules for working on electrical equipment!

6.4.5 Auxiliary recess with spring bolts

Moving procedure steps for sections with vertical copper arrangement

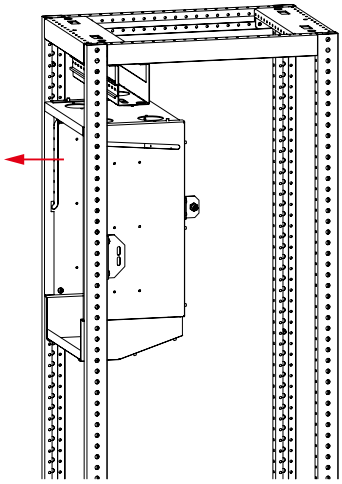
To achieve access to the rear area behind the auxiliary recess, follow the next steps. The guide rail is integrated into the auxiliary recess to ensure the path of moving process and prevent it from accidental falling. The auxiliary compartment is fixed to the C-profile by spring bolts. It can be placed back to its original position by doing the opposite of this process.

1



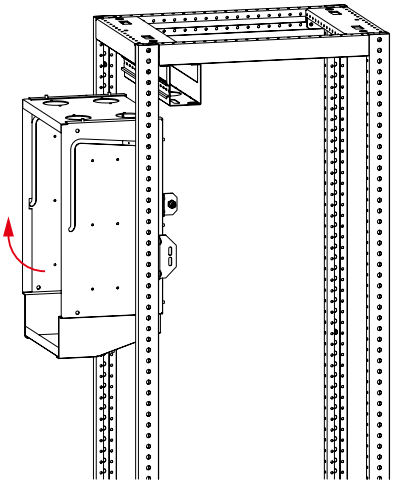
Step 1: Unscrew the four fixing screws.

2



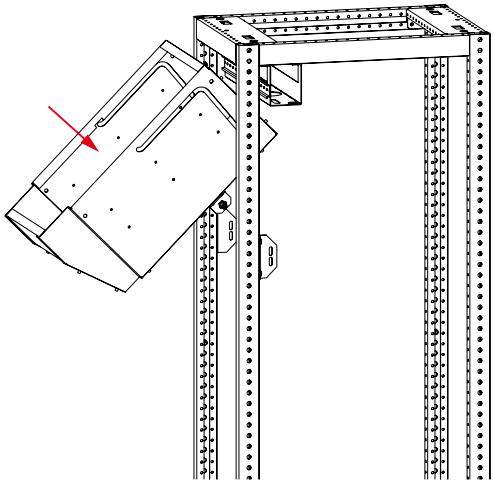
Step 2: Slide the recess out of the section with a forward motion.

3



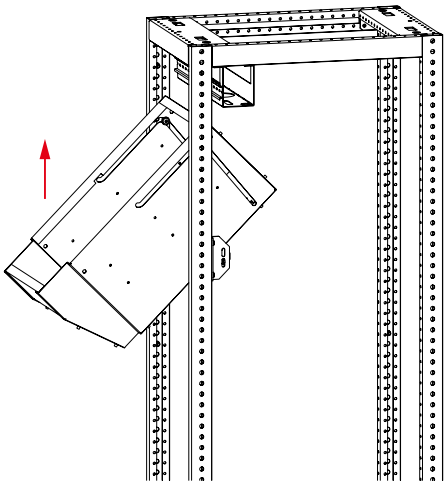
Step 3: Rotate from bottom with an upwards motion.

4



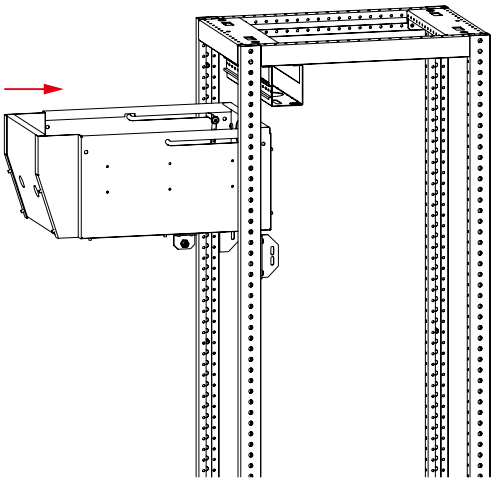
Step 4: The top of the recess rotates down.

5



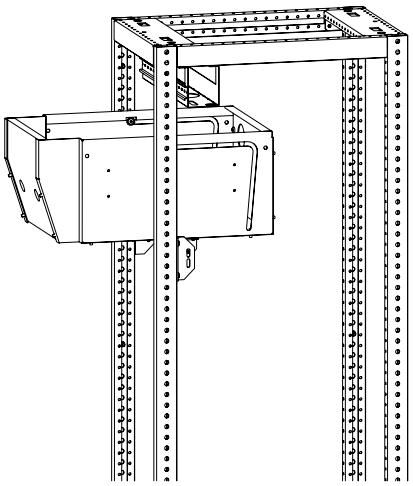
Step 5: It is then possible to move the recess upwards towards its final positon.

6



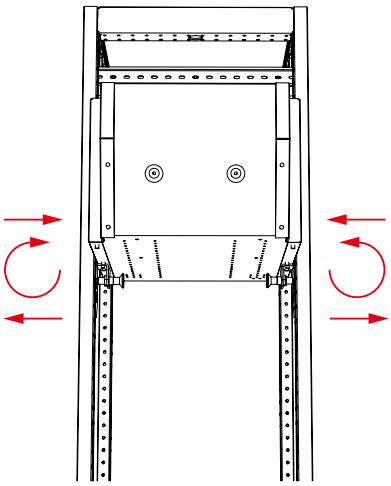
Step 6: Then slide the recess back into the section.

7



Step 7: Recess in the section.

8



Step 8: Fix the recess with the spring bolts.

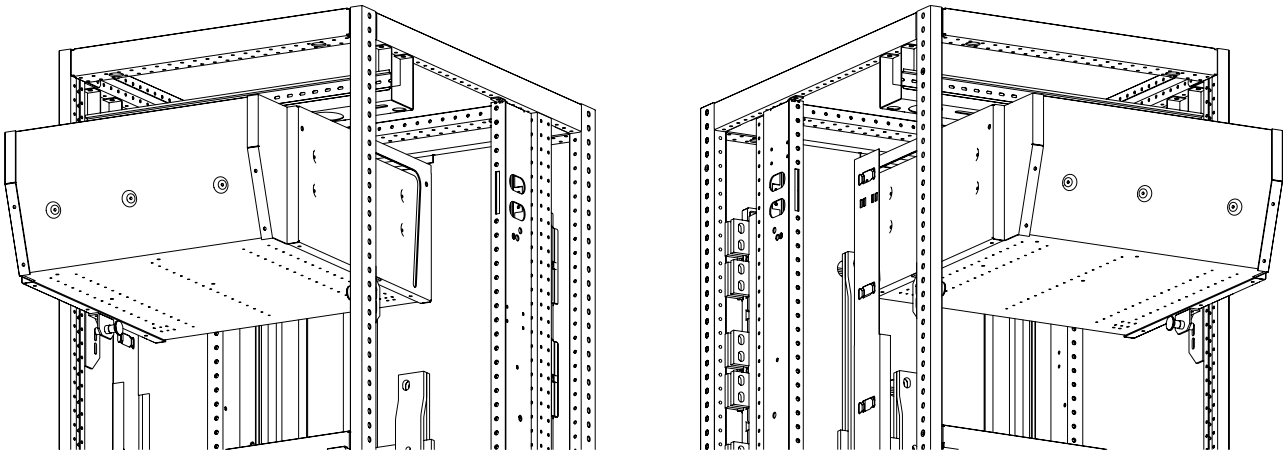


Figure 6-07 Fixing the recess with spring bolts / detail

6.4.6 Auxiliary recess without spring bolts

Section with horizontal copper are equipped with auxiliary recess without spring bolts. Only top auxiliary recess is preassembled to rotate it to mounting position.

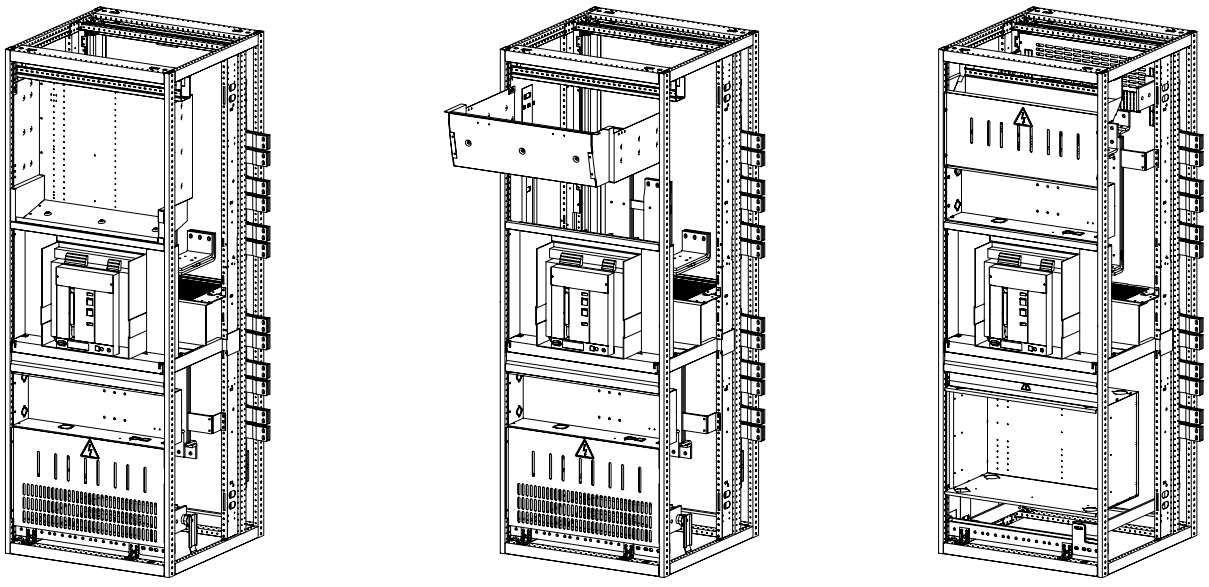


Figure 6-08 Top auxiliary recess in standard and mounting position and bottom auxiliary recess in standard position

6.5 Electrical equipment – Fixed modules operation

Module operation for fixed is normally outside, however, options with circuit breakers also allow for inside operation. To switch on the supply turn the rotary isolator switch clockwise 90°. The module is interlocked to prevent opening when the fused switch is on.
It is still possible to open the door when switched on by unlatching the handle interlock latch by a tool.
See “Figure 6-30: Module opening without disconnection”

Opening the front cover/doors of any live switchboard is possible to touch live parts.
Site operation procedure must be adhered to.

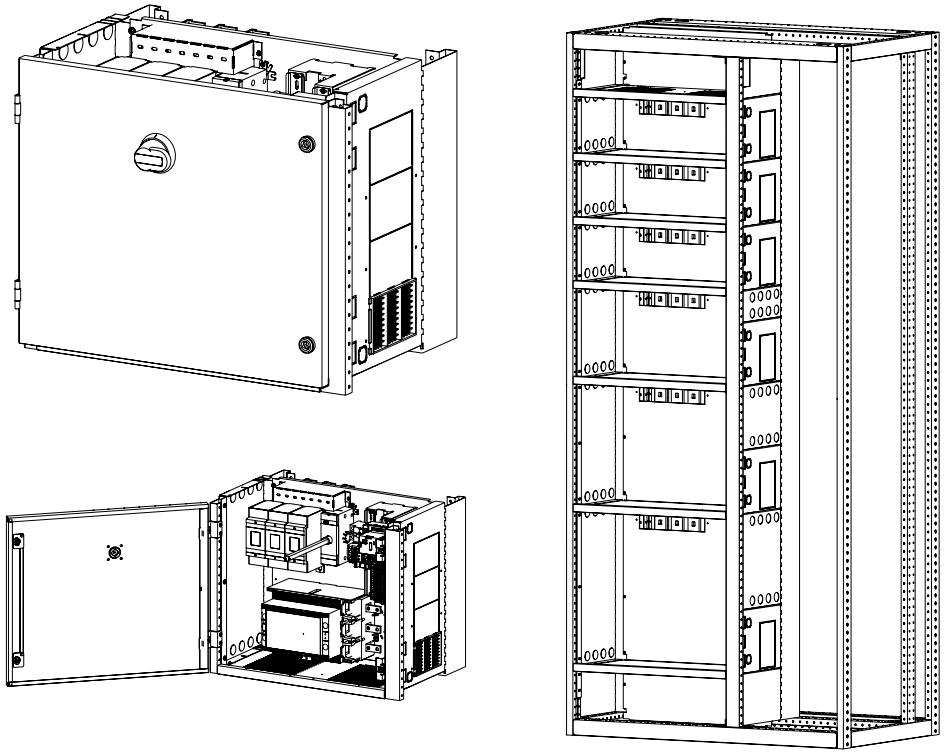


Figure 6-09 Fixed module example open and close (left), fixed empty section example (right)

6.5.1 Fixed modules switch handle

Table below illustrates basic positions of fixed module standard handles.

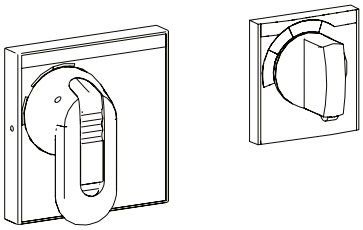
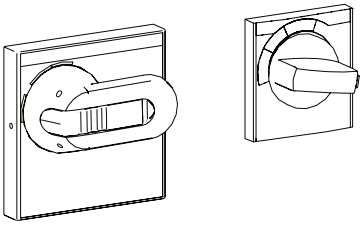
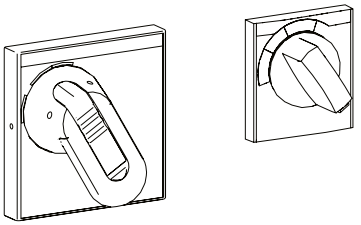
	Position of the switch	Main and control circuits
	**ON**	All main circuits are closed. Handle position has no influence on control circuits.
	**OFF** Can be locked with 3 padlocks, see 6.9.5	All main and control circuits are disconnected. Handle position has no influence on control circuits.
	**TRIP**	All main circuits are disconnected. Handle position has no influence on control circuits.

Table 6-02 Fixed modules switch handle – handle positions for circuit breaker

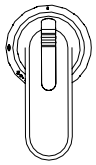
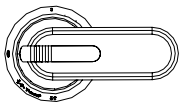
	Position of the switch	Main and control circuits
	**ON**	All main and control circuits are closed
	**OFF** Can be locked with 3 padlocks,	All main and control circuits are disconnected

Table 6-03 Fixed modules switch handle – handle positions for fuse switches

6.6 Electrical equipment – Plug-in modules operation

6.6.1 Plug-in modules

Two options for operation are available for the plug-in modules either inside or outside. Please note the operating instructions for the electrical components installed in the plug-in module. For outside operation, the symbols shown on the service handle are to be observed.

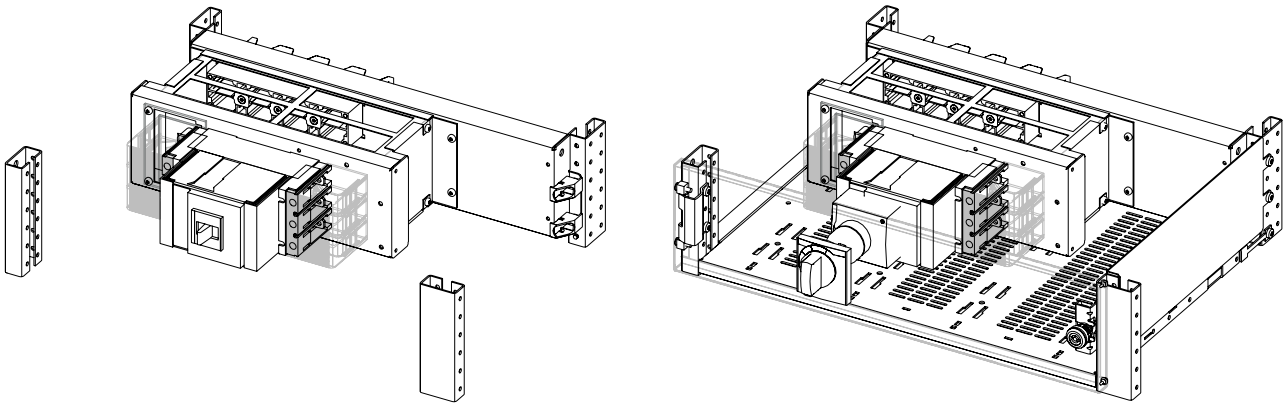


Figure 6-10 Plug-in module example with inside (left) and outside operation (right)

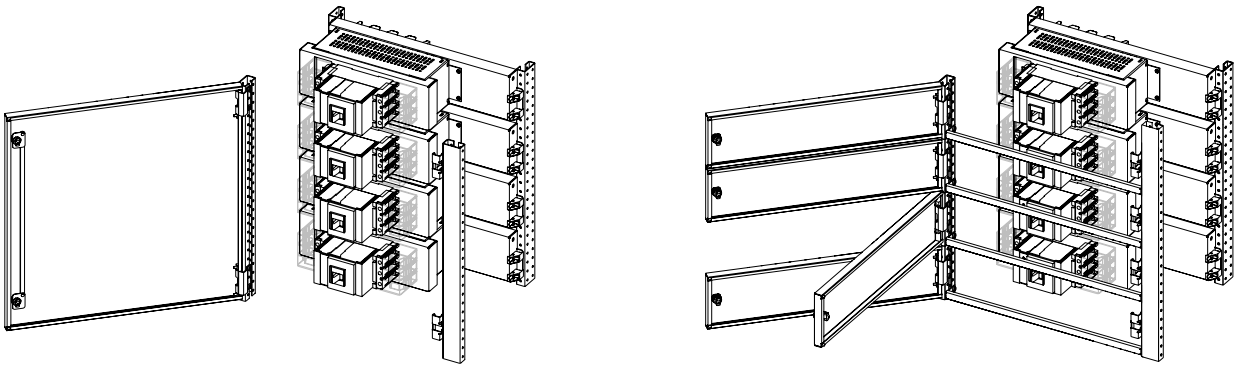


Figure 6-11 MNS section with plug-in modules with different door configuration

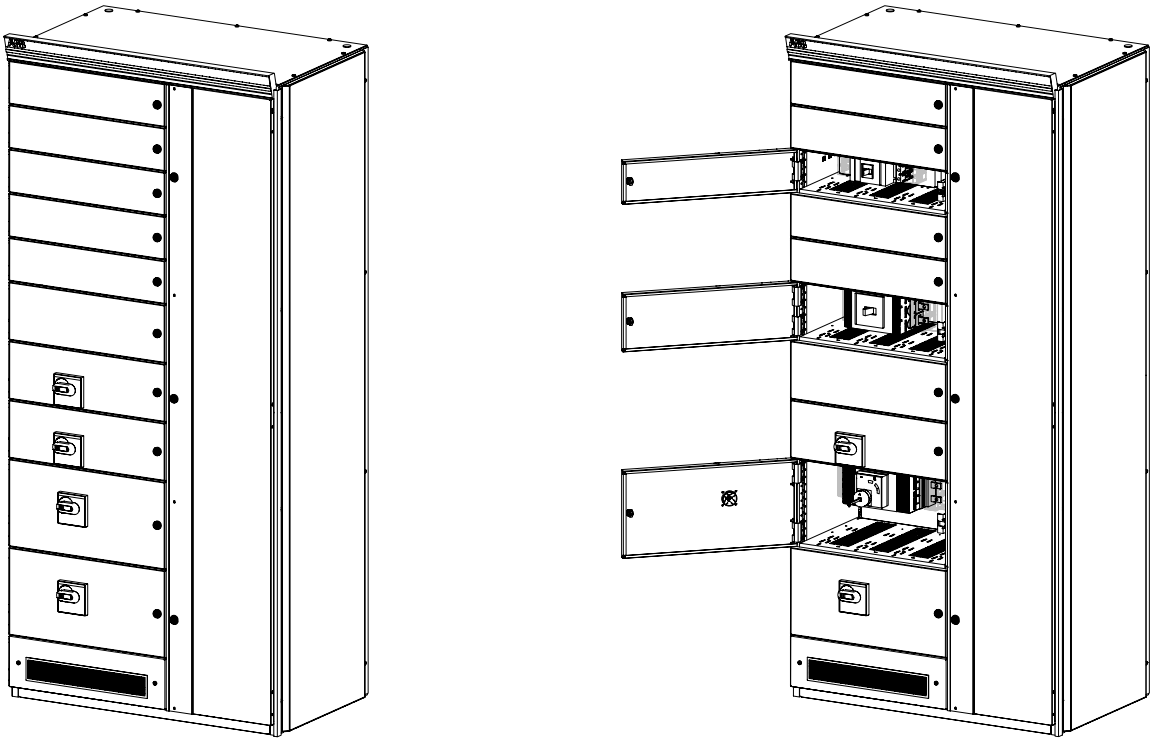


Figure 6-12 MNS section with plug-in modules (inside & outside operation)

Inside operation for plug-in and compact module

Inside operation is directly on the MCCB lever, the positions on / off / trip are clearly indicated.
Dependant on the solution the orientation may be left to right or right to left.

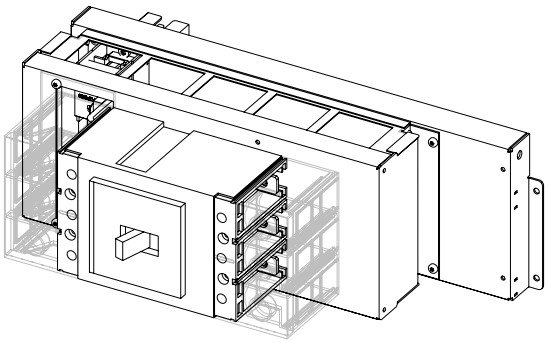


Figure 6-13 Operation directly with MCCB lever

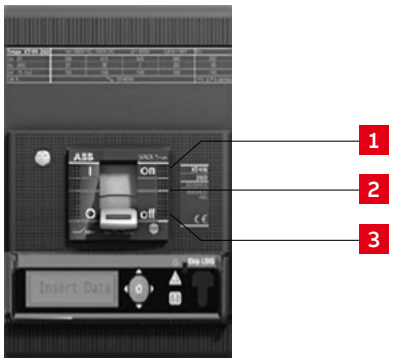


Figure 6-14 Generic facia from MCCB

To switch the circuit breaker on, move the lever from position 3 to 1.
To switch off, move the lever from position 1 to position 3.
The trip position is located approximately 1/3 of complete lever travel distance below the on position.
To reset the circuit breaker in the event of a trip the lever must first be moved to the off position before it can be switched operated again. Circuit breaker test functionality is also possible from the front facial, once the test function has been activated the circuit breaker must again be reset before it can be operated again.

6.6.2 Plug-in modules switch handle

Table below illustrates basic positions of plug-in module standard handles.

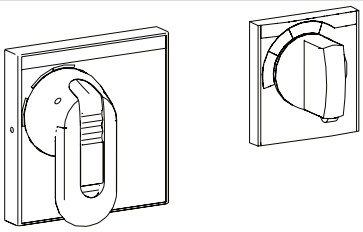
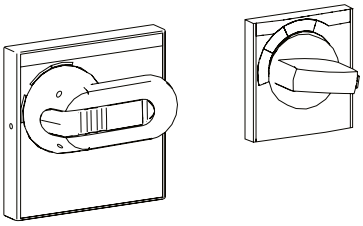
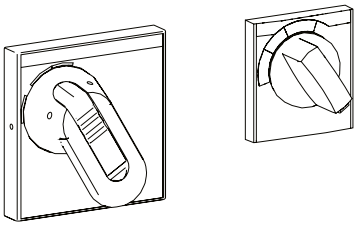
	Position of the switch	Main and control circuits
	**ON**	All main circuits are closed. Handle position has no influence on control circuits.
	**OFF** Can be locked with 3 padlocks, see 6.9.5	All main and control circuits are disconnected. Handle position has no influence on control circuits.
	**TRIP**	All main circuits are disconnected. Handle position has no influence on control circuits.

Table 6-04 Plug-in modules switch handle – handle positions for circuit breaker

Plug-in modules switch handle – handle positions (continued)

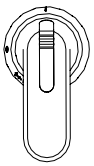
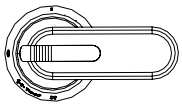
	Position of the switch	Main and control circuits
	**ON**	All main and control circuits are closed
	**OFF** Can be locked with 3 padlocks,	All main and control circuits are disconnected

Table 6-05 Plug-in modules switch handle – handle positions for fuse switches

6.7 Electrical equipment – SlimLine XR plug-in moduls

The XR is operated by moving the operating handle sideways, approx. 90°. The handle can be folded in both “On” and “Off” position. The true ON / OFF position is shown by the switch indicator in front.

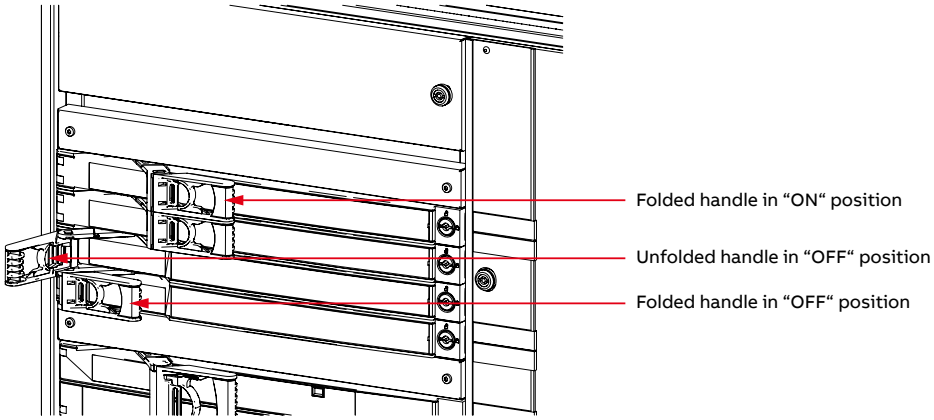


Figure 6-15 SlimLine folded handel in “ON“ and in “OFF position“

Switch ON / OFF indicator. Each XR switching status can be viewed from the mechanical indicator.

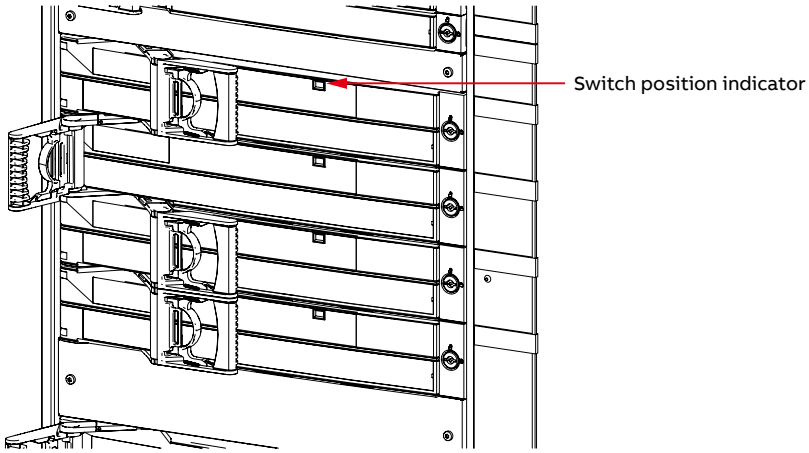


Figure 6-16 The true ON / OFF position is shown by the switch indicator in front.

The folded operating handle can be padlocked in OFF position by use of up to 3 padlocks with Ø 5 mm. If more space is requested for the padlocks, a padlock extension is available as accessory.

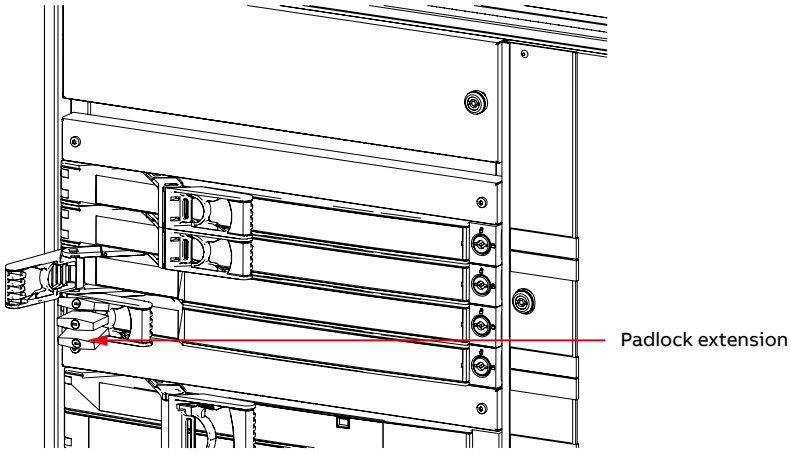
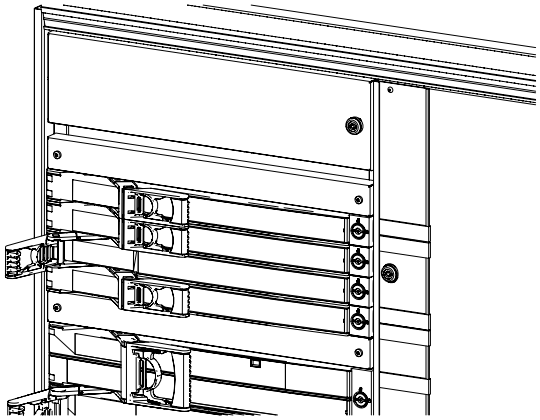


Figure 6-17 Padlocking the XR module

Replacement of the NH fuses in the XR
This procesure describes how to replace NH fuses in a XR 00 that is placed between other XR apparatus in ON position.

1. Switch OFF the XR where the NH fuses shall be replaced and open the front cover.



2. The operating handles of the XR's placed above and below can be released by use of a screwdriver and moved to park-position with the XR's still in ON position. All operating handles at XR 00,1,2 and 3 can be placed into live park-position.

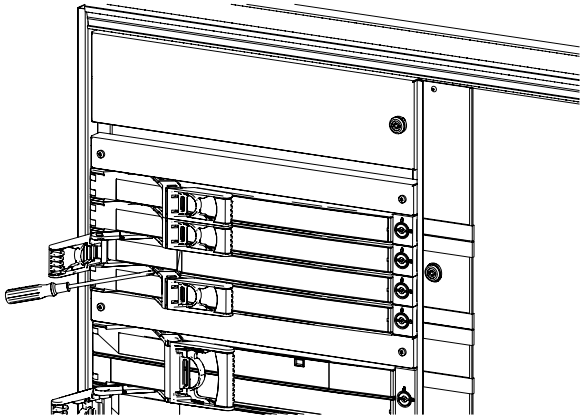


Figure 6-18 Replacement of the NH fuses in the XR

3. With the operating handles above and below in park-position, there is easy access to the L1 fuse in the XR in the middle.

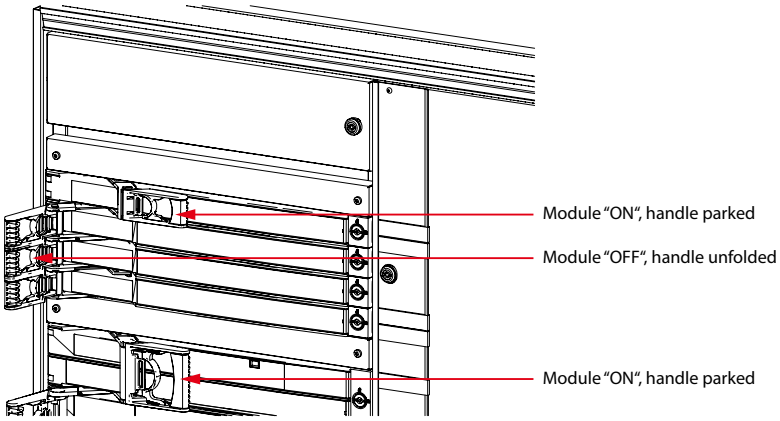


Figure 6-19 Replacement of the NH fuses in the XR

4. By use of a NH replacement tool (fuse puller), the NH fuses in the XR 00 in the middle can easily be removed / replaced.

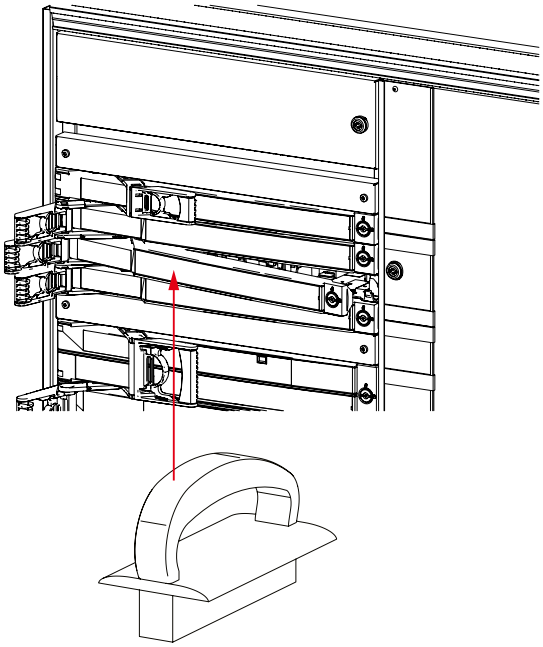


Figure 6-20 Replacement of the NH fuses in the XR shall be completed with the use of the tool shown above

6.8 Electrical equipment Reactive power compensation modules

Power compensation solutions available with with plug-in modules in a MNS section complete with reactive power controller installed directly in the section door.

Power factor will be automaticaly compensated based on the measured power factor by the controller by switching on various steps capacitor banks.

The area of concern is to make sure the fuses of each plug-in compensation modules are periodically checked and ventilation of the section is maintained.

It has to be secured, that the ventilation, also after the extension of the section with additional RPC modules is sufficient.

- Maximum modules per section with natural ventilation 3 modules with max. 125 kvar
- Maximum modules per section with forced ventilation (fan) 5 modules with max. 250 kvar

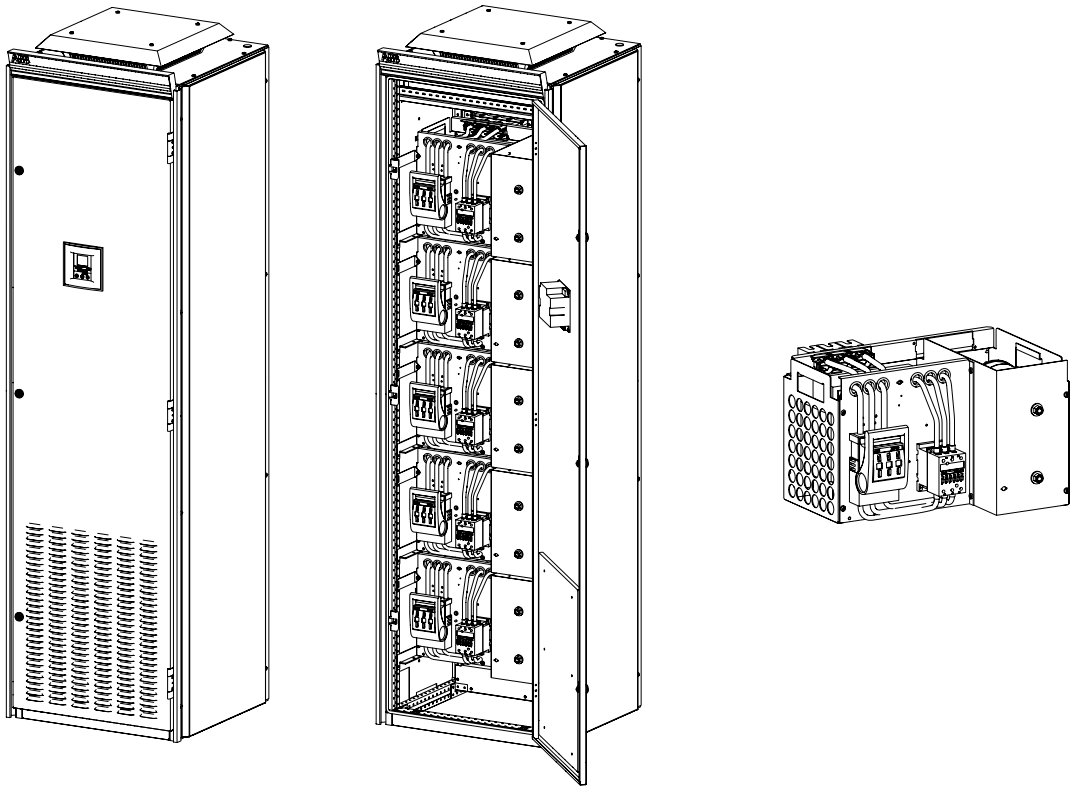


Figure 6-21 MNS section with reactive power compensation moduels

6.9 Electrical equipment – Withdrawable modules

6.9.1 Withdrawable units size 8E/4 and 8E/2

Withdrawable units size 8E/4 and 8E/2 comprise:

- One or two base profile sections for mounting snap-on components,
- a rear wall with integrated power contacts inclusive wiring and with the 8E/4 having one 16- or 20-pole control plug and the 8E/2 having one or two 16- or 20-pole control plug,
- a front panel made of insulating material with knockouts for mounting measuring, operating and indicating instruments,
- the side walls.

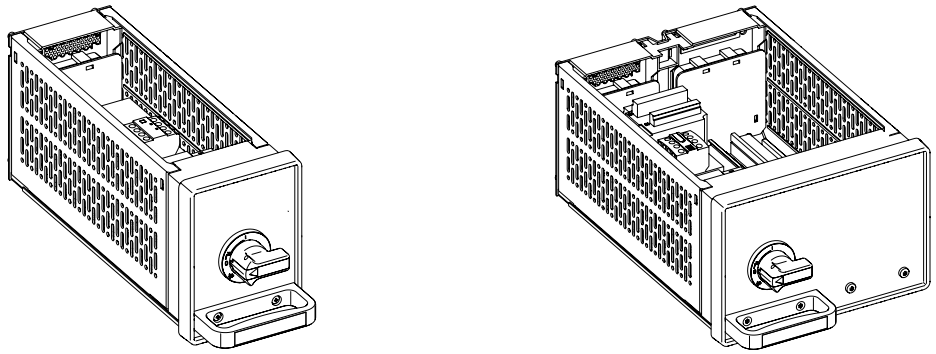


Figure 6-22 Example of small modules, size 8E/4 (on the left side) and 8E/2 (on the right side)

The handle for operating short-circuit protecetion devices (SCPD) also activates the electrical and mechanical interlocking. A micro switch with 2 × NO and 2 × NC contacts is provided for electrical interlocking.

The switch handle can be moved from position “OFF” to position “ON” only after the handle has been depressed (push-to-turn feature). The switch handle can be locked in the positions “OFF” and “TEST” and the isolated position with up to three padlocks, see Table 6-01. Switch handles of withdrawable units that are not used must be in position “OFF” or “ISOLATED”.

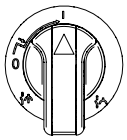
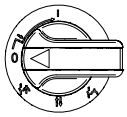
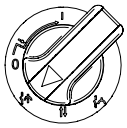
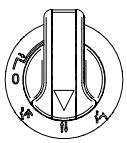
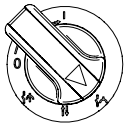
	Position of the switch	Position of the module and applicable degree of protection	Main and control circuits
	**ON**	in section corresponds with the degree of protection of the assembly, minimum IP 30	All main and control circuits are closed
	**OFF** Can be locked with 3 padlocks, see 6.9.5	in section corresponds with the degree of protection of the assembly, minimum IP 30	All main and control circuits are disconnected
	**TEST** Can be locked with 3 padlocks	in section corresponds with the degree of protection of the assembly, minimum IP 30	All main circuits are disconnected, the control circuits are closed
	**MOVE Position**	in section corresponds with the degree of protection of the assembly, minimum IP 30 isolated position the module is withdrawn 30 mm from the section, IP 20 module removed from section	All main and control circuits are disconnected
	**ISOLATED Position** Can be locked with 3 padlocks	The module is withdrawn 30 mm from the section, IP 20	All main and control circuits are disconnected and the isolating distance is fulfilled

Table 6-06 Small withdrawable module operation positions

6.9.2 Withdrawable units size 4E up to 24E

The withdrawable unit sizes 4E up to 24E are built-up of sheet steel components which constitute the supporting frame for the electrical components and the contact elements. The hinged front cover offers the advantage of easy accessibility to the built in components from the front side. Opening the front cover with a key is only possible in “ISOLATED“, “TEST“ or “OFF” position of the withdrawable unit. In larger modules when parallel coupling is installed, opening of one lock is sufficient.

To ensure safe movement and contact guidance of all power and control contacts, the withdrawable unit must only be racked into the switchgear compartment by the two handles in the lower part of the module. By using the metal front cover of the withdrawable unit for inserting the module, lack of alignment may occur between the contacts and the cable connection unit.

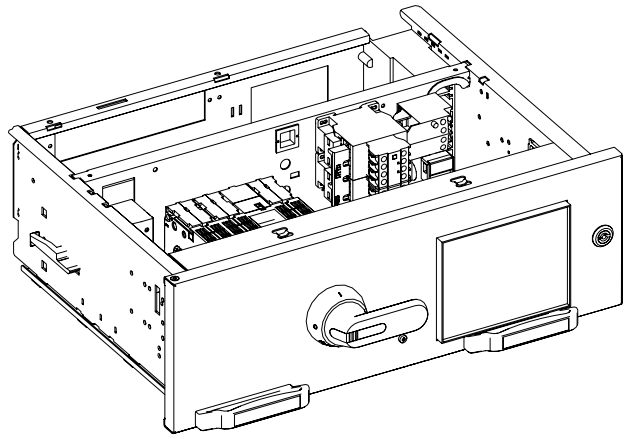


Figure 6-23 Example of standard module size 8E

The withdrawable unit standard arrangement can be equipped with an instrument panel made of insulating material for the installation of measuring, operating and indicating instruments. The hinged instrument panel is mounted to the withdrawable unit and is visible via a door cut out. This panel remains in position when the front cover is opened. If the front cover is open, the instrument panel can be tilted down by unlocking the locking lever on the left and right side of the panel. After tilting down the instrument panel a better access to the equipment both in the withdrawable unit and the instrument panel is provided (see Figure 6-25: Withdrawable module door opening)

The main switch is operated by the operating handle which is also used for the mechanical and the electrical interlocking. A micro switch with maximum 2 × NO and 2 × NC contacts is provided for the electrical interlocking.

A secure breaking of the main circuit is achieved in the OFF-position due to the isolating characteristics of the main switching devices. In addition it is necessary for working at the consumer to achieve a secure isolation of the mainand control-circuits by moving the withdrawable module to the isolated position.

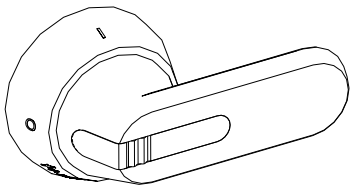


Figure 6-24 Operating handle for withdrawable modules ≥4E

According to the sizes of the module, the operating handle length is 45 mm, 65 mm, 95 mm and 125 mm. The module handle is door interlocked so that the door cannot be opened when it is in in the ON position.

If opening the module door while the operating handle is in the „ON“-position it is possible to touch live parts. Safe working practice shall be observed in this situation.

Overriding the door lock and opening a door of a withdrawable module while the switchgear in energized is not recommended. If the switchgear cannot be taken out of service it is mandatory that a risk assessment is performed, the person completing the job must be trained for this job and use correct PPE and tools. On site operating procedures must be observed when utilizing the main switch defeat mechanism.

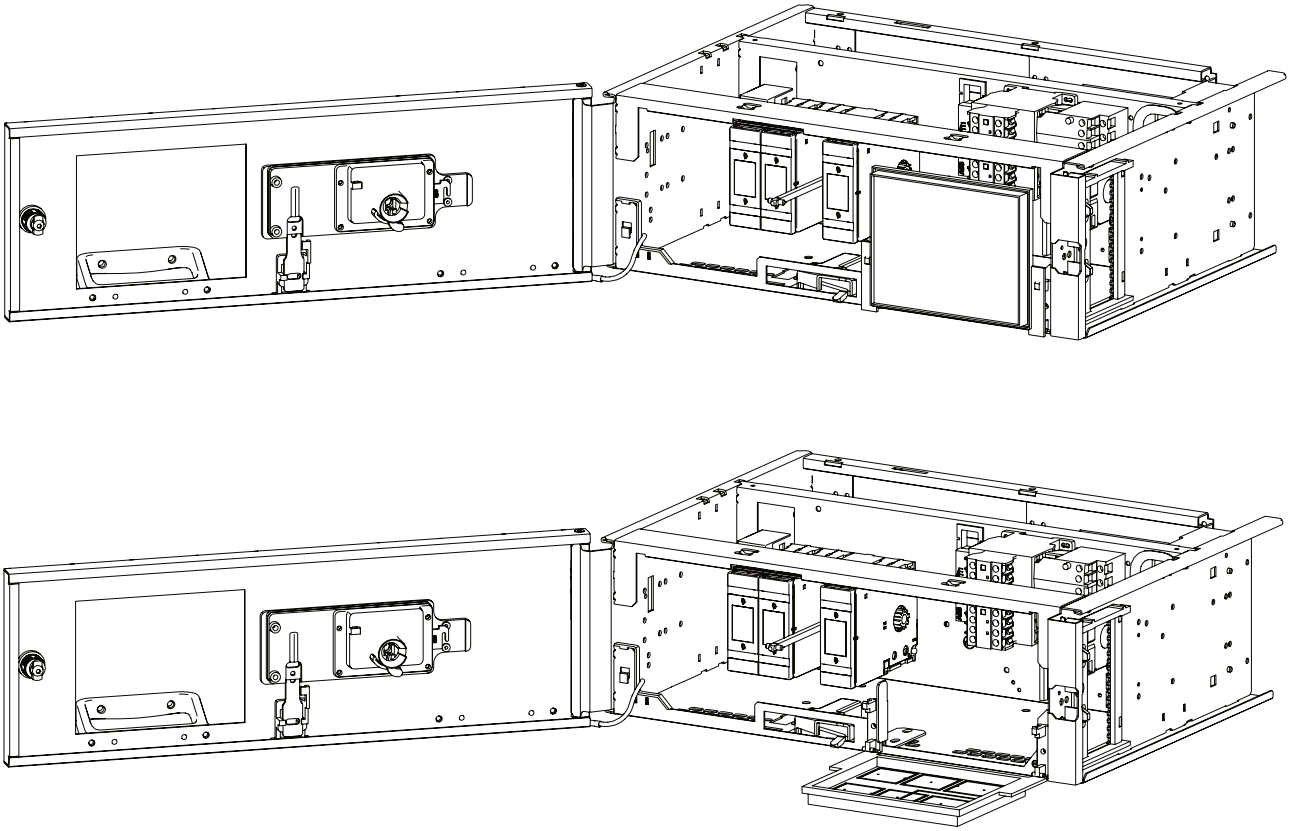


Figure 6-25 Withdrawable module door opening example

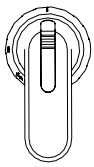
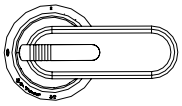
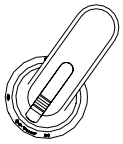
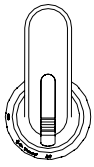
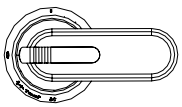
	Position of the switch	Position of the module and applicable degree of protection	Main and control circuits
	**ON**	in section corresponds with the degree of protection of the assembly, minimum IP 30	All main and control circuits are closed
	**OFF** Can be locked with 3 padlocks,	in section corresponds with the degree of protection of the assembly, minimum IP 30	All main and control circuits are disconnected
	**TEST** Can be locked with 3 padlocks	in section corresponds with the degree of protection of the assembly, minimum IP 30	All main circuits are disconnected, the control circuits are closed
	**MOVE Position**	in section corresponds with the degree of protection of the assembly, minimum IP 30 isolated position the module is withdrawn 30 mm from the section, IP 20 module removed from section	All main and control circuits are disconnected
	**ISOLATED Position** Can be locked with 3 padlocks	The module is withdrawn 30 mm from the section, IP 20	All main and control circuits are disconnected and the isolating distance is fulfilled

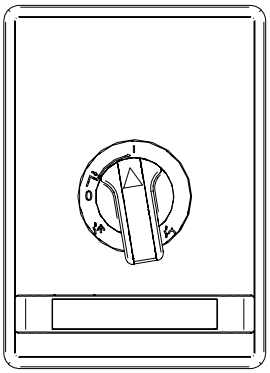
Table 6-07 Large withdrawable module operation positions

6.9.3 Resetting circuit breakers in withdrawable modules

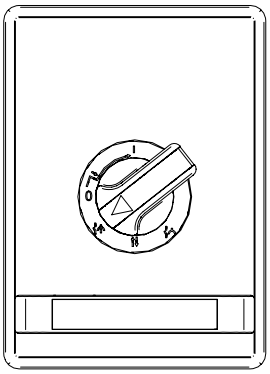
When moulded-case circuit breakers trip due to a fault conditions, the switch handle may locate into an intermediate position between “ON” and “OFF“. The function of the circuit breaker can only be re-established by a reset. Then, the circuit breaker can be switched on again.

A clear release tripped indication can only be realized with an electrical signal (e.g. pilot lamp).

Resetting circuit breaker in withdrawable module, size 8E4 and 8E2, module drawn in

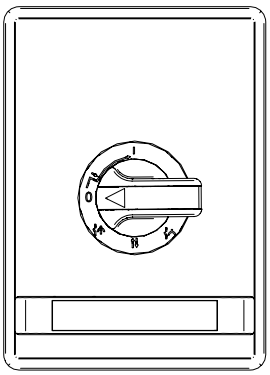


1. Position of triped moulded-case circuit breaker may locate between “ON“ and “OFF“ or directly in “ON“ position.



2. Press and turn the operation handle of the module in counter-clockwise direction over the “OFF” position until the reset position is achieved as shown in side picture. The reset position is located between the “OFF” position and the “TEST“ position. The module is then reset and available for normal operation.

3. It is important that the operation handle is not released during the reset process.



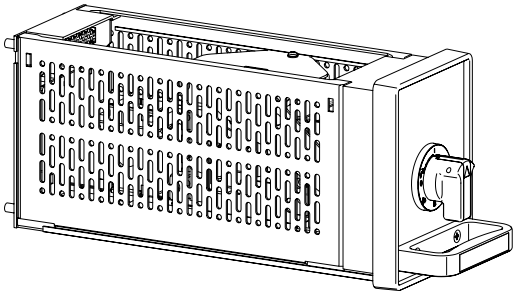
4. Once reset of breaker is done, the operation handle can be released to “OFF” position.

Figure 6-26 Reset operation in small modules, size 8E4 and 8E2, module drawn in

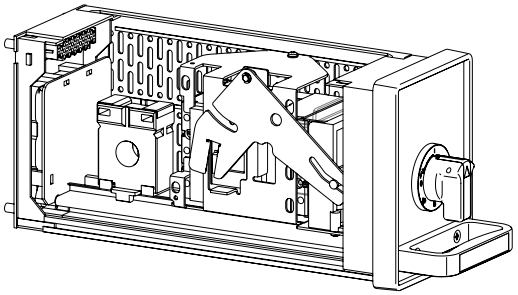
Failure to comply with the procedure above may require the module to be removed from the section and the MCCB switch to be reset directly.

Resetting circuit breaker in withdrawable module, size 8E4 and 8E2, module drawn out

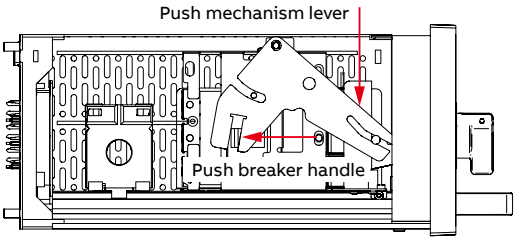
If the operation handle is not pressed continuously until reaching reset position as mentioned in previous chapter, the module interlocking mechanism is then blocked and the resetting the module with the handle is no longer possible. In this case, following steps need to be taken to reset the breaker.



1. Draw out withdrawable module



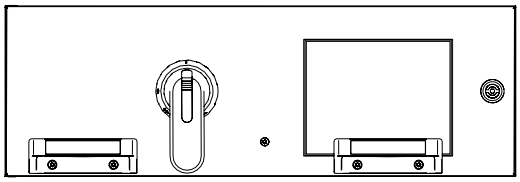
2. Remove the module left side wall-



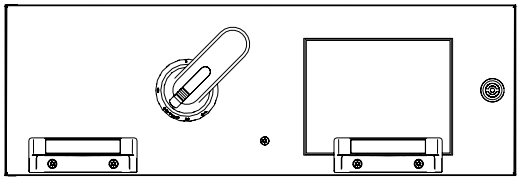
3. Reset circuit breaker by pushing breaker handle or mechanism lever

Figure 6-27 Reset operation in small modules, size 8E4 and 8E2, module drawn out

Resetting circuit breaker in withdrawable module, size 4E to 24E

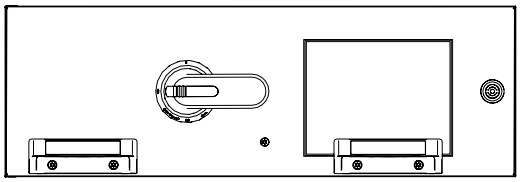


1. Position of triped moulded-case circuit breaker might be between “ON“ and “OFF“ or directly in “ON“ position.



2. Press and turn the operation handle of the module in counter-clockwise direction over the “OFF” position until the reset position is achieved as shown in side picture. The reset position is located between the “OFF” position and the “TEST“ position. The module is then reset and available for normal operation.

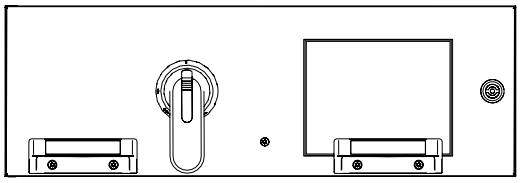
3. It is important that the operation handle is not released during the reset process.



4. Once reset of breaker is done, the operation handle can be released to “OFF” position.

Figure 6-28 Reset operation in modules, size 4E and 24E

Resetting motorized circuit breaker in withdrawable module, size 6E to 24E



1. Position of triped moulded-case circuit breaker is in “ON“ position.
2. Reset circuit breaker as instructed in the catalogue of the circuit breaker

Figure 6-29 Reset operation in modules, size 4E to 24E with motorized circuit breaker

6.9.4 Opening the door of 4E-24E modules while still in operation

The main switch of the full width modules incorporates a defeat mechanism enabling the front door to be opened whilst the modules is switched on.

To defeat the interlocking insert a screwdriver at the base of the switch moulding as shown below then open the module door lock.

The door can be closed without using the screwdriver. Once the door is closed the interlock mechanism is engaged.

If opening the front cover with the defeat mechanism while the operating handle is in „ON“- position it is possible to touch live parts. In this situation please observe the applicable procedures for working on energized equipment and / or in close proximity to live equipment.

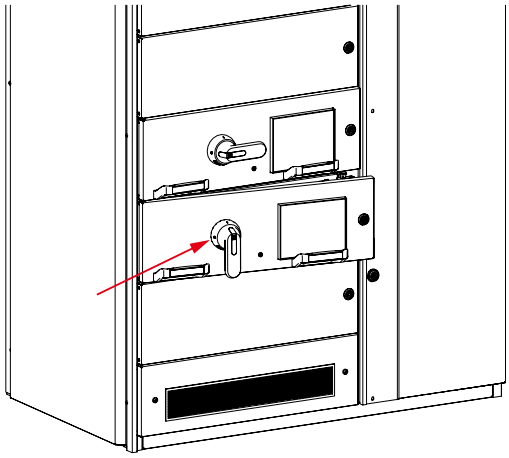


Figure 6-30 Module opening without disconnection

6.9.5 Padlocking of handles

All MNS withdrawable modules utilise handles which are padlockable with up to 3 padlocks each with 8 mm shaft.

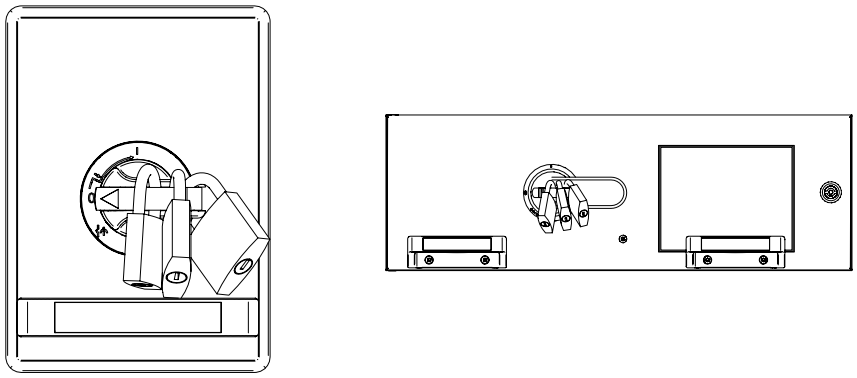


Figure 6-31 Padlocking small size (left) and standard size (right)

6.9.6 Padlocking of doors

Padlocking of module doors.

This accessory of a lock cover can be used to prevent door opening independent if main-switch is on or off. The door can only be opened if the module moved to the isolated position. The total assembly contains two screws for fixing to the module door.

Without padlocks For max. 2 padlocks

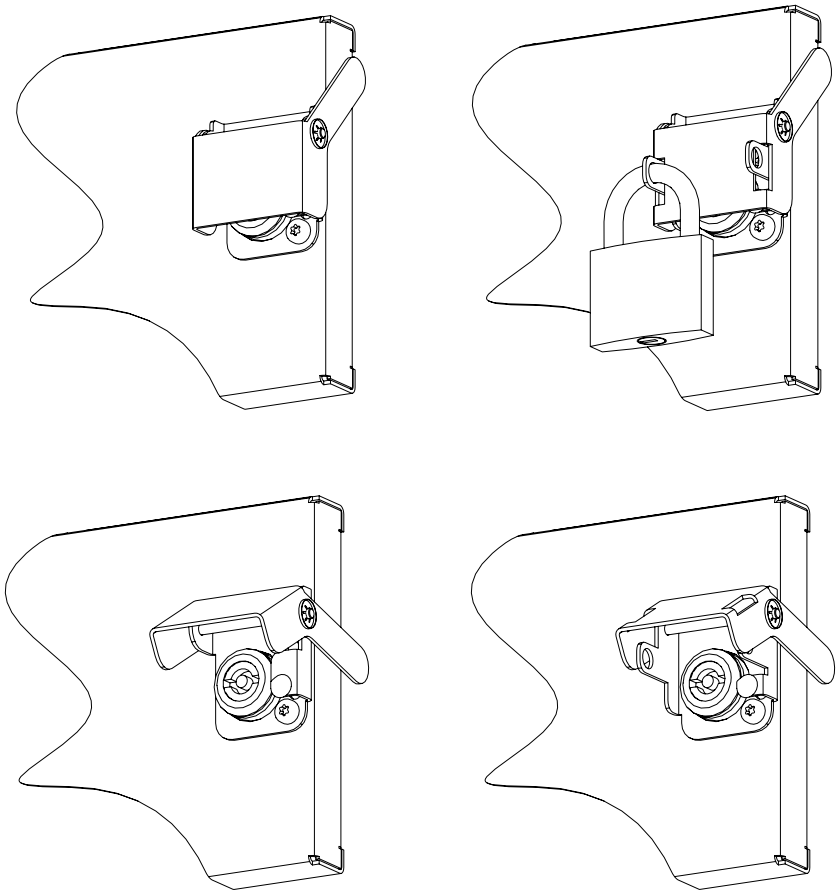


Figure 6-32 Lock covers for full size withdrawable modules

Padlocking of other door

Similar to the lock cover described in previous paragraph a lock cover is available to prevent opening of MNS section or module doors, e.g. cable compartment door or plug-in module door. Lock covers can be open in all positions
The total assembly contains two screws for fixing to the module door. Also the drilling template for rework of the doors is available.

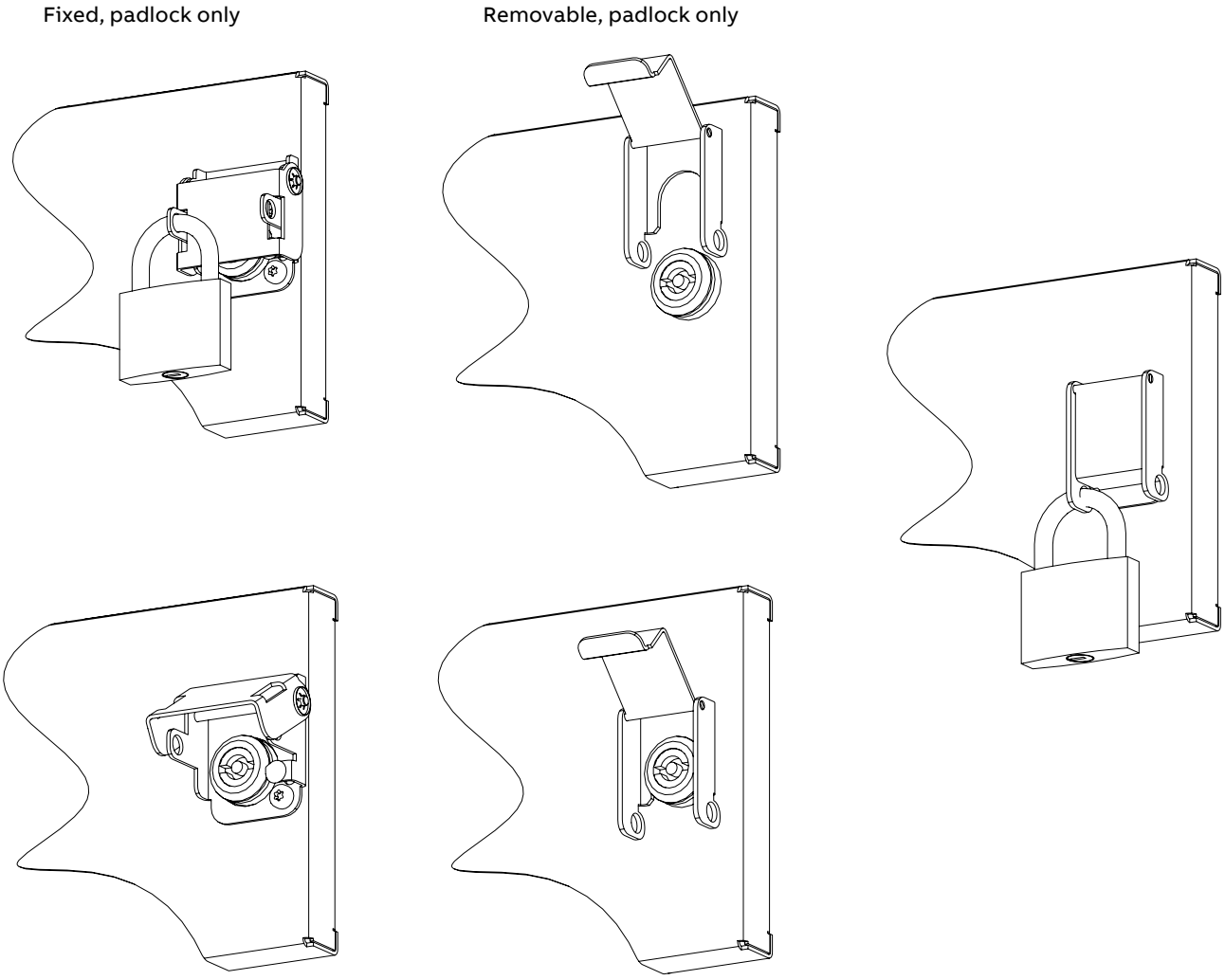


Figure 6-33 Lock covers for full size withdrawable modules

A padlock adapter is available if padlocking of MNS withdrawable modules, doors and other applications, like circuit breakers when more than 3 padlocks are required.

It is possible to apply up to 4 padlocks with 5 mm, 7 mm or 8 mm shackle diameter.

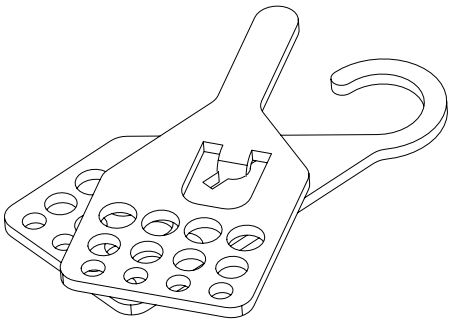


Figure 6-34 Padlock adapter

6.10 Operation of function units

Depending on the control wiring arrangement, operation can be structured to be control with below control method:

- Manual control motor with local control station – the local control station is wired direct to the control terminals of the starter module.
- Manual control motor with local distribution panel – the local distribution panel is complete with all the motor starting components. This arrangement is common for sub supply package system and with multiple motors in one package. The module used to supply the local distribution panel is a feeder module.
- Distributed control system (DCS) can be wired to the MCC switchboard or direct to the local distribution panel to perform the remote motor control operation.
- DCS may be wired to each motor starter by:
  - Conventional wiring to all the motor starter.
  - Serial communication (Profibus, Profinet, Modbus, DeviceNet or others) for MNS Digital.
  - A mixture of serial communication & remote input/output (RIO) module method to MCC or local distribution panel

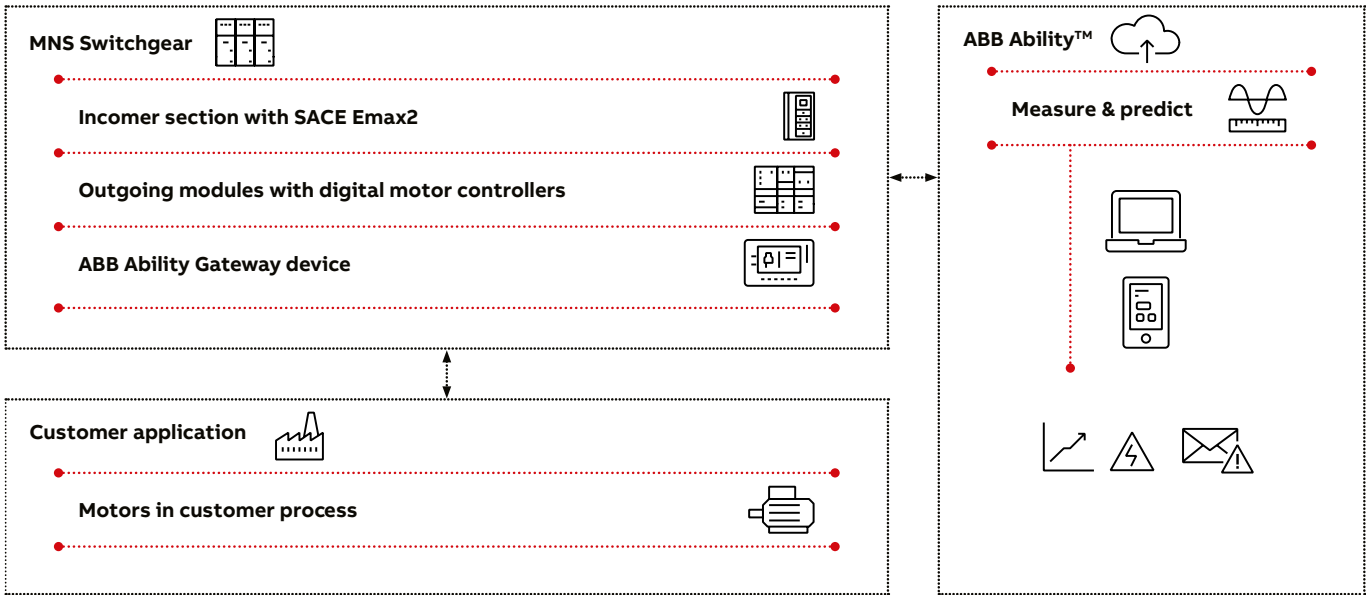


Figure 6-35 MNS Digital motor control operation

07

Maintenance

Maintenance

7.1 General

MNS Low Voltage Switchgear assemblies are designed for a typical lifetime of 30 years. The actual performance depends on how the switchgear was installed, how much it has been utilized or operated and under what environmental condition it operates.
At any point of time the condition of a switchgear assembly is between fully functional satisfactory and non-functional. Towards the end of the life of a switchgear the regular maintenance determines the level of functionality from the following three scenarios:

- The lifetime expectation can be met
- The lifetime expectation is shorter than expected
- The lifetime expectation can be extended

Power switchgear assemblies can never be designed or are intended to remain perpetually energized without maintenance as there are mechanical and electrical parts that are exposed to wear and tear that, if unattended, may lead to a failure.

The general principles requires that the electrical systems and equipment must be operated in accordance to applicable rules i.e. EN 50110 for European countries or corresponding laws applicable in other regions.

According to the applicable national and international standards and provisions (e.g. for Germany, DIN 57 105 part 1/ VDE 0105 part 1; DGUV Vorschrift 3), electrical plants must be maintained in an orderly condition by their operator.

All defects in a power switchgear assembly must be immediately rectified and in the event of imminent danger, electrical systems must no longer be operated. If danger to persons, property or the environment is imminent, defective electrical systems or equipment must be immediately taken out of operation and must not be used in defective condition. Safety rules as outlined in chapter 1 of this manual apply under all circumstances.

As the leading manufacturer of power switchgear assemblies ABB has designed MNS to minimize maintenance required and to ensure the highest operational safety and availability. The MNS power switchgear assembly contains sub-assemblies that are designated maintenance free, these areas require simply visual inspection to ensure their operational availability is not compromised, these sub-assemblies being:

- The frame structure
- The main busbar system
- The combined assembly of the distribution busbars and multifunctional wall

Switchgear maintenance needs can be checked by the client using an online LV switchgear condition assessment tool by ABB Service free of charge. In addition to the above ABB also provides digital solutions to optimize maintenance procedure.
For more information please visit https://new.abb.com/low-voltage/service/services-for-switchgear

7.2 Maintenance practices

Owners and operators are responsible for implementing maintenance practices that support to maximize the life, reliability and availability of the MNS switchgear.

Besides the normal aging of materials, external influences that affect the life time are:

- Environmental conditions: room temperature, humidity, dust, air quality, proximity to sea or high altitude, water ingress;
- Operational habits: number of withdrawals, not switching the breaker on or off for long periods of time; lack of maintenance routines
- Change of loads (motor replacement), addition of electrical loads to the switchgear, process changes (over/under loads).

Further, switchgear internal situations create an impact on life time such as: electrical and mechanical faults, earth faults, arc faults, short circuit and dielectric flash over.

Maintenance is performed to minimize the risk of failures in electrical equipment, prevent unnecessary downtime with the result of increased reliability and reduced operational expenditure.

In addition to reactive maintenance following a failure or breakdown in the electrical assembly, preventive maintenance and predictive maintenance are the common practices with the latter requiring sufficient data to be analyzed in order to predict the area with a need for maintenance to be carried out.

Maintenance with respect to electrical assemblies can be performed in either non-intrusive (maintenance on energized switchgear) or intrusive (maintenance on de-energized switchgear).

Non-intrusive maintenance means that the switchgear can continue in normal operation however, maintenance work may require access to area where voltage is present.
Intrusive maintenance means that the switchgear needs to be de-energized and safety procedures for isolation shall apply prior to any work being carried out.

Prior to any maintenance work on the MNS switchgear assembly it is imperative to strictly observe the site owner/operator and ABB OHS instructions, see also chapter 1 of this manual.

Please do not hesitate to contact your ABB representative should any assistance be required to ensure the lifetime expectancy of the MNS low voltage switchgear is not compromised.

7.3 Preventive maintenance checks and intervals

Initial preventative maintenance may be carried out to ensure maximum performance and availability. This is achieved by regularly repeated visual inspection and operation test procedures and it is outlined in the tables below.

For information on the mechanical and electrical life (i.e. operation cycle) of electrical equipment as part of the power switchgear assembly, please refer to the relevant product documentation.

All maintenance work i.e. required tightening torques relating to the electrical equipment in use must also be carried out in accordance with the manufacturer´s instructions.

Preventive maintenance is carried out as visual inspection. Where further maintenance is found to be required (i.e. intrusive such as repair or replacement of equipment) scheduling may then be required depending upon operational requirements.

General inspection

A) Recommended preventive maintenance (regularly, non-intrusive)

Non-intrusive maintenance does not interfere with plant operation schedules and can be performed as a regular procedure in a 6 month to 12 month repetition. It is aimed to ensure workplace safety and proper operating condition for the power switchgear assembly.

Findings and corrections of issues shall be recorded.

	Work to be performed	**Measured, test and limit values, operating and auxiliary materials**	**Remarks**
A	External inspection		
A.1	Verify accessibility conditions	• Room accessibility, door locked • Room cleanliness • Presence of any unauthorized equipment • Escape routes marked and accessible path width ≥ 650 mm with open switchgear doors	
A.2	Verify ambient conditions	• Room temperature between 5°C to 35°C • Relative humidity ≤ 50% at 40°C • Air quality (salt, chemical substances) • Dust • Water ingress	
A.3	Check room ventilation system	• Air supply (ventilation, air conditioning) available (no obstruction, functioning)	
A.4	Check switchgear ventilation	• Cleanliness of ventilation louvres	
A.5	Check condition of enclosure/ outside part of assembly	• Ingress protection (IP class, IEC60529) • Any damage or corrosion present • Missing parts such as module doors or covers • Compartment doors closed, locks operable • Roof plate contaminated/covered/obstructed • Fastening of cable compartment doors, side and back walls • Position of withdrawable modules (present and in operating or isolated position) • Correct labels, safety signs all legiable	
A.6	Documentation (drawings, parameter settings)	• Documentation and drawings available and updated to current design as installed and operated • Parameter settings and data storage (for electronic devices) available and updated as installed and operated	
A.7	Installed equipment	• Diversity/density factor of switchgear as per design criteria (number, size and location of modules, changes compared to initial design, design criterial i.e. power loss confirmed)	

Table 7-01 Recommended preventive maintenance (regular, non-intrusive)

B) Recommended preventive maintenance (based upon the conditions described below, intrusive)

Intrusive maintenance should be performed in line with process operational schedules and require partial or full switchgear de-energization. The following three scenarios are to be considered:

1. Normal Operation:
For power switchgear assemblies under normal operating conditions it is not recommended to exceed 5 years operation without performing the recommended intrusive maintenance.

2. Heavy Duty Operation:
For power switchgear assemblies under heavy duty operation condition, with frequent and high load operations, harsh environments (chemicals, dust in air) the recommended maintenance cycle is annually/bi-annually and it is not recommended to exceed 2 years operation without performing intrusive maintenance.

3. Following the occurrence of an Electrical Fault:
In installations that have experience an electrical fault within the assembly or on external loads (i.e. short circuit with high current circuit breaker operation, dielectric faults or flash over) is highly recommneded to perform intrusive maintenance and functional tests following the incident and before the power switchgear assembly is brought back into operation.

	Work to be performed	**Measured, test and limit values, operating and auxiliary materials**	**Remarks**
B	Interior inspection of sections		
B.1	Equipment compartment • Check diversity/density factor • Internal conditions	• Arrangement of modules in accordance with engineering and design documents • Contamination, e.g. dust • Surface of electrical contacts blackening • Loosened screws	• Clean if required • Clean with cloth and solvent • Tightening torque indicated in table 4-09 required for constructional requirements for example thread rolling screws M sizes applicable. • Silver plated connections may become darker within operation or due to environmental conditions.
B.2	Cable compartment / cable terminal compartment	• Incoming sections are in accordance with project documentation • Sufficient room/strain relief • Cable routing and fixing, bending radii • Protective covers/bellows in place and fixed accordingly • Correct installation of cover where shipping splits are present	• Tightening torque indicated in chapter table 4-07
B.3	Control equipment compartment (if present) • Check filling/density factor • Internal conditions • Cable routing and connection	• Arrangement of modules in accordance with engineering and design documents • Contamination, e.g. dust • Loosened screws • Cable routing and fixing, bending radii	• Clean if required • Tightening torque indicated in table 4-09 required for constructional requirements for example thread rolling screws M sizes applicable.
B.4	Air Circuit Breaker	• See related installation, operation and maintenance instructions of manufacturer	• Carry out recommended maintenance procedures
B.5	Busbar compartment • Check busbar sections • Check busbar supports • Visual inspection of the condition of the busbar insulation (if present)	• Tightening marker present and correct • Color change at bolted connections • Cracks, dust • Signs of contamination or flashover, arc • Discharge marks • Correct installation of covers	• Clean if required • Replace parts if required • Replace insulation material
B.6	Earth and Neutral busbar joints and related connections • Check busbar supports	• Loosened earthing connections • Tightening marker present and correct • Discolouring, corrosion • Cracks, dust	• Clean if required • Replace parts if required
B.7	Busbars (main busbars, distribution busbars, connection between busbars, connection between busbars and circuit breakers)	• Tightening marker present and correct, where access is possible • Discolouring, corrosion • Discharge or smoke marks • On insulated busbars check insulation materials for physical damage where access is possible	• Clean if required • Replace parts if required

Table 7-02 Recommended preventive maintenance (based upon conditions, intrusive)

With respect to a functional unit's further inspection as part of the intrusive maintenance the following may be required.

The table below applies in general for different type of functional units such as ACB, withdrawable, plug-in and fixed design.

	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Remarks
C	Intrusive inspection of functional units (withdrawable, plug-in, fixed)		
C.1	Assembly of conductors	• Check for insulation damage	• Measure the insulation resistance
C.2	Check electrical equipment installed	• Check contact corrosion, contact gaps are line with the requirement and grease is present and not discolored, ionization chamber, arc splitter, rated currents, settings and tripping. Minimum creepage distance ≥ 12.5 mm	• For the complete maintenance work, observe the instructions of the equipment manufacturer.
C.3	If Sn plating in modules is present: Check clearance and creepage paths and remove any whiskers mechanically	• In accordance with IEC 61439-1	• If heavy duty operation is applicable, annually inspection is required.
C.4	Required protection class	• IEC 60529 in line with project documentation	
C.5	Check efficiency of protective conductor connection	• Check continuity with signal test apparatus	
C.6	Function test of the control device	• In accordance with circuit diagram	• Check numbers of control connection cables if present.
C.7	Check measuring loops	• In accordance with circuit diagram	
C.8	Check of mechanical functionality (operation and interlocks)	• In accordance with mechanical design of the functional unit	

Table 7-03 Functional units intrusive maintenance

ABB recommends the use of checklist as provided in chapter "12.1 Maintenance and inspection checklist" for detailed work.

7.4 Examination of MNS contact systems

NOTE:
All main contacts utilized within the MNS system must be greased with Klüberlectric KR44-102 or with KR 44-402. The color of the grease is off white, any change to red-brown/black requires immediate investigation.

7.4.1 Routine verification (Assembly manufacturer)

Each module (withdrawable / plug-in module, fused Slimline switch, or withdrawable module condapter) is subject to the following routine verification procedures in line with the requirements in IEC 61439.

The visual inspection of the contact system includes the following items:
- Contacts are movable and properly located in position in the withdrawable module rear wall or contact apparatus housing.
- Deformation of contacts (bent), mechanical damage.
- Medium-force fit of the contact spring (withdrawable modules 8E/4 and 8E/2) in its specified position.
- Contacts are greased.

7.4.2 Examination on site

Each module (withdrawable / plug-in module, fused SlimLine switch, or withdrawable module condapter) is subject to the following visual inspection prior to the installation in the section:
- Deformation of contacts (bent), mechanical damage.
- Contacts are greased.

7.4.3 Regular visual check

Recommendation is to perform the visual check of the MNS power contacts after every 100 mechanical movements of the withdrawable modules or every 5 years for normal operation, or every two years for heavy duty operation, whichever occurs earlier.
The definition of normal operation and heavy duty operation is described in chapter 7.3 clause B.

7.4.4 Reduce downtime

Quick visual check of the contacts and grease!

In many process environments, withdrawable solutions are applied. When a lock out for the module is required, a simple practice to apply is a quick visual check of the contacts and grease! The normal color of the grease is off white color.

Discoloration of the grease to a red-brown/black gives early indication of an increase in temperature and that there is requirement for a more detailed investigation, as defined below.

7.4.5 Inspection/assessment procedure

Before the visual check
- Check colour of contact grease as a first indication of overheating is discoloured contact grease (red-brown to black).
- Should this be the condition then, remove the grease from the power contact and:

Check for visible damage at the power contact system, its contact surface or their counter parts (distribution bars, compact plug in and withdrawable module, withdrawable module condapter, outgoing cable connection unit).

The following are indicators that can lead to unwanted outages. Should any of these indicators be present a more in depth assessment is required.
- Discoloured contact grease (red-brown to black).
- Worn silver or tin plating / visible bare copper on contact tips or contact surface.
- Melted spots on contact tips or on contact surfaces.
- Signs of inadmissible heating, such as discolouring due to heat.
- Cable insulation damage, melted or swollen. Any other signs of overheating.
- Plastic parts broken, melted or swollen. Any other signs of overheating.
- Contacts are mechanically deformed, bent or damaged.

Addition visual inspection of:
- Contacts are movable and properly located in position in the contact housing.
  Details see chapter 7.4.6.
- The power contact spring is still in original position, properly fixed and not loose.
- The connected cables are smoothly routed and proper bending radii are kept.

After visual check or replacement is finalized, power contacts shall be properly greased according to chapter 7.6.1.

Before checking the distribution bars or the withdrawable module condapters disconnect the section from the power supply!

7.4.6 Correct procedure for installation of the power contacts

This instruction applies to all compact, plug-in and the withdrawable modules sizes 4E – 24E. The contacts are required to located correctly in their housings on the incoming (multifunction separation wall) side and for withdrawable modules on the outgoing (cable connection unit) side.

Incorrect installation of the main contact result in unwanted outages, therefore it is essential the following instructions are observed.s the use of checklist as provided in chapter "12.1 Maintenance and inspection checklist" for detailed work.

Please do not hesitate to contact your ABB representative should any assistance be required.

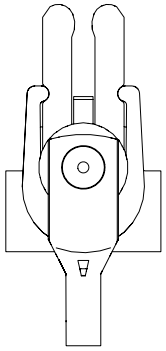
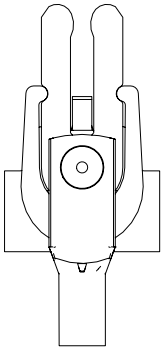
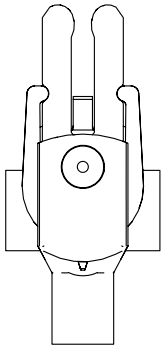
Conductor cross section	6 / 10 / 16 mm²	35 mm²	70 mm²
Contact type			

Table 7-04 Power contacts conductor cross section

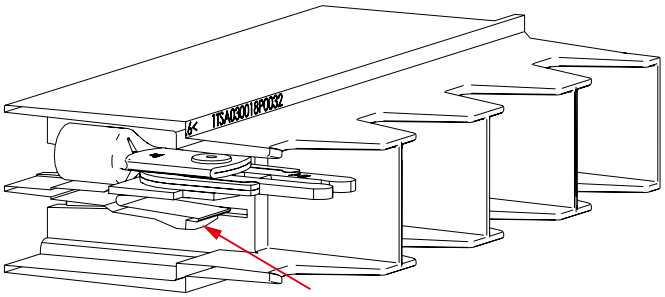
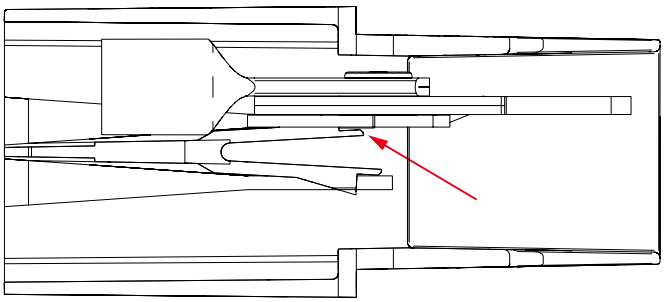
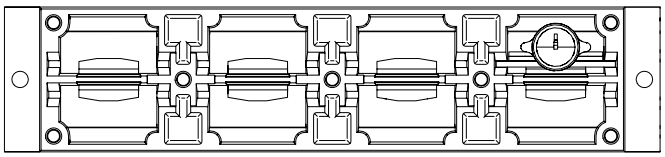
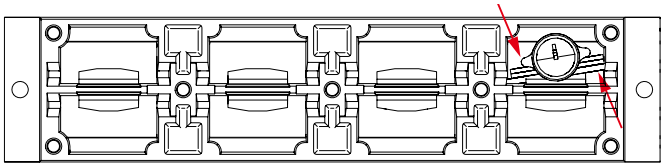
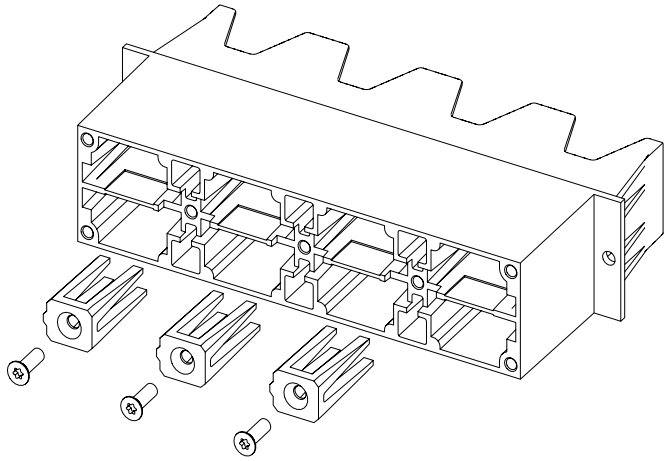
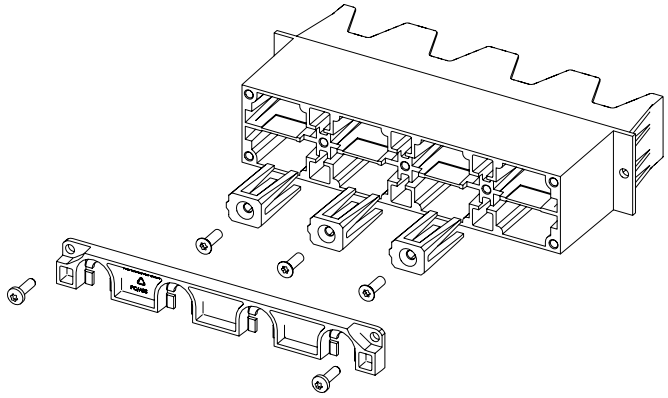
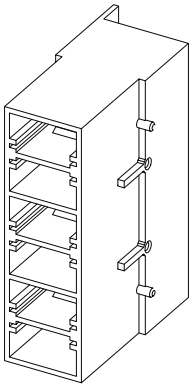
Contact mounting	Instruction
	It is possible to insert two main contacts per phase in the module incoming housing, the lower contact is turned 180° with respect to the upper contact. The graphic left indicates the correct location of the upper main contact The main contacts are inserted until there is an audible click. This is the locating tab ensuring the contact is correctly positioned. The locating tab of the lower contact is indicated on graphic left.
	The detailed graphic shows the correct position for the upper locating tab when the contact is correctly inserted. This can be easily verified by pulling the cable, when the contact is not correctly located it the tab will not retain the contact in the housing.
	Shown left is the contact located correctly in the housing.
	Shown left is incorrect location in the contact housing. Such a situation can result in unwanted outages and shall be avoided.

Table 7-05 Main contact installation instructions

Table 7-05 Main contact installation instructions (continued)

Contact housing	Instruction
	To further ensure that the contact is correctly mounted the insert shown left shall be fitted once the contacts have been inserted. The inserts shall be flush mounting with the housing and can only be inserted one way.
	For some plug-in solutions with smaller diameter cables the IP cover is fitted.
	For the withdrawable modules the housing shown left is utilized. Installation is as before: The main contacts are inserted until there is an audible click. This is the locating tab ensuring the contact is correctly positioned. This can be easily verified by pulling the cable, when the contact is not correctly located it the tab will not retain the contact in the housing.

7.4.7 Power contact types openings and tolerances

In the situation where there is an absence of visible damage and if one of the following situations is identified.

- Power contact has been in use for more than 1000 operating cycles
- No grease is present on the power contacts
- Contact grease that is dark-discolored, burnt or visible, red-brown to black

It is recommended to measure the contact opening by using a Vernier caliper (calibrated) this is applicable for the Sotax / Small / Condaptor contacts.

With respect to the ABB ID Type 101 the following tool is required:
MNS Type 101 Contact Gauge (1TNA500119R0001)

The contact opening defined in the table below, need to be within the tolerances given to ensure safe operation. Contacts shall be exchanged if contact the opening is not within the specified tolerances.

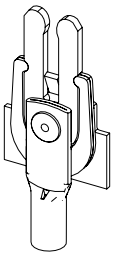
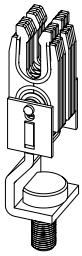
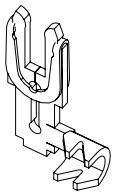
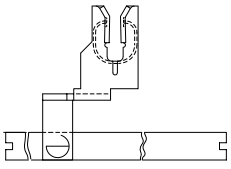
Contact type, visual ID	Contact type, part number ID and application	Contact opening following production	Contact opening during normal operation, wear and tear
	1TGB100101 Type 101 Power contact of: - withdrawable modules 6E – 24E - withdrawable modules 4E (incoming) - plug-in modules	$3.95\ ^{+0.05}_{-0.2}$ mm	4.10 mm
	1TSA060001R0019 Type SOTAX Power contact of: - withdrawable modules ≥ 16E - plug-in modules The SOTAX contact contains four single contacts. Contact opening is valid for a single contact.	$4.2\ ^{+0.4}_{-0.4}$ mm	4.85 mm
	GLBS200520 Type Small Power contact of: - withdrawable modules 8E/4 and 8E/2 - withdrawable modules 4E (outgoing)	$4.7\ ^{+0.05}_{-0.2}$ mm	4.85 mm
	GLBS200517 Type Condaptor Power contact of: - withdrawable condapter for module 8E/4 and 8E/2 (incoming)	$4.8\ ^{+0.0}_{-0.3}$ mm	4.85 mm

Table 7-06 MNS contacts openings and tolerances

7.4.8 Exchange material

Should any of the conditions mentioned in chapter 7.4.5 be identified, it is recommended to exchange the power contacts including the connected cables or if 8E/4 and 8E/2 withdrawable modules are affected, replacing the complete withdrawable rear wall.

Depending upon the severity of the condition of the main contact circuit and the associated component parts it may be necessary to replace these components also.

Should there be any uncertainty please contact your local ABB service representative.

7.5 Examination of MNS power contact systems

Functional units in MNS switchgear assemblies of withdrawable or plug-in design utilizing the MNS power contact system. Contact systems must be greased according to chapter 7.6 in this document. The power contacts should be inspected regularly to ensure correct electrical performance.

If irregularities are detected, we recommend informing the respective ABB Service department in order to determine and coordinate further measures.

Silver and Tin contacting solutions shall not be mixed.

Before checking the distribution bars or the withdrawable module condapters disconnect the section from the power supply!

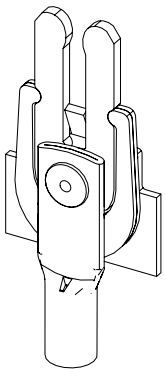
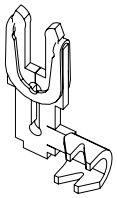
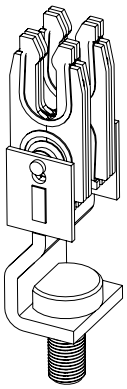
Application	**Power contact of withdrawable modules 4E...24E and plug-in modules**	**Power contact of small withdrawable modules 8E/4 and 8E/2 and of full size withdrawable modules 4E**	**Power contact of withdrawable modules ≥16E and plug-in modules**
Contact type			

Table 7-07 Power contacts according application

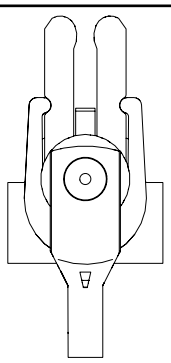
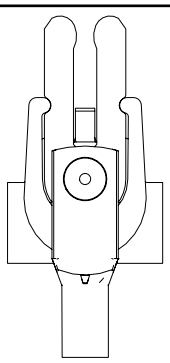
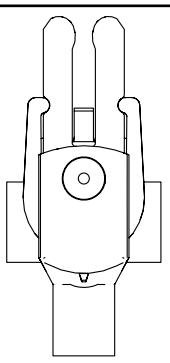
Conductor cross section	6 / 10 / 16 mm²	35 mm²	70 mm²
Contact type			

Table 7-08 Power contacts conductor cross section

7.5.1 Visual inspection

Recommendation is to perform the visual inspection of the MNS power contacts after every 100 mechanical movements of the withdrawable modules or in line with maintenance procedures detailed above in Table B, which ever occurs earlier.

Depending upon the severity of the condition of the main contact circuit and the associated component parts it may be necessary to replace these components also. Should there be any uncertainty please contact your local ABB service representative.

7.5.2 Inspection procedure

Under normal operating condition the original colour of the grease should be maintained, white/off white. (The original grease KR44-102 or KR44-402 'color space' is white as defined by the manufacturer Klüber Lubrication). In addition to this the contact finger areas should be clean and of a polished appearance.

Check for visible damage at the power contact system, its contact surface and where possible the counter parts.
Initial out of tolerance conditions may be identified by the following visual indicators:

- Discoloured contact grease (red-brown to black).
- Worn silver or tin plating/visible bare copper on contact tips or copper bars.
- Melted spots on contact tips or on the copper bars.
- Signs of inadmissible heating, such as discolouring due to heat.
- Cable insulation damage, melted or swollen.Any other signs of overheating.
- Plastic parts broken, melted or swollen. Any other signs of overheating.

Ensure that the contacts are movable and properly located in position in the contact housing.
Ensure that the contacts are not mechanically deformed, bent or damaged.
Ensure that the power contact spring is still in original position, properly fixed and not loose.
Ensure that connected cables are smoothly routed and proper bending radii are kept.
Following the visual check or replacement, power contacts shall be properly greased according to chapter 7.6.1.

7.6 Greasing of contact areas

7.6.1 Greasing of power contacts

Greasing the contacts is a mandatory prerequisite for reaching the operating cycles to which the unit is certified via verification testing as the grease reduces the wear of the contact area finish. Furthermore, the force needed for withdrawing and inserting the modules is reduced.

Contact areas of the power contacts are to be cleaned and greased whenever the following conditions apply:

- the assembly work and routine testing has been completed in the workshop
- after 100 plug-in cycles or after max. 5 years, whichever is earlier

Before installing the module in the section.

- The following grease to be applied: Contact grease Klüberlectric KR44-102 or KR44-402
- Use a brush to apply the grease.
- Avoid excess grease on the contacts.
- If the modules are supplied as loose parts, the contacts should be greased prior to be inserted in the section.
- For contact areas to be greased, see Figure 7-01

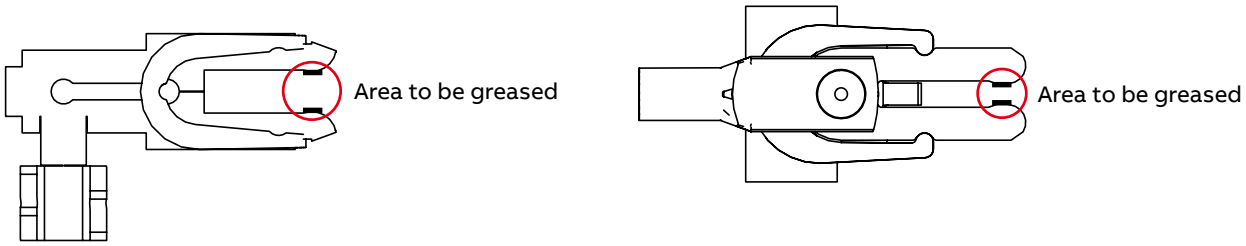


Figure 7-01 Power contacts for withdrawable modules size 8E/4 and 8E/2 (left) size 4E to 24E (right)

Contacts of the withdrawable module condapter as well as switch disconnectors shall also be greased accordingly. Prior to transport packaging the appropriate number of tubes has to be fixed to the modules by the manufacturing department (tubes are fixed to the withdrawable module handle, at least one tube per packaging unit, in case of major deliveries the grease can also be supplied in tins).

7.6.2 Greasing the fuse links

The contact lugs of the LV HRC fuses must also be greased every time before being inserted into the fuse holder of any type of switching device. If the fuses are supplied loosely, 0,5 tubes of contact grease are re-quired for each module (1 set = maximally 4 fuses for all sizes).

7.6.3 Required quantities

The following quantities are needed for modules to be supplied loosely:

- Small withdrawable modules size 8E/4 and 8E/2, 1 to 4 units 1,00 tube each
- 1 withdrawable module size 4E to 24E, for each fraction of 8 contacts 0,50 tube each
- 1 plug-in module up to 400 A, for each fraction of 4 contacts 0,25 tube each
- 1 plug-in module 400 A to 630 A, for each fraction of 4 contacts 1,00 tube each

For ordering information refer to "List of cleaning materials & lubricators" in section 7.9.

7.7 Condition-based maintenance

Condition-based maintenance practice is based on the assessment of the switchgear assembly condition utilizing data provided by intelligent electronic devices such as protection unit of circuit breaker, protection relays and other monitoring devices. Additionally sensors for temperature and humidity can be installed within the switchgear assembly and in the switch room. Visual inspection as part of preventive maintenance is not sufficient to perform such task.

Where such technology is not employed manual tasks to gather such additional information may be performed. Such manual tasks need to be executed under strict observation of safety instructions as outlined in chapter 1 of this manual.

With the adoption of monitoring solution like ABB Ability™ CMES that is an 24/7 online condition monitoring solution collecting data from temperature and humidity sensors and data from intelligent electronic device, non-intrusive and intrusive maintenance as described in previous chapter may be performed based on detected conditions rather than in a preventative, time-based manner.

7.7.1 Manually performed maintenance services

Manually performed predictive maintenance services can be provided on request by ABB Service:

1. Infrared thermal inspection

It provides a one-time inspection of electrical equipment to identify poor electrical connections, unbalanced electrical loads and defective components. IR viewing windows, which may have been installed in the switchgear, allow these inspections to be performed safely with doors closed.

To conduct IR monitoring requires the switchgear to be energized therefore safe working practices shall be followed.

Infrared thermal monitoring is generally considered a non-intrusive practice. It should be noted however that due to the internal arrangement and / or forms of separation, not all areas may be accessible.

2. Insulation resistance measurement

It provides means to determine the electrical and mechanical health of the power equipment and power distribution system and how long it will likely continue to function as initially designed.

Insulation measurement need to be done intrusive i.e. the switchgear assembly under test needs to be de-energized.

The data collected manually are then assessed and analyzed by ABB Service experts to provide input for possibly intrusive maintenance activities.

7.7.2 Online condition monitoring services

Condition monitoring solutions are either installed with the power switchgear assembly or can be installed after switchgear commissioning for continuous condition monitoring to replace certain non-intrusive maintenance tasks. Those solutions are typically electronic devices and sensors that provide additional information and a data collection and analysis software.

Check with your nearest ABB Service for installation options if it has not be included in the original design and delivery of the power switchgear assembly.

Following online condition monitoring solutions are available for MNS:

1. Temperature Monitoring Systems (TMS)
   It monitors the temperature of critical cable or busway connections to air circuit breaker, the busbar joints between cubicles (typically the transport sections). The TMS can provide alarms for fluctuations in temperature caused by unbalanced loads, as well as constant monitoring where the temperature level can be utilized to initiate an intrusive preventative maintenance task (i.e. monitoring the power contacts of MNS modules to determine the quality of the contacts).

   The TMS for MNS power switchgear assembly utilized infrared, wireless and cable-bound sensors, installed appropriately within the assembly to monitor temperatures. The data are collected within the ABB Ability™ CMES and accessible through displays either installed as part of the switchgear assembly or accessible through secure plant network connections.

2. Environment Monitoring (ENV)
   It monitors the environmental conditions such as temperature and humidity within the power switchgear assembly and the condition in the switch room. As the power switchgear assembly is typically designed according to IEC 61439 it is important to ensure that those operating conditions are monitored and a change in conditions is informed to the operator.

   Those data are collected and analyzed within the ABB Ability™ CMES and accessible through displays either installed as part of the switchgear assembly or accessible through secure plant network connections.

3. Power Quality Monitoring Systems (PQM)
   Offers a full range of power quality features such as waveform capture, wave shape analysis, disturbance recording, disturbance direction detection and transient analysis allowing plant maintenance managers to understand whether and where transients occur. Active filter options that interfere with the occurrence of harmonics can help to minimize the effect, if continuously monitored it allows plant managers to identify potential problems and minimize downtime.

4. Condition of switching devices and feeder/motor starter modules
   This condition monitoring solution utilizes the data available from intelligent electronic devices such as protection units of circuit breaker, load protection relays, motor protection relays and other devices.

   Those data are operation cycles, operation periods, number of trips, load levels and many more that are collected and analyzed within the ABB Ability™ CMES and accessible through displays either installed as part of the switchgear assembly or accessible through secure plant network connections.

7.7.3 Condition-based and predictive maintenance

The MNS power switchgear condition monitoring solution Ability™ CMES is an online condition monitoring solution utilizing a data collection device (the CMES Edge) installed within the switchgear assembly or in the switch room. It provides online information that is collected from one or multiple switchgear assembly intelligent devices or through sensors as mentioned in chapter 7.4.2, The data are displayed in trend graphics, sequence of event lists and condition reports that help plant maintenance managers to identify the maintenance needs of the electrical equipment.

The ABB Ability™ CMES can be installed as a temporary monitoring solution or as continuous monitoring system and added non-intrusively to an existing switchgear assembly that complies with technical requirements. It covers the following main functions:

- Collection of operational data of the supervised circuit breaker and MNS modules
- Collection of all alarms and trips generated in the supervised devices and modules
- Collection of maintenance warnings derived from additional assessment logic in CMES related to the supervised modules
- Display of the MNS switchgear assembly structure highlighting modules signaling problems
- Display of historical data in trend displays
- Detailed information on the identification, location, and type of supervised modules
- Online supervision of temperature or power loss related problems within individual sections.

ABB Ability™ CMES is a scalable solution, supervises sensors and modules in MNS, connected through the internal switchgear communication bus based on Ethernet technology. Examples of connected devices is here:

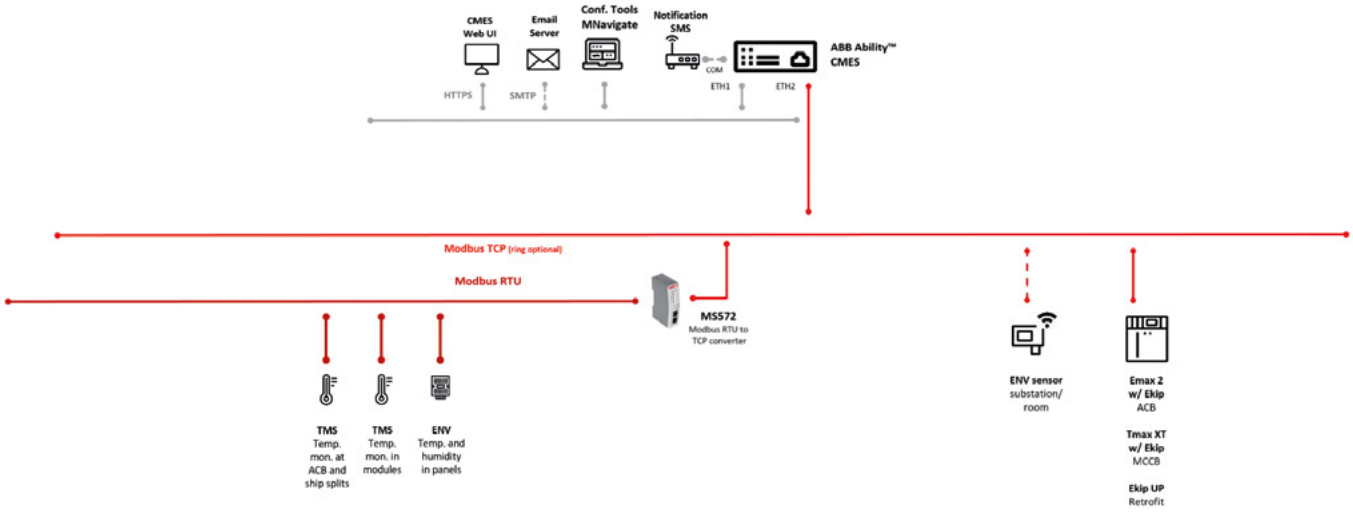


Figure 7-02 Temperature and environmental monitoring system (TMS + ENV)

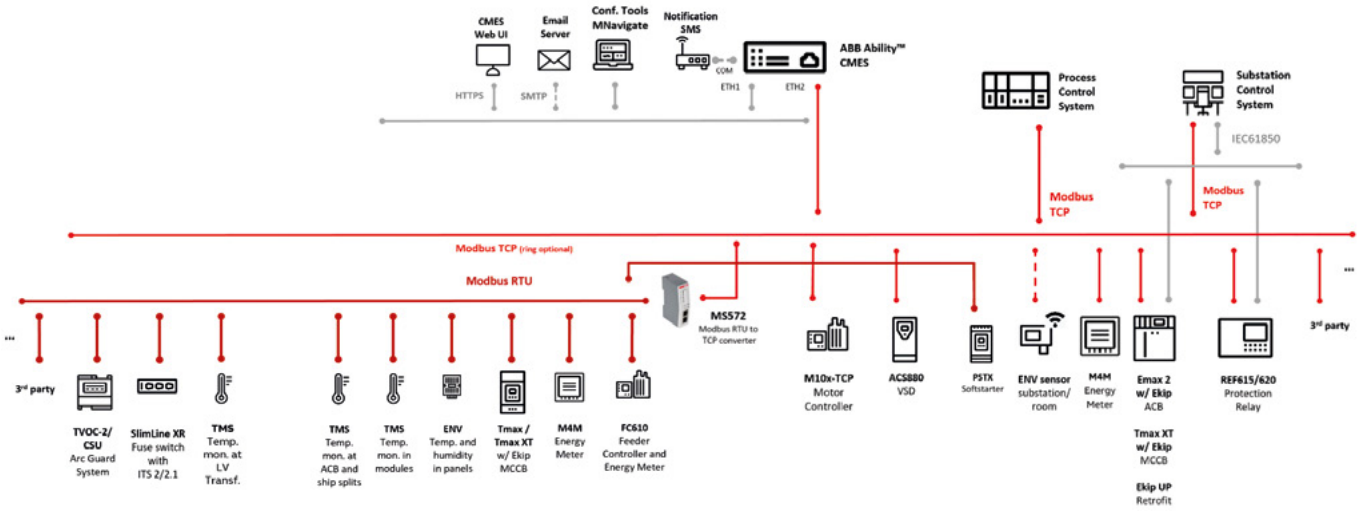


Figure 7-03 MNS condition monitoring with ABB Ability™ CMES

Following maintenance tasks are monitored and maintenance schedule recommendation (suggested maintenance) is provided with ABB Ability™ CMES:

	Work to be performed in preventive maintenance	Tasks	Changes with condition-based monitoring implemented
D	External inspection (non-intrusive)		
D.1	Verify accessibility conditions	Room accessibility	Door contacts inform door open/ close status
D.2	Verify ambient conditions	Room temperature, humidity, air quality	Environment sensors inform about conditions
D.3	Check room ventilation	Air supply available	Environment sensors inform about conditions
D.4	Switchgear ventilation	Cleanliness of ventilation louvres	Environment sensors inside of switchgear inform about condition
D.5	Check condition of enclosure	Compartment doors closed, modules in position	Door contact, module position monitoring inform about positions

Table 7-09 External inspection (non-intrusive)

	Work to be performed in preventive maintenance	Tasks	Changes with condition-based monitoring implemented
E	Interior inspections of sections (intrusive)		
E.1	Equipment compartment	Arrangement of modules	Module position available, electrical connec tions monitored by temperature sensors
E.2	Cable compartment	Electrical connections	Temperature sensors in modules monitoring cable connections (4E and larger)
E.3	Air circuit breaker	Acc. to operating manual	Monitoring of circuit breaker operation, contact wear, load levels to determine maintenance
		Electrical connections	Temperature sensors at cable / busway connection monitor quality
E.4	Bus bar compartment	Check bus bar joints	Temperature sensors at shipping split joints monitor connection quality
E.5	Power loss	Acc. to design criteria	Online monitoring of power loss to determine correct usage, space for extension, efficiency

Table 7-10 Interior inspections of sections (intrusive)

	Work to be performed in preventive maintenance	Tasks	Changes with condition-based monitoring implemented
F	Inspections of functional units (intrusive)		
F.1	Electrical equipment	Acc. to operating manual	Temperature sensors in modules monitor conditions, number of insertions is counted to predict maintenance needs

Table 7-11 Inspections of functional units (intrusive)

Above data collected in condition monitoring solution ABB Ability™ CMES is further analyzed and used to determine and predict maintenance needs based on preventive time schedule as defined in chapter 7.2 and chapter 7.3 combined with actual condition.

Maintenance information of the ABB Ability™ CMES system and other systems components itself can be found in the ABB Ability™ CMES User Manual.

7.8 Maintenance of door gaskets

For improved operation, lubrication of door gaskets is recommended. This helps maintain the IP class and reduces friction of the door gaskets particularly on the area where gasket seals against the hinges. It is recommended to lubricate this area during the manufacturing process and should be checked in line with routine maintenance measures.

Molykote Omnigliss spray can used – manufacturer Dow Corning.

Use of lubricators or aerosols containing silicon should be avoided!

It is recommended to lubricate door sealing at the location of the hinges. Sealing to be lubricated on all doors and on the IP protection cover where indicated below.

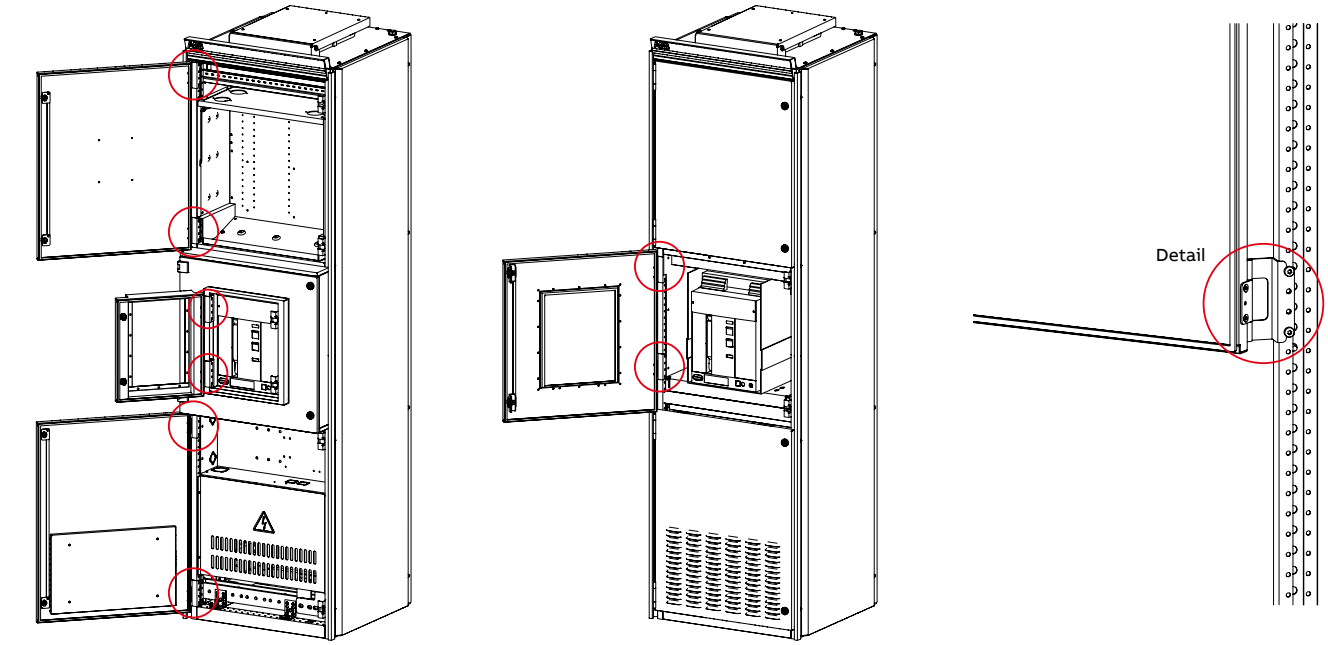


Figure 7-04 Sealing to be lubricated

7.9 List of cleaning materials & lubricators

Lubricant

- Molykote Omnigliss spray – manufacturer Dow Corning

Contact grease

- KR 44-102 – manufacturer Klüberlectric
- KR 44-402 – manufacturer Klüberlectric

Description	Ordering number
Tin containing 1 kg of grease	1TGB000172R1000
Tube containing 7 g (8 ml) of grease	1TGB000172R0008

For aluminium busbar connections the following jointing compound should be utilised:

- Penetrox™ A-13 Oxide-inhibiting joint compound – manufacturer Burndy

08

Extension and upgrade

Extension upgrade

8.1 Extensions

Contact your ABB representative for more information on upgrades which are possible for MNS switchgear. Local contacts can be found on www.abb.com/mns

8.1.1 Extension of MNS 3.0

MNS 3.0 switchgear is backward compatible with MNS 2.0 (ABB & BBC) switchgear.

Checklist of the extension of MNS 3.0 and/or MNS 2.0:

	Work to be performed	Notes
A.1	Physical dimensions	
A.2	Color	
A.3	Floor plan	
A.4	Shipping sections	
A.5	Cable entry (top / bottom)	
A.6	Ventilation	
A.7	Environment	
A.8	Heat loss calculation	
A.9	"Additional load list and load capacity (current and seervised configuration)"	
A.10	Main busbar layout (top / bottom)	
A.11	Main busbar dimensions	
A.12	Main busbar rating	
A.13	Main busbar insulation	
A.14	Auxiliary and control circuits (24 V / 110 V / etc)	
A.15	Earthing network system type (TN-C / TN-S / TN-C-S / IT / TT)	
A.16	"Technical drawings (e.g. schematics,datasheets, general arrangements)"	
A.17	Protection type (conventional / intelligent)	

Table 8-01 Checklist for the extension of MNS 3.0 and / or MNS 2.0

IEC 61439-1 requires marking according to section “6.1 Assembly designation marking” similar to the example shown below. Details can be find on the label.

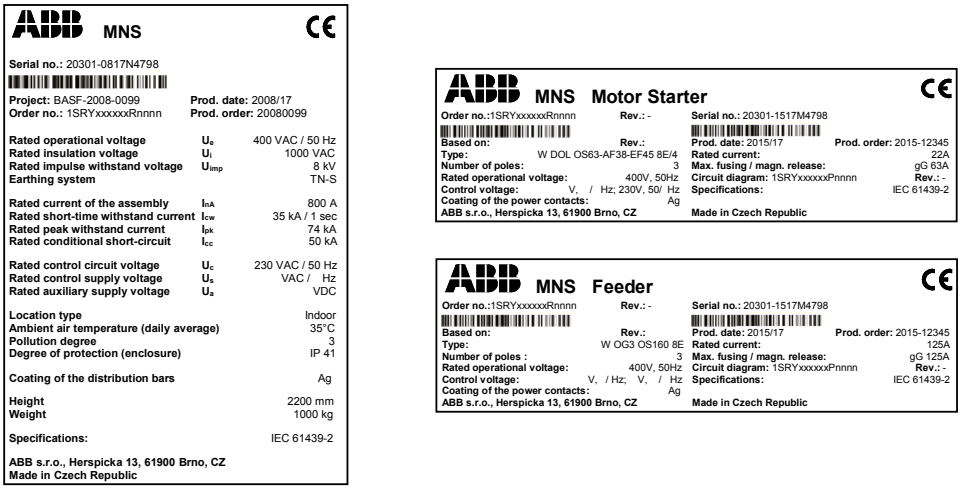


Figure 8-01 Example of ABB section (left) and modul marking (right)

This information provides the electrical properties configured during the original configuration. In addition to this it is highly recommended that prior to any extension or upgrade of the assembly a detailed evaluation of the assembly is performed by an ABB service engineer.

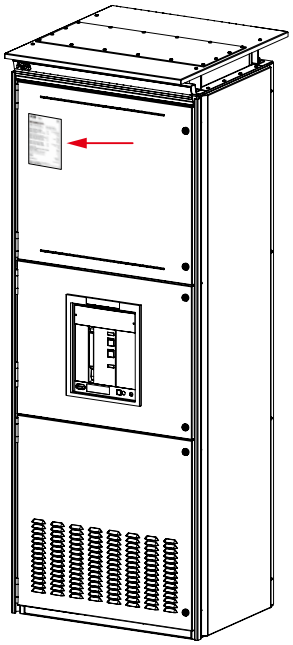


Figure 8-02 Switchgear marking is placed on or inside of the ACB top door (switchgear incommer)

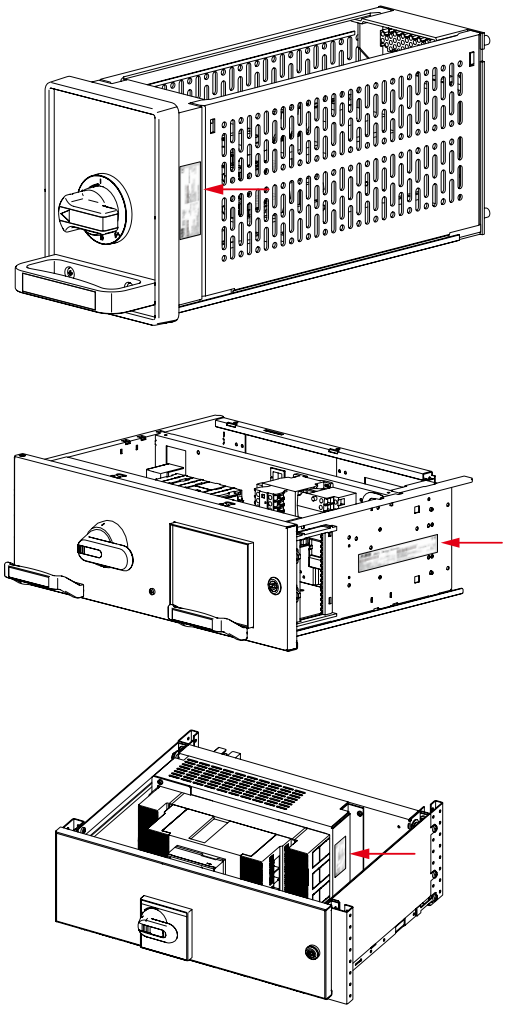


Figure 8-03 Module marking: small module (top), standard module (middle) and plug-in module (bottom)

8.1.2 Section extension to the left for front access switchgear

MNS front access solution can be easily extended on the left and right. For more information please contact your local ABB representative.

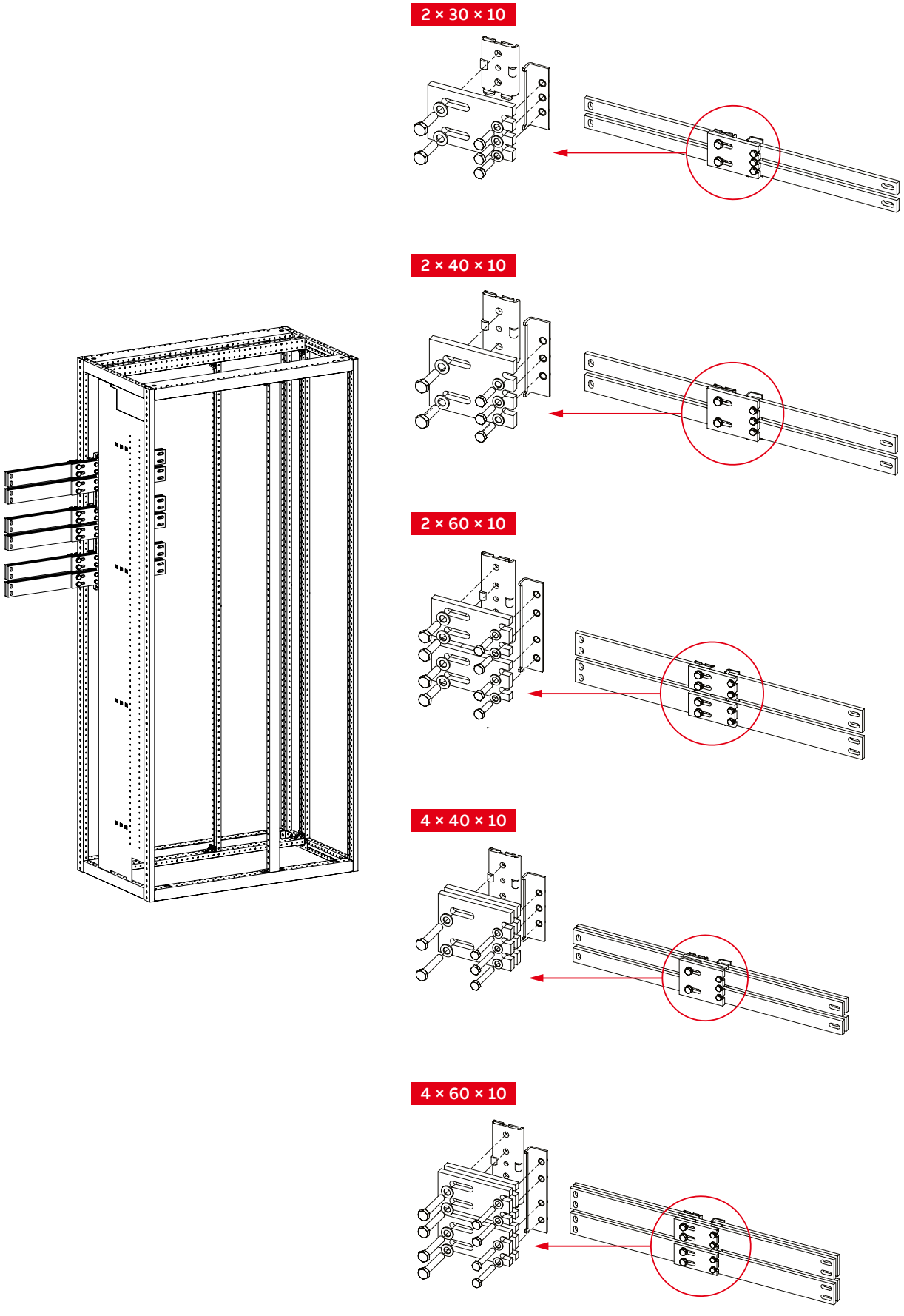


Figure 8-04 Generic extension examples

8.1.3 Section extension to the left for rear access switchgear

MNS rear access solution is designed for right extension as standard. However, left extension is possible. For more information please contact your local ABB representative.

8.1.4 Extension of 3rd party switchgear

If the switchgear type MNS is to be connected to 3rd party switchgear, the solution will be with a link / joggle section, see Figure 8-05. This is a project-specific driven solution that your local ABB representative can help to engineer and install. All of the previous checkpoints listed shall also apply when extending to a 3rd party switchgear assembly.

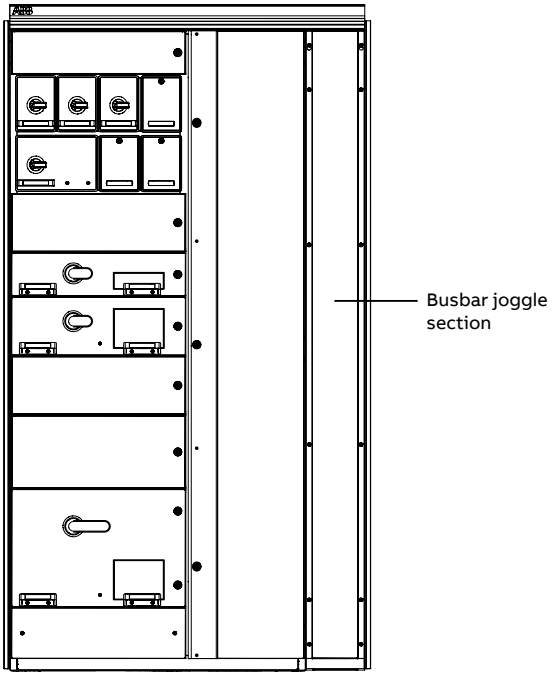


Figure 8-05 Switchgear marking is placed on or inside of the ACB top door (switchgear incommer)

8.2 Upgrades

Contact your ABB representative for more information on upgrades which are possible for MNS switchgear. Local contacts can be found on www.abb.com/mns

Possible upgrades available as ready-made solutions for MNS 3.0

- Direct replacement of ACB breaker Emax New to Emax2
- Direct replacement of ACB breaker type Novomax to Emax New
- Direct replacement of ACB breaker type Megamax to Emax2
- Direct replacement of ACB breaker type Novomax to Emax2
- Direct replacement of ACB breaker type Otomax to Emax2
- Direct replacement of circuit breaker type Isol to Isomax
- Direct replacement of circuit breaker type Fusol to Tmax
- Direct replacement of circuit breaker type Isomax / Tmax / Tmax XT
- Upgrade of Insum 1 to MNS Digital
- Upgrade of Insum 2 to MNS Digital

8.2.1 MNS 2.0 to MNS 3.0

MNS 2.0 switchgear modules can be upgraded to MNS 3.0. Assessment and inspection is required of the existing switchgear and withdrawable modules (both feeders and motor starters) prior to proceeding. This shall be conducted with local ABB representative.

- No visible damage to the busbars or busbar supports
- No visible damage to the frame of the switchgear
- Horizontal and vertical distribution bars need to be assessed
- Mechanical parts – new compartment components for full size modules required (4E–24E)
- Installation of new module doors / spare space covers with new MNS 3.0 color for reference purposes

8.2.2 INSUM 1 to MNS Digital

A customer specific solution for spares or migration shall be defined between customer and ABB for upgrade INSUM 1 solutions.

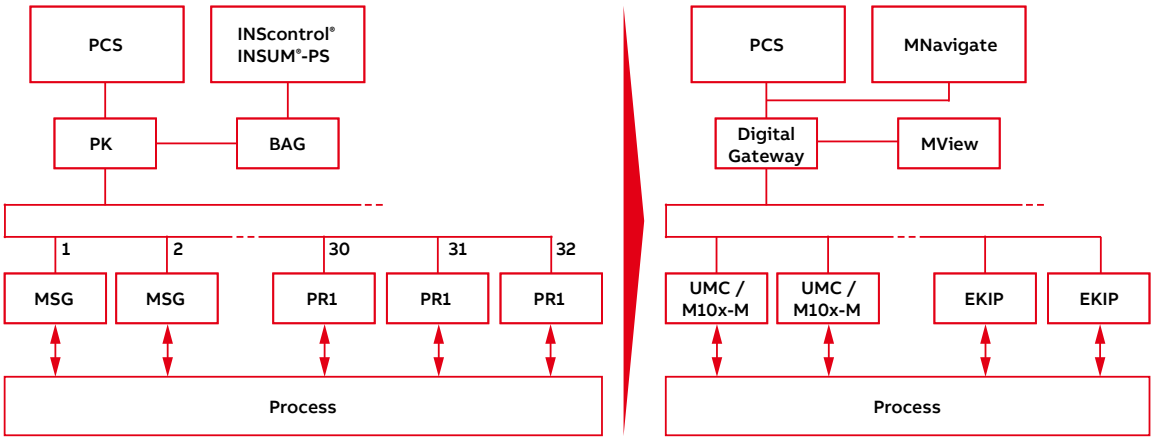


Figure 8-06 Typical ABB upgrade solution from INSUM 1 to **MNS Digital**

PCS	Process Control System
INScontrol®	PC software tool
INSUM®-PS	PC software tool
PK	Protokol converter Modbus RTU for DCS
BAG	User interface for monitoring and parametering
MSG	Motor starter
PR1	SACE circuit breaker Megamax optional with PR1

8.2.3 INSUM 2 to MNS Digital

A customer specific solution for spares or migration shall be defined between customer and ABB for upgrade INSUM 2 solutions.

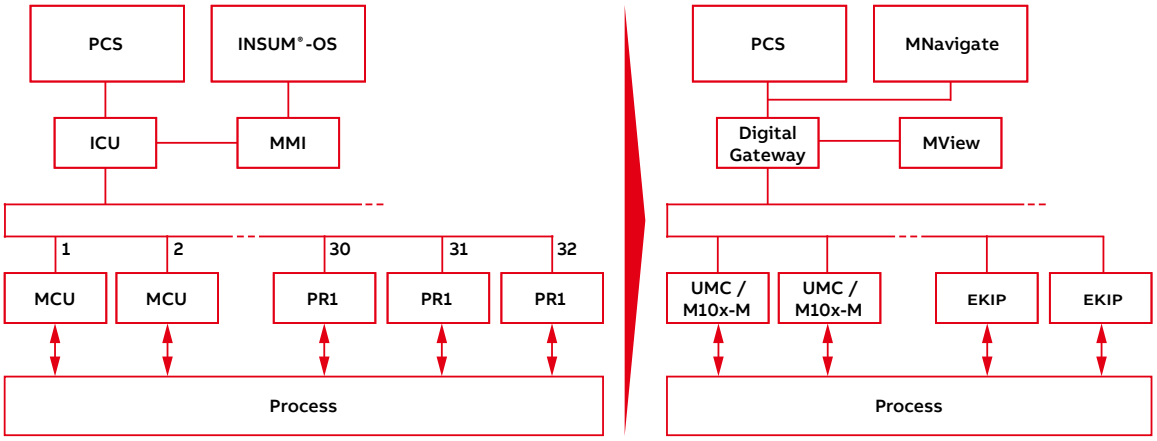
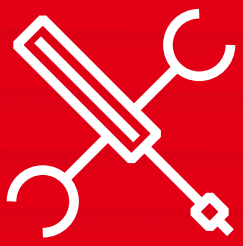


Figure 8-07 Typical ABB upgrade solution from INSUM 2 to **MNS Digital**

PCS	Process Control System
INSUM®-OS	PC software tool
ICU	Protokol converter Modbus RTU for DCS
MMI	User interface for monitoring and parametering
MCU	Motor starter
PR1	SACE circuit breaker Megamax optional with PR1

Note:
Solutions supporting earlier PR123 and PR223 devices are also available, please contact your local service organisation.

09



Repair, spares and consumables

Repair, spares and consumables

9.1 Damage to paint work

Preparation of the damaged location:

- Surfaces or locations soiled by grease/oil shall be cleaned with an aliphatic cleaning agent using a linen cloth.

Execution

- The paintwork repair (see below) can be ordered from your local ABB service contact. Please ensure that the set colour shall match that part of the plant cleaned for paintwork repair. The hardening agent in the small container shall be completely added to the larger container filled with paint. The quantity of hardening agent exactly matches the quantity of the paint. After hardening agent and paint have been thoroughly mixed the mixture shall be applied using a brush or a lambskin paint roller to the surface to be repaired. Small marks may be repaired separately; but the success depends on the surface preparation and/or the “handling”.

9.2 Mechanical damage

Preparation of the damaged location

- When major damage to large areas has occurred the respective surfaces shall be ground with abrasive paper (grade 400). The damaged area has then to be wiped with a linen cloth and cleaning agent or cleaned with compressed air to remove the dust.

Execution

- A filler material (alkyd resin basis) shall be applied flush with the surface using the abrasive paper. The filler shall be left to set over night. The filled-in location has again to be slightly ground. Thereafter the paint has to be applied as described above.

Materials

- Colour: RAL e.g. 7035, light-grey, 2-component synthetic resin varnish
- Repaire paint: hardener (paint repair set)
- Filler: alkyd resin base
- Cleaning agent: aliphatic (e.g. white spirit)

Tools

- For cleaninig: linen cloth (lint-free), abrasive paper (grade 400)
- For painting: brush or lambskin paint roller
- For repair: scraper

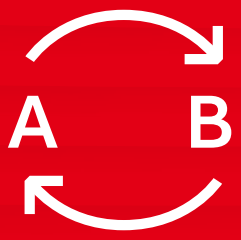
9.3 Spares and consumables

Due to the nature of the low voltage project business, spare and consumables can be obtained from your local service contact.

Spare parts list are readily available for the following:

- Commissioning and Start up
- 2 years operational

10



Re-configuration of switchgear

Re-configuration of switchgear

It is highly recommended that the ABB Service organisation is consulted prior to any re-configuration, as changing of operating parameters may affect the performance and lifetime expectancy of the switchgear.

10.1 Fixed - technique

Switchgear of a fixed construction shall be de-engergised prior to any removal or replacement of any type of functional units.

10.1.1 Removing a module

Proceed as follows to remove a module:
- Isolate the module
- Isolate the system and observe safe working practices
- Detach outgoing cables and disconnect control cables, with draw these to the cable compartment.
- Detach the cables or copper bars from the incoming size of the SCPD
- Remove / replace the separation plate between module and cable compartment, when required.
- Remove module fastening screws and carefully remove the module out of the section
- If required remove the incoming cables or copper bars from the distribution busbars, ensure that the distribution bar connecting screws are not allowed to fall.
- Where necessary, empty slots must be covered with blanking plates. (Please contact your ABB supplier)

Installing the modules is the reverse process of the above.

10.1.2 Plug-in and withdrawable modules

Both the Plug-in and withdrawable techniques utilise either the MFSW or MSW.

The separation walls are arranged between the busbar and the equipment compartment. The distribution bars are embedded within the multi-function wall and are fully phase segregated and insulated. For MNS Rear switchgear, the separation walls are arranged under the main busbar compartment, between equipment compartment and cable compartment.

NOTE:
The contact opening are IP 2X and when plug-in and withdrawable modules modules are utilized the contact housing and the multifunction wall ensure full isolation and separation of each phase prior to the connection of the main contacts to the distribution bars. This ensures a high degree of protection during removal and insertion of the modules.

Before the conversion and/or change of the module and associated compartment access to the area directly below the selected module is also required. It is recommended that the compartment bottom plate in the area below is covered to prevent any small part falling into the assembly during the re-work.

10.1.3 Plug-in modules

The installation and removal of modules is reserved to skilled electrical personnel.
Live connections behind covers. Observe safe working practices.

Proceed as follows to remove a module:
- Isolate the module
- Detach outgoing cables and disconnect control cables
- Remove module fastening screws and carefully remove the module out of the section using integrated module handles
- If necessary, empty slots must be covered with blanking plates. (Please contact your ABB supplier)

Installing the modules is the reverse process of the above.

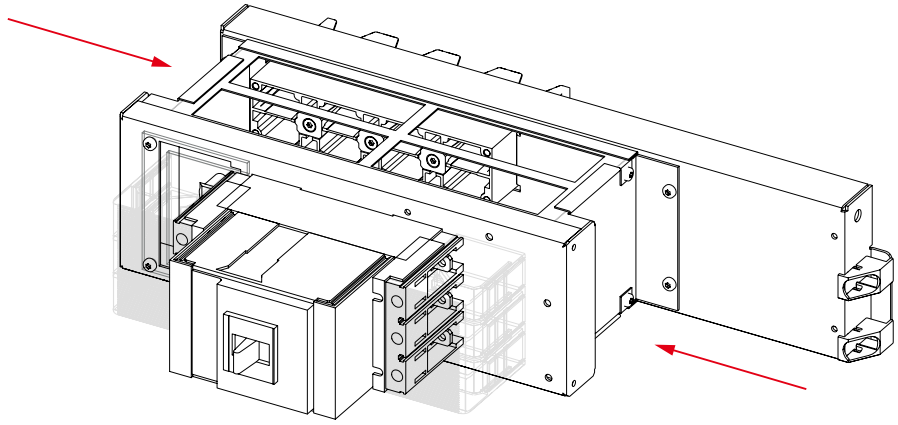


Figure 10-01 Plug-in modules integrated handles

Compact modules follow same procedure as above. Live connections behind covers. Observe safe working practices. Fixing points differ for Compact modules care must be taken when removing module fixing screws.

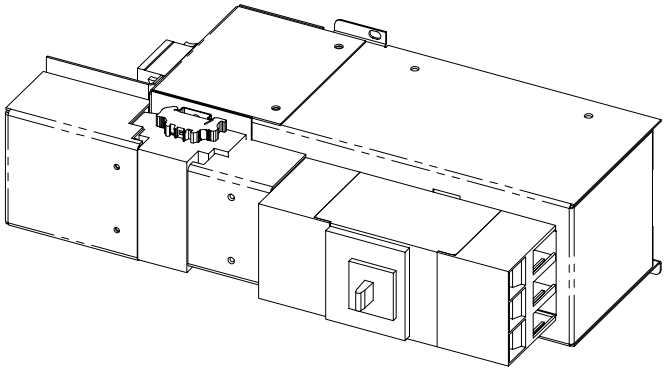
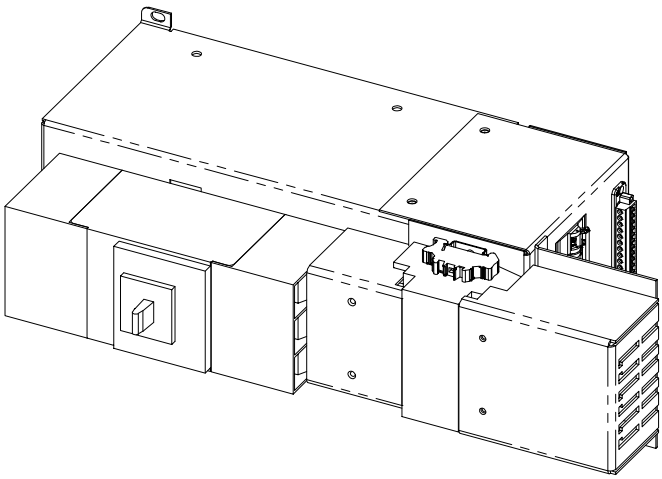


Figure 10-02 Compact module left side mounting



Compact module right side mounting

10.2 Replacement of a withdrawable module

The withdrawable module can be exchanged or removed and replaced within the compartment during maintenance without die-energisation of the switchgear.

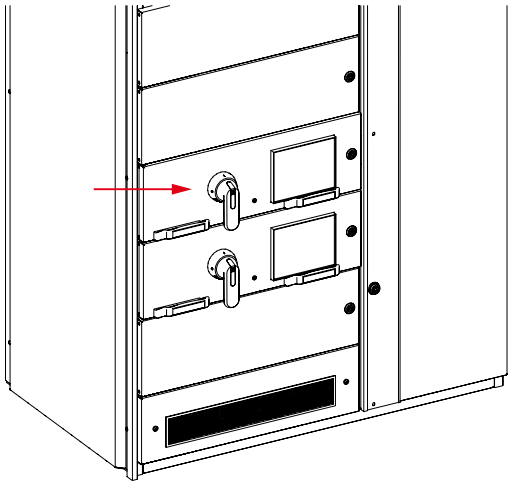
With the interlocking switch handle in the move position, withdrawable modules size 8E/4 and 8E/2 can be withdrawn without stop. The modules sizes 4E up to 24E have to be withdrawn up to the stop position, then released to be removed completely (see Figure 10-03).

Main fuses in withdrawable modules with hinged module door are accessible after the main switching device has been turned OFF and after the front cover has been unlatched.

Unlocking the front cover with the module in the operating position can only be achieved by means of a tool, e.g. a screw driver (see Figure 6-30). The interlocking mechanism can be found at the side of the switch handle.

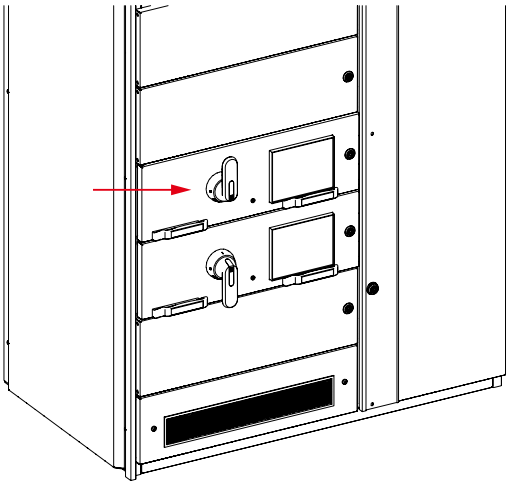
For conversion or modification of complete withdrawable module units, e.g. replacement of one large unit through several smaller units or vice versa, the frame-mounted compartment has to be exchanged, too (see chapter 10.3).

1



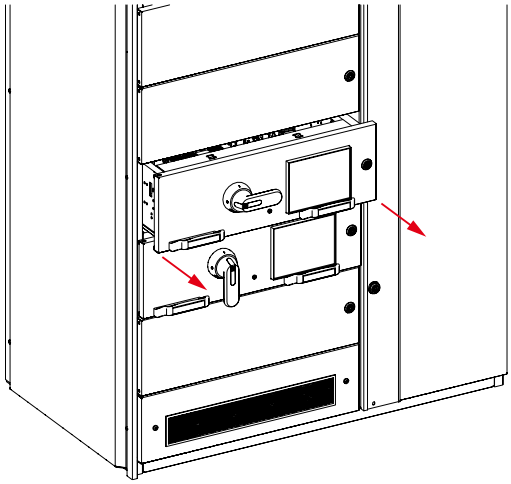
Module in ON-position.

2



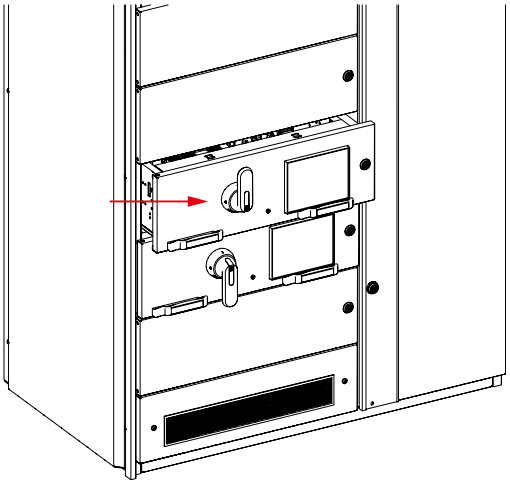
Switch the module to MOVE-position.

3



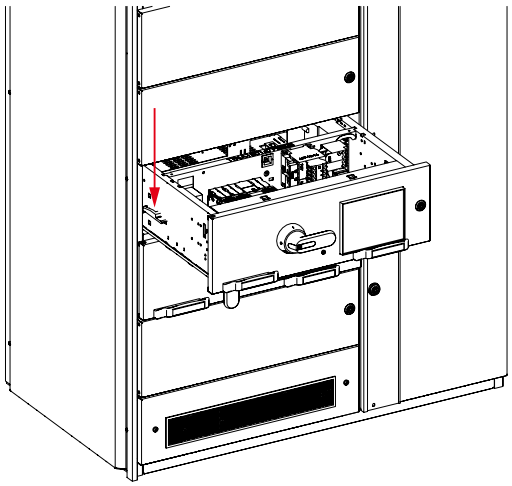
Draw the module out from section. The handle will automatically switch to OFF-position. Module is in isolated position.

4



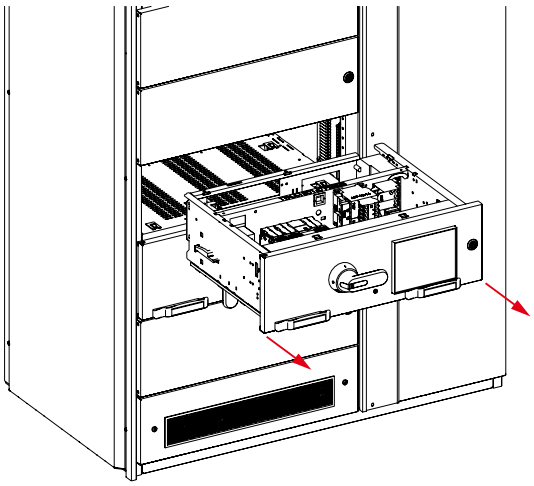
Switch the handle again to MOVE-position.

5



Draw the module out from section. Unlock the protection mechanicsm on the left side of the module.

6



Remove the module completly out from section.

Figure 10-03 Draw out of withdrawable module

10.3 Conversion and change of withdrawable module compartments

Take notice of the risks when converting a compartment to accommodate different sizes of withdrawable modules: It is recommended to do this task on a de-energized switchgear. If the switchgear cannot be taken out of service, service it is mandatory that a risk assessment is performed, the person completing the job must be trained for this job and use correct PPE and tools. A hot work permit is required. Follow the safety instruction and guidelines.

Before the conversion and/or change of the module and associated compartment access to the area directly below the selected module is also required. It is recommended that the compartment bottom plate in the area below is covered to prevent any small part falling into the assembly during the re-work.

Modifications of switchgear sections may introduce a possible change of the heat balance inside the sections. This shall be taken into account. The allowed limit of temperature-rise inside the switchgear section may not be exceeded (see Figure 10-05). Should there be any doubt with respect to this please contact your local ABB representative.

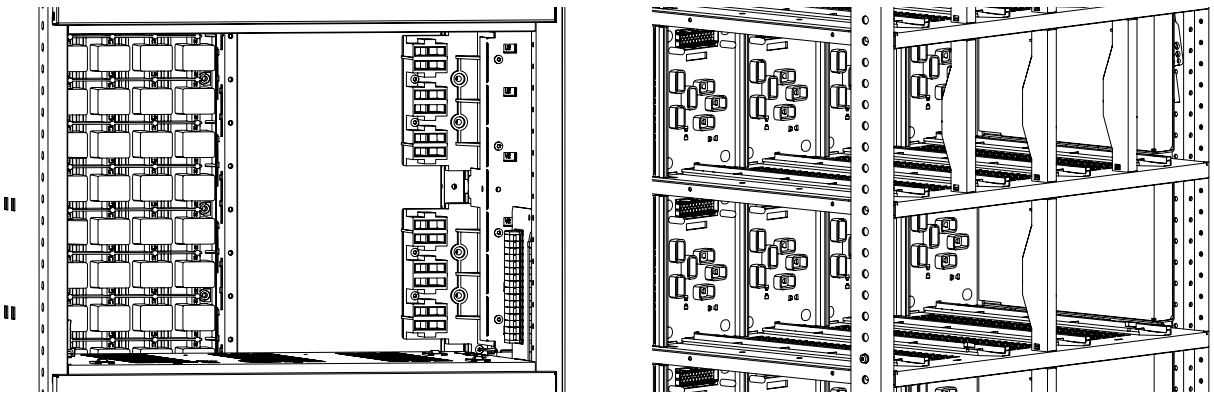


Figure 10-04 Withdrawable module compartment size 8E with outgoing cable connection unit (left)
Conversion to withdrawable module compartments size 8E/4 and 8E/2 (right)

Explanation of diagram curves

The curves correspond to average maximum air temperature within the section of switchgear. A maximum air temperature of 60°C is permitted directly below the roof plate of the switchgear section.

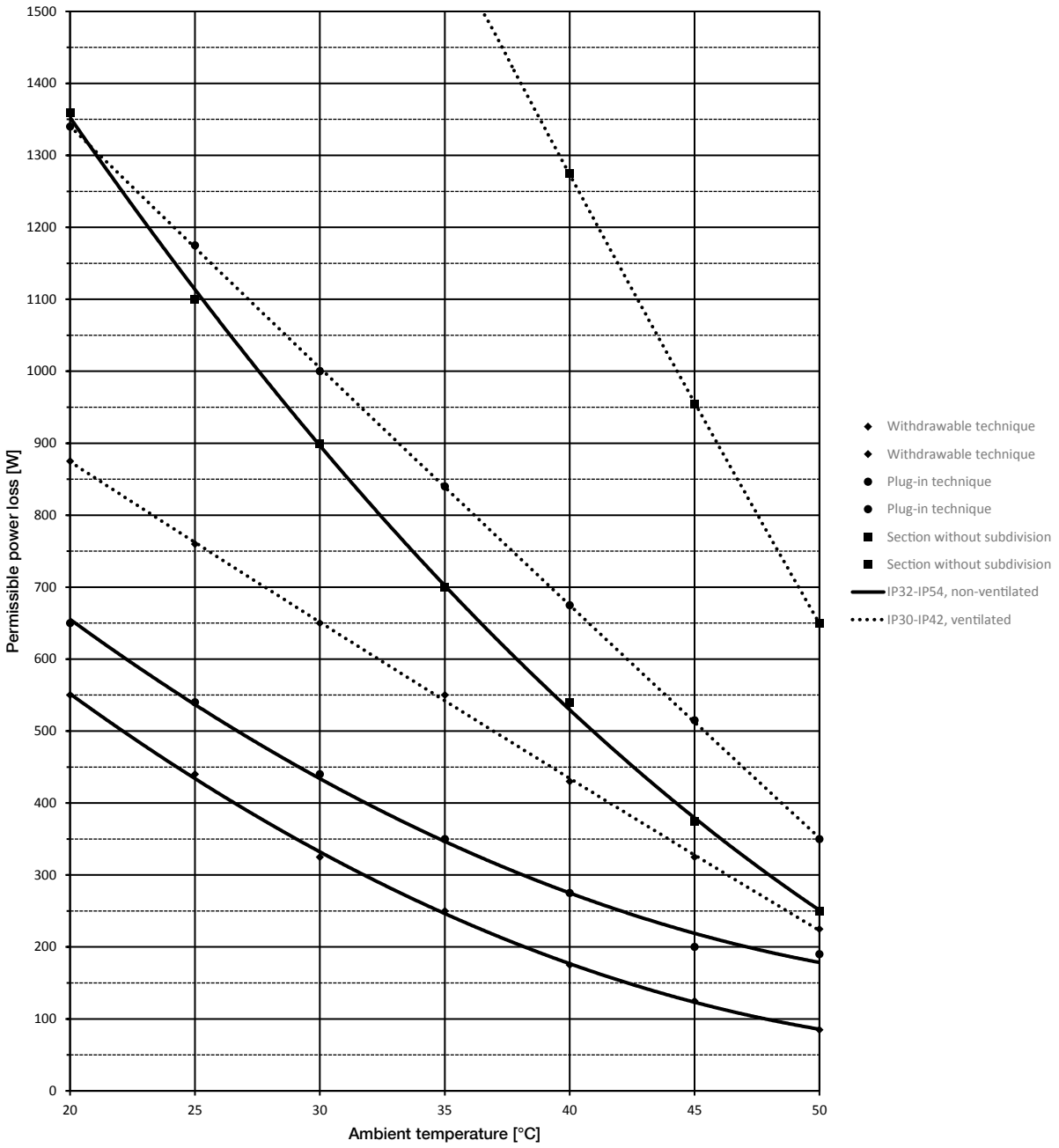


Figure 10-05 Standard values of maximum admittable effective power loss for sections with 600 mm equipment compartment width

10.3.1 Example 1: Retrofit of 1×16E into 4×8E/4 and 2×8E/2

Example: Retfofit of one unit size 16E (height 400 mm) into four units each of size 8E/4 (height 200 mm) and two units each of size 8E/2 (height 200 mm). The following sequence is applicable:

Disassembly

1. Remove the withdrawable unit.

2. Disconnect power cables after protective cover (bellows) has been removed. Check the protective covers on the adjacent cable connection units to ensure work inside the cable compartment can be performed without danger.

3. Disconnect control wiring.
4. Remove control terminal block and its support located at the lower right hand side of the compartment (in the cable compartment).

5. The left guide rail on the Iower compartment bottom plate has to be removed.

6. Remove cable connection unit.

Reassembly

1. Install a new compartment bottom plate 200 mm from top and bottom of the old compartment and fix it with screws.

2. At the rear of the newly created two compartments install one withdrawable unit condapter each, one for four withdrawable units size 8E/4, one for two withdrawable units size 8E/2.

3. During mounting of a withdrawable unit condapter it has to be made sure that a earthing connection is established at the lower right screw connection using a bushing and a washer.

4. 8 plastic guide rails have to be mounted, four for each compartment bottom plate.

5. Install 3 front posts between two compartment bottom plates for 8E/4 modules and one front post for 8E/2 modules in the other compartment.

6. Connect power cables and control wiring.

7. Insert four withdrawable modules size 8E/4 into the upper compartment and two withdrawable units size 8E/2 into the lower compartment. Should new material be required contact the nearest ABB-sales office or representative.

During mounting of a withdrawable unit condapter it has to be made sure that a earthing connection is established at the lower right screw connection using a bushing and a washer.

10.3.2 Example 2: Retrofit of 1×24E into 3×8E

Example: Retrofit of one unit size 24E (height 600 mm) into three units size 8E (height 200 mm each). The sequence is applicable:

Disassembly

1. Remove withdrawable unit.

2. If required exchange power cable or leave for one of the units size 8E if suiting.

3. Disconnect control wiring or leave for one of the units size 8E if desired.

4. The compartment bottom plate with the guide rail and the top compartment bottom plate remain unchanged.

Reassembly

1. Install 2 outgoing cable connection units.

2. Insert two new compartment bottom plates with a distance of 8E each and fix with screws.

3. The newly installed bottom plates must be equipped with the left guide rail and the rollers and covers have to be mounted.

4. Between the newly installed compartment bottom plates one control terminal block support per withdrawable module compartment with one or two 16-/20-pole terminal blocks must be mounted on the right hand side (in the cable compartment). If only one terminal block per support is required it must be mounted in the upper part of the cut-out of the support. The lower part has to be covered with a cover plate.

5. Connect power cables with their protective covers (bellows) and also the control wiring.

6. Lubricate and insert three new withdrawable units size 8E.
   Should new material be required contact the nearest ABB-sales office or representative.

10.3.3 Example 3: Retrofit of 6×8E/2 into 1×24E

Detail: Conversion of 6 units size 8E/2 (height 200 mm) into one unit size 24E (height 600 mm). The conversion has to take place in the following sequence:

Disassembly

1. Remove out the 6 withdrawable units.
2. Disconnect power and control cables and wiring.
3. Disassemble the two middle compartment bottom plates with front posts and guide rails.
4. Remove guide rail and front post from the lower compartment bottom plate.
5. Remove the 3 withdrawable module condapters with their terminal blocks.

Reassembly

1. Install one outgoing cable connection unit depending on the module design. High current and star/delta modules require specific solutions.
2. Install guide rail left on the lower compartment bottom plate.
3. Mount roller and cover in the compartment bottom plate.
4. Install control terminal block support with one or two 16-/20-pole control terminal blocks. When only one 16-/20-pole control terminal block is required mount it in the upper part of the support and use a cover for the lower part of the support.
5. Connect power cable including protective cover and control wiring. For parallel connection of two out-going cable connection units an additional bellow is required.
6. Lubricate and insert new withdrawable unit size 24E.
   Should new material be required contact the nearest ABB sales office or representative.

10.3.4 Example 4: Retrofit of 3×8E into 1×24E

Example: Retrofit of 3 units size 8E (height 200 mm) into one unit size 24E (height 600 mm). The following sequence is applicable:

Disassembly

1. Remove the 3 withdrawable units.

2. Disconnect power cables after protective cover (bellows) has been removed. Due to the protective covers on the adjacent outgoing cable connection units working inside the cable compartment can be performed without danger.

3. Take out the two upper control terminal block supports with their control terminal blocks. The lower support may remain unchanged or, if necessary, can be converted to one or two 16- / 20-pole control terminal blocks. When converting from two to one control terminal block the remaining one must be at the top of the support while the space below has to be cov-ered with a cover.

4. Dismantle the two middle compartment bottom plates with their guide rails The lower bottom plate remains unchanged.

5. Depending upon module design remove one or two outgoing cable connection units. When necessary exchange outgoing cable connection unit. High current and star/delta modules require specific solutions.

Reassembly

1. Connect power cable including protective cover (bellows) and control wiring.

2. Lubricate and insert new withdrawable unit size 24E.
   Should new material be required contact the nearest ABB sales office or representative.

Please note that the similar procedures can also be applied to the Plug-in modules. Forms of separation may vary and final project documentation shall be referred to prior to conducting any replacement or retrofit work.

Compact modules can also be easily exchanged due to the open construction of the assembly.

Safety procedures shall be observed for types of retrofit / replacement of modules.

Any type of work for fixed construction replacement shall be undertaken ONLY when the switchgear is de-energisged. A similar form of construction is also applied to the fixed modules and final project documentation shall be referred to prior to any work being carried out.

10.4 Replacing switchgear

Replacing a switchgear requires extensive preparation and planning, as every switchgear is individually engineered and designed to perform its task, a specific guideline cannot be given in this manual. However, following checklist may be used as guidance:

It is highly recommended that you contact your local ABB representative for support.

Task	Description	Remarks
A	Collection of initial design data	
A.1	Ensure original design criteria are available (electrical rating, protection class, ambient temperature, applicable IEC standards), this is typically documented on the switchgear type label by the original manufacturer. Verify that same criteria are applicable for replacement design. In case of changes ensure new requirements are considered. If such information is not available, the data must be collected during a site assessment.	
A.2	Ensure general arrangement drawings, single line drawings and electrical parameters of individual loads are available. This is typically available in form of drawings and documents with the last switchgear operator. If such documentation is not available anymore, the data must be collected during a site assessment.	
A.3	Ensure mechanical dimension drawings, switchgear size, module size, location of cable entry, connection of incoming cable or bus duct are available. If such documentation is not available anymore, the data must be collected during a site assessment.	
B	Collection of revised design data	
B.1	Review initial load data with actual site condition i.e. change in motor sizes or load connection can be reconsidered in a new design to optimize the switchgear design.	
C	Design and engineering of new switchgear	
C.1	If existing cable are re-used it is mandatory to ensure that available cable length is considered in new switchgear design (i.e. module location in same section, same height as in existing switchgear). Alternatively cable connection boxes need to be planned.	
C.2	Cable entry size into the new assembly needs to allow for existing cable size and location. Alternatively cable connection boxes need to be planned.	
C.3	Clarify section mounting on existing or new floor construction.	
D	Erection and commissioning	
D.1	Dismantling and removal of the existing switchboard shall be undertaken by ABB or an operator/ customer approved company. The company shall be experienced in dismantling and recyclingof materials used in a switchgear assembly.	
D.2	Recycling of materials shall be done by the approved contractor according to applicable standards and regulations.	
D.3	Erection and commissioning of the new switchgear shall be conducted by an operator/customer approved company. Where possible the service team of the original manufacturer shall be employed.	
D.4	Erection and commissioning shall be supervised by an original manufacturer certified person knowledgeable in site safety, switchgear design and commissioning processes.	

Table 10-01 Replacing switchgear check list

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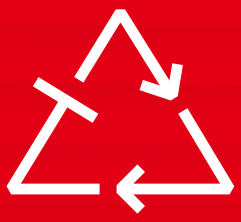

End of life

End of life

11.1 Service solution

ABB Service provides complete manpower and infrastructure for the switchgear decommissioning and waste disposal. The switchgear decommissioning covers switchgear dismantling, removal from site and recycling and/or disposal. This section of the manual provides a simplified overview of the requirements only. Each and every end of life project will require specific activities depending upon the installation of the switchgear.

The switchgear decommissioning can follow in reverse order the installation process described in this manual.

The handover of the electrical system from customer to decommissioning team, and the decommissioning report at the end of the job shall be documented by separate handover report, preferably stating the switchgear was decommissioned correctly and the substation is handed over to the customer in good shape for further work. A list of defects with minor items for follow up works can be included.

11.2 Personnel skills needed

As a minimum the supervisor for the decommissioning team should be certified for work on electrical systems. ABB Service center can provide skilled technician certified on Low Voltage Switchgear service. The supervisor leads and supervises the group of workers in the decommissioning process and serves as the responsible person.

11.3 Infrastructure and equipment needed

For a correct decommissioning procedure of the switchgear, usually a lifting (crane) and shifting (forklifts, cylinders, levers, jacks) equipment is required.

A standard maintenance tool kit is also required.

11.4 Recycling and dispoal

The recycling or disposal of the material should be provided according to Table 11-01 below. Local rules for recycling and disposal must be applied. Disposal of material must follow requirements on health, safety and environment and may be performed by 3rd party companies.

Raw material	Recommended method of disposal
Metal material (FE, Cu, Al, Ag, Zn, W, others)	Separation and recycling
Thermoplastics	Recycling or disposal
Epoxy resin	Separation of metal material and the disposal of rest
Rubber	Disposal
Packing material – wood	Recycling or disposal
Packing material – foil	Recycling or disposal

Table 11-01 Recommended method of raw material disposal

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Attachments and checklists

Attachments and checklists

12.1 Maintenance and inspection checklist

The recommend list below should be performed prior to commissioning, then in line with the maintenance frequencies defined in section 7.3 "Preventive maintenance checks and intervals".

Items to be checked	Result	
Instrument / control compartment		
Control fuses present in the operation position	Yes ☐	N/A ☐
Control circuit breakers switched to operation position	Yes ☐	N/A ☐
Current transformer links in the correct operation position	Yes ☐	N/A ☐
Wiring termination secured	Yes ☐	N/A ☐
Protection shroud/barrier in the operation position	Yes ☐	N/A ☐
Protection relay settings verified	Yes ☐	N/A ☐
Electrical functionality check completed	Yes ☐	N/A ☐
ACB compartment		
Protection relay settings verified	Yes ☐	N/A ☐
Wiring termination secured	Yes ☐	N/A ☐
ACB movement function checked	Yes ☐	N/A ☐
ACB operation interlocks verified	Yes ☐	N/A ☐
Protection shroud/barrier in operation position	Yes ☐	N/A ☐
Electrical functionality check completed	Yes ☐	N/A ☐
ACB service to recommendation by ABB		
Number of operation cycle exceeded	Yes ☐	N/A ☐
ACB contact wear alarm indicated	Yes ☐	N/A ☐
Other alarm indicated	Yes ☐	N/A ☐
Contact grease condition inspected	Yes ☐	N/A ☐
Surge Protection Device (SPD) compartment		
Backup fuse disconnector closed	Yes ☐	N/A ☐
Backup fuses present/not blown	Yes ☐	N/A ☐
Backup circuit breaker not tripped	Yes ☐	N/A ☐
Surge Protection Device (SPD) indicator healthy	Yes ☐	N/A ☐
Cable connection compartment		
Cable connection tightness checked	Yes ☐	N/A ☐
Cable entry point sealed to site requirement	Yes ☐	N/A ☐
Protection shroud/barrier in operation position	Yes ☐	N/A ☐
Switchboard overall cladding		
All doors secured	Yes ☐	N/A ☐
Roof plate secured	Yes ☐	N/A ☐
Ventilation mesh cleaned	Yes ☐	N/A ☐
Passage way cleared	Yes ☐	N/A ☐
Rusted sections treated	Yes ☐	N/A ☐
IP rating of the section is maintained	Yes ☐	N/A ☐
Operation observations / Any Yes in this group requires immediate investigation!		
High switchboard surface temperature	Yes ☐	N/A ☐
Abnormal noise generated	Yes ☐	N/A ☐
Vibration	Yes ☐	N/A ☐

Table 12-01 Maintenance and inspection checklist

12.2 Related documents references

The Service manual for MNS 3.0 sections refers to following documents:

No.	Document	Reference number
1	E1.2 – Installation, operation and maintenannce instructions for the installer and the end user	1SDH000999R0002
2	E2.2 / E4.2 / E6.2 – Installation, operation and maintenannce instructions for the installer and the end user	1SDH001000R0002
3	SlimLine XR Switch Disconnector Fuse 63-630 A	1SEQ100098P0001 – XRG00 1SEQ100099P0001 – XRG1 1SEQ100100P0001 – XRG2/3

Table 12-02 List of related documents references

12.3 Abbreviations

ACB	Air circuit breaker	MCT	Measuring current transformer
B2B	Back to back	MFSW	Multi-function separation wall
BBA	Busbar area	MNS®	Modular Niederspannungsschaltanlagen (Modular Low Voltage switchgear)
BBB	Busbar bottom	MS	Motor starter
BBT	Busbar top	MSD	Main switching device
BoM	Bill of materials	MSW	Metal Separation Wall
BT	Bus-tie / bus coupler	N	Neutral
CCU	Cable connection unit	NB	Neutral bottom
CT	Current transformer	NRDOL	Non-reversing direct online
DBB	Distribution Busbar	NT	Neutral top
DOL	Direct online	PB	Phases bottom
E	Dimension utilized in MNS to denote 25 mm 1E = 25 mm	PCT	Protection current transformer
ED	Energy distribution	PEN	Positive earth and neutral
EFM	Electronic fuse monitor	RDOL	Reversing direct online
EOL	Electronic overload	REF	Restricted earth fault
EQ	Equipment compartment depth	RPC	Reactive power compensation
HDOL	Heavy duty direct online	RRP	Raised roof plate
HR	Horizontal terminals in ACB section	SCPD	Short circuit protection device
IK	Impact protection	SD	Star-delta
IOB	Incoming / outgoing Bottom	SG	Switchgear
IOT	Incoming / outgoing Top	SPD	Surge protection device
IP	Ingress protection	SSW	Step-up section width
IR	Infrared	SW	Section Width
MBB	Main busbar	TOL	Thermal overload
MCB	Miniature circuit breaker	UMC	Universal motor controller
MCC	Motor control centre	VSD	Variable speed drive
MCCB	Moulded case circuit breaker		

Table 12-03 List of abbreviations

12.4 Appendix

12.4.1 List of figures

Table 12-04 List of figures

12.4.2 List of tables

Table 12-05 List of tables

Additional information
We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

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ABB Service

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Contact your local sales organization on the ABB homepage
https://new.abb.com/contact/form

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