

DISTRIBUTION SOLUTIONS

MNS[®] low voltage switchgear

Installation and maintenance manual



- Unmatched safety for protection of personnel and plant exceeding the standards
- Increased availability/reliability from comprehensive design verification
- Lower cost of ownership through maintenance free designs
- On-premise and cloud based data collection and analysis with ABB Ability™

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.

Table of contents

01. Safety first	04
02. Technical description	10
03. Packing, storage and transportation	48
04. Erection and installation	68
05. Commissioning	118
06. Operation	124
07. Maintenance	154
08. Extension and upgrade	170
09. Repair, spares and consumables	178
10. Re-configuration of switchgear	182
11. End of life	194
12. Attachments and checklists	198

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01



Safety first

1.1	Safety relevance	06
1.2	Understanding and managing the risk	06
1.3	Warning signs and labels	07
1.4	Basic principles and precautions to be observed	07
1.5	Areas of work	07
1.6	Five safety rules	08
1.7	Permit to work	08
1.8	Personal Protection Equipment (PPE)	08
1.9	Special considerations when working on electrical equipment	08
1.9.1	Capacitors	08
1.9.2	CT's	08
1.9.3	Auxiliary or temporary supply	08

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 signs are typically applied:

High Voltage ISO3864	Arc Flash Hazard ISO3864	Warning Sign ANSI Z535.4	Danger Sign ANSI Z535.4
		 <div data-bbox="667 405 847 555" style="border: 1px solid black; padding: 2px;"> <p>⚠ WARNING ARC FLASH and SHOCK HAZARD Appropriate PPE and Tools required when working on this equipment</p> </div>	 <div data-bbox="1034 405 1214 555" style="border: 1px solid black; padding: 2px;"> <p>⚠ DANGER Arc Flash Hazard Follow requirements for safe work practices and appropriate PPE. Failure to comply can result in death or injury.</p> </div>

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 required¹;
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 the minimum standard for clothing is that products shall be capable of withstanding e.g. electrical arc with an incident energy of 8cal/cm². 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 Assessment 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.

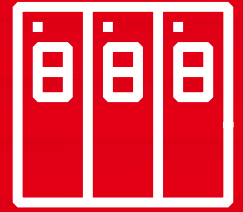
1.9.2 CT's

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.

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.



Technical description

2.1	Technical data	12
2.2	MNS Switchgear	13
2.3	Service conditions and operating environment	14
2.3.1	Special service conditions acc. IEC 61439-1	14
2.4	Functional compartments and segregation	15
2.5	Assembly arrangements	16
2.5.1	MNS Rear assembly arrangements	16
2.6	MNS dimensions	17
2.6.1	MNS Rear dimensions	17
2.7	Mechanical construction	18
2.7.1	MNS frame	18
2.7.2	MNS Rear frame	19
2.7.3	The enclosure/external cladding	19
2.7.4	Internal construction/internal cladding	19
2.8	The busbar system	20
2.8.1	The main busbar	20
2.8.2	MNS Rear main busbar system	22
2.8.3	The multifunction separation wall	24
2.8.4	The distribution bar system	25
2.8.4.1	MNS Rear distribution bar system	26
2.8.4.2	Fixed type distribution bar system	27
2.8.5	The power contact	28
2.9	Sections and functional units	29
2.9.1	ACB (Air Circuit Breakers) sections	30
2.9.2	Fixed modules in MNS	33
2.9.3	Compact modules in MNS	34
2.9.4	Plug-in modules in MNS	36
2.9.5	Withdrawable modules in MNS	43
2.9.6	Withdrawable modules	45

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
Test certificates	Protection against electric shock	Common aspects for installation and equipment	IEC 61140
		General rules	IEC 61439-1
Approvals		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	
		Design and engineering practice	Shell
Electrical data	Rated voltages	Rated insulation voltage U_i	1 000 V 3~, 1 500 V-
		Rated operating voltage U_e	690 V 3~, 750 V-
		Rated impulse withstand voltage U_{imp}	6 / 8 / 12 kV, depending on equipment
	Rated currents	Overvoltage category	II / III / IV
		Degree of pollution	3
		Rated frequency	up to 60 Hz
Arc fault containment	Main busbar		
	Rated current I_n		up to 6 300 A
	Rated peak withstand current I_{pk} Rated short-time withstand current I_{cw}		up to 220 kA up to 100 kA
Surface protection	Distribution bars		
	Rated current I_n		up to 2 000 A
	Rated peak withstand current I_{pk} Rated short-time withstand current I_{cw}		up to 220 kA up to 100 kA
Mechanical characteristics	Dimensions	Rated operational voltage	up to 690 V
		Prospective short-circuit current	up to 100 kA
		Duration	300/500 ms
Degree of protection	According to IEC 60529	Criteria (IEC TR 61641)	1 to 7
		Sections and frames	ISO 2768
		Recommended height	2 200 mm *)
External mechanical impact (IK)	Halogen-free, self-extinguishing, flame retardant, CFC-free	Recommended width	400, 600, 800, 1 000, 1 200, 1 400 mm
		Recommended depth	400, 600, 800, 1 000, 1 200 mm
		Basic grid size	E = 25 mm acc. to DIN 43660
Plastic components	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)
Steel components	Equipment compartment Busbar compartment Cable compartment		External from IP 30 to IP 54
			Internal from IP XXB
			up to IK10
Forms of separation	up to Form 4		IEC 60707, DIN VDE 0304 part 3
Internal subdivision	Frame incl. internal subdivisions 2,0 / 2,5 mm Cladding, internal 1,5 / 2,0 mm; external 1,5 mm		
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.

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.

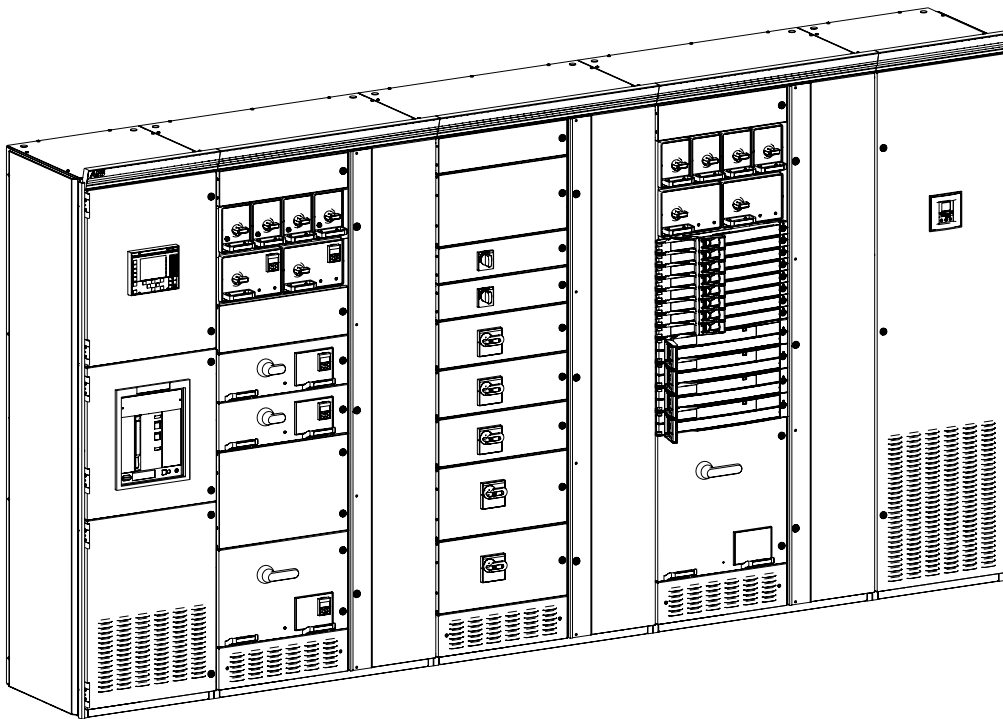


Figure 2-01 MNS 3.0 front access switchgear

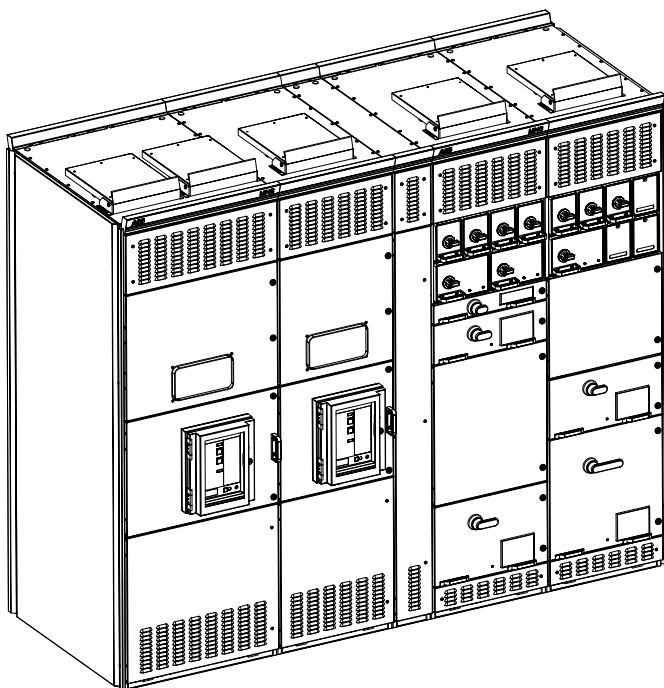


Figure 2-02 MNS Rear access switchgear

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.

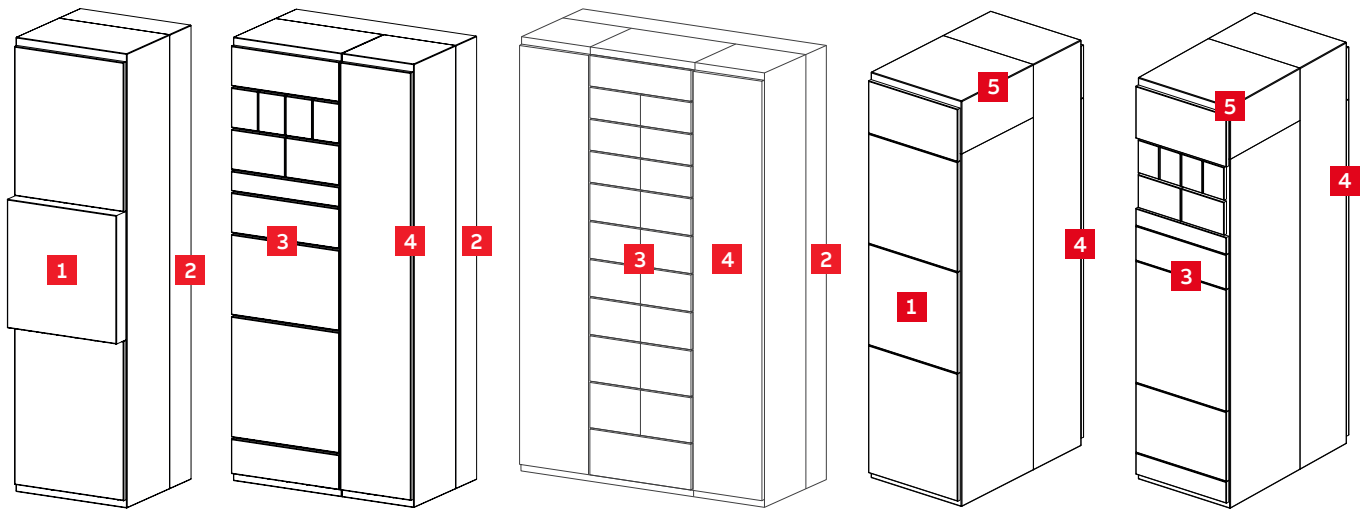


Figure 2-03
Circuit breaker section

Figure 2-04
Outgoing section

Figure 2-05
Compact outgoing section

Figure 2-06
Rear circuit breaker section

Figure 2-07
Rear outgoing 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.

2.5 Assembly arrangements

MNS sections can be arranged in the following configurations.

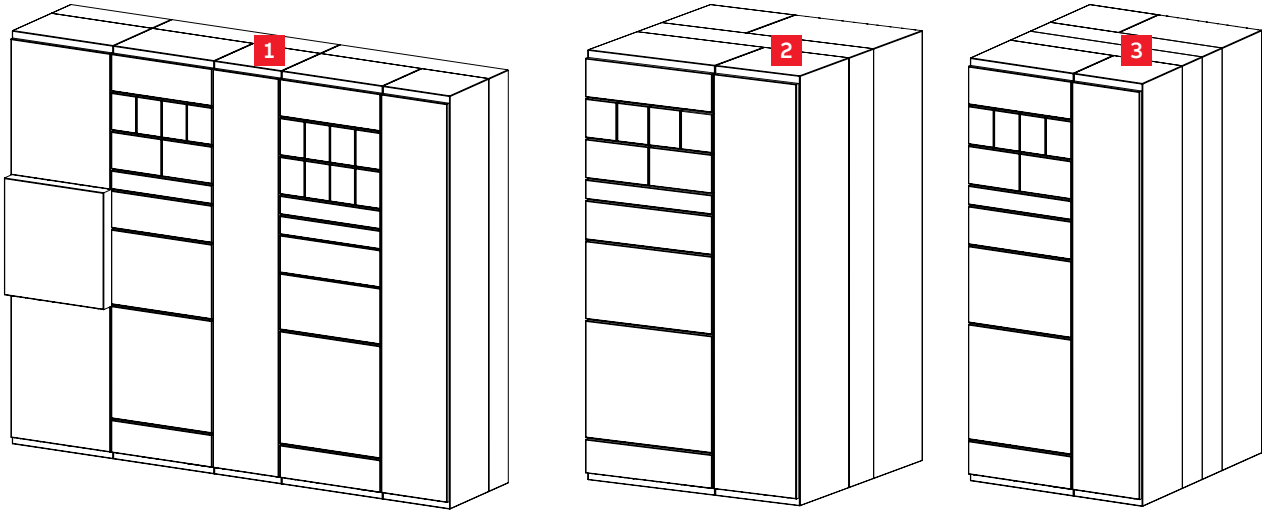


Figure 2-08 Assembly arrangements (from left): standard / duplex / back to back arrangement

1. Standard arrangement as free standing or back to wall.
2. Duplex arrangement 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.

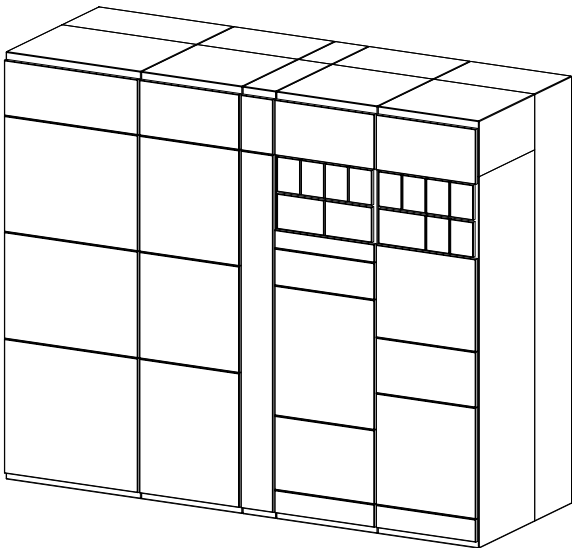


Figure 2-09 MNS Rear assembly arrangement

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

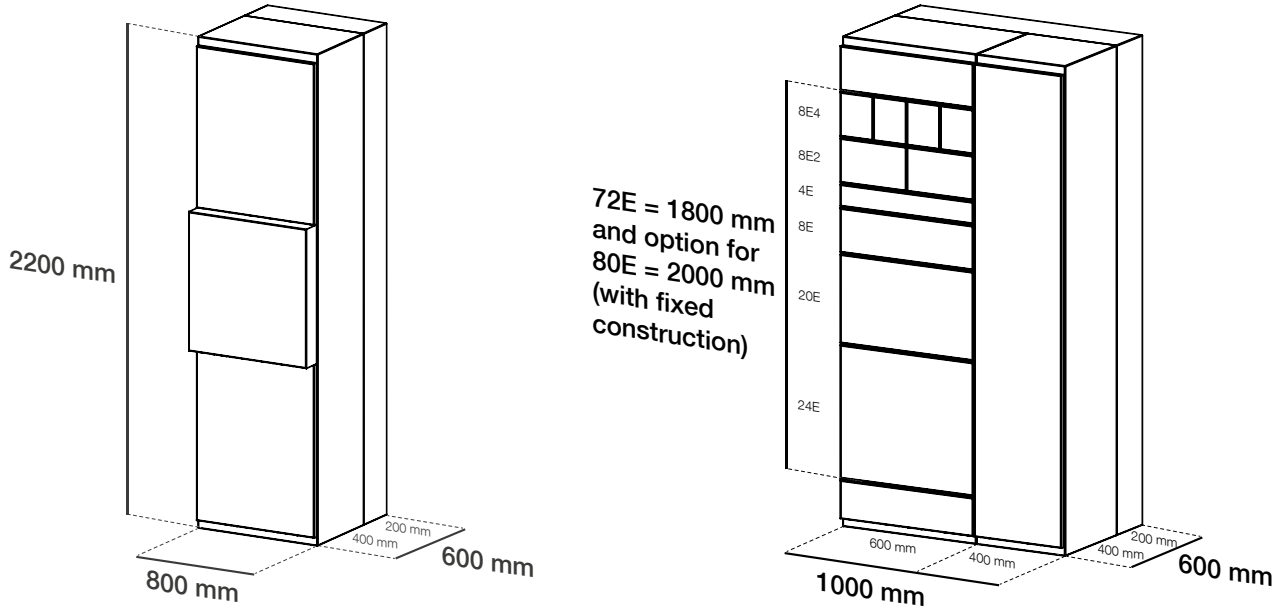


Figure 2-10 Incoming / outgoing circuit breaker section (left), outgoing section (right)

2.6.1 MNS Rear dimensions

MNS Rear sections have options of section depth, 1000 mm and 1200 mm.

The following variations are applied to the width of MNS Rear sections: 400, 600, 800, 1000, 1200 mm.

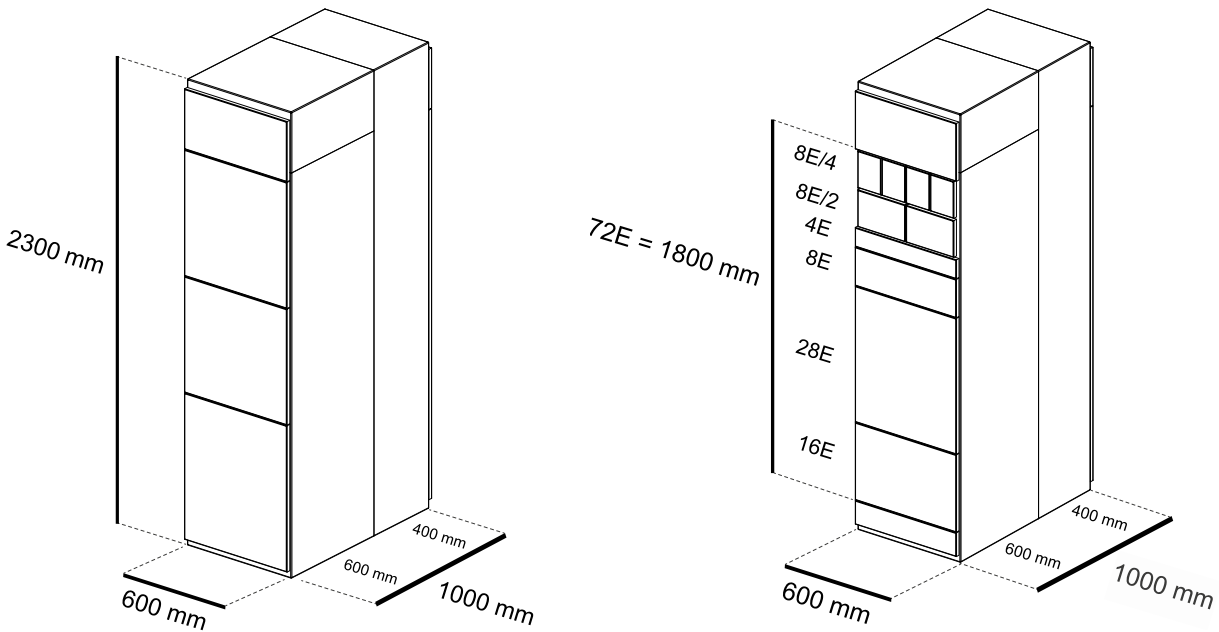


Figure 2-11 MNS Rear ACB section (left), module section (right)

2.7 Mechanical construction

The basic mechanical design comprises:

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

2.7.1 MNS frame

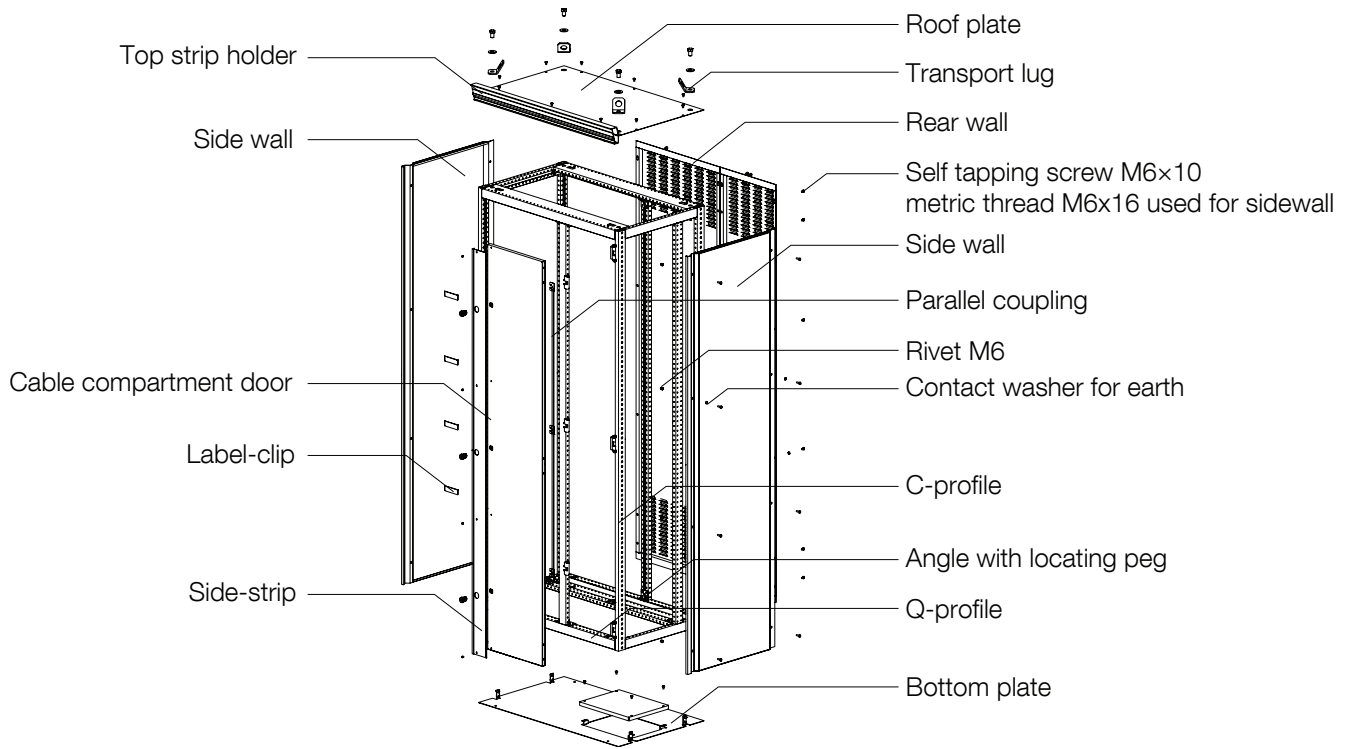


Figure 2-12 MNS frame & enclosure

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.

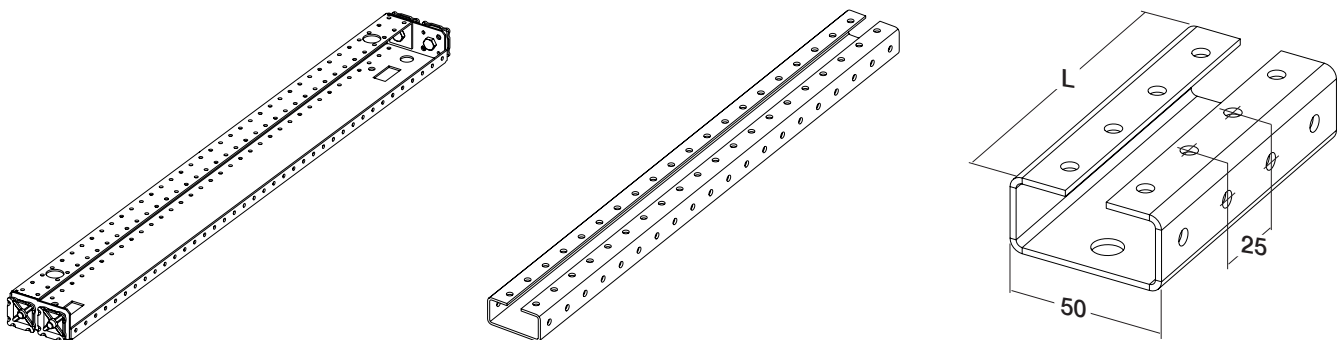


Figure 2-13 “Q” Profile (left), “C” profile (middle) and detail of “C” profile (right)

2.7.2 MNS Rear frame

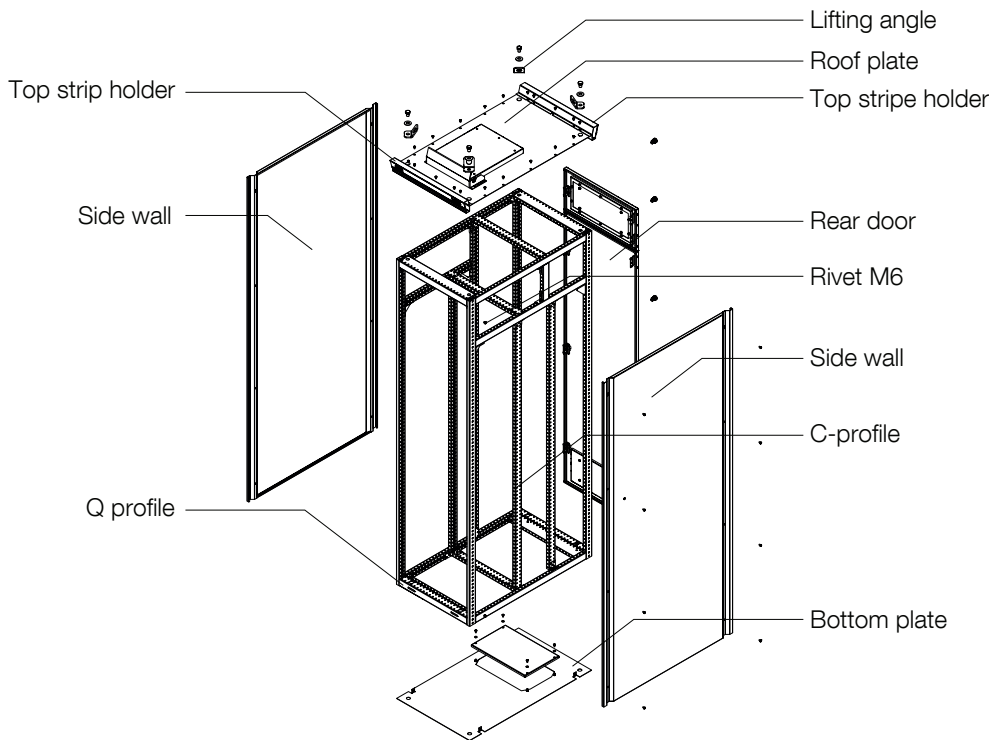


Figure 2-14 MNS Rear frame & enclosure

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.

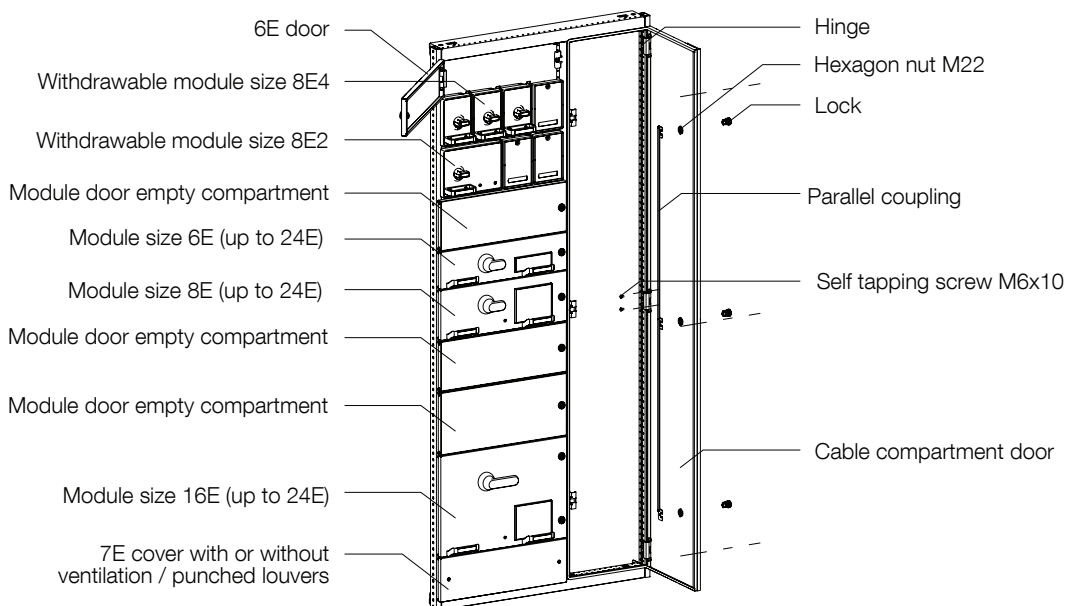


Figure 2-15 Front access modules and cable compartment (example)

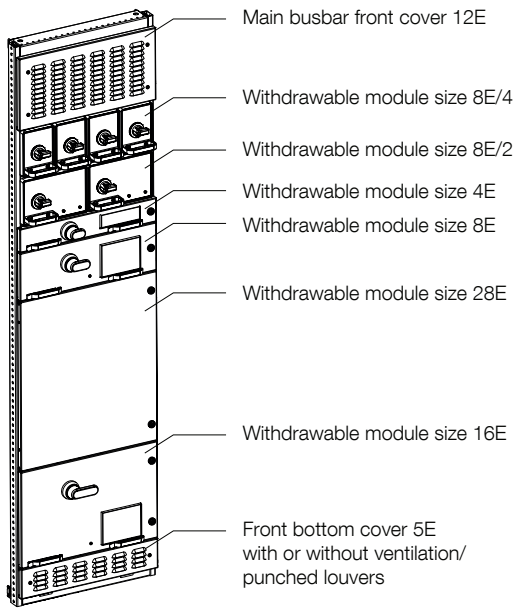


Figure 2-16 MNS Rear modules (example)

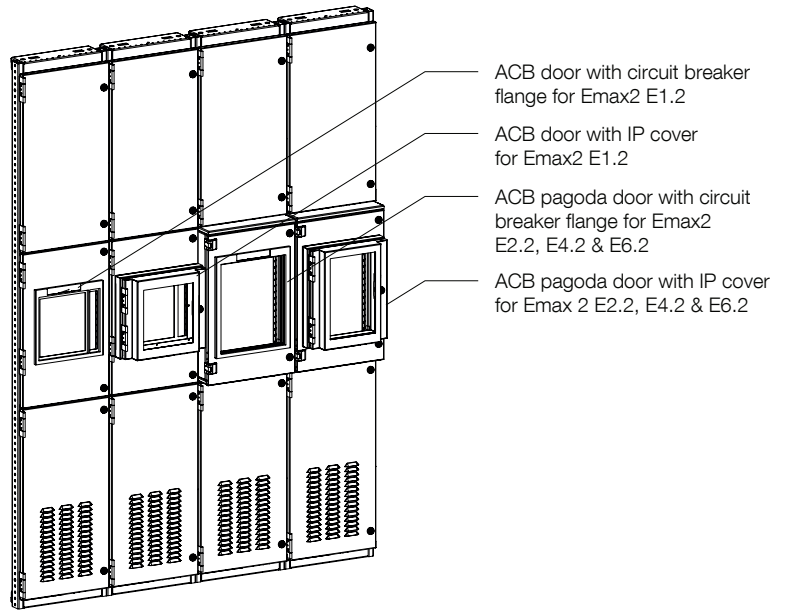


Figure 2-17 Air circuit breaker sections (example)

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.

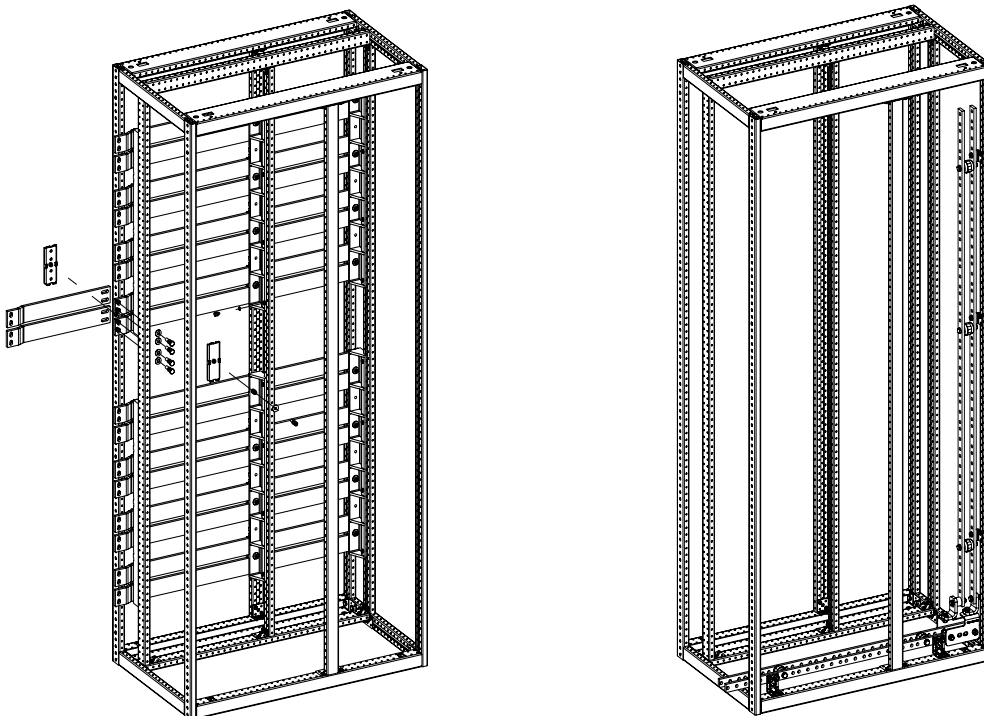


Figure 2-18 Main busbar arrangement (left), N/PEN front distribution (right)

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 picture of Figure 2-18).

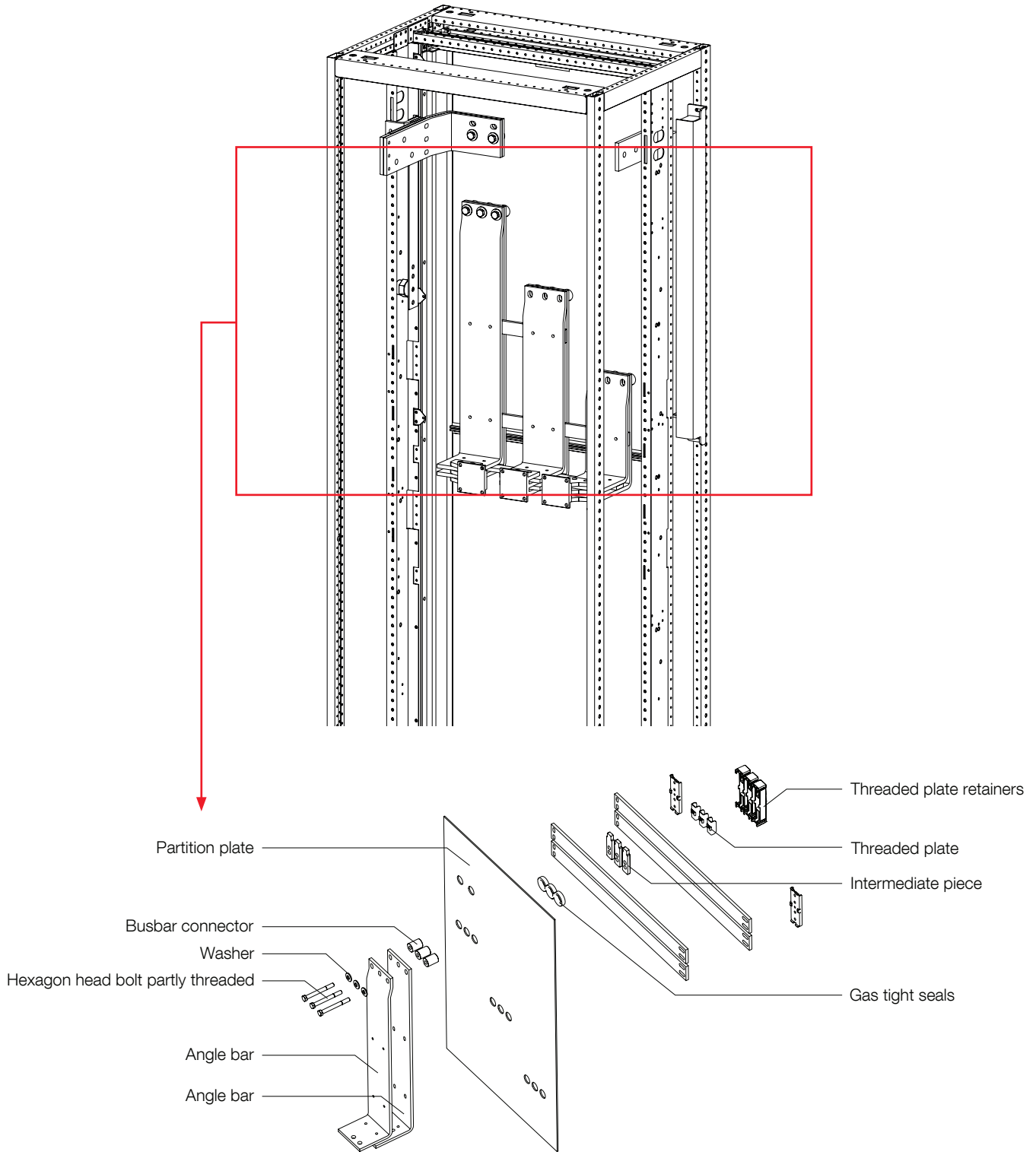


Figure 2-19 ACB copper connection to main busbar

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.

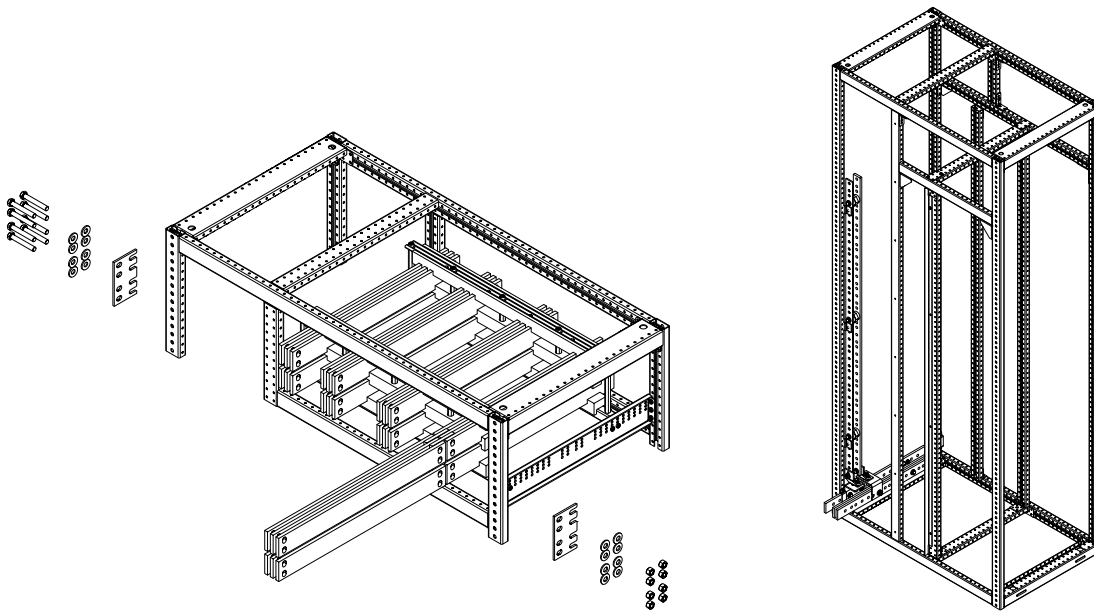


Figure 2-20 MNS Rear main busbar arrangement (left), PE/N/PEN rear distribution (right)

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 100% neutral 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 phase busbars at the top (see picture above of MNS Rear main busbar arrangement).

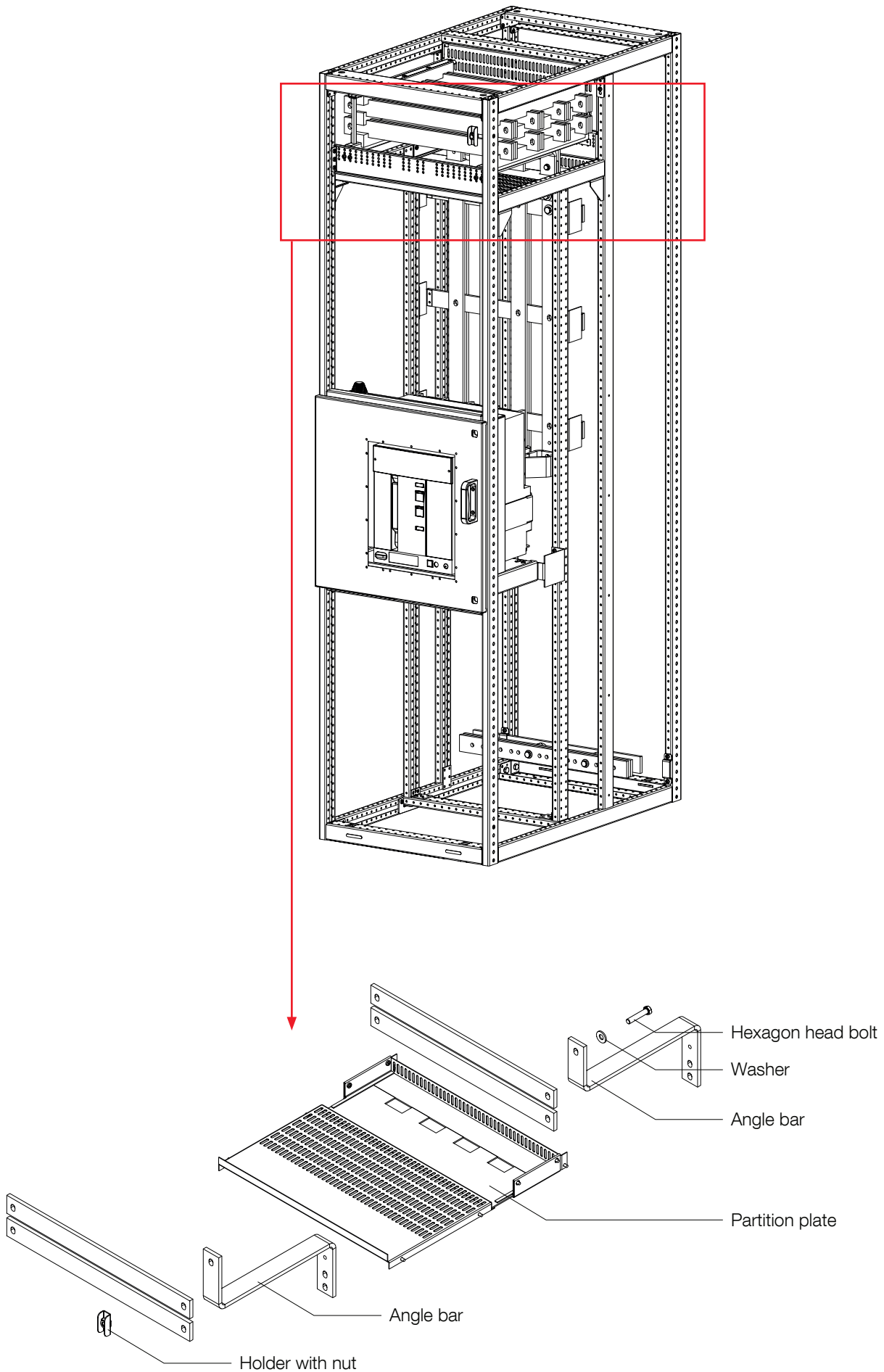


Figure 2-21 MNS Rear ACB copper connection to main busbar

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.

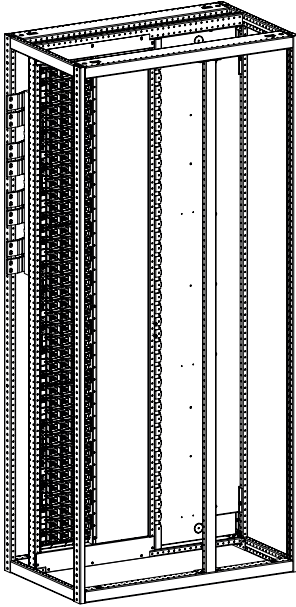


Figure 2-22
MFSW location in front access section located to the left

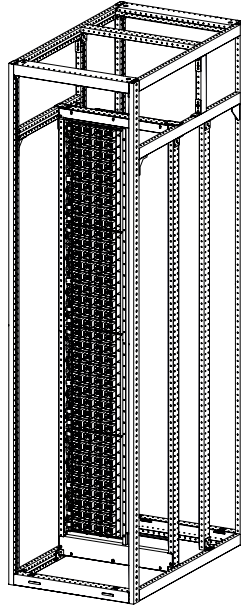


Figure 2-23
MFSW location in rear access section

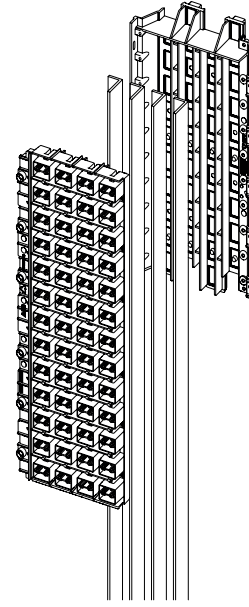


Figure 2-24
Exploded view with front and rear MFSW components and the distribution bars

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.

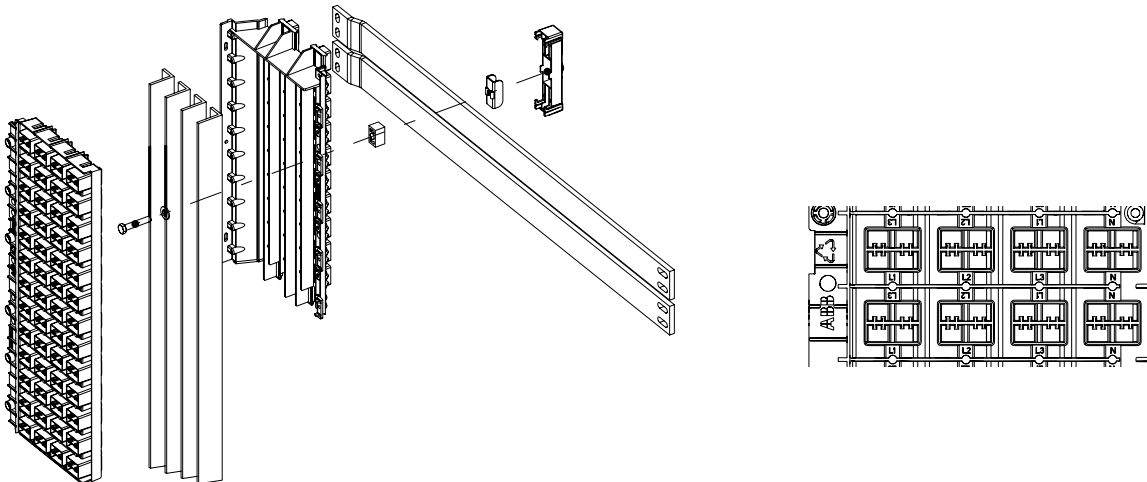


Figure 2-25 Distribution bars. The right hand side shows a detailed view

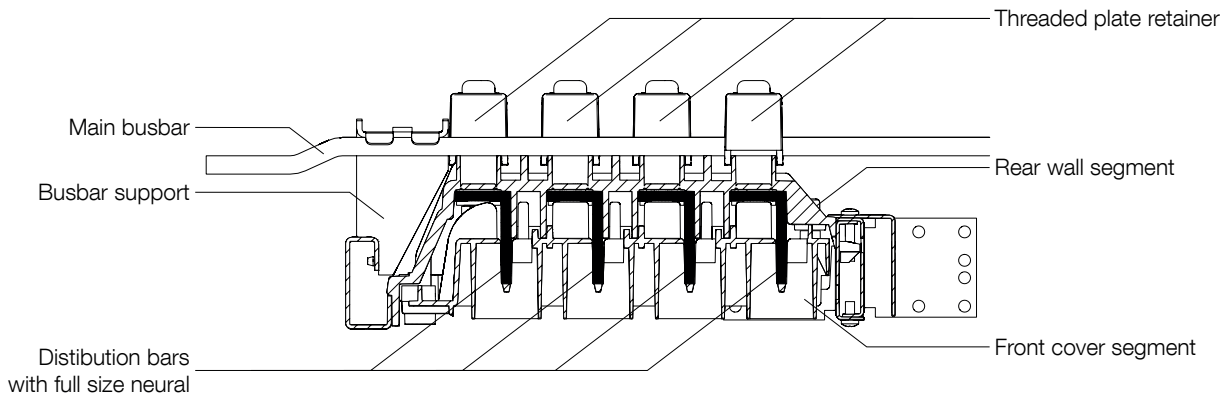


Figure 2-26 Top view of distribution bars

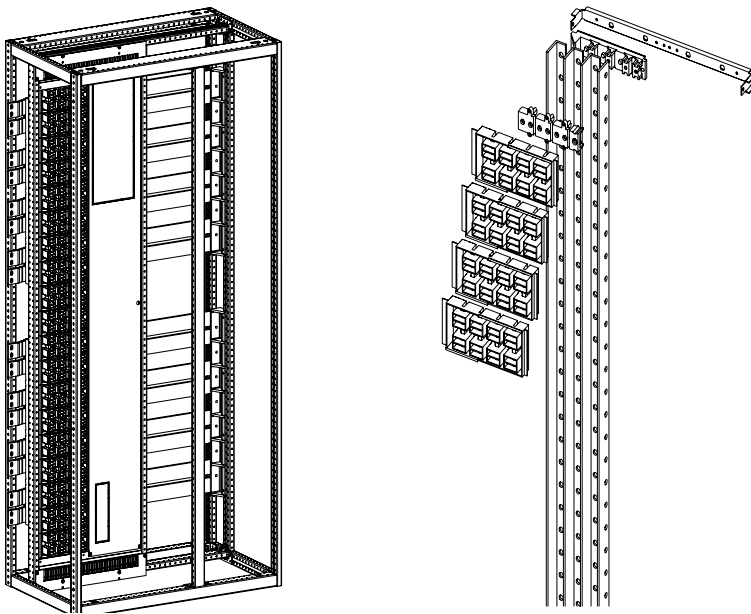


Figure 2-27 Metal separation wall MSW

Figure 2-27 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.

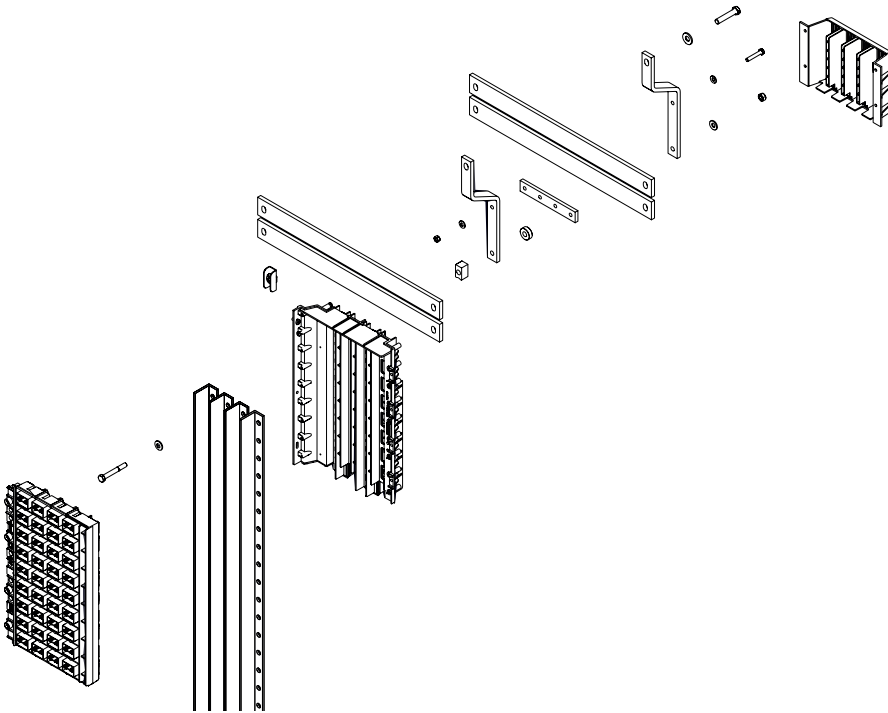


Figure 2-28 MNS Rear distribution bars

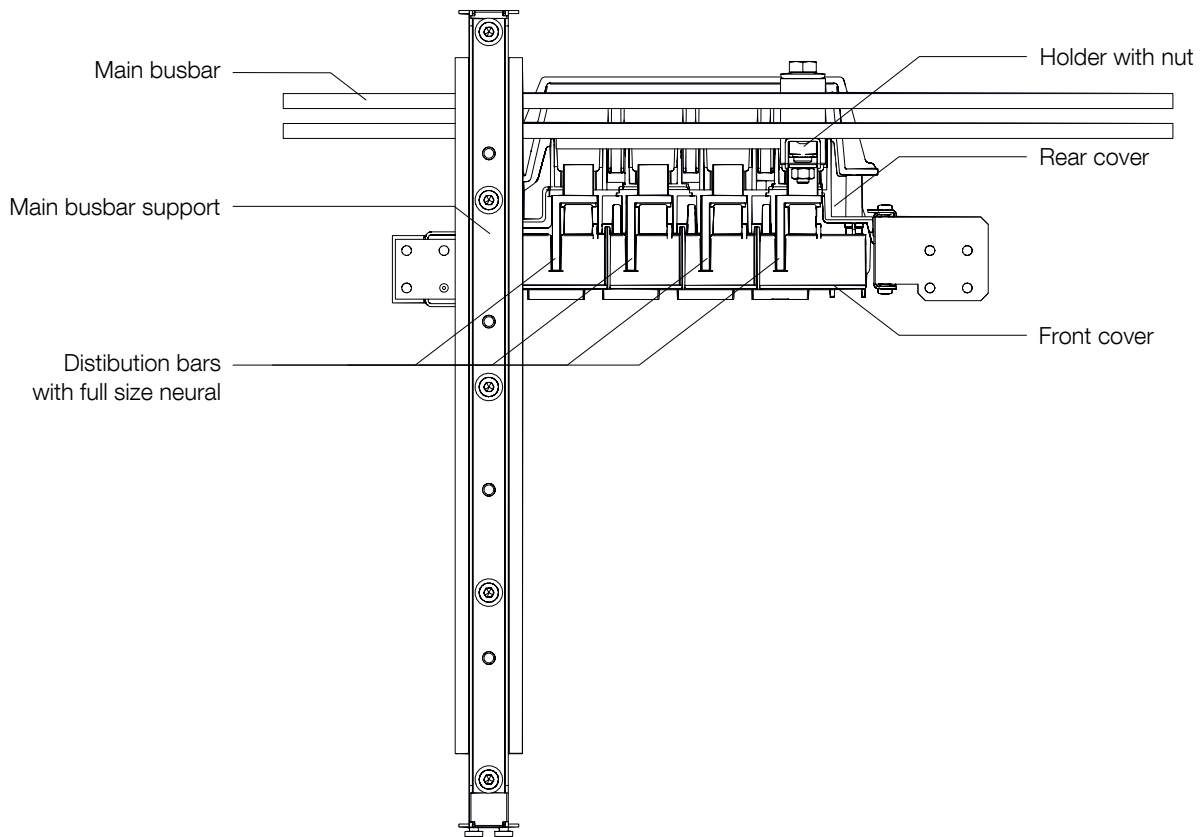


Figure 2-29 Top view of MNS Rear distribution bars

2.8.4.2 Fixed type distribution bars system

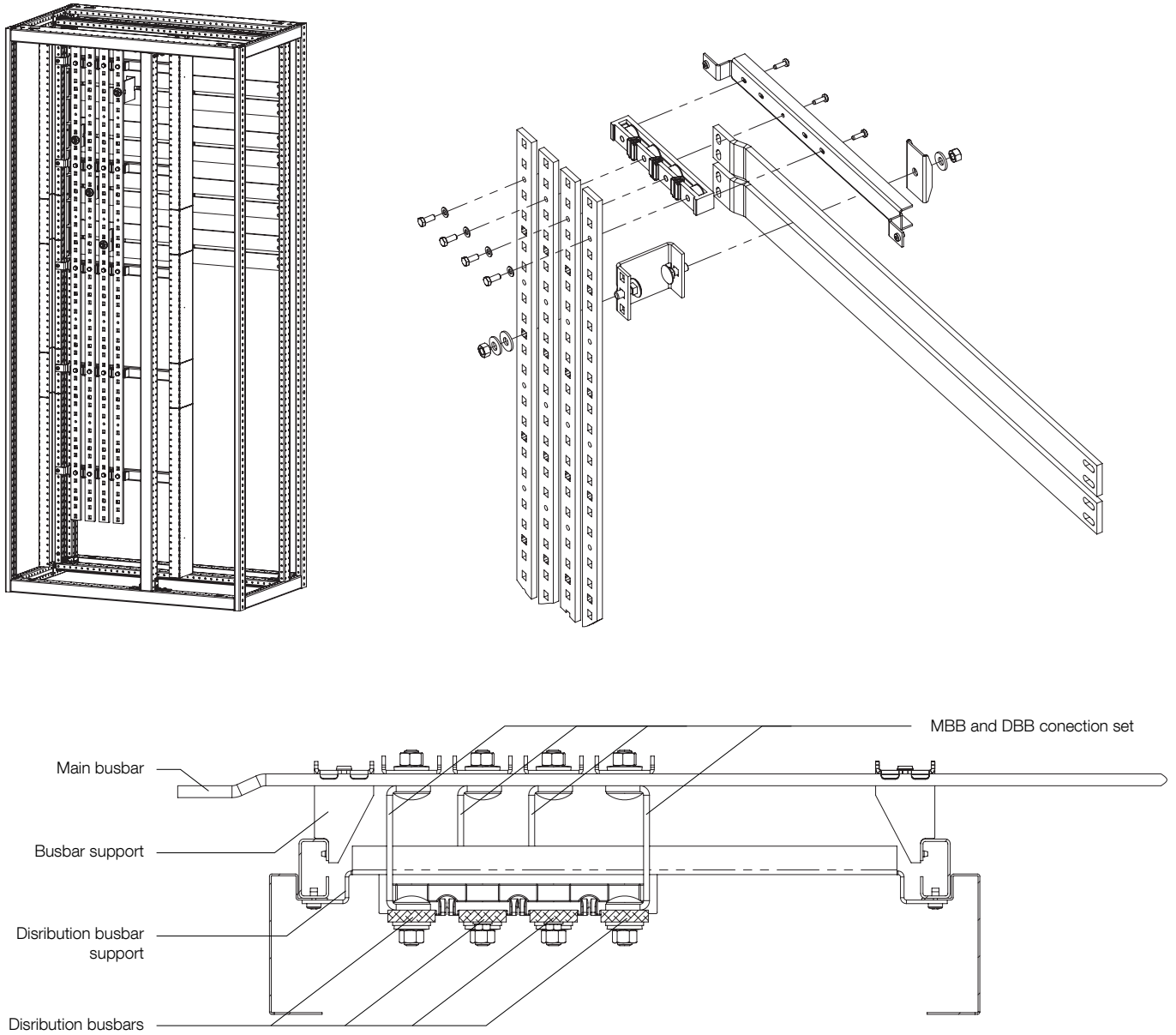


Figure 2-30 Fixed distribution bar system

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 mm²,
- serial number of production,
- year of production,
- calendar day of production,
- contact force,
- manufacturing country acc. ISO 3166.

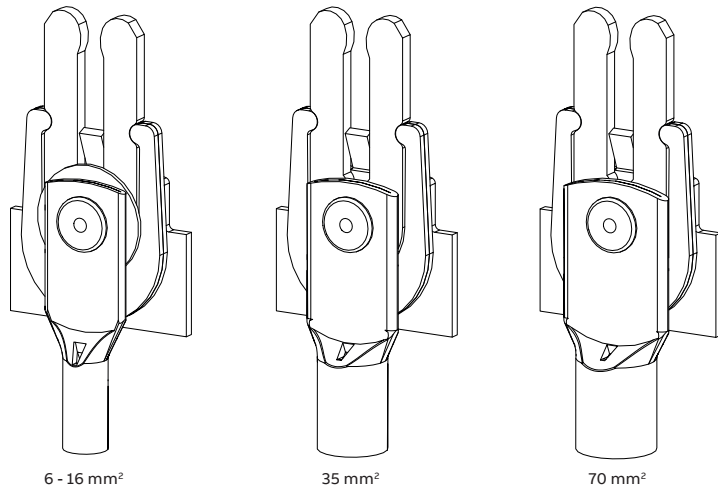


Figure 2-31 Power contacts used in MNS switchgear for different cable cross-sections

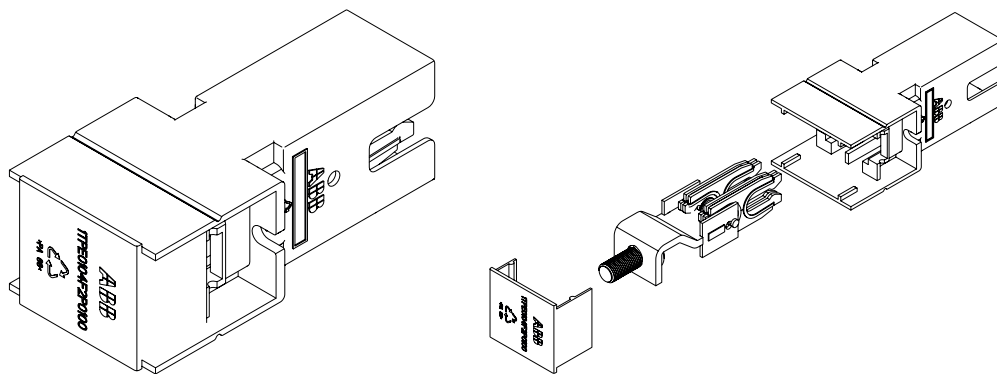


Figure 2-32 Sotax contacts are used for higher current application



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 – Fixed 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.

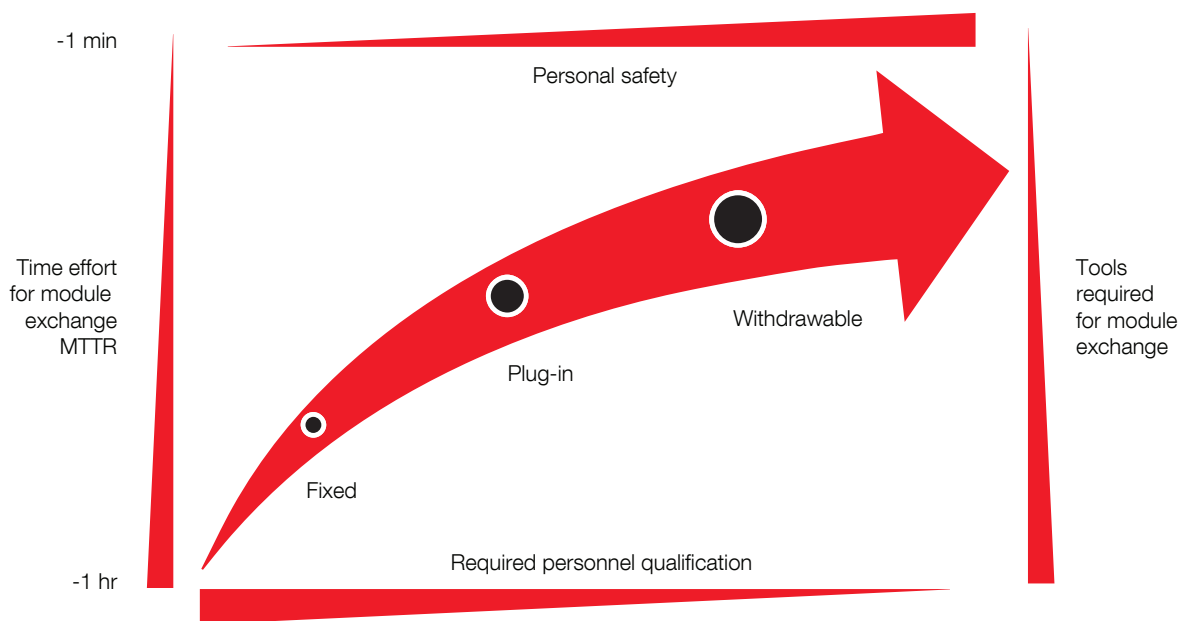


Figure 2-33 Characteristics of functional unit design

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.

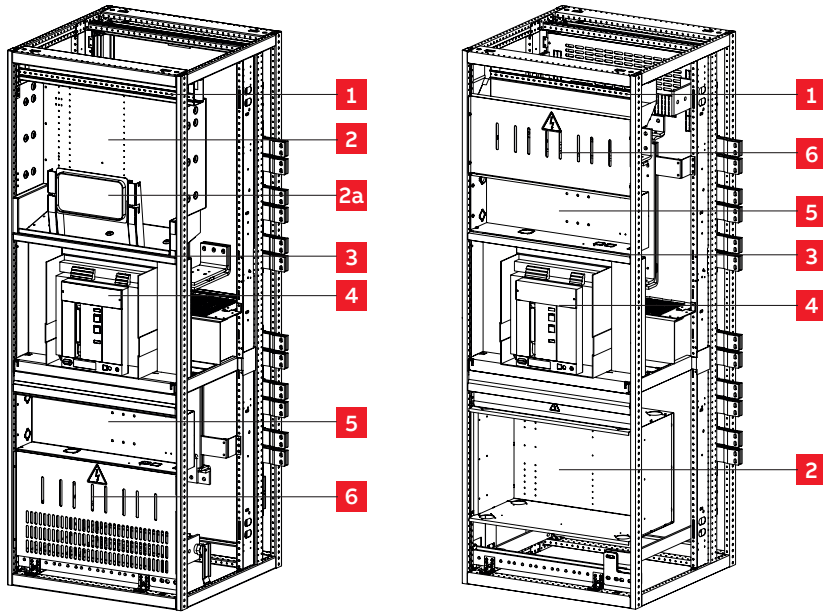


Figure 2-34 ACB section bottom entry configuration (left), top entry configuration (right)

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.

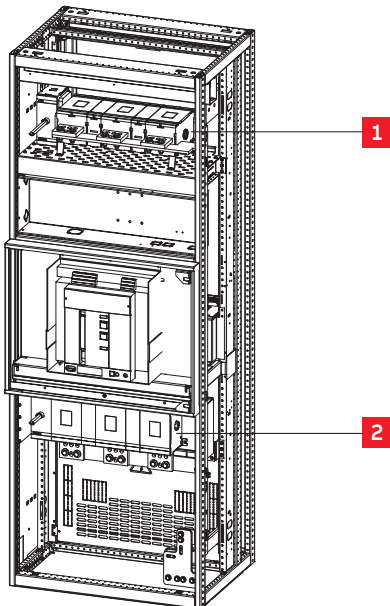


Figure 2-35 Positions for optional earthing switch solutions
 1 Position shown for upper earthing switch
 2 Position shown for lower earthing switch

SPD compartment description

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

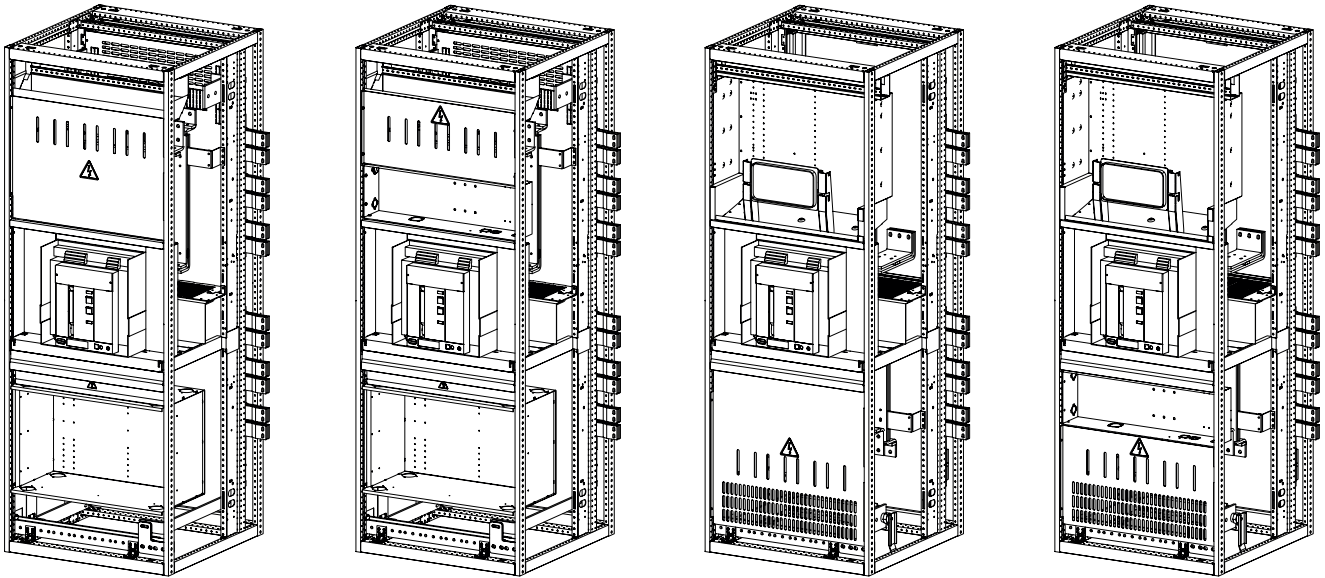


Figure 2-36 Sections with cable top entry (left) and bottom entry (right)

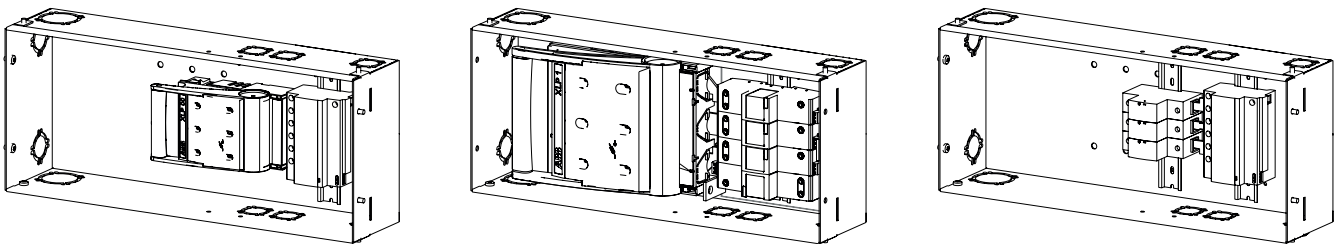


Figure 2-37 SPD with fuse backup protection XLP0 (left), XLP1 (middle) and MCB backup protection (right)

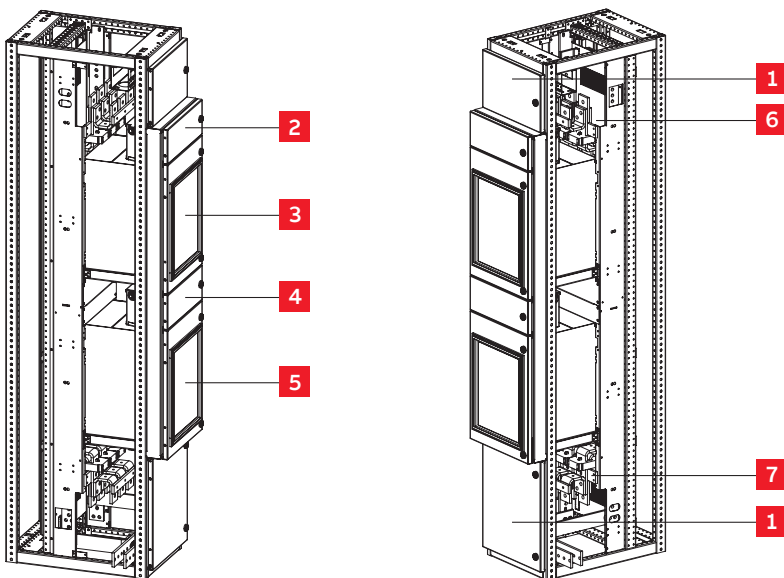


Figure 2-38 MNS Front access switchgear with double stacked ACBs

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 shown below. SPD compartment is provided as an option to accommodate SPD or other devices within ACB section.

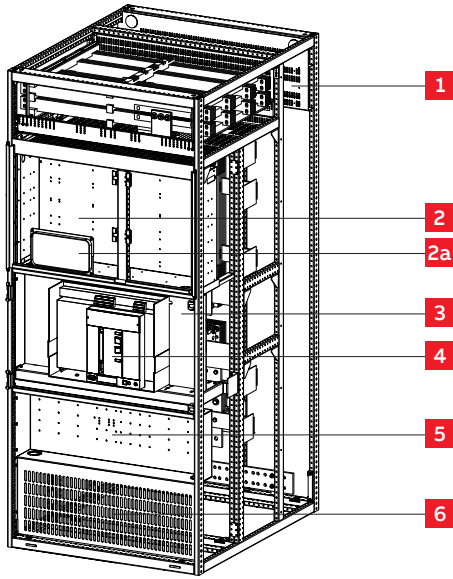


Figure 2-39 MNS Rear ACB section configuration

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

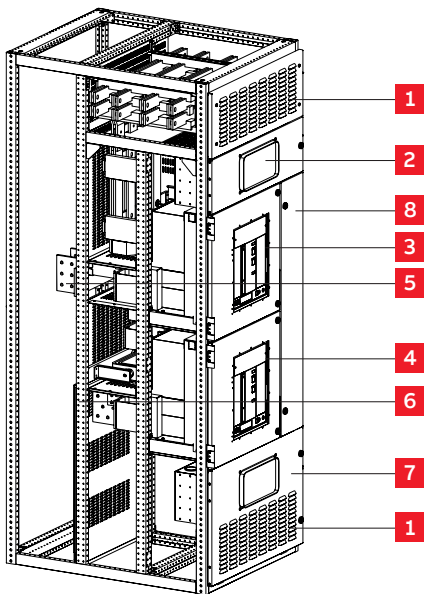


Figure 2-40 MNS Rear access double stacked ACB

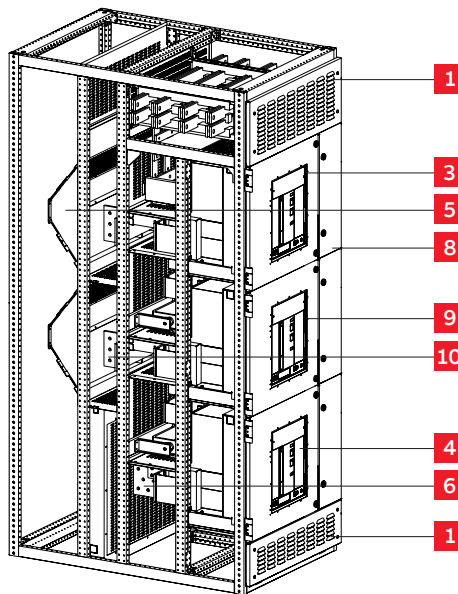


Figure 2-41 MNS Rear access triple stacked ACB

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

2.9.2 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

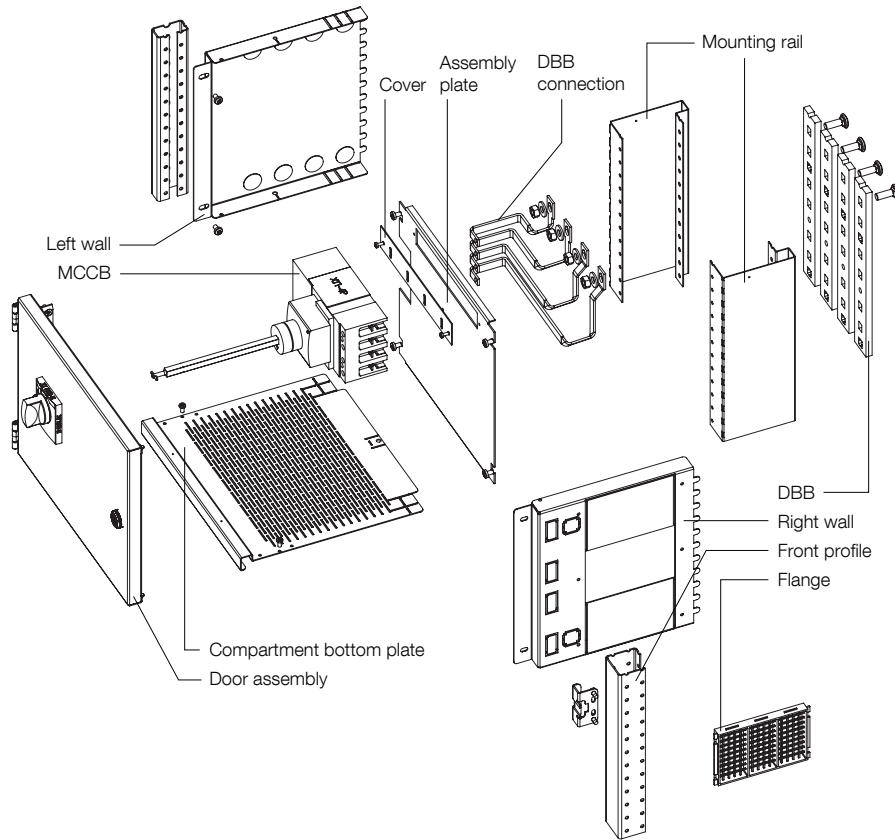


Figure 2-42 Fixed module size 12E

Fixed module construction and connection to distribution busbars

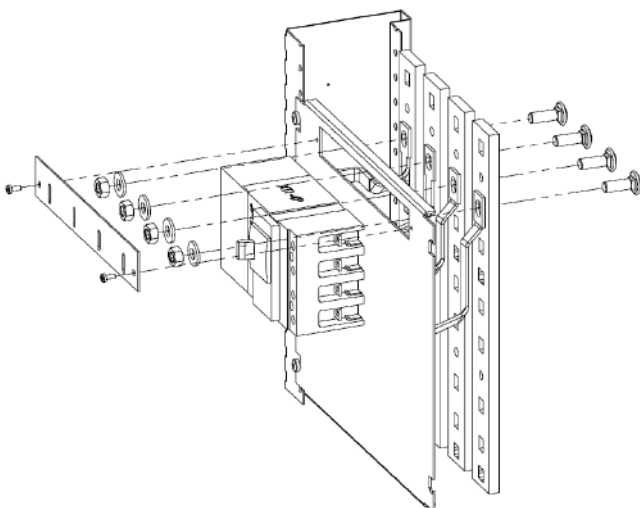


Figure 2-43 DBB connection with busbars

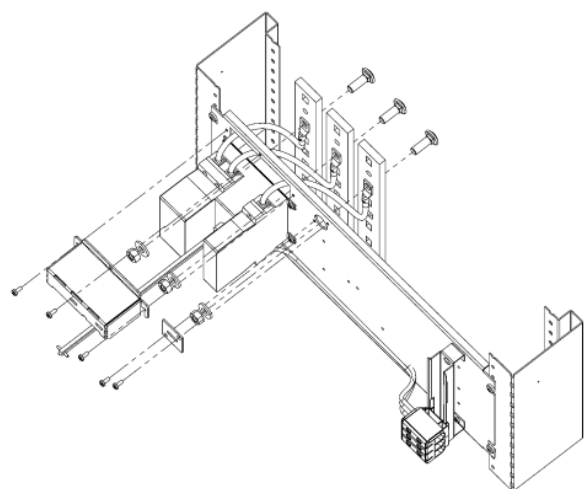


Figure 2-44 DBB connection with cables

2.9.3 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 2-28.

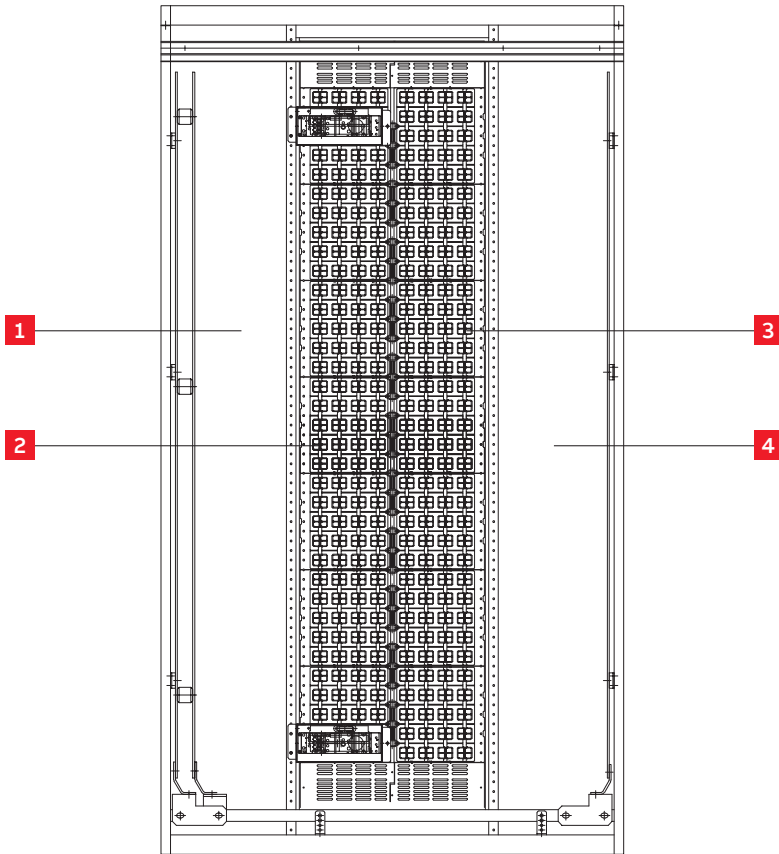


Figure 2-45 Multi-Function Separation Wall (MFSW) in section

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

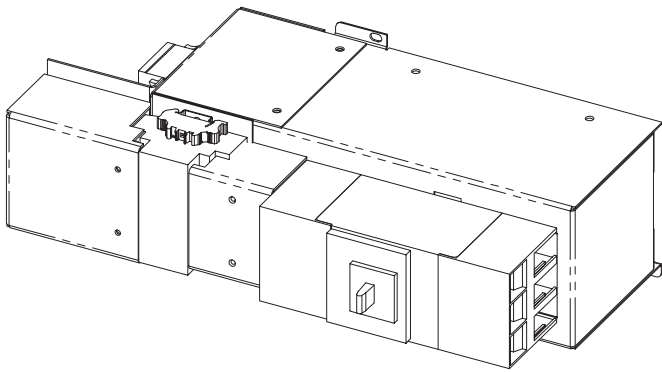
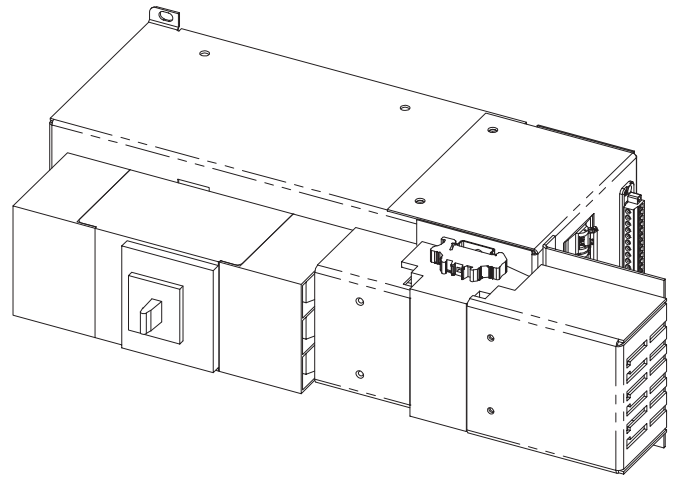


Figure 2-46 Compact module left side mounting



Compact module right side mounting

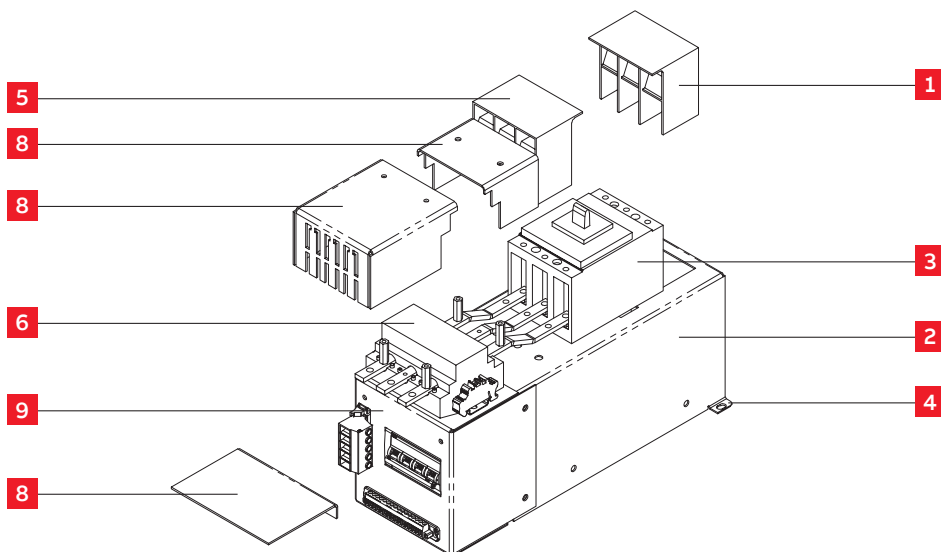


Figure 2-47 Exploded view

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.

2.9.4 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.

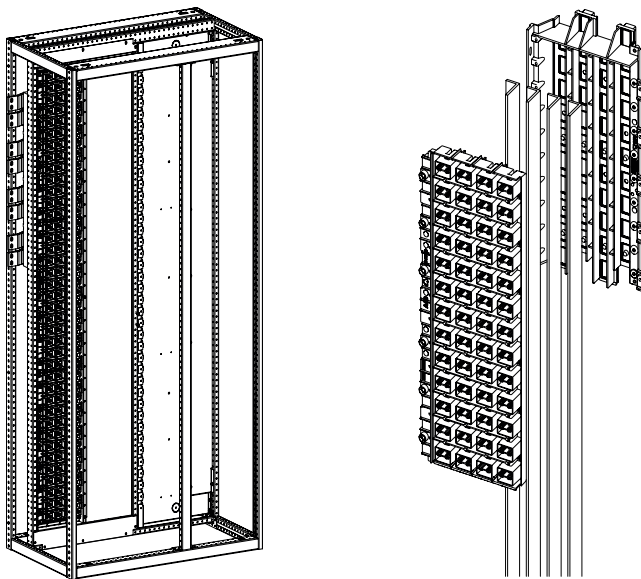


Figure 2-48 Multi-Function Separation Wall (MFSW) in section

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.

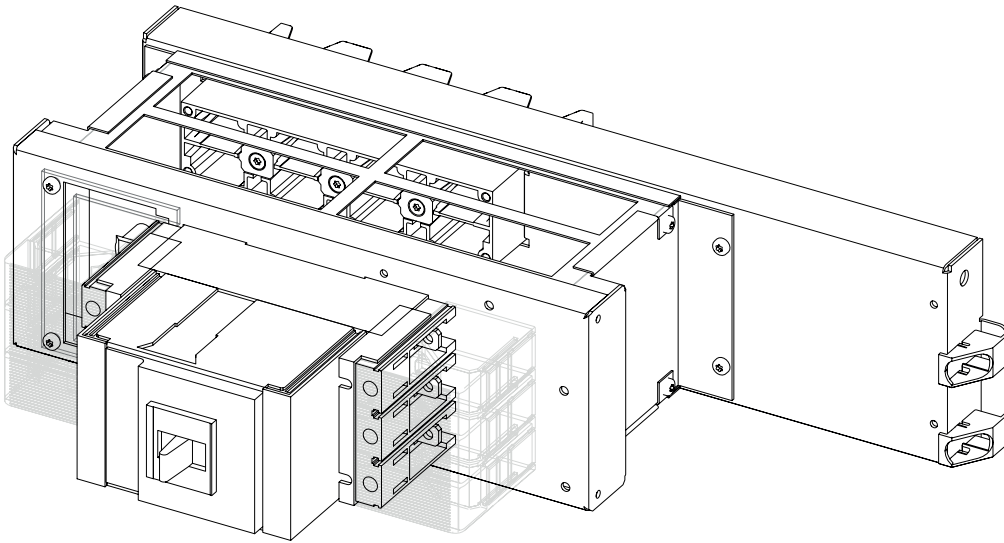


Figure 2-49 Basic plug-in energy distribution module

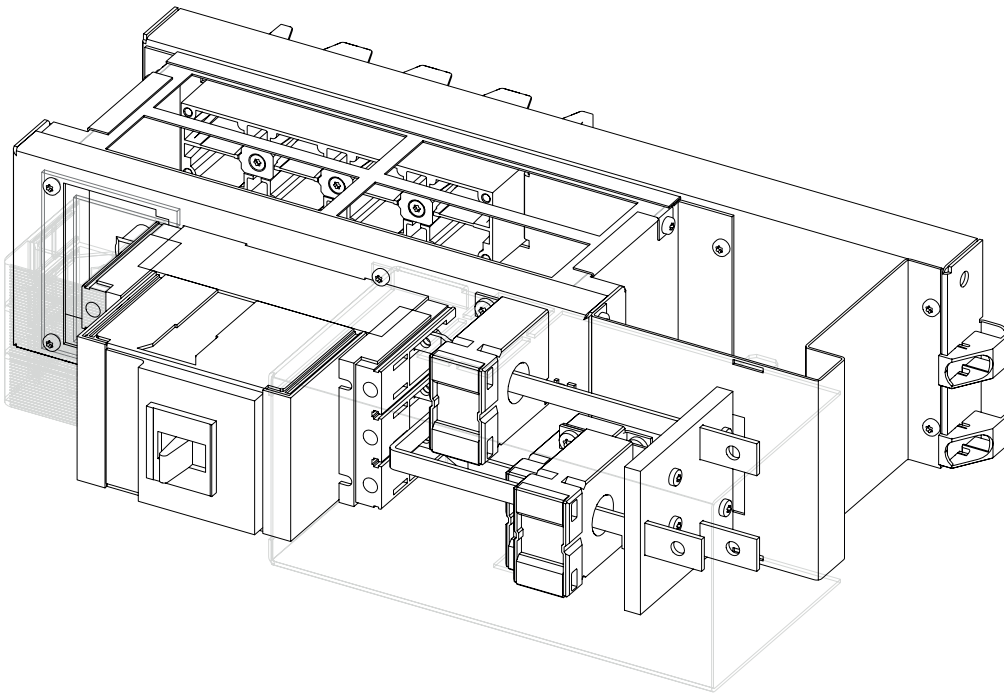


Figure 2-50 Energy distribution module with optional CT's

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.

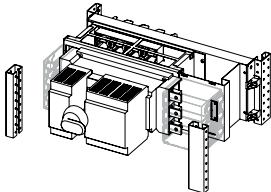
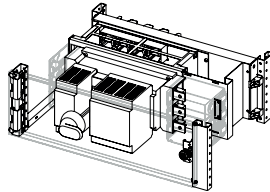
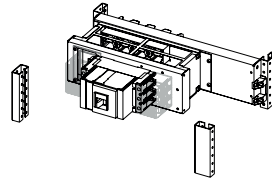
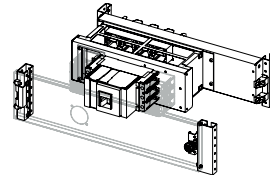
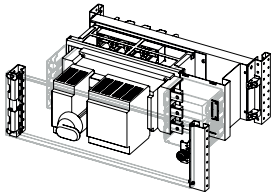
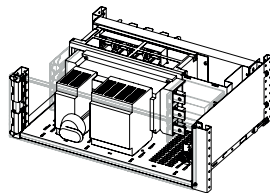
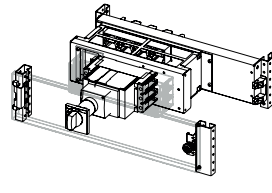
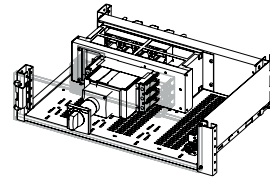
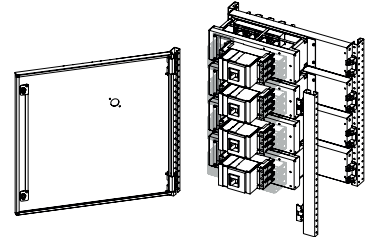
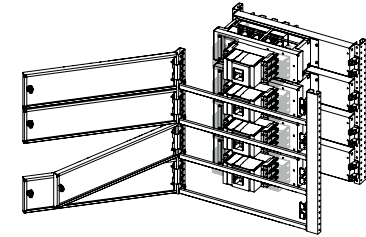
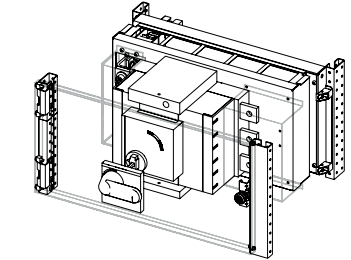
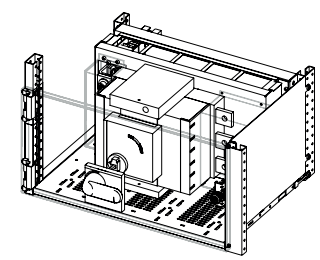
	Fuse switch	Fuse switch	MCCB	MCCB
	Form 4a	Form 4a	Form 4a	Form 4a
Internal operation	<ul style="list-style-type: none"> door sizes selectable up to full section height without compartment bottom plate 	<ul style="list-style-type: none"> individual door for each module without compartment bottom plate utilizing door rail 	<ul style="list-style-type: none"> door sizes selectable up to full section height without compartment bottom plate 	<ul style="list-style-type: none"> individual door for each module without compartment bottom plate utilizing door rail
				
External operation	<ul style="list-style-type: none"> individual door for each module without compartment bottom plate utilizing door rail 	<ul style="list-style-type: none"> individual door for each module with compartment bottom plate 	<ul style="list-style-type: none"> individual door for each module door rail utilised 	<ul style="list-style-type: none"> individual door for each module compartment bottom plate and side wall options shown
				
	MCCB		MCCB	
	Form 4a		Form 4a	
Internal operation	<ul style="list-style-type: none"> common door for 4 x MCCB door options upto 72E 		<ul style="list-style-type: none"> individual door for 4 x MCCB without compartment bottom utilizing door rail 	
				
External operation	<ul style="list-style-type: none"> Individual door 		<ul style="list-style-type: none"> 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.

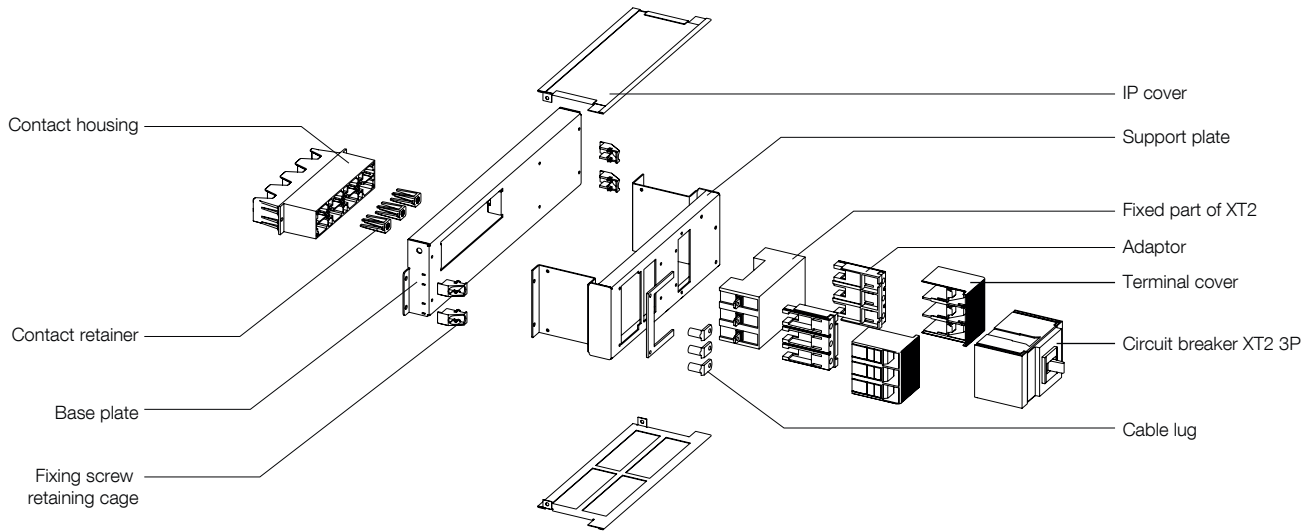


Figure 2-51 Exploded view of plug-in module cable connection to main contacts

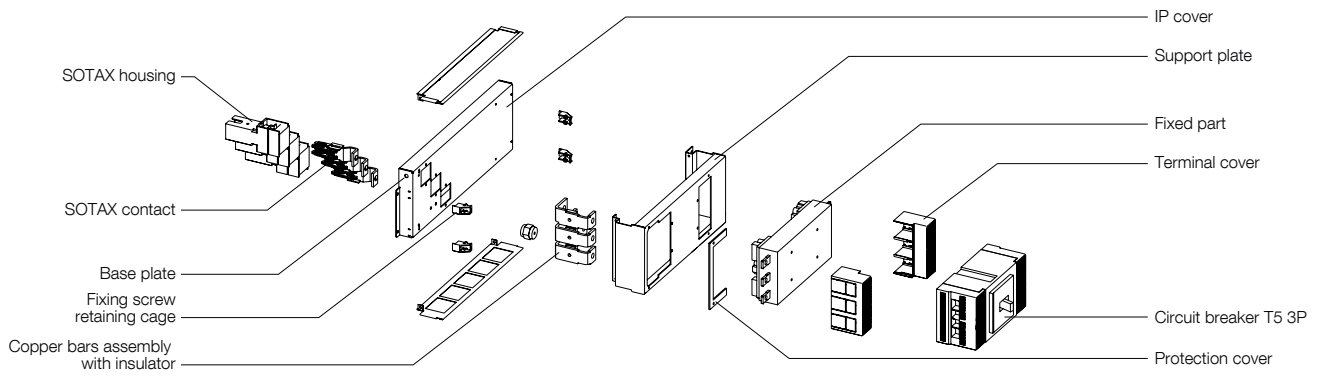


Figure 2-52 Exploded view of plug-in module with copper connection to main contacts

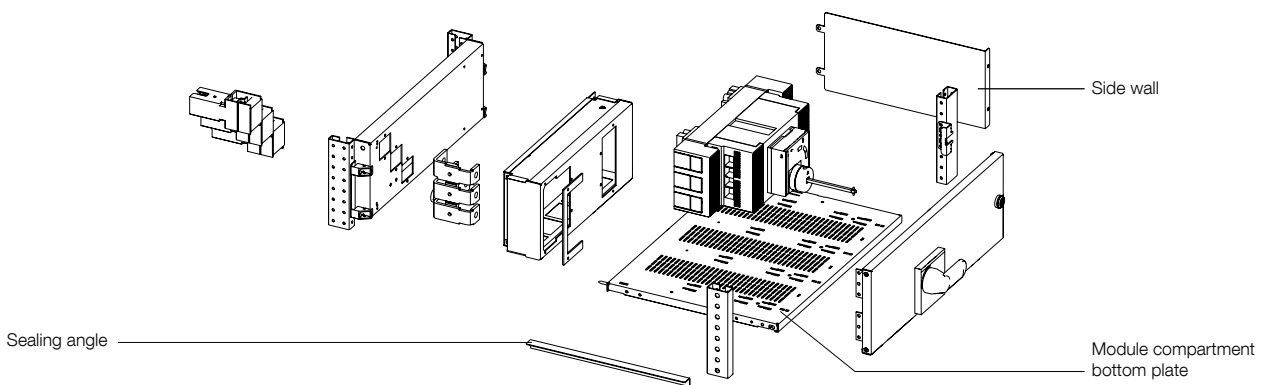


Figure 2-53 Exploded view of plug-in module with optional separation components

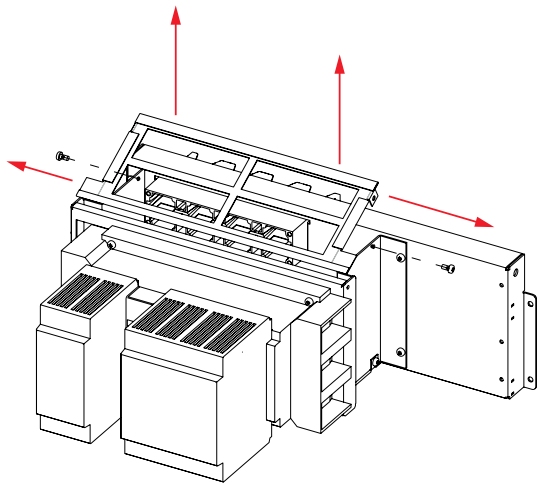


Figure 2-54 IP cover clip for all modules up to 250 A. To remove undo screws on left and right side and flip cover up, same is applicable for lower cover. Re-fitting is the reverse procedure.

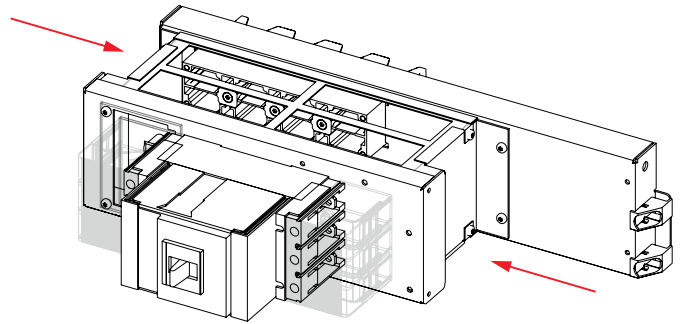


Figure 2-55 Ergonomic design for improve module handling. The module support plate is designed with handles on both sides.

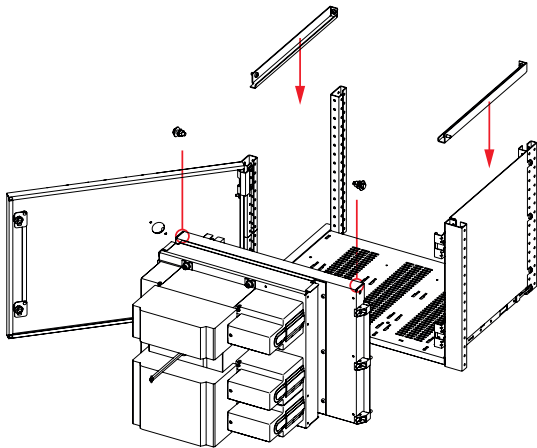
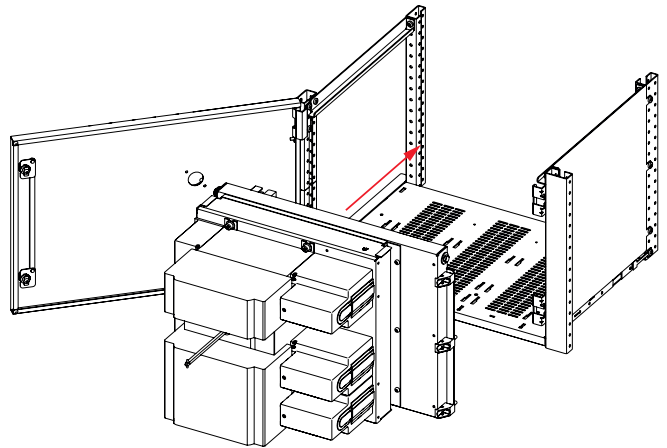


Figure 2-56 Module location guides and rails for larger modules. Larger modules can be equipped with location guides fixed to the top of the base plate. Guide rails are then mounted in the section.



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

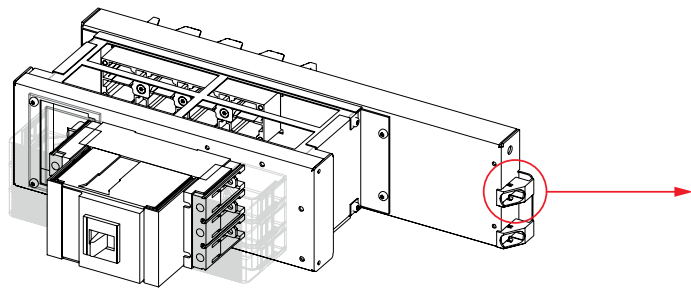


Figure 2-57 Fixing of the plug-in modules to the section

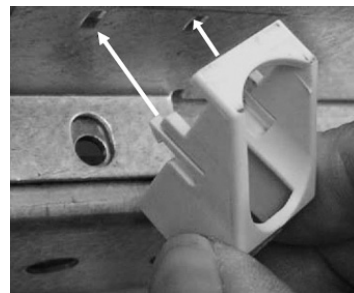


Figure 2-58 Detail of captive screw holder

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 utilised on the left and right hand side of the modules.

Slimline XR modules

The Slimline XR switch disconnecter 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.

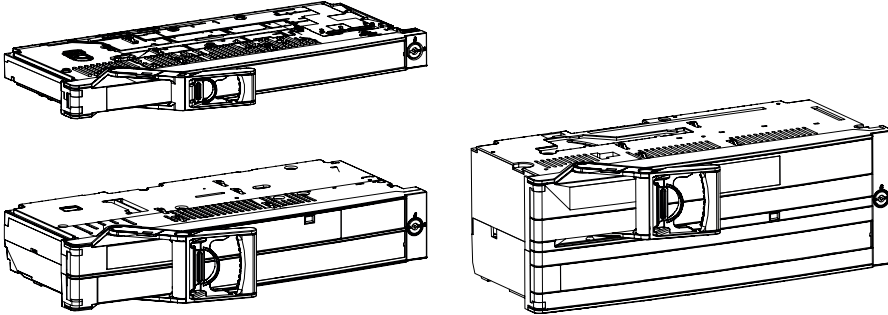


Figure 2-59 SlimLine XR Seiries



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

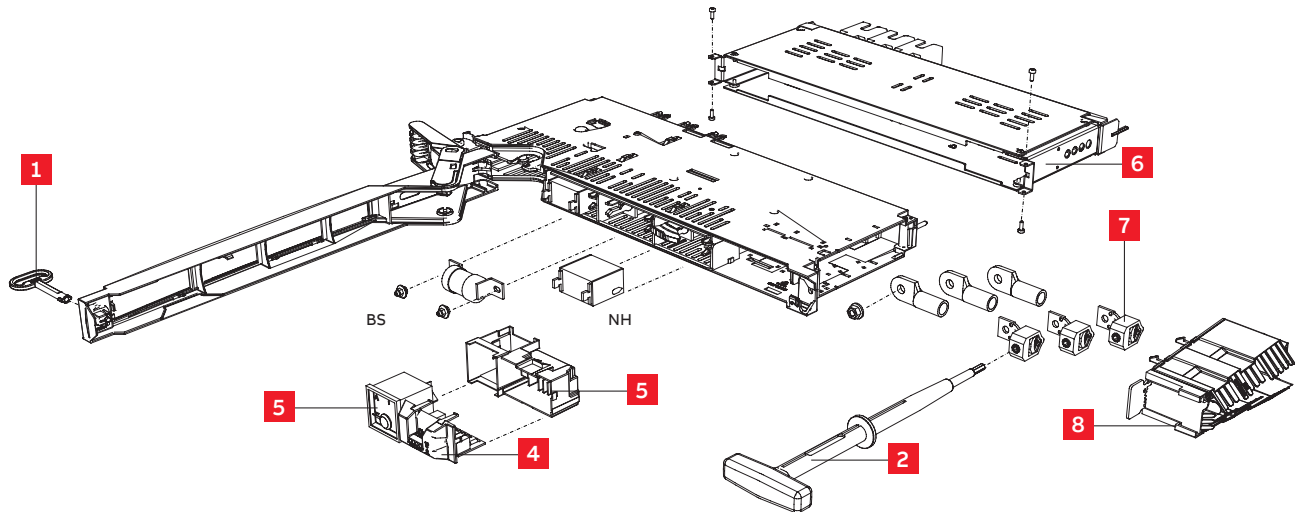


Figure 2-60 Exploded view and optinal accessories of XR00

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

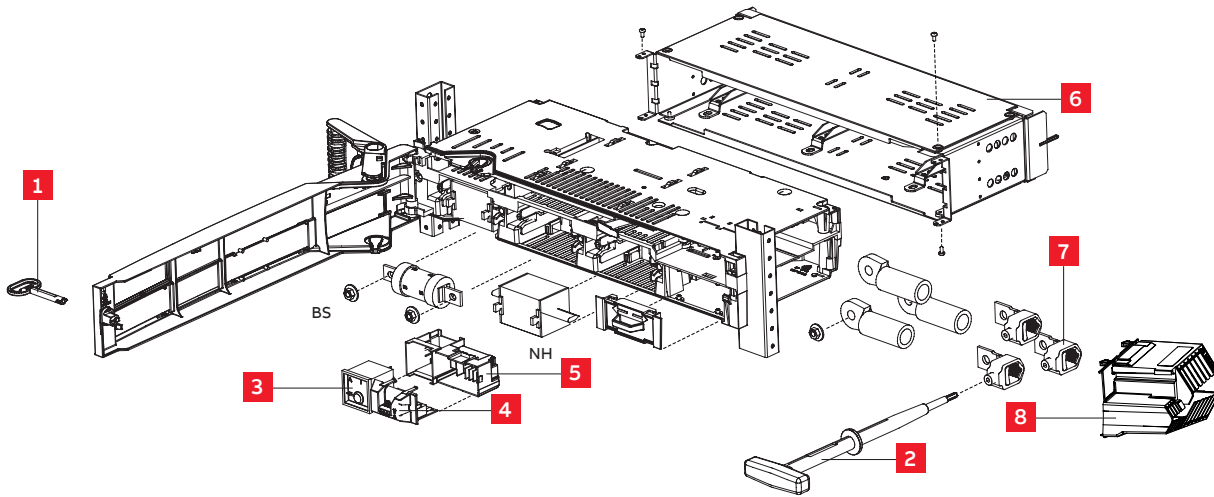


Figure 2-61 Exploded view and optional accessories of XR1

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

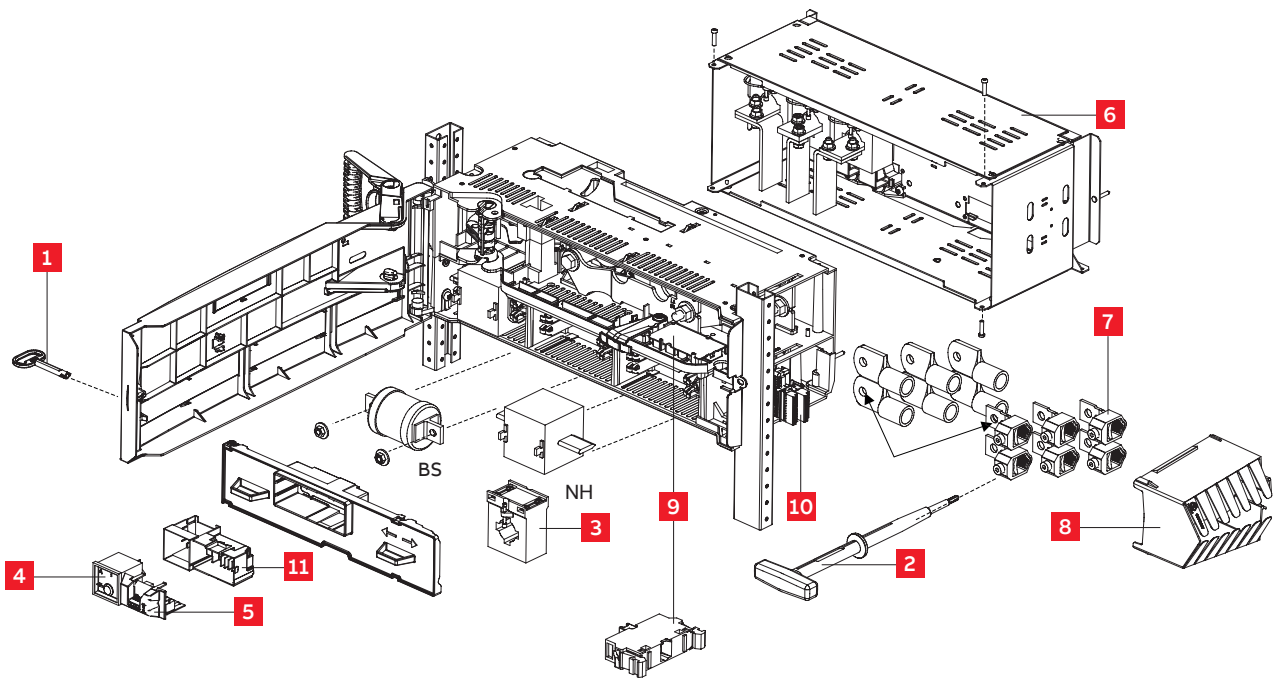


Figure 2-62 Exploded view and optional accessories of XR2-3

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	Ammeter bracket
6	Contact extension		

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.

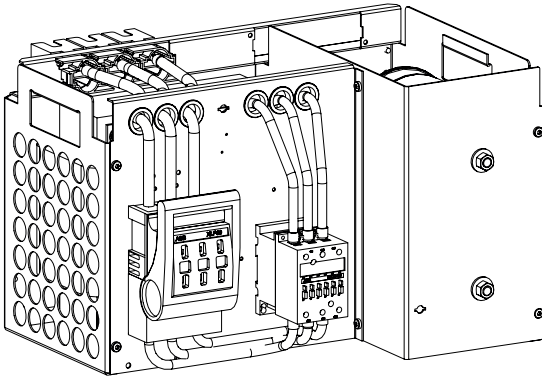


Figure 2-63 Reactive power compensation module (RPC module)

2.9.5 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

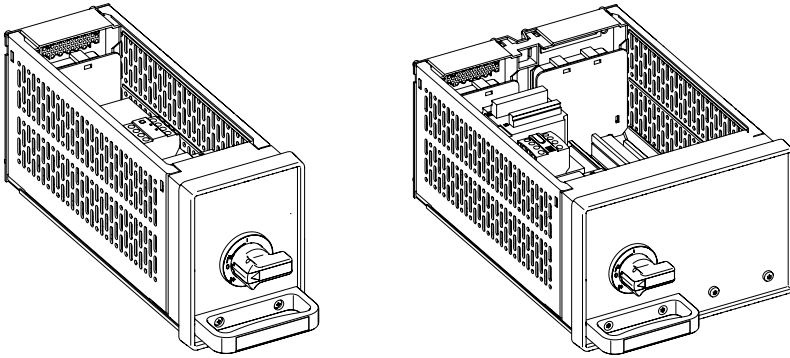


Figure 2-64 Examples of 8E/4 and 8E/2 modules

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

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

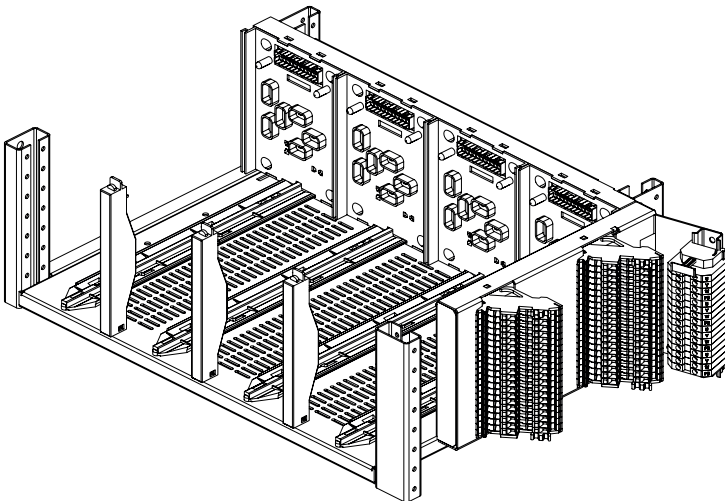


Figure 2-65 Withdrawable module compartment for 4 units size 8E/4

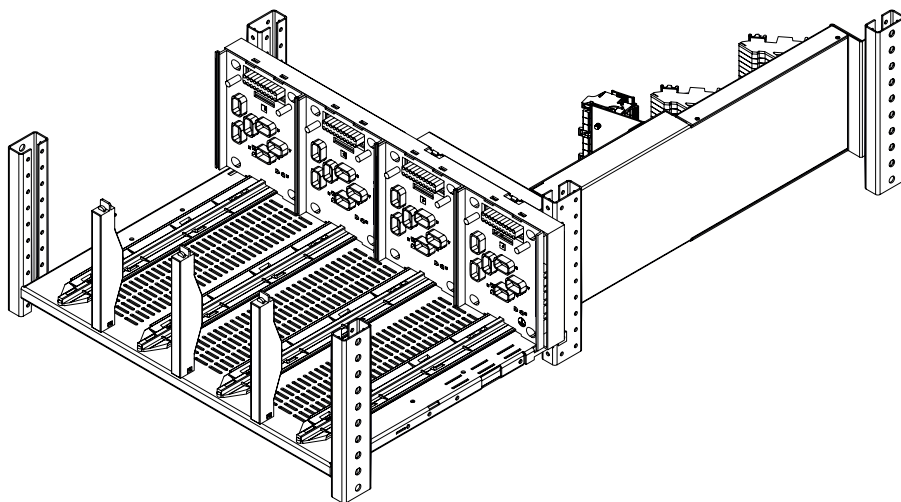


Figure 2-66 MNS Rear withdrawable module compartment for 4 units size 8E/4

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 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.

2.9.6 Withdrawable modules

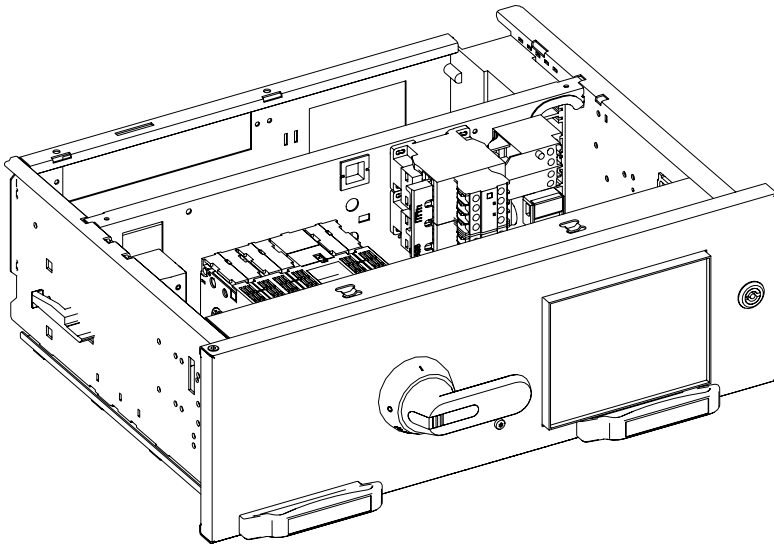


Figure 2-67 Examples of full withdrawable modules

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 10, 16, 20, 24 or 48 pole
 - for 8E to 24E size 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.

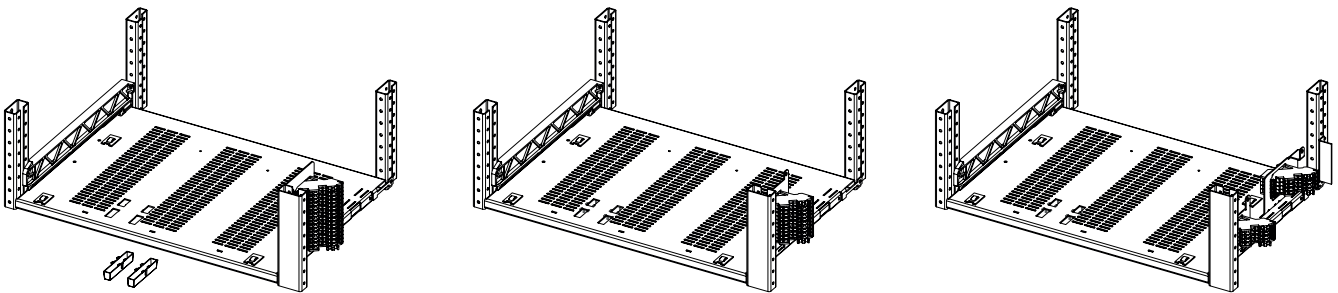


Figure 2-68 Withdrawable module compartment for units size 4E ... 24E

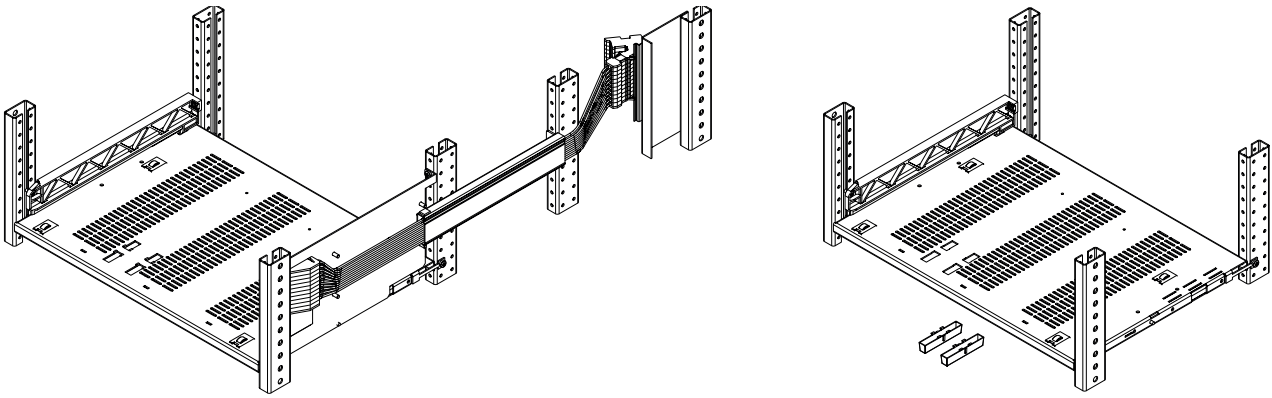


Figure 2-69 MNS Rear withdrawable module compartment for unit size 4E...24E (left), with control plug system (right)

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03



Packing, storage and transportation

3.1	General	50
3.1.1	Container shipment	53
3.2	Recommended packing methods	53
3.2.1	The packing for normal road transport	53
3.2.2	The seaworthy packing	54
3.2.3	Horizontal transportation	60
3.2.4	Packaging of switchgear components	61
3.3	Handling of switchgear components	61
3.3.1	Circuit breaker	61
3.3.2	Withdrawable modules	61
3.4	Unloading and transport at site	62
3.4.1	Ground transport	62
3.4.2	Transport by crane	63
3.4.3	Transport by truck	65
3.5	Intermediate storage	66
3.5.1	Storage of spare modules	66
3.6	Environmental conditions of transport, storage and installation	67

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 3100 x 1300 x 2300
- Packed in crate 3300 x 1500 x 2590 (see also “3.1.1 Container shipment”)

In all cases the ACB must be transported separately from the section. It is not allowed to transport it within the section. The ACB requires special attention during transport and handling. Please refer to original manuals 1SDH000999R0002 and 1SDH001000R0002, Chapter 2: Transport and checking on receipt.

Note: Shipping dimensions and weights here are approximate. These are meant to be used as a guide only. Please refer to project specific documentation.



Remove all ACBs from sections and transport them separately!

Module type	Protection circuit	Type	Module size
Withdrawable modules	Fuse	TOL / EOL	8E4 upto 24E
		UMC100	
	Circuit breaker	M10x	
		TOL / EOL	
	Energy distribution	UMC100	
		M10x	
Plugin modules	Fuse	SFU	6E upto 24E
		Contactor feeder	
	Circuit breaker	MMS / MCCB	
		Contactor feeder	
	Energy distribution	SFU	
		Contactor feeder	
Circuit breaker	SlimLine		
	MMS / MCCB		
		Contactor feeder	

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 (incoming 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 depth 600 mm
- Section weights for main busbar compartment depth 800 mm
- Section weights are defined with 4 measuring CTs + 3 protective CTs per section. If the CT quantity is fewer, the overall weight might be lower
- Section weights for incomer / feeder are defined with IO set for busduct from top. For IO set with cable, the overall weight might be lower
- Section weights do not contain internal devices (except CTs) and wiring
- Section weights do not contain side walls and main busbar end covers

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 of main busbar compartment depth 600mm [kg]	Section with ACB fixed part of main busbar compartment depth 800mm [kg]
Incomer / feeder, 3 pole	E1.2 – up to 1600 A	400	–	310	330
Incomer / feeder, 3 pole	E1.2 – up to 1600 A	600	–	345	385
Incomer / feeder, 3 pole	E2.2 – up to 2000 A	400	–	330	360
Incomer / feeder, 3 pole	E2.2 – up to 2500 A	600	–	435	475
Incomer / feeder, 3 pole	E4.2 – up to 3200 A	600	–	510	555
Incomer / feeder, 3 pole	E4.2 – up to 4000 A	800	–	–	800
Incomer / feeder, 3 pole	E6.2 – up to 5000 A	1000	–	–	1025
Coupler, 3 pole	E1.2 – up to 1600 A	600	–	350	–
Coupler, 3 pole	E2.2 – up to 2500 A	600	–	450	–
Coupler, 3 pole	E4.2 – up to 3200 A	800	–	590	630
Coupler, 3 pole	E4.2 – up to 4000 A	1000	–	–	960
Coupler, 3 pole	E6.2 – up to 5000 A	1200	–	–	1200
Incomer / feeder, 4 pole	E1.2 – up to 1600 A	600	–	395	465
Incomer / feeder, 4 pole	E2.2 – up to 2500 A	600	–	500	610
Incomer / feeder, 4 pole	E4.2 – up to 3200 A	800	–	630	685

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 of main busbar compartment depth 600mm [kg]	Section with ACB fixed part of main busbar compartment depth 800mm [kg]
Incomer / feeder, 4 pole	E4.2 – up to 4000 A	1000	–	–	1035
Incomer / feeder, 4 pole	E6.2 – up to 5000 A	1200	–	–	1245
Coupler, 4 pole	E1.2 – up to 1600 A	600	–	400	–
Coupler, 4 pole	E2.2 – up to 2500 A	600	–	525	–
Coupler, 4 pole	E4.2 – up to 3200 A	800	–	680	750
Coupler, 4 pole	E4.2 – up to 4000 A	1000	–	–	1180
Coupler, 4 pole	E6.2 – up to 5000 A	1200	–	–	1460
Empty module section, 3 pole	–	600	–	305	315
Empty module section, 4 pole	–	600	–	330	350

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
Plugin modules	24E	65
	6E	8
	8E	15
	12E	16
	16E	31
	24E	36

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.

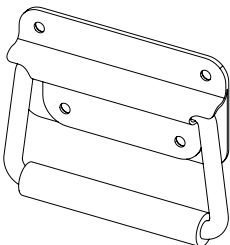


Figure 3-01 Module side handle

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.

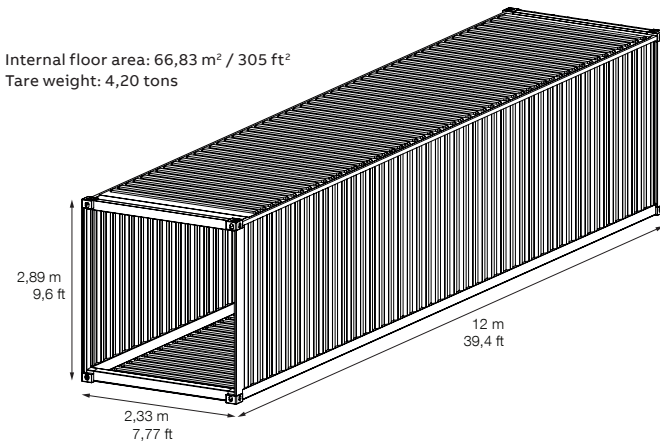


Figure 3-02 Inner dimensions of 40' high cube container

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.

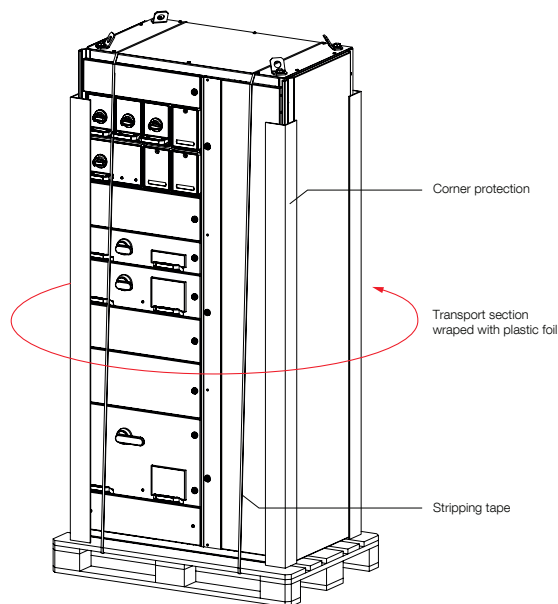


Figure 3-03 Packing for normal road transport

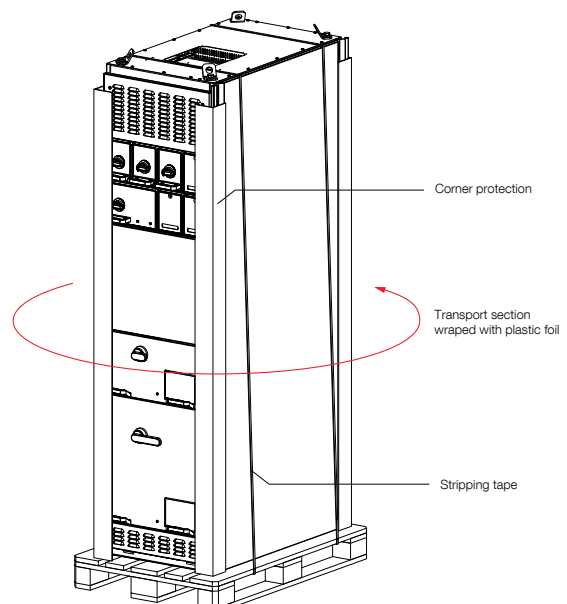


Figure 3-04 Packing for MNS Rear switchgear

Standardized pallets are suitable for handling by forklift 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 3400 mm – 5 × wooden beams

2. Side walls

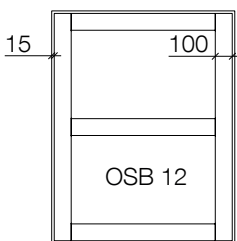
- Support beams 23 × 100 mm
- Side wall panels OSB 3 (thickness 12 mm)

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



Inside dimensions:
 A – Length
 B – Width
 C – Height

Number of beams:
 A < 800 mm – 2 × Beam
 A < 1700 mm – 3 × Beam
 A < 2500 mm – 4 × Beam
 A < 3400 mm – 5 × Beam

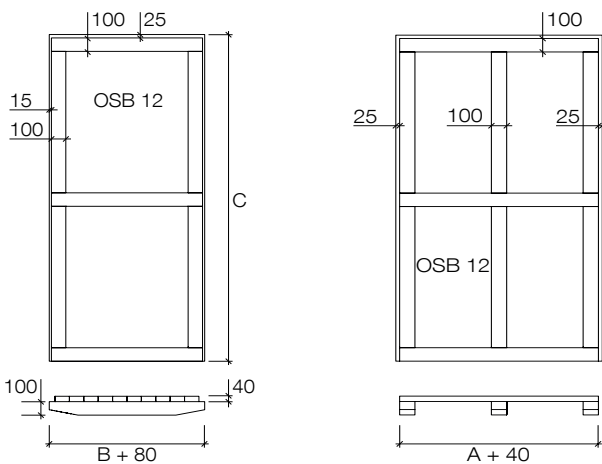


Figure 3-05 Wooden parts dimensions

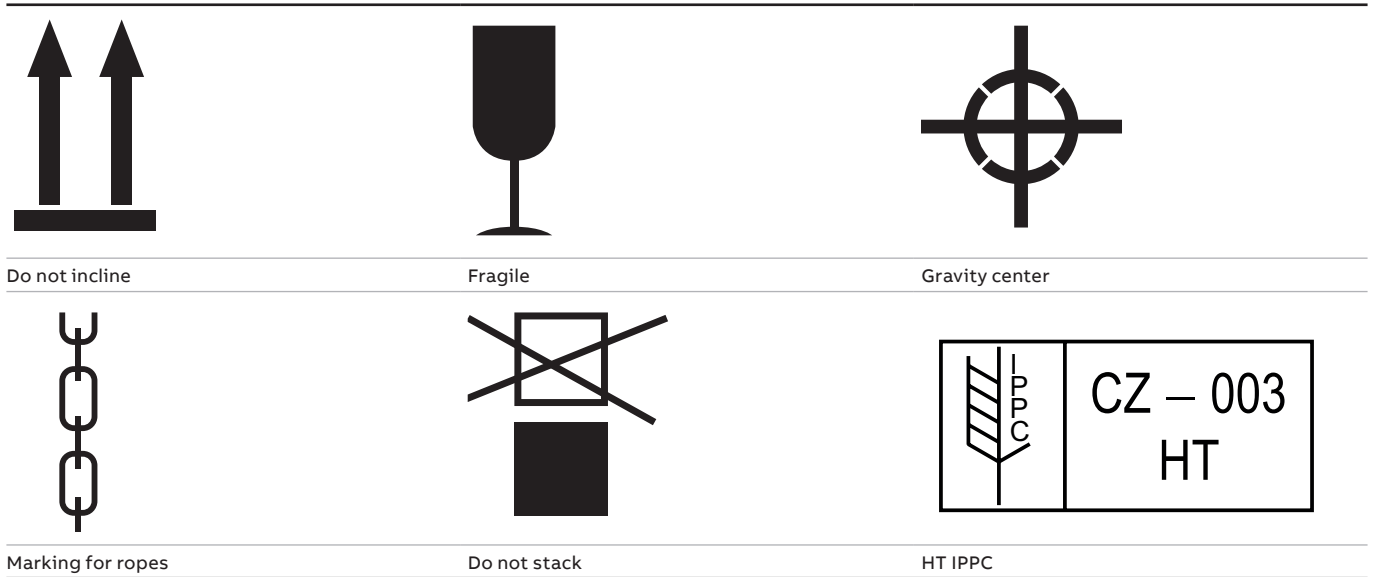
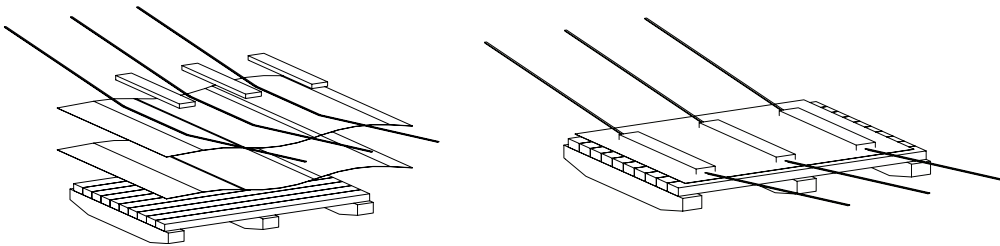


Figure 3-06 Transport marking

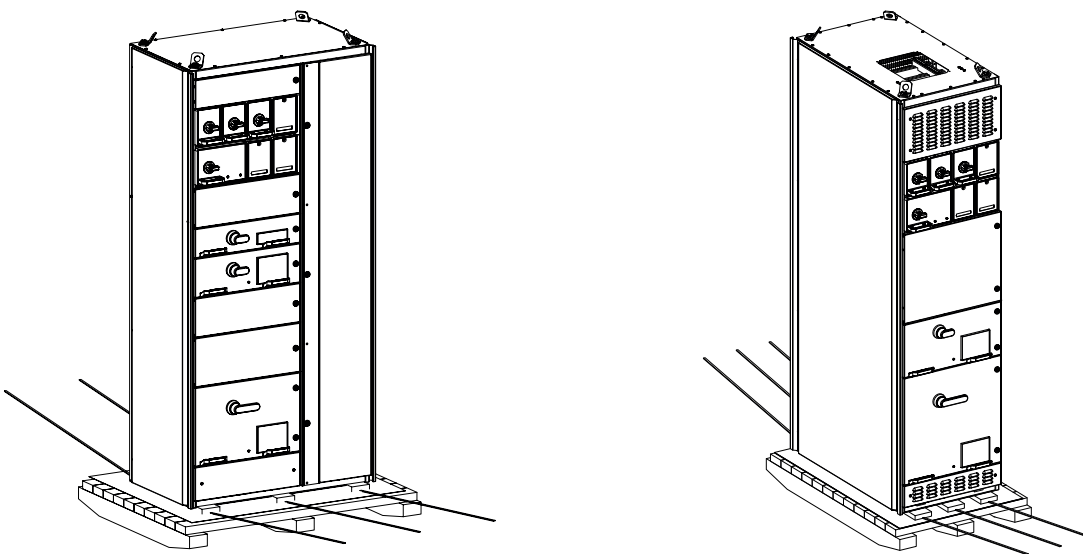


All sawn wood shall be thermal treated according ISPM 15 standard.

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.

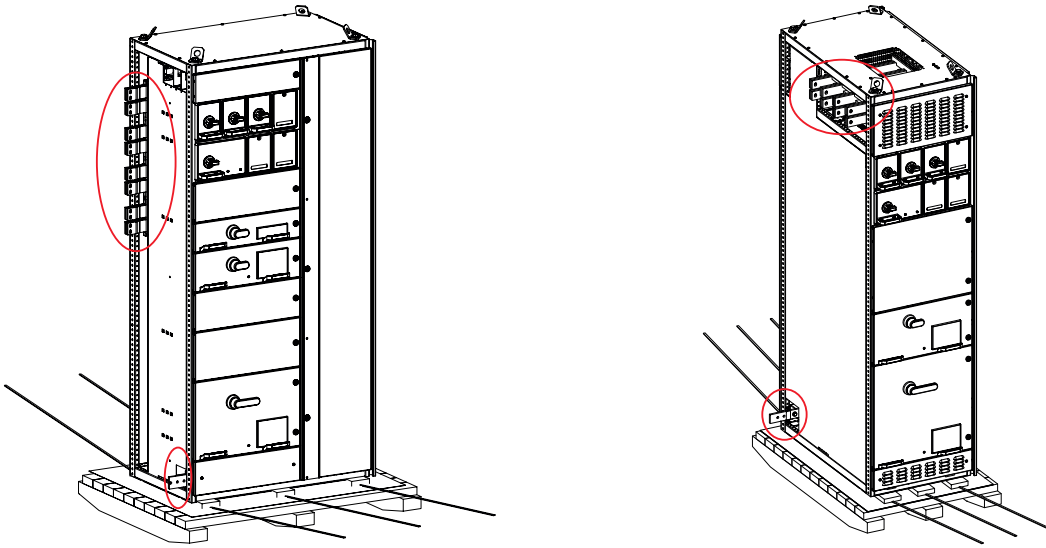
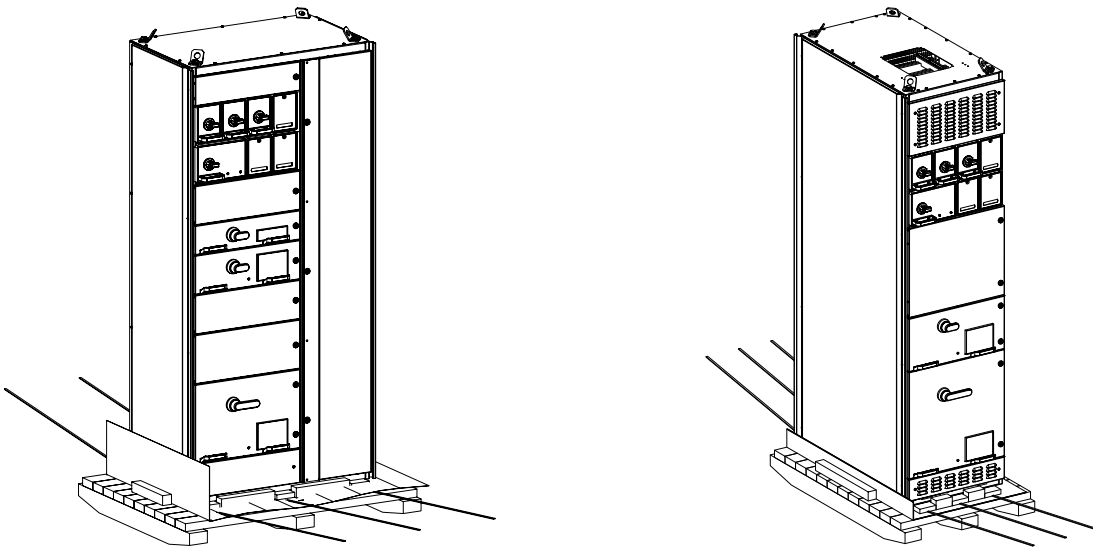


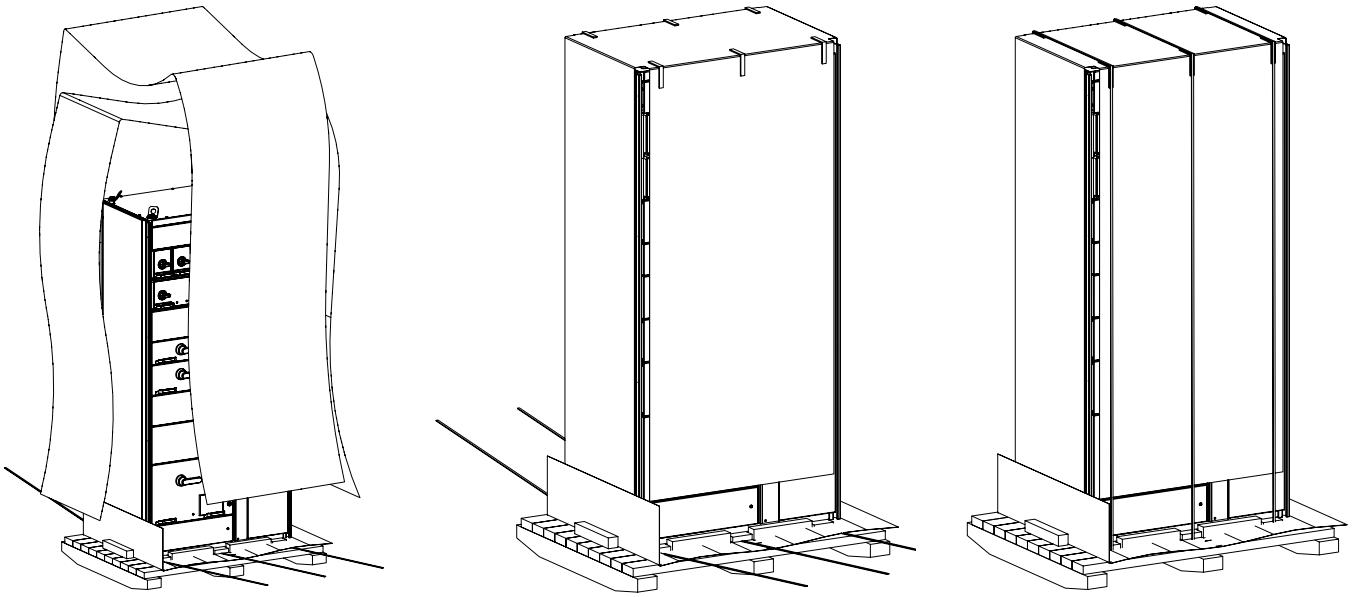
Figure 3-07 Seaworthy packing procedure, steps 1, 2 & 3 (left), for MNS Rear switchgear (right)

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.

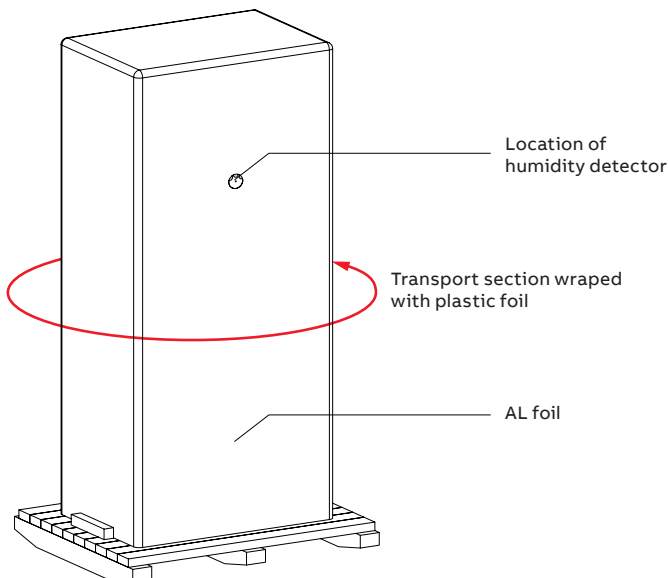
5. Miralon 2 mm is placed all over the shipping section and is stripped by tape. The tape is supported by plastic edge protection.



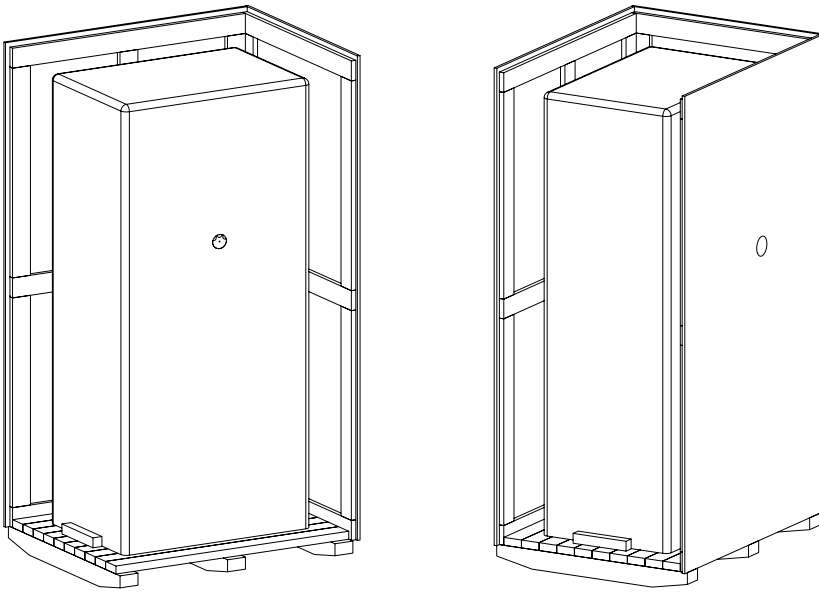
A drying agent is required for seaworthy packing. A single packet 32 DIN is required per 3 m² box.

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.

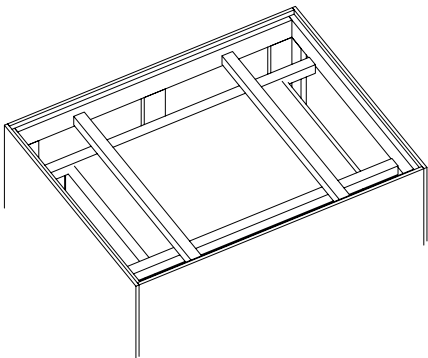
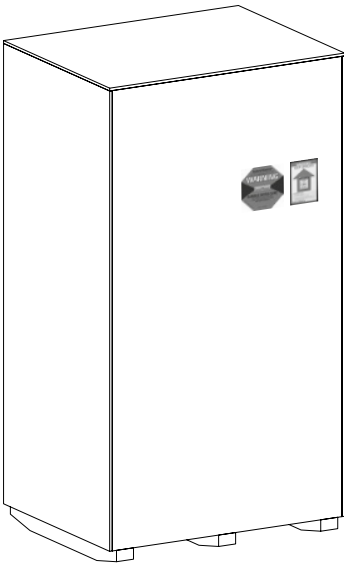


Figure 3-09 Seaworthy packing procedure, steps 6, 7 & 8

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

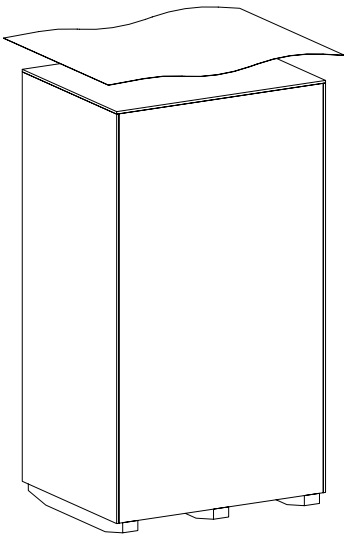


Figure 3-10 Seaworthy packing procedure, steps 9 & 10

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 be 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.

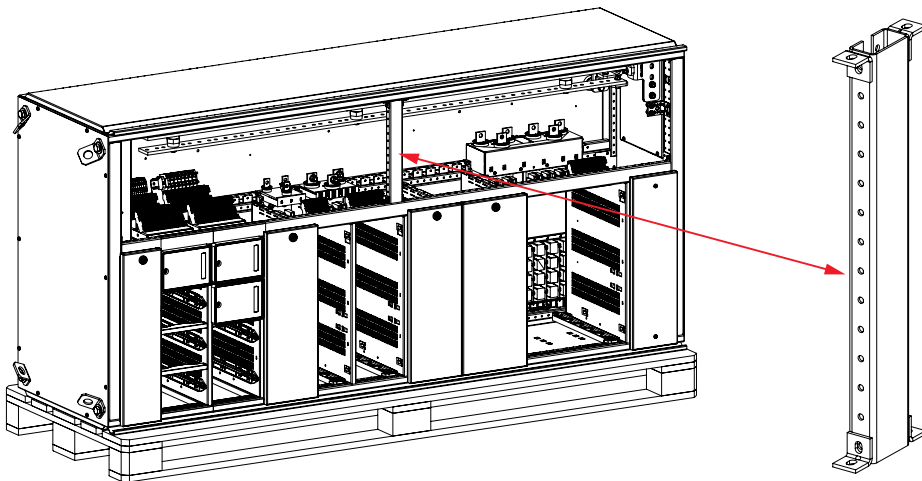


Figure 3-11 Reinforcement for horizontal transport

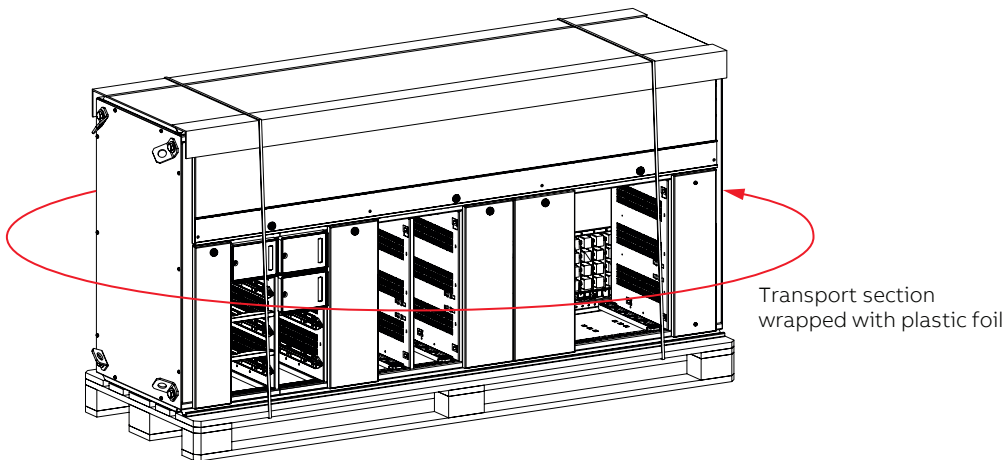


Figure 3-12 Example of horizontal transport



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 chapter 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.

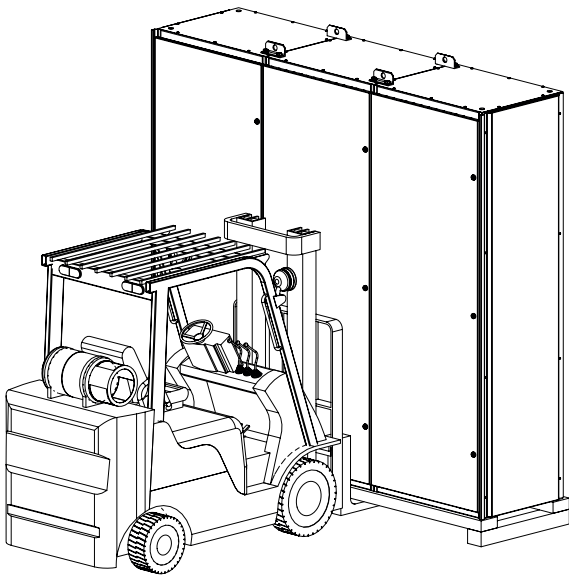


Figure 3-13 Fork-lift transport

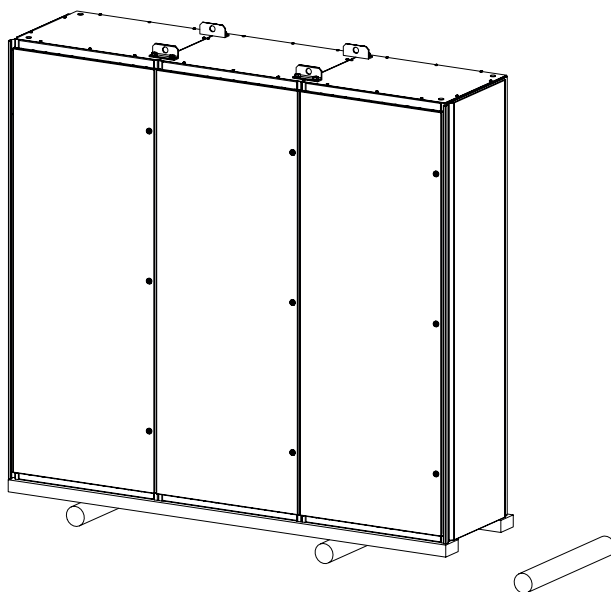


Figure 3-14 Roller transport (only for weight of transport units up to 1200 kg)



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).

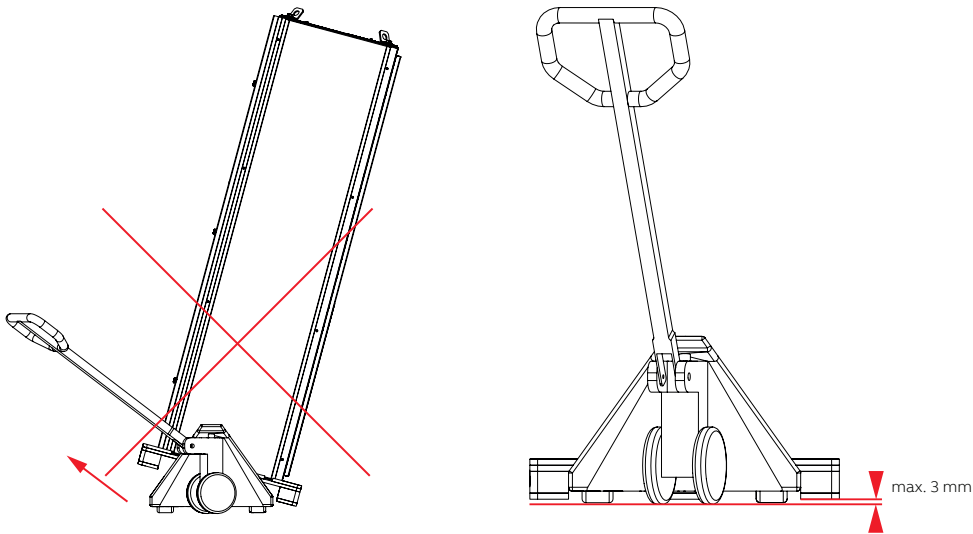


Figure 3-15 Transport with a hand-pulled truck



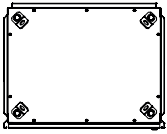
When using motor operated lifting truck or hand-pulled truck always check the position of gravity center mark. Note, marking of transport section with gravity center is always required for seaworthy transport, otherwise the marking is optional.

3.4.2 Transport by crane

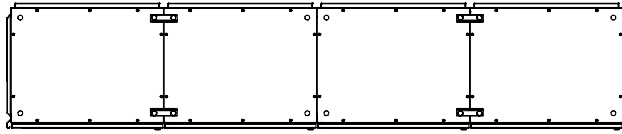
- For the transport by crane the shipping units are equipped with lifting angles (see Figure 3-15).
- Fastening of any lifting device directly to the frame sections is not permitted.
- The lifting rope angle at the crane hook must not be larger than 120° (see Figure 3-16).
- The lifting angles may be removed after the switchgear has been erected.
- The fastening holes for the lifting angles are to be plugged with plugs if removing the lifting angles. (see "4.13 Fastening of shipping sections")

Rope diameter [mm]	Permissible load for a four-rope arrangement, rope angle at crane hook 120		
	Hamp rope acc. DIN 83325	Perlon ropes acc. DIN 83330	Steel ropes acc. DIN 15060 (160 kg / mm ²)
	[kg]	[kg]	[kg]
8	–	x	890
10	180	400	1440
12	280	600	2100
14	350	820	2900
16	470	1060	–
18	580	1340	–
20	720	1660	–
24	1000	2400	–
30	1600	–	–
36	2400	–	–

Table 3-05: Guide values for permissible rope loading



1600 kg at a rope angle of 120° max.



2400 kg at a rope angle of 120° max.

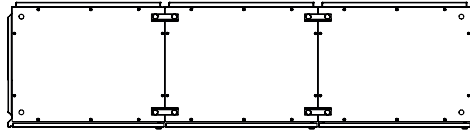
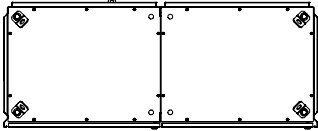
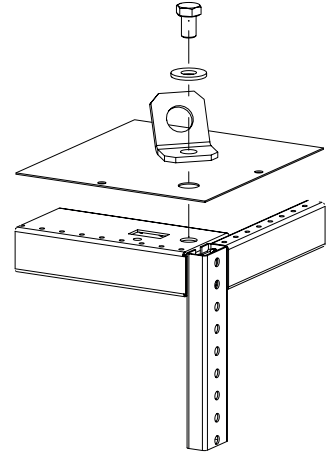


Figure 3-16 Arrangement of lifting angles (plan view of MNS section), detail values see Table 3-04

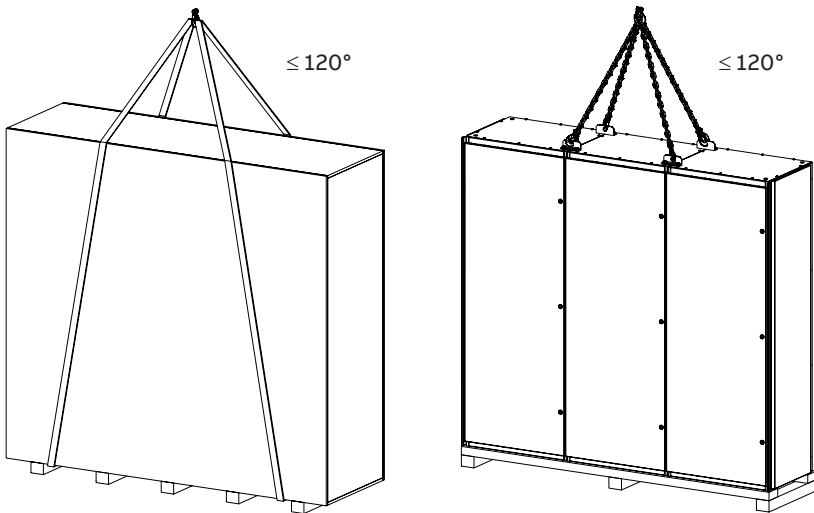


Figure 3-17 Crane transport packed sections (left side picture), crane transport unpacked sections (right side picture)

For a rope angle of 90° the permissible load is approximately 40 % larger than the values given in the table.

The arrangements of the lifting angles are shown in Figure 3-15.

Shipping units with one or two cubicles are equipped with single angles.

Shipping units consisting of three or four sections are equipped with dual angles.



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 3-18).

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 switch-board.

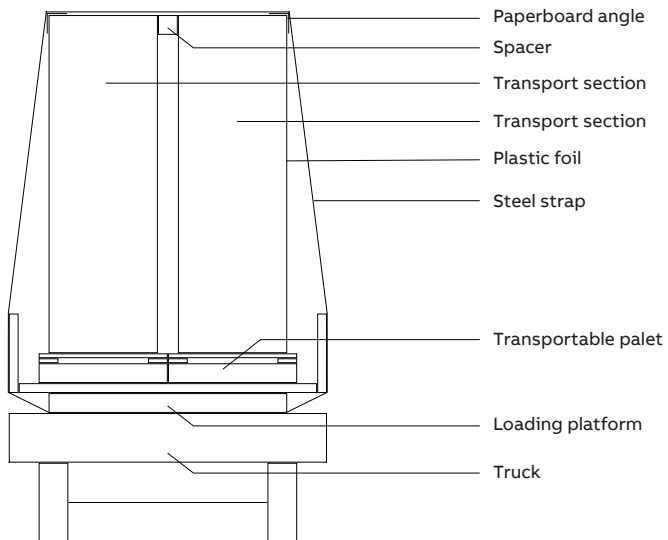


Figure 3-18 Transport by truck

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 $\geq 16\text{E}$ one on top of the other.

3.6 Environmental 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 its 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

4.1	Warranty aspects	70
4.2	Delivery checks	70
4.3	Switchgear room and placement requirements	70
4.4	Escape routes	74
4.5	Front access section foot print	77
4.5.1	MNS Rear access section foot print	78
4.6	Section hight	79
4.7	Section lenght	79
4.8	Floor cut-outs	80
4.8.1	Front access floor cut outs	80
4.8.2	Rear access floor cut outs	81
4.9	Preparation for installation	81
4.10	Work flow	83
4.11	Transportation of vertical sections	83
4.12	Alignment of sections to floor	83
4.13	Fastening of shipping sections	83
4.14	Front access busbar connection between sections	84
4.14.1	Busbar connection options	85
4.14.2	Rear access busbar connection between sections	86
4.14.3	Example of front access ACB incoming connections	87
4.14.4	Example of rear access ACB incoming connections	89
4.14.5	Screw connections with threadlocking WSH-ESLOK	90
4.14.6	Screw connections with threadlocking LOCTITE 263	90
4.14.7	Insulated busbar installation	91
4.15	Special considerations when working on electrical equipment	91
4.15.1	Direct fixing of the switchgear to false floor	92
4.15.2	Direct fixing of the switchgear to UPN channel	93
4.15.3	Direct fixing of the switchgear to concrete floor	93
4.15.4	Direct fixing of the switchgear to HALFEN/UNISTRUT channels	94
4.16	Securing the section to the floor in special environment conditions	96
4.16.1	Degree of protection	97
4.16.2	Field cable or busduct installation – incoming/outgoing full size sections front access construction	103
4.16.3	Power and control cable installation	108
4.16.4	Power cable installation – SlimLine modules	111
4.16.5	Field cable or busduct installation – protective conductor connections	112
4.16.6	Power cable installation – neutral conductor connections	112
4.16.7	Installation of equipment – functional units	115
4.16.8	ACB lifting crane feature	115
4.16.9	Surge Protection Device (SPD) Compartment and check of SPD function	116

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 contaminants.
- 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.

Internal 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!

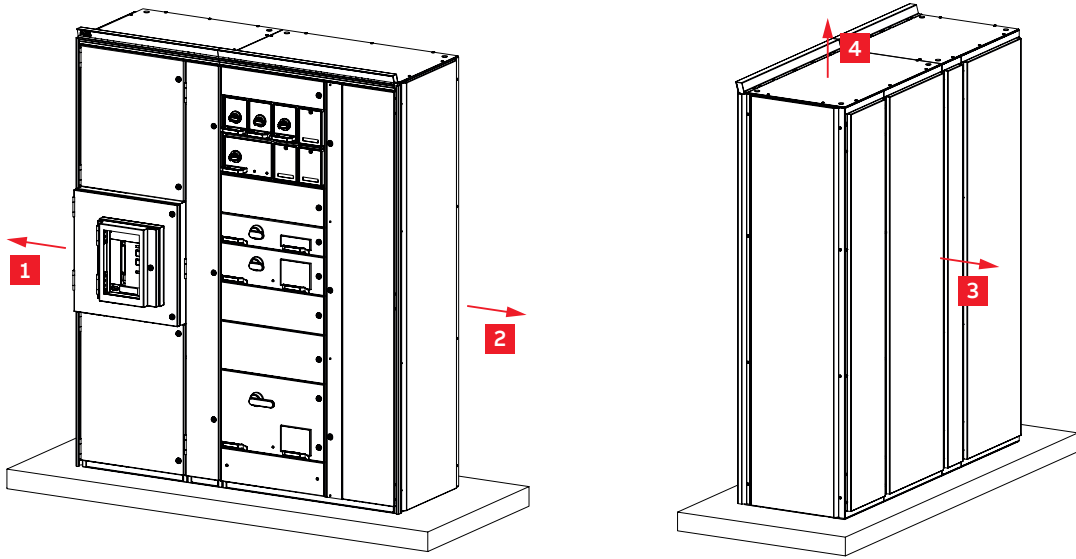


Figure 4-02 Section minimum clearances

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.

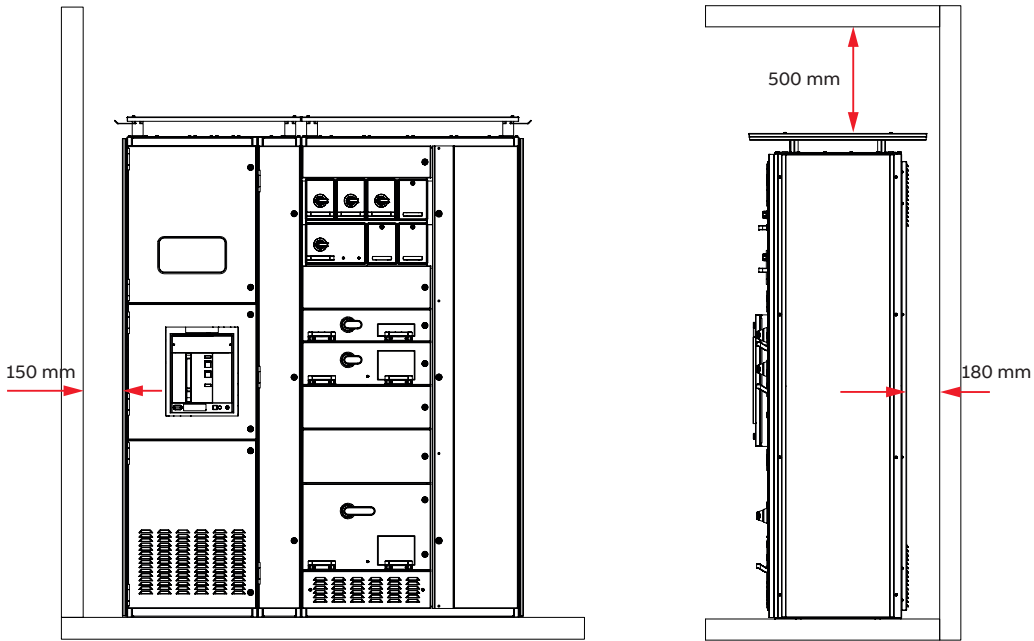


Figure 4-03 Section minimum clearances for raised roof plate IPx1/IPx2 with left mounted doors

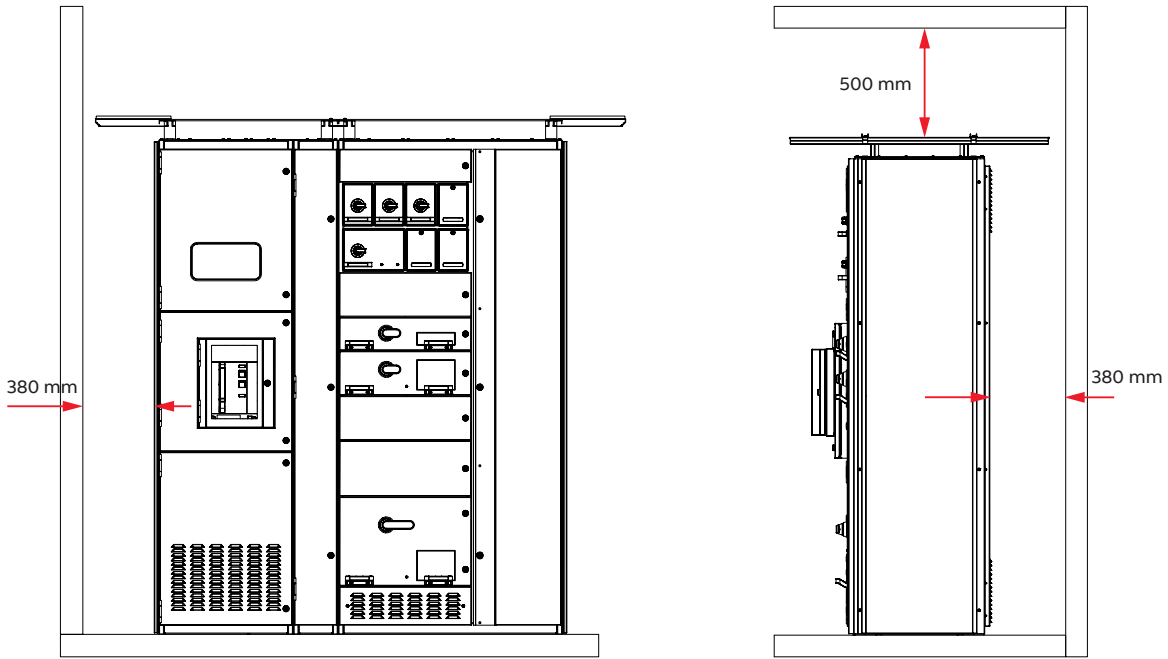


Figure 4-04 Section minimum clearances for raised roof plate IP43 with left mounted doors

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

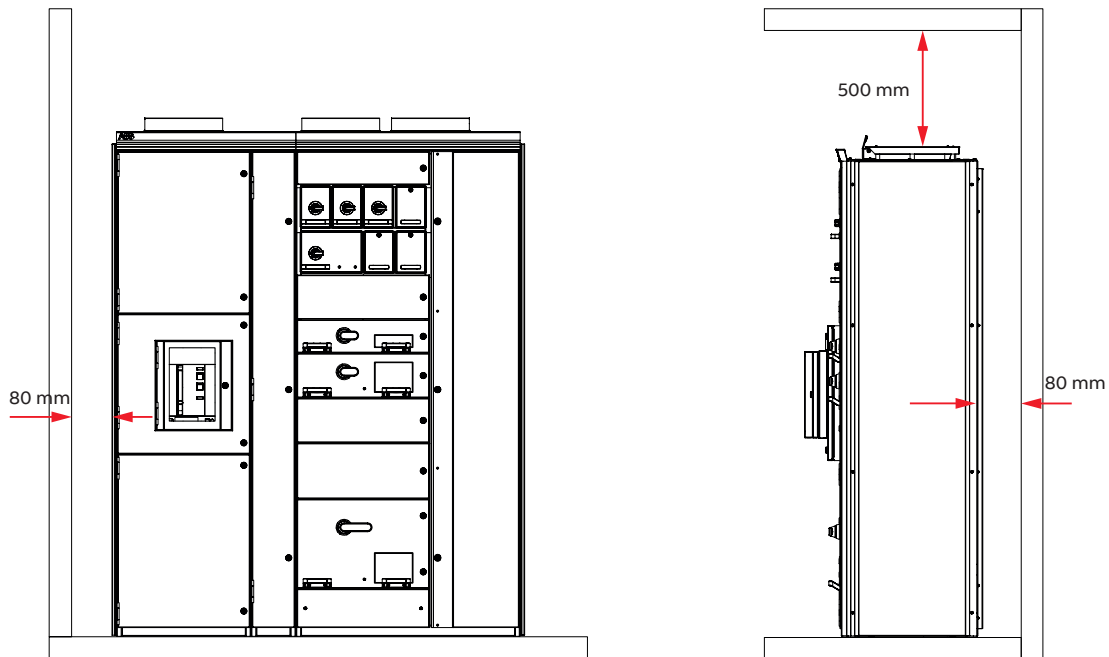


Figure 4-05 Section minimum clearances for pressure relief roof (flap roof) with right mounted doors

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).

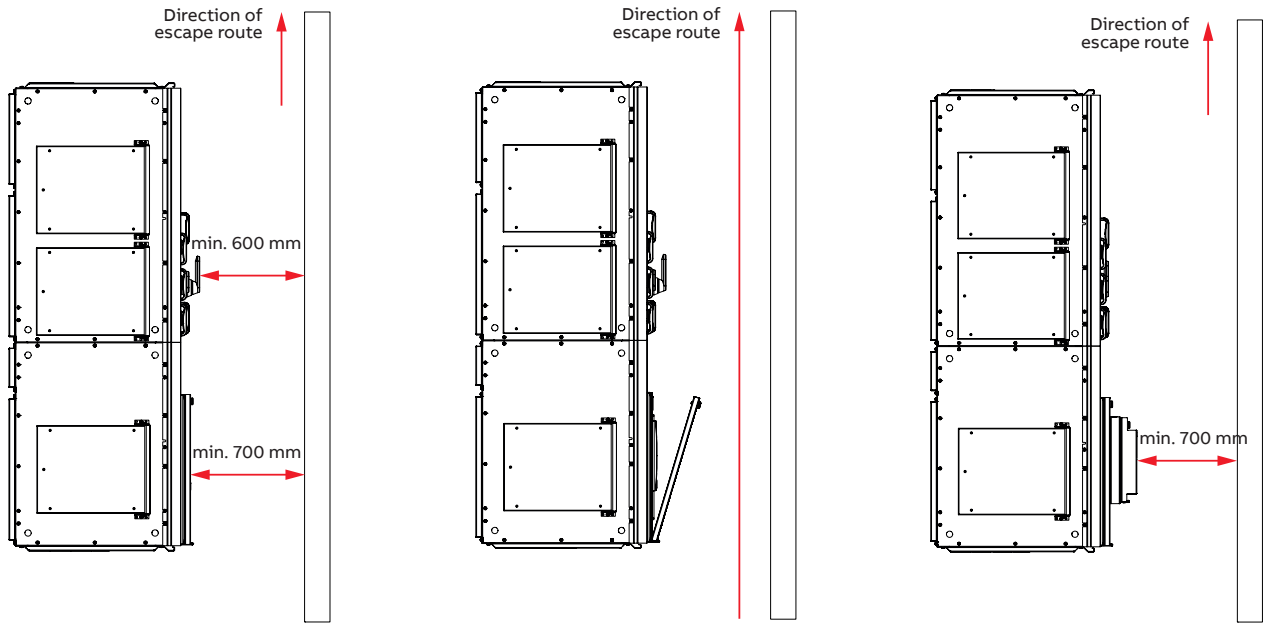


Figure 4-06 Front access section minimum clearances for escape routes

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.

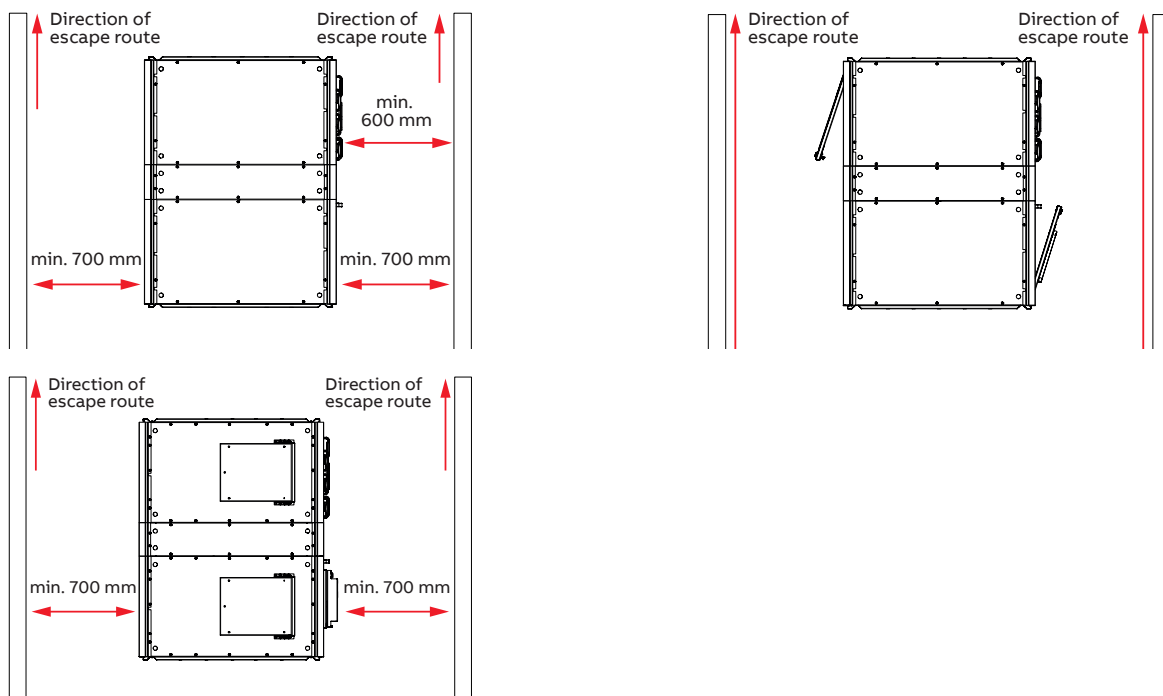
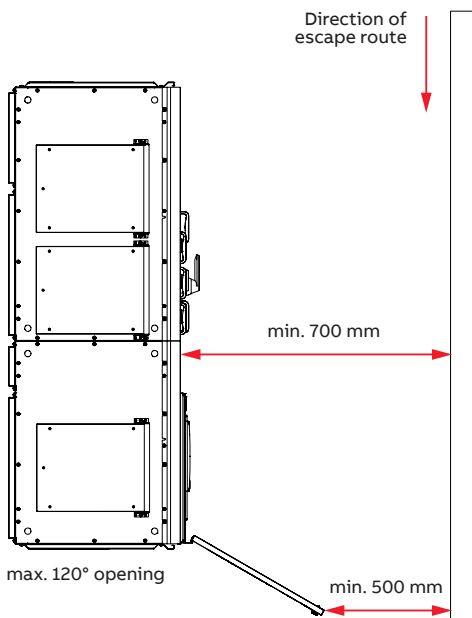
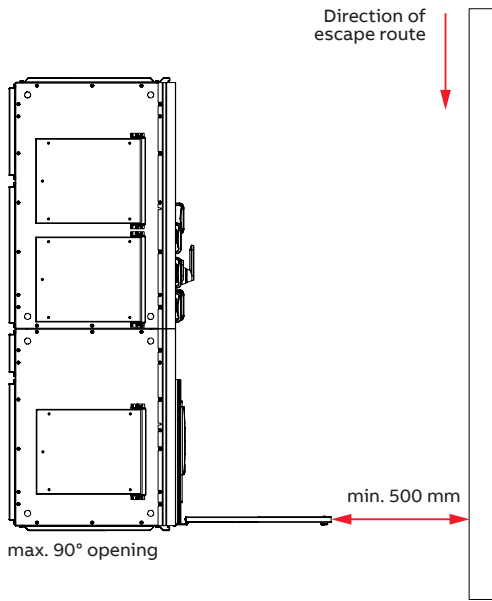
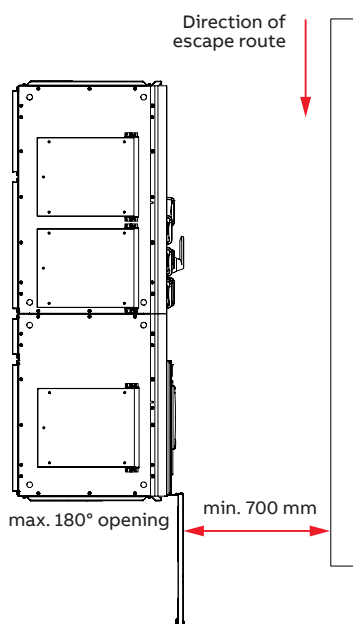


Figure 4-07 MNS Rear access section minimum clearances for escape routes

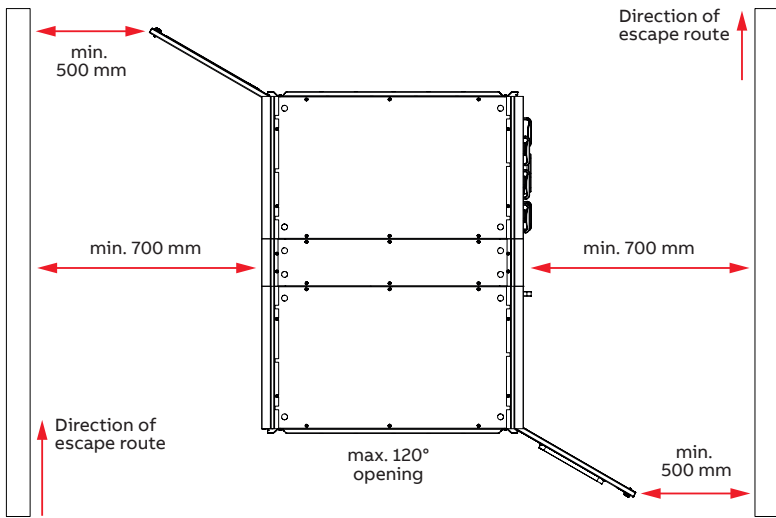
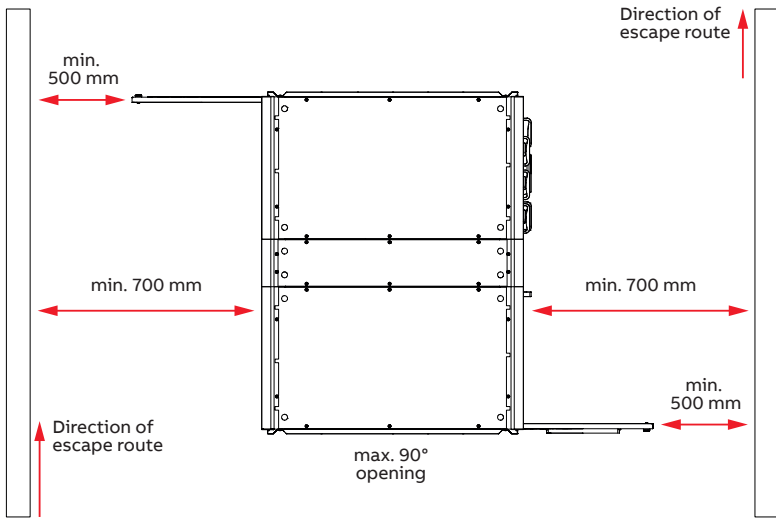


In case of 120° degree opening, don't forget to adhere the minimum operating aisle especially when sections with narrow width are installed (e.g. 400 mm).

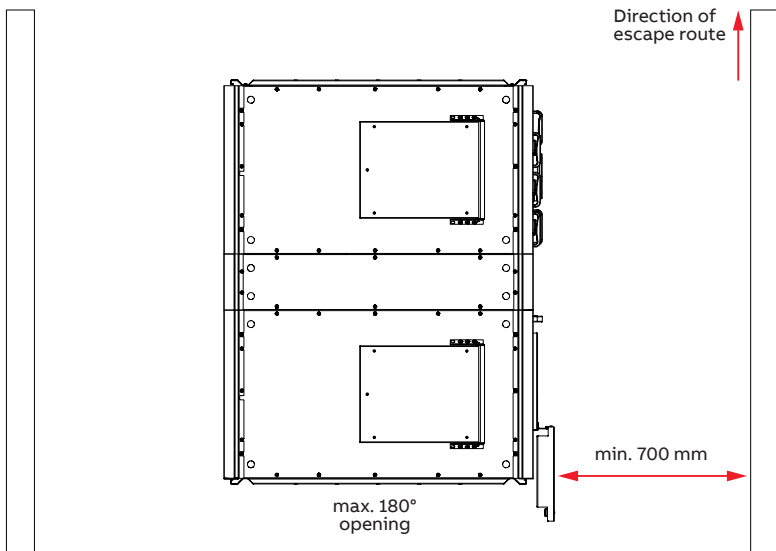


In case of 180° degree opening, the escape aisle is equal to minimum operating aisle width.

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 operating aisle especially when sections with 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 4-09 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.

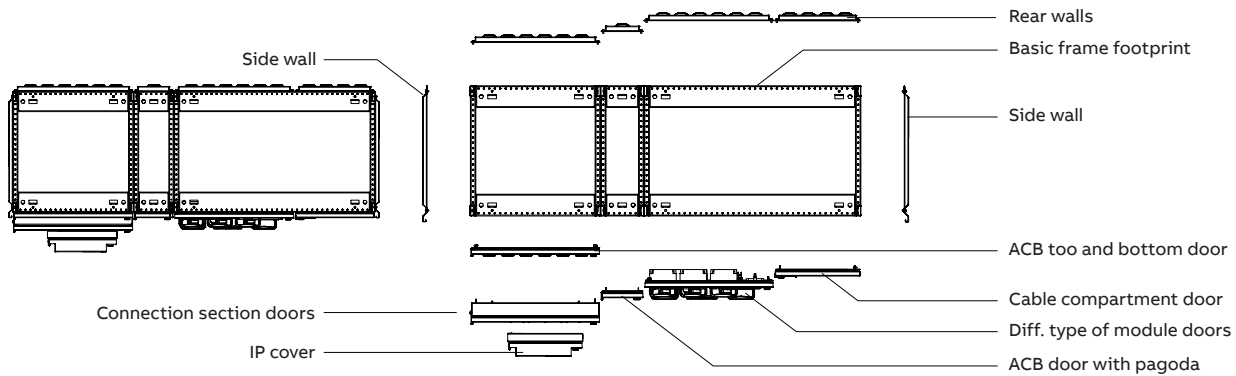


Figure 4-10 Example of section foot print extension parts

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
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 ($\geq 4E$)	27 mm
	Module door with handle ($\geq 4E$)	85 mm
	Module cover 7E	27 mm
	Module cover 7E with ventilation louvers	28 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

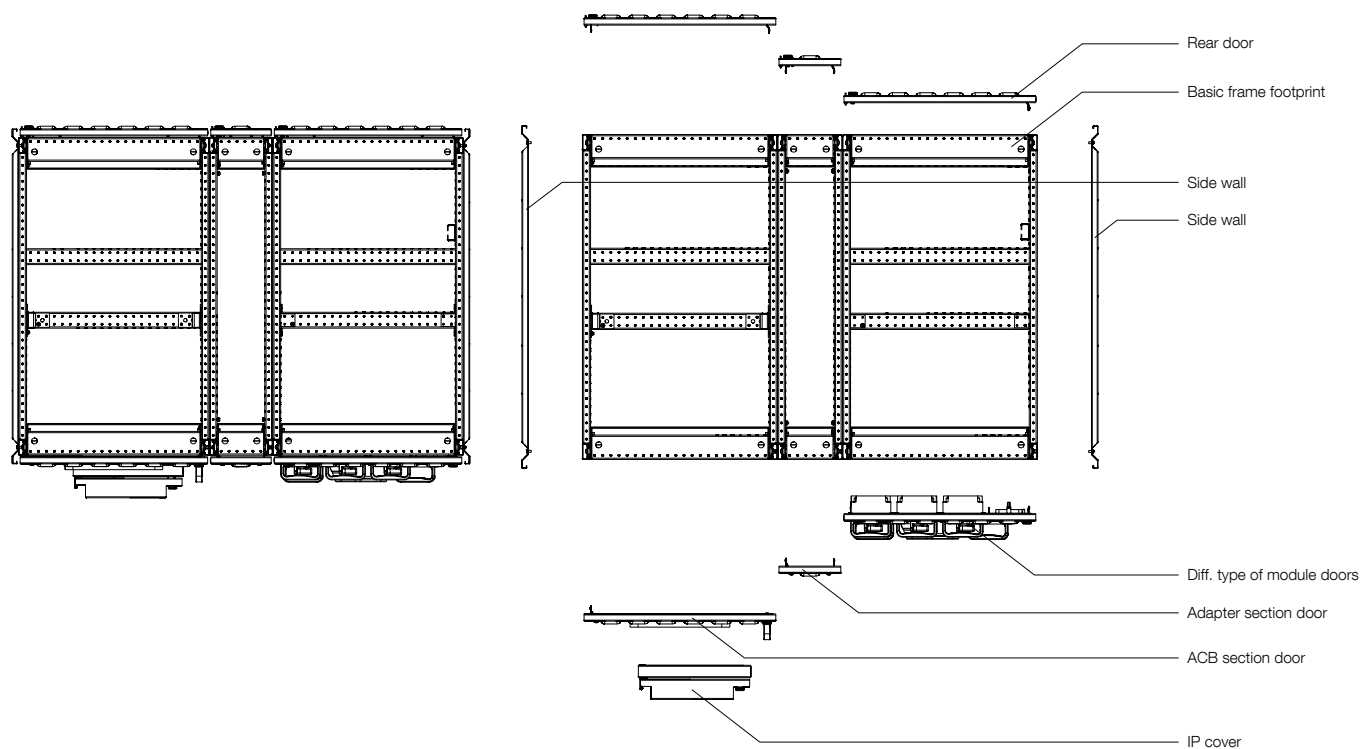


Figure 4-11 Example of section foot print extension parts

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 without ventilation	27 mm
	Front cover 12E with ventilation louvers	30 mm
	Front cover 12E with punched louvers	36 mm
ACB section door	Top door 25E without instrument panel	27 mm
	Top door 25E with instrument panel	45,5 mm
	Middle door 23E	27 mm
	Middle door 23E with handle	84 mm
	Middle door 23E with IP cover	135 mm
	Bottom door 29E without ventilation	27 mm
	Bottom door 29E with ventilation louvers	30 mm
Module section door	Bottom door 29E with punched louvers	36 mm
	Small module cover (8E/4, 8E/2)	23 mm
	Small module cover with handle (8E/4, 8E/2)	75 mm
	Module door empty ($\geq 4E$)	27 mm
	Module door with handle ($\geq 4E$)	85 mm
	Front cover 5E without ventilation	27 mm
Module section door	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.

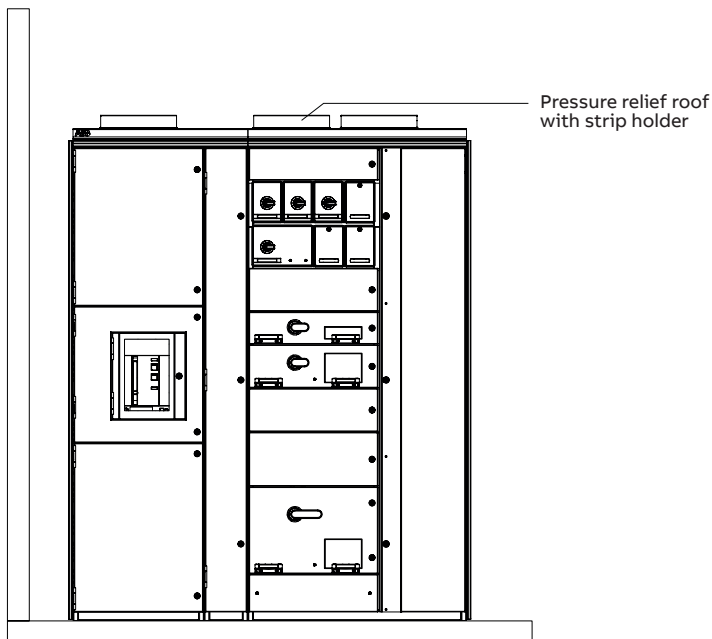


Figure 4-12 Example of section hight extension parts

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:
- $20\text{ mm} + 1\text{ mm} + 400\text{ mm} + 1\text{ mm} + 400\text{ mm} + 1\text{ mm} + 400\text{ mm} + 1\text{ mm} + 20\text{ mm} = 1244\text{ mm}$.



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.

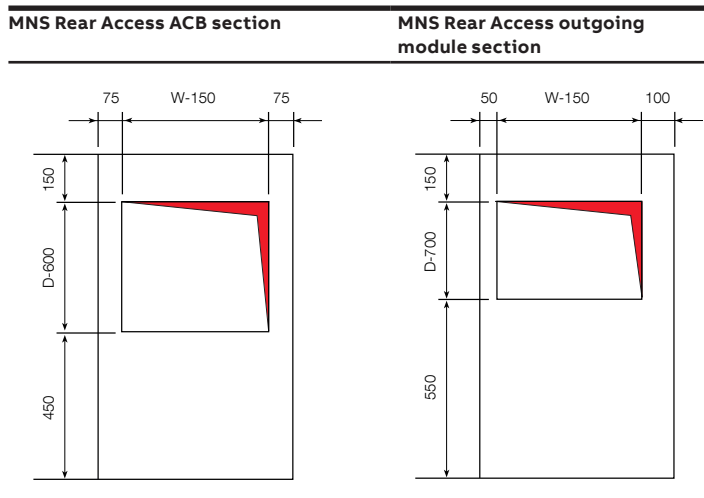


Figure 4-13 Floor cutouts for MNS Rear sections
All dimensions are in mm

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.

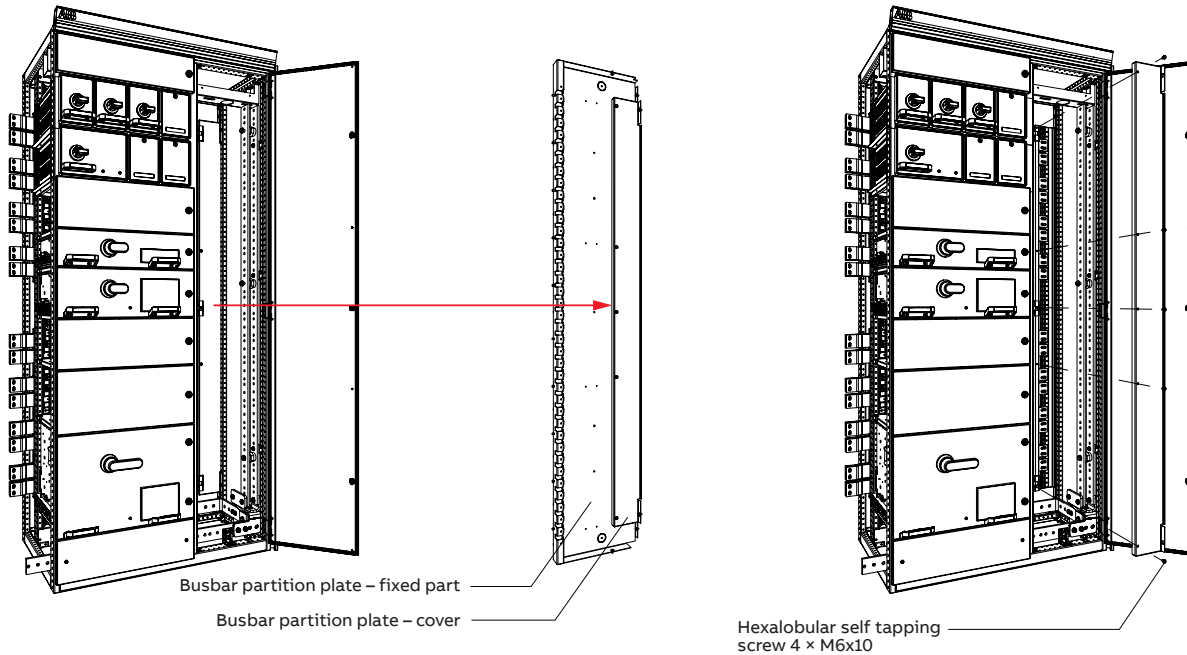


Figure 4-14 Busbar partition plate and fixing hole locations

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 4-12) shall be removed,
- check the loose items within the switchboard required for securing of busbars, section fastening and operation.

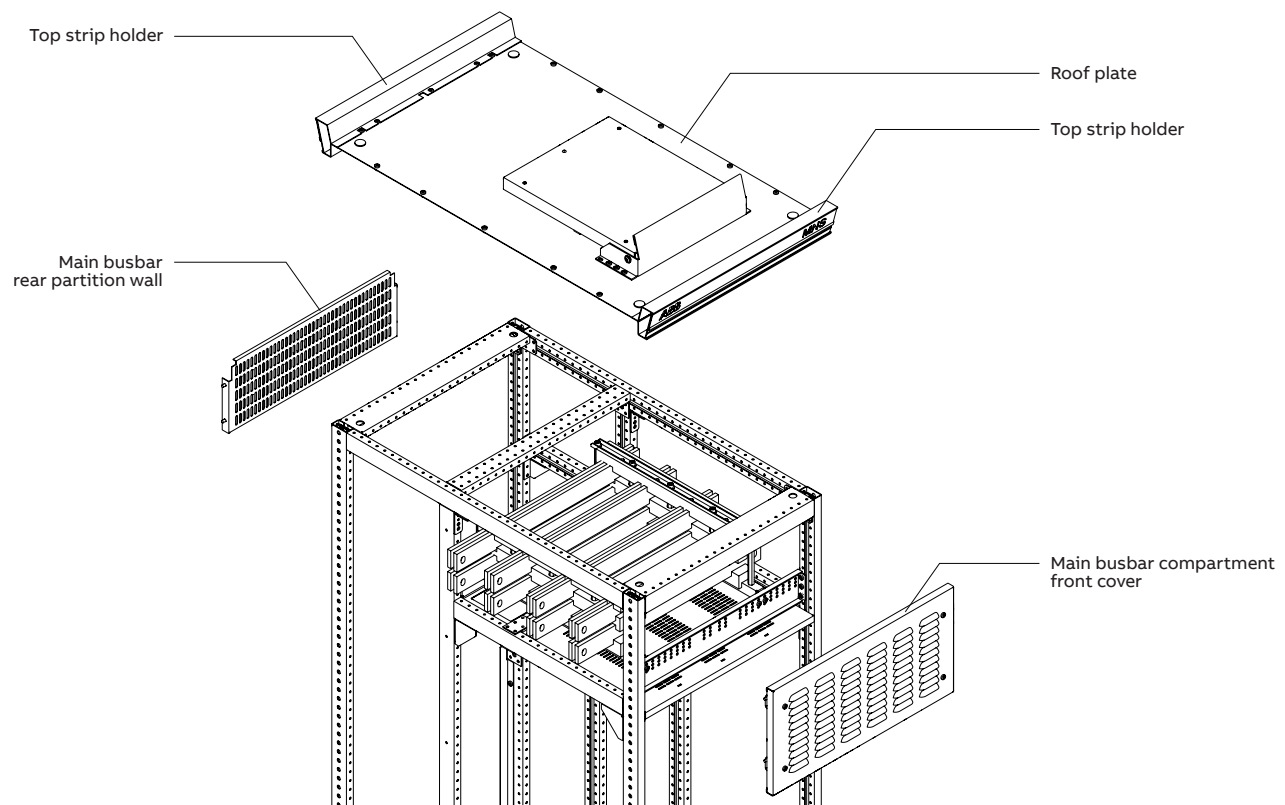
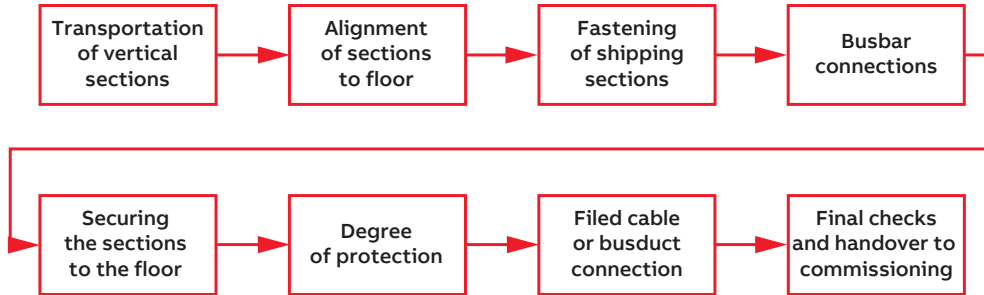


Figure 4-15 Rear access busbar partition plate and fixing hole locations

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.

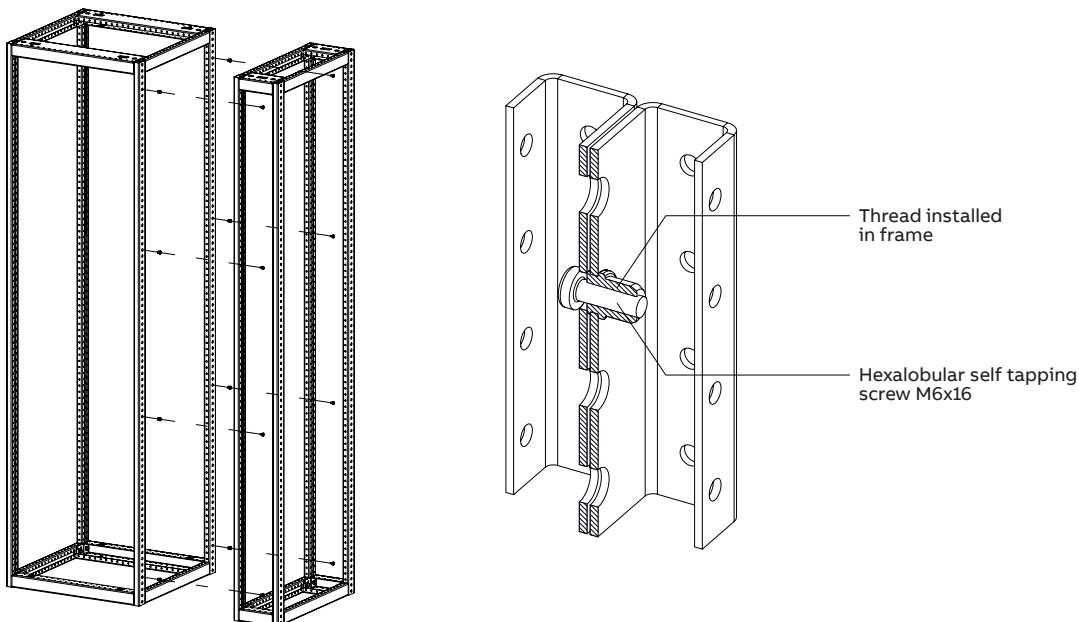


Figure 4-16 Connection points (threads installed in frame) with detail of connection

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.

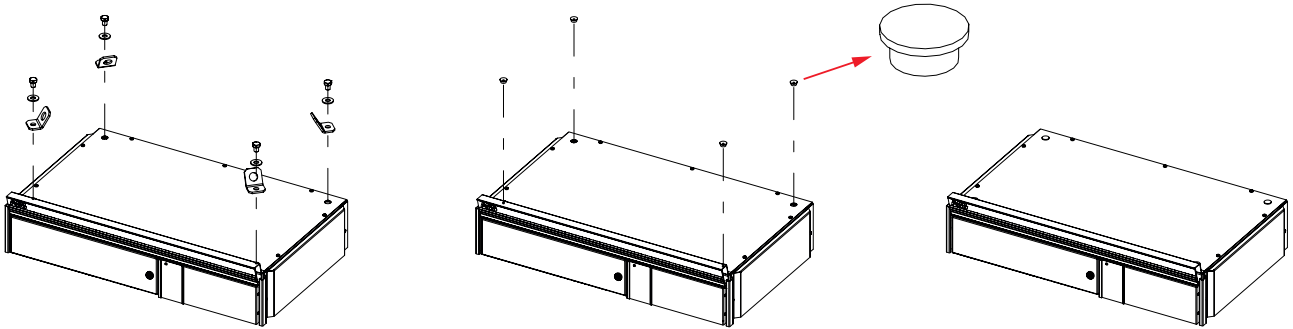


Figure 4-17 Lifting holes plug

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.

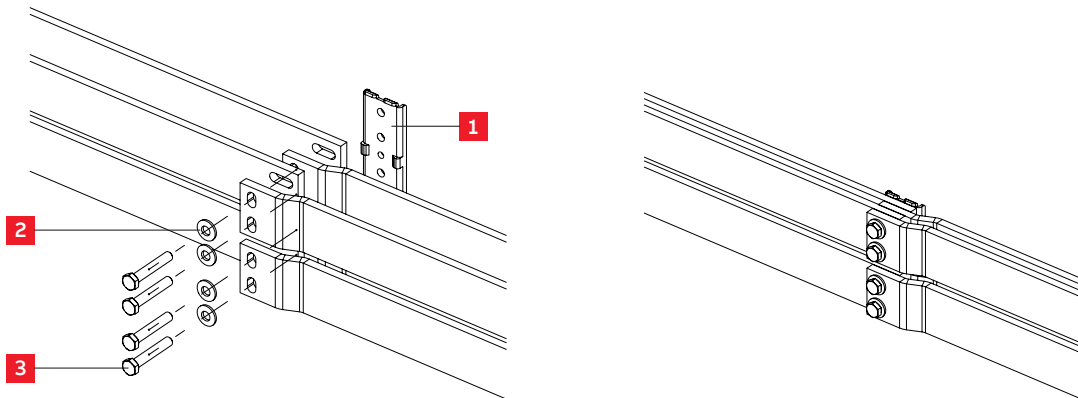


Figure 4-18 Example of busbar connection – main busbar connection

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, corrosion 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 Penetrox-(TM) A-13 to ensure effective electrical connection.

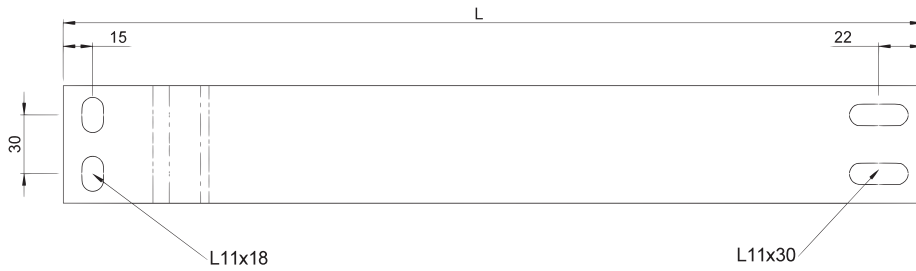


Figure 4-19 Generic busbar dimension in mm

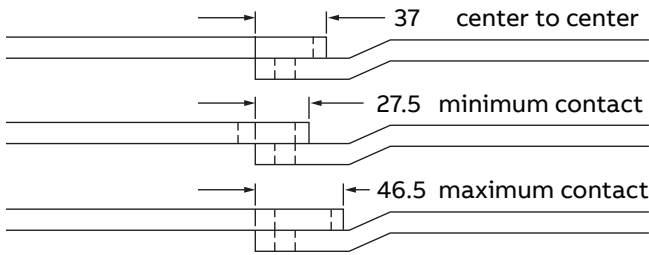


Figure 4-20 Main busbar overlapping ranges in mm

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 within 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

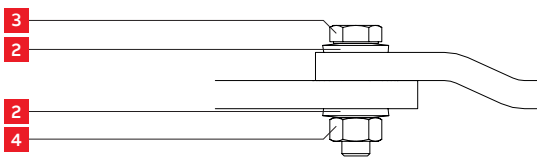


Figure 4-21 Copper to copper

- 2 Conical spring washer
- 3 Bolt
- 4 Nut

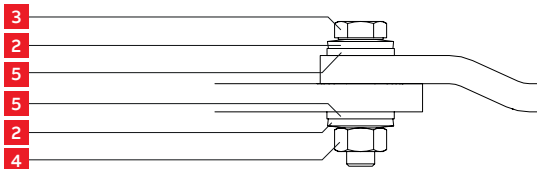


Figure 4-22 Aluminium to aluminium

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

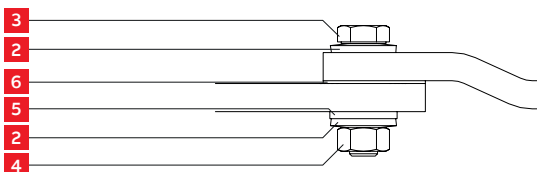


Figure 4-23 Copper to aluminium

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

4.14.2 Rear access busbar connections between sections

MNS Rear busbars can be secured on the levelled switchgear sections as per Figure 4-23. The fastening of busbars shall be undertaken with a calibrated torque wrench as per the torque values in Table 4-09.

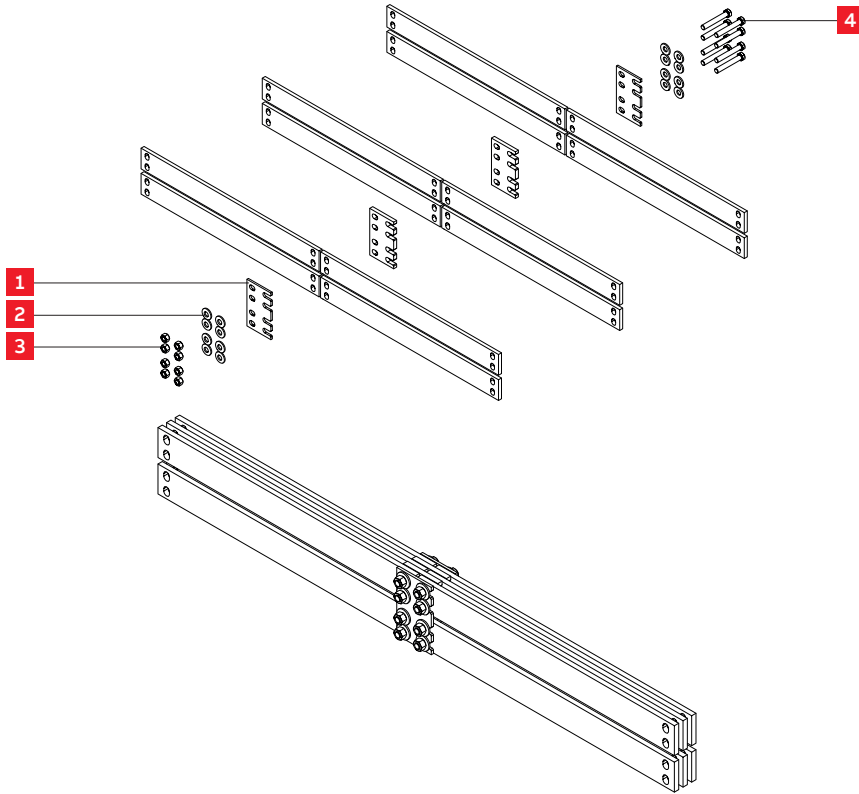


Figure 4-24 Example of MNS Rear busbar connection – main busbar connection

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	M12x40 for 2x ... x 10 main busbar M12x60 for 4x ... x 10 main busbar M12x80 for 6x ... x 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.

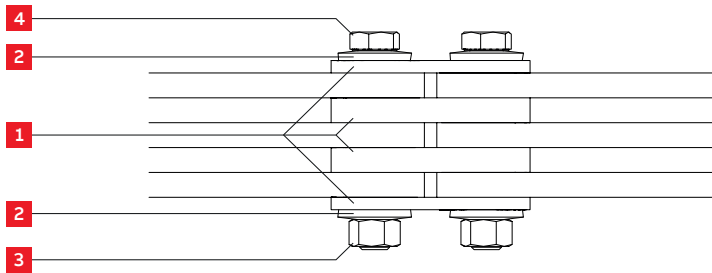


Figure 4-25 MNS Rear main busbar connection

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

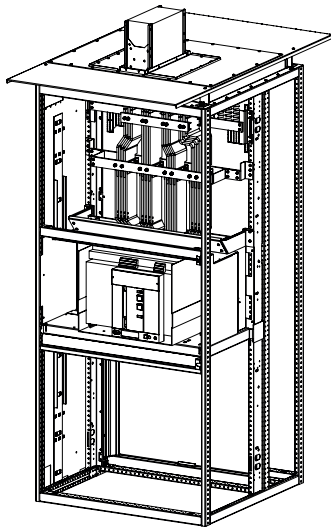


Figure 4-26 Example of busbar connection – busduct connection

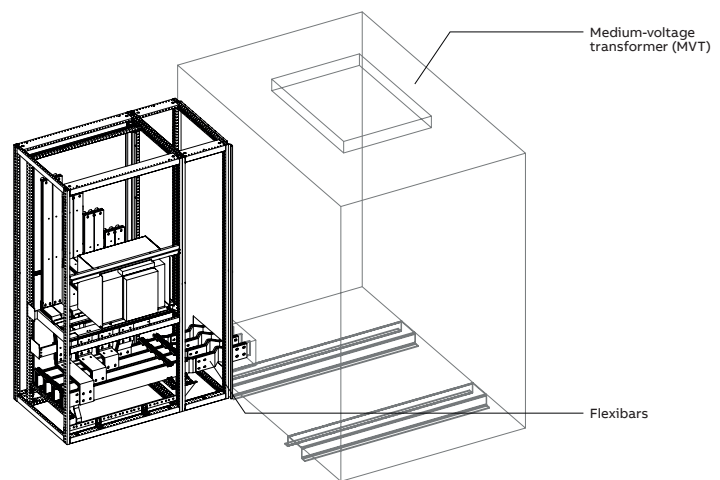


Figure 4-27 Example of section high extension parts



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 Penetrox(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 4-26.

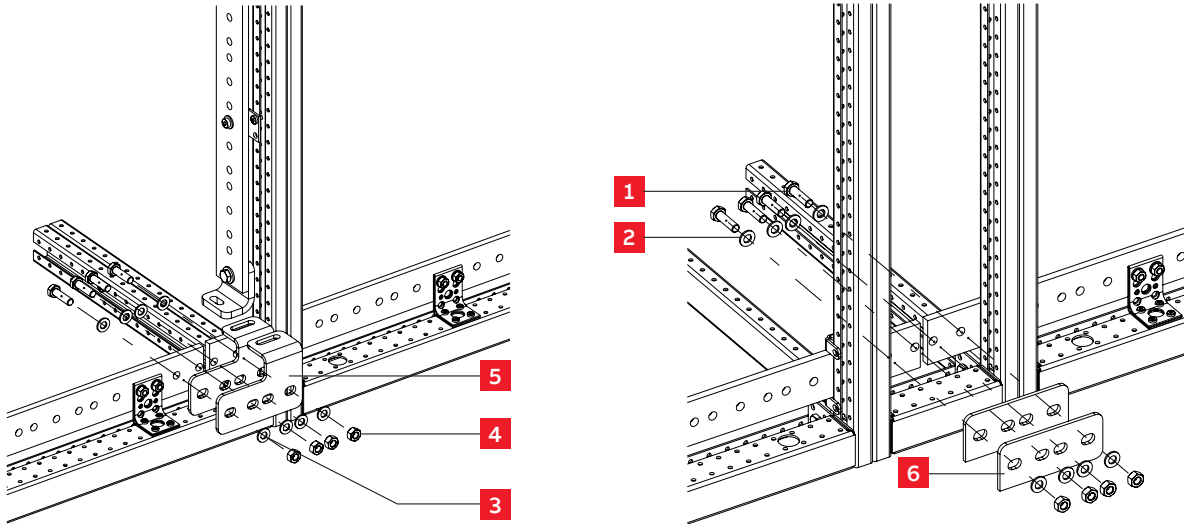


Figure 4-28 PE / PEN busbar connection

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

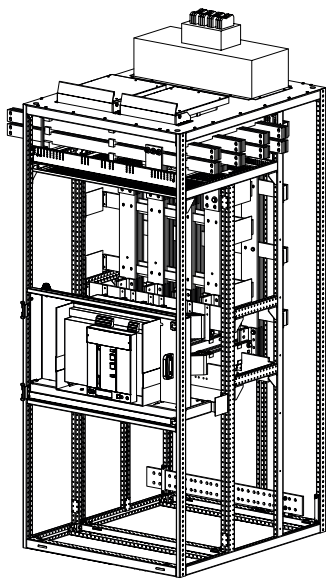


Figure 4-29 Example of busbar connection – busduct connection for MNS Rear switchgear

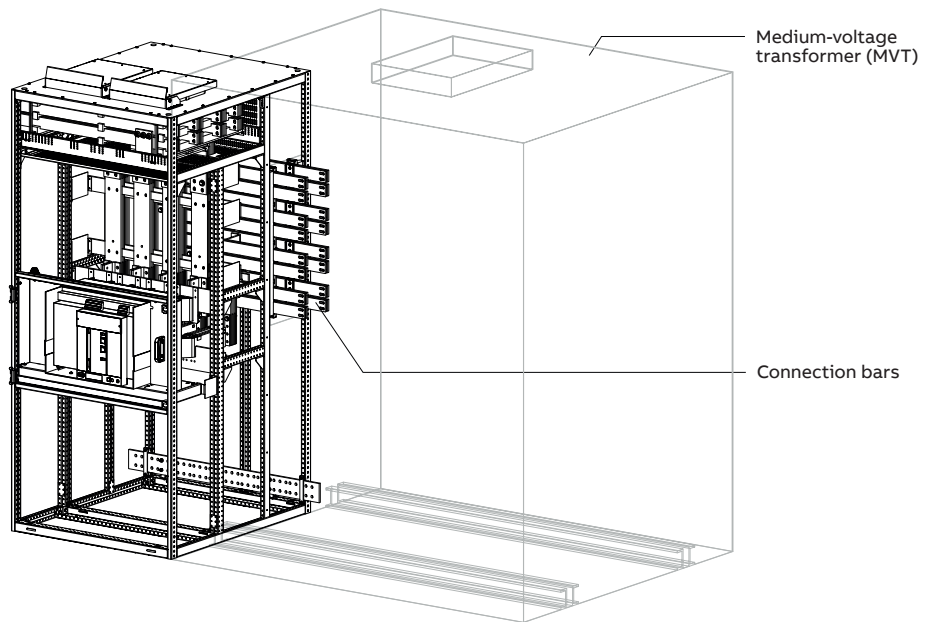


Figure 4-30 Example of busbar connection of MNS Rear switchgear to medium-voltage transformer

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

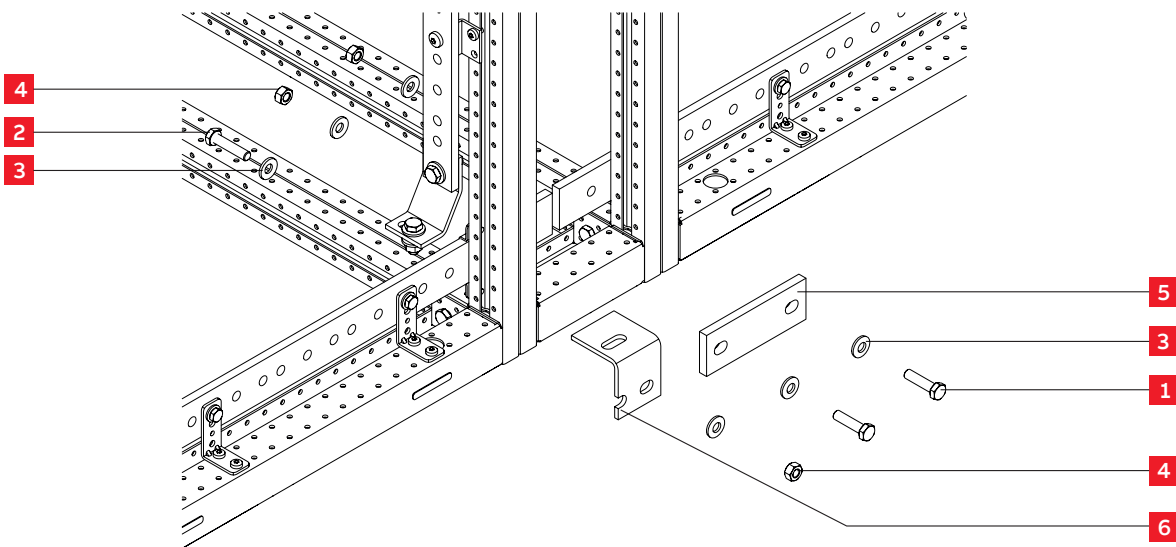


Figure 4-31 MNS Rear PE/PEN bar connection

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

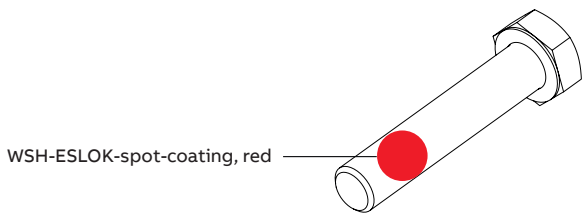


Figure 4-32 Bolt with WSH-ESLOK spot coating

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

The WSH-ESLOK-threadlocking effects by an abrasive resistant 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 \times 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

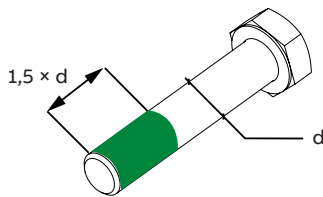


Figure 4-33 Bolt with LOCTITE spot coating

If, according to the parts list, a screw with threadlocking which is not stocked has to be used, a non-coated screw 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. $1,5 \times d$ (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 SCOTCH 2228 and / or 3M SCOTCHFIL ELECTRICAL INSULATION PUTTY) or provided with the protective cover, see Figure 4-20.

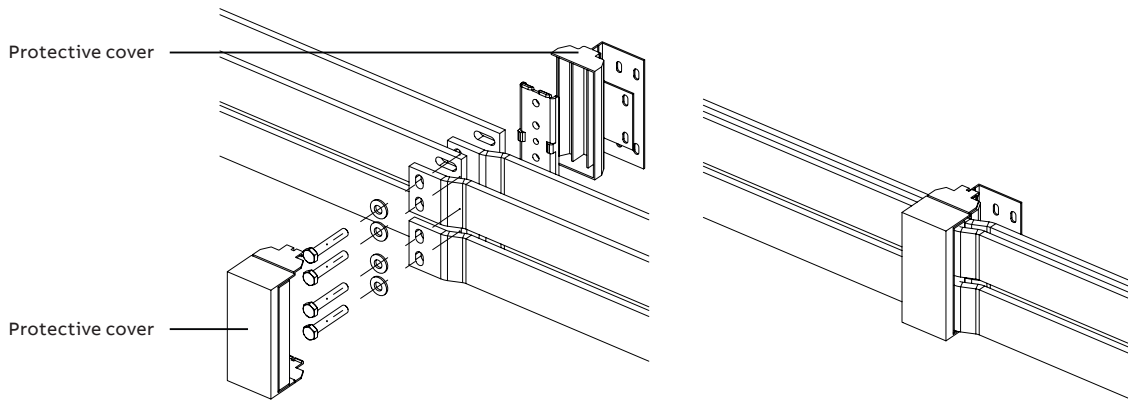
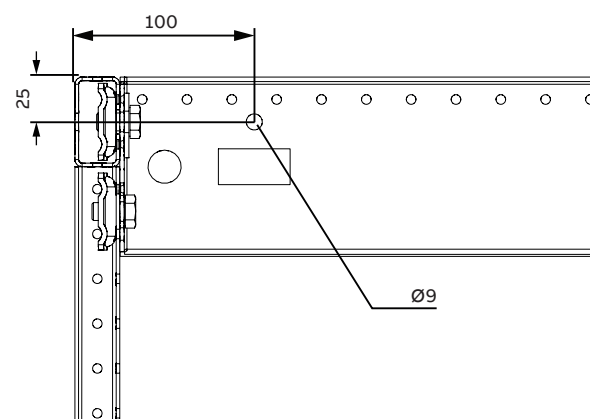
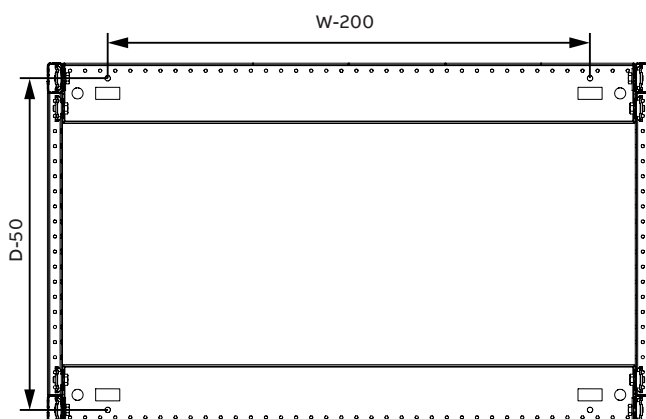
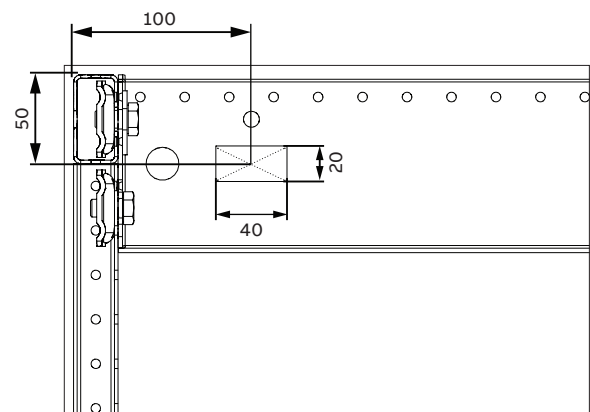
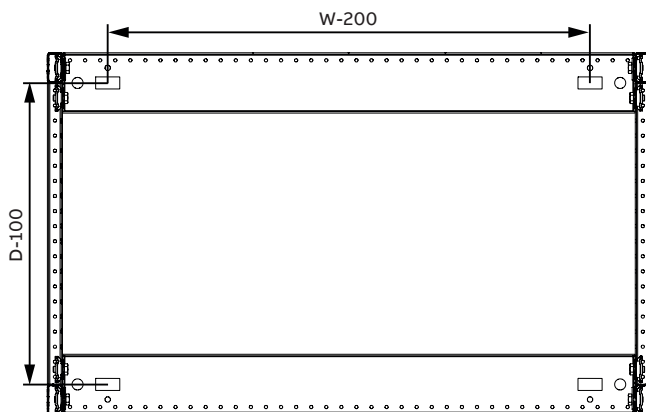


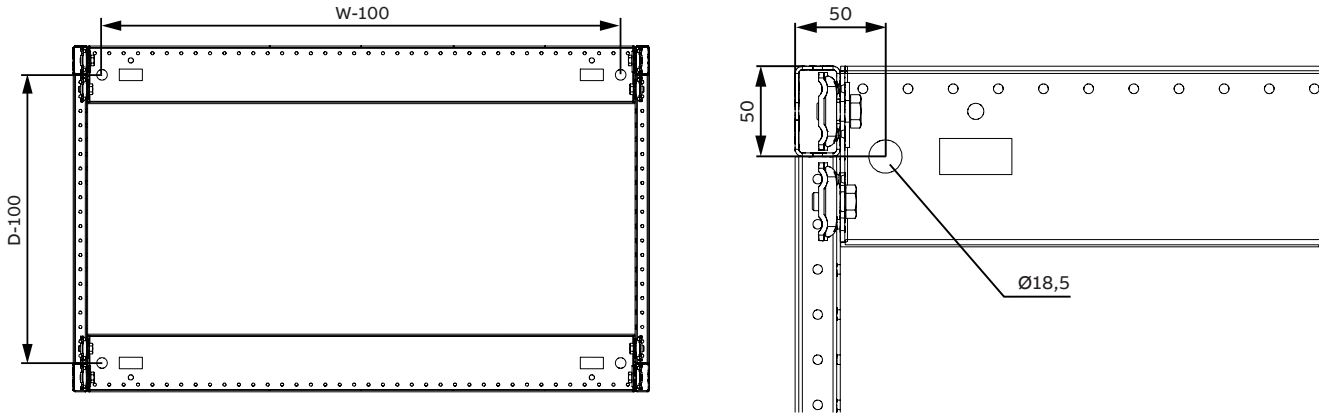
Figure 4-34 Isolated busbar connection cover

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 4-35 Detail dimensions of mounting holes

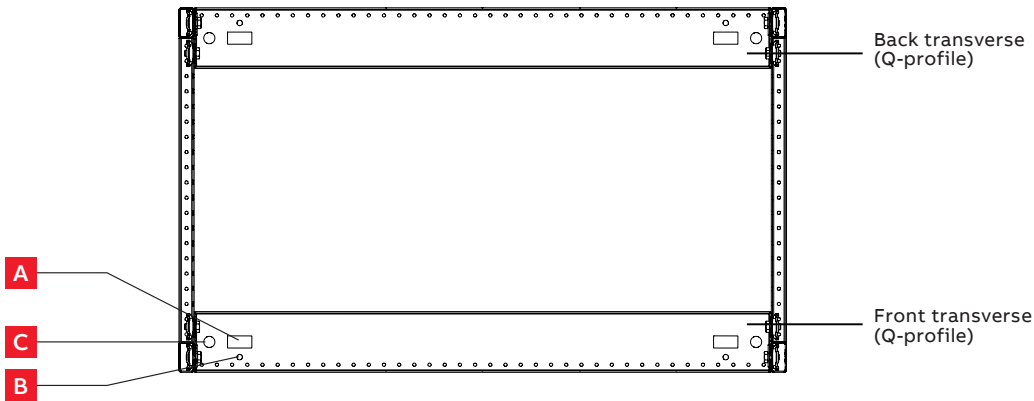


Figure 4-36 Typical installation mounting holes A, B and C



In earthquake free environments fixing of the assembly at the front transverse 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
Section placed in open space	No			
	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 $p = 20 \text{ kN} / \text{m}^2$ (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.

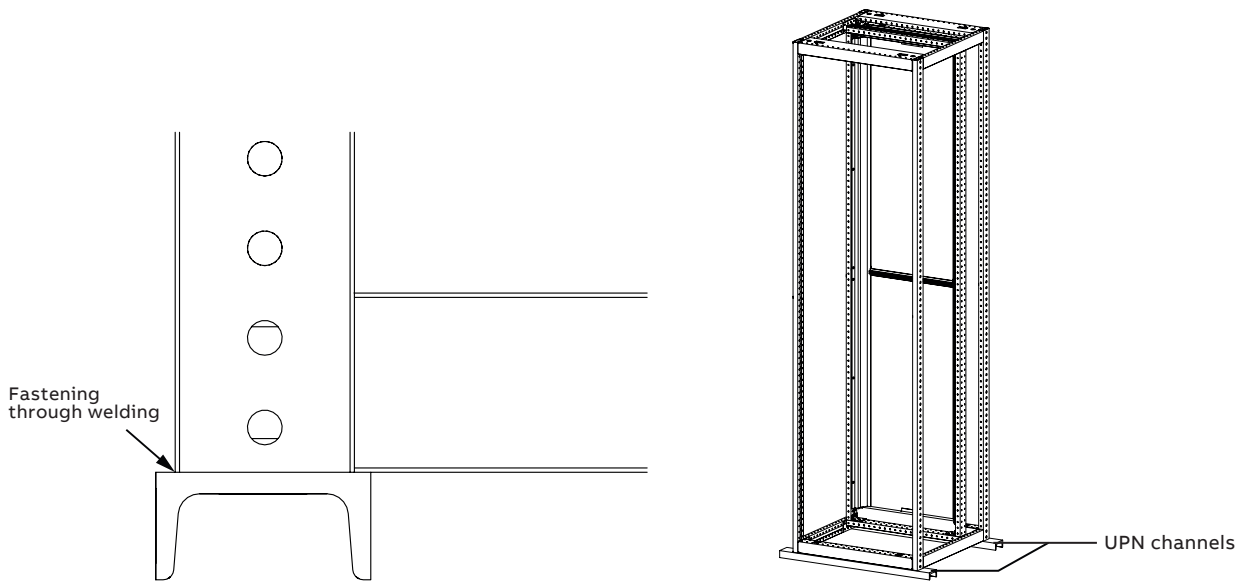


Figure 4-37 Weld seam position

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 C. 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 4-36 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.

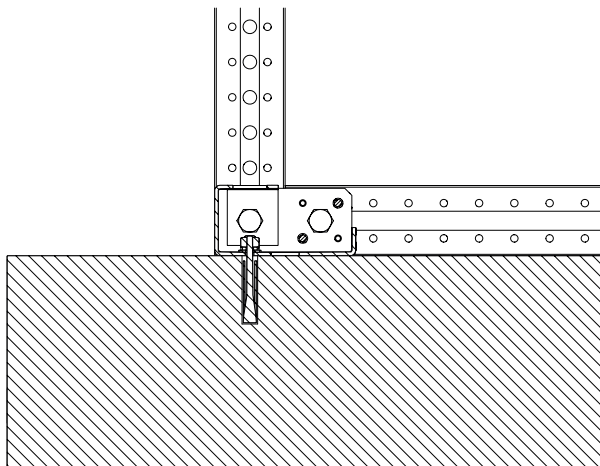


Figure 4-38 Fastening to foundation – concrete floors

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 length 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 following 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.

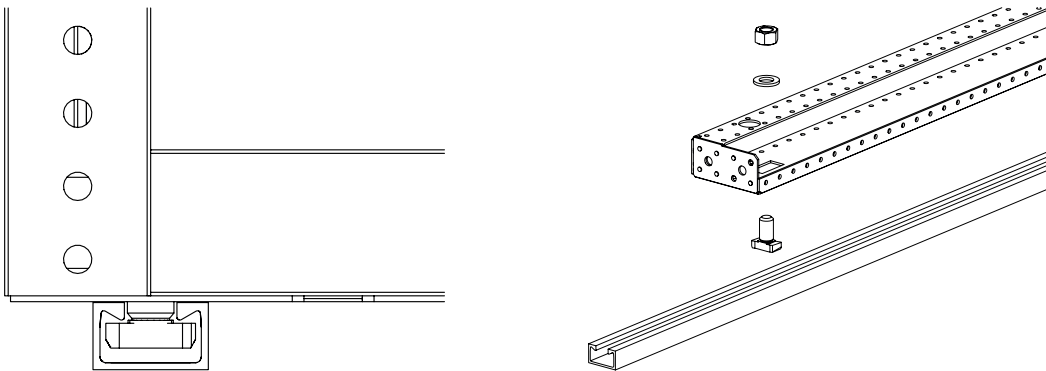


Figure 4-39 Fastening to foundation – HALFEN channel

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 tightening torque.

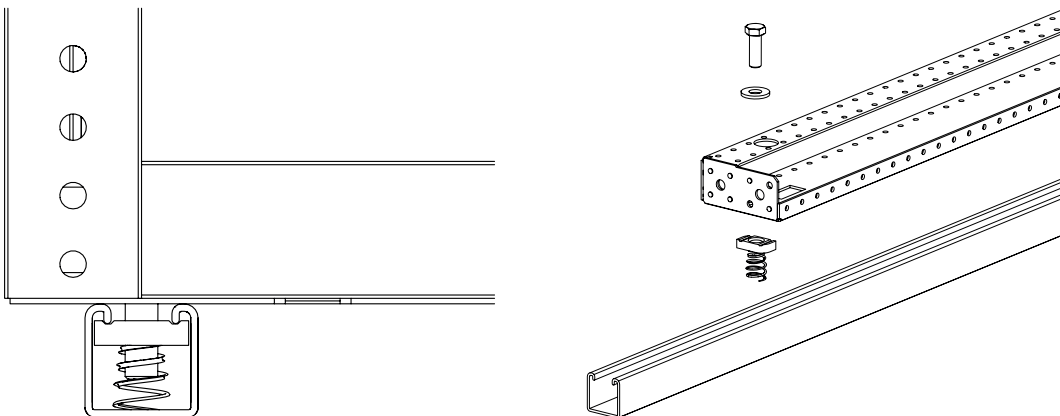


Figure 4-40 Fastening to foundation – UNISTRUT channel

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

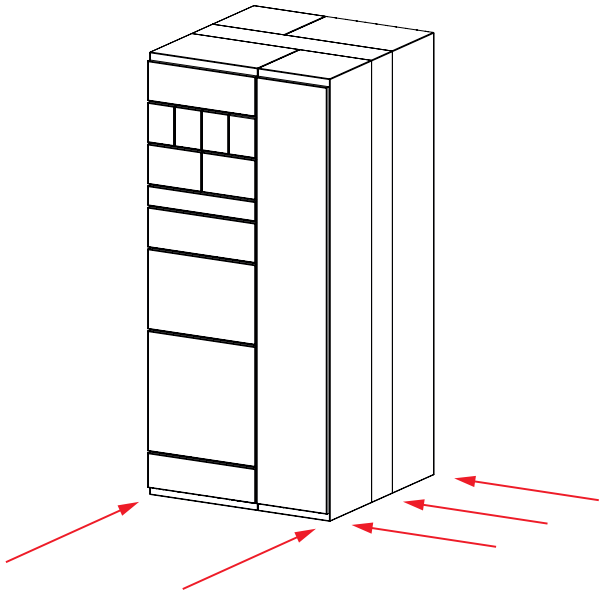


Figure 4-41 HALFEN / UNISTRUT positions for Duplex

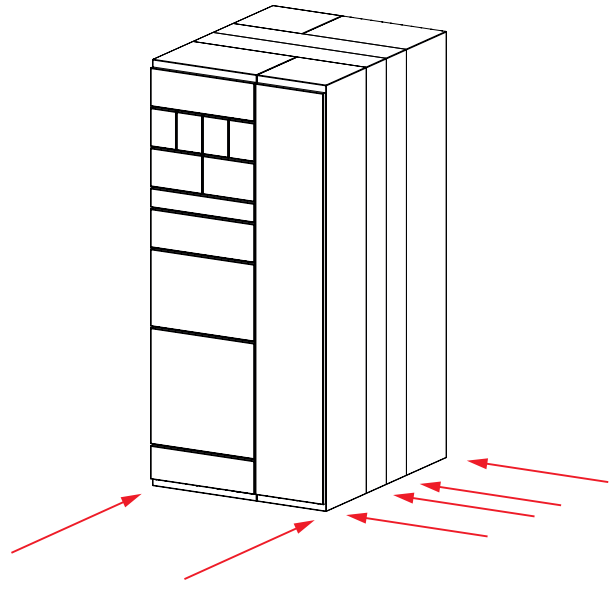


Figure 4-42 HALFEN / UNISTRUT positions for Back to Back

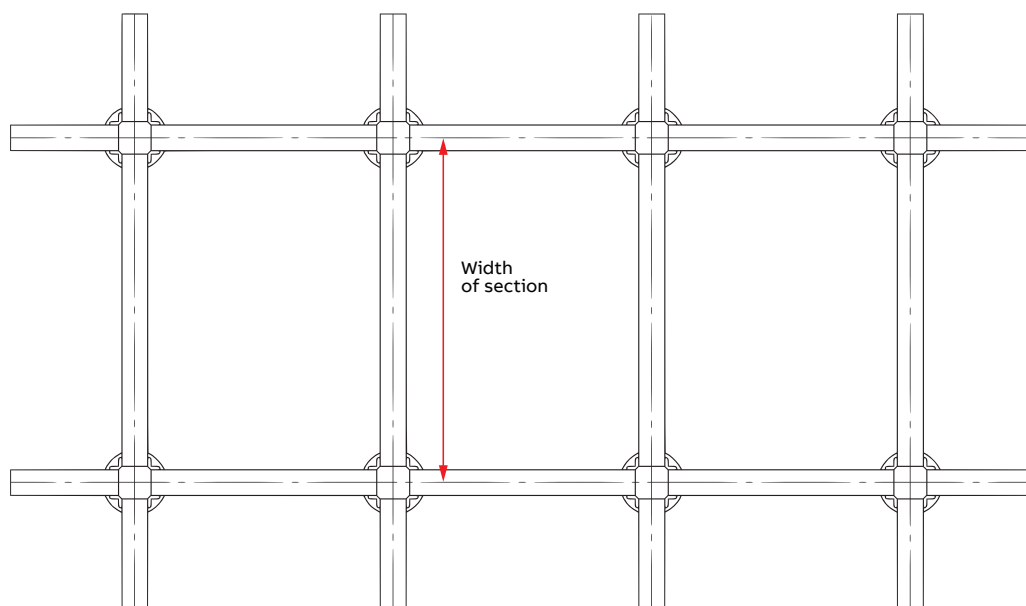
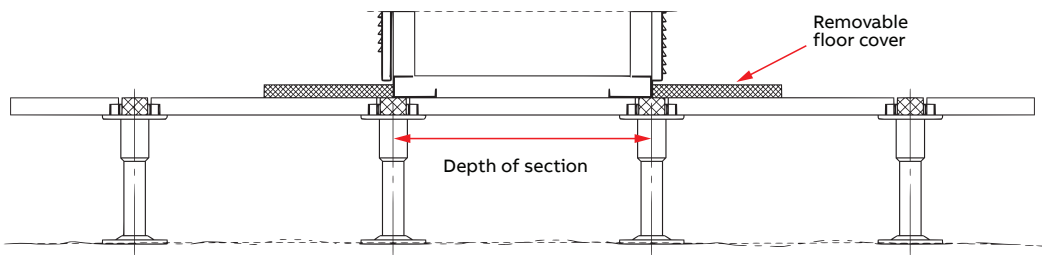


Figure 4-43 Installation on false floors

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 foundation fixing in earthquake environment

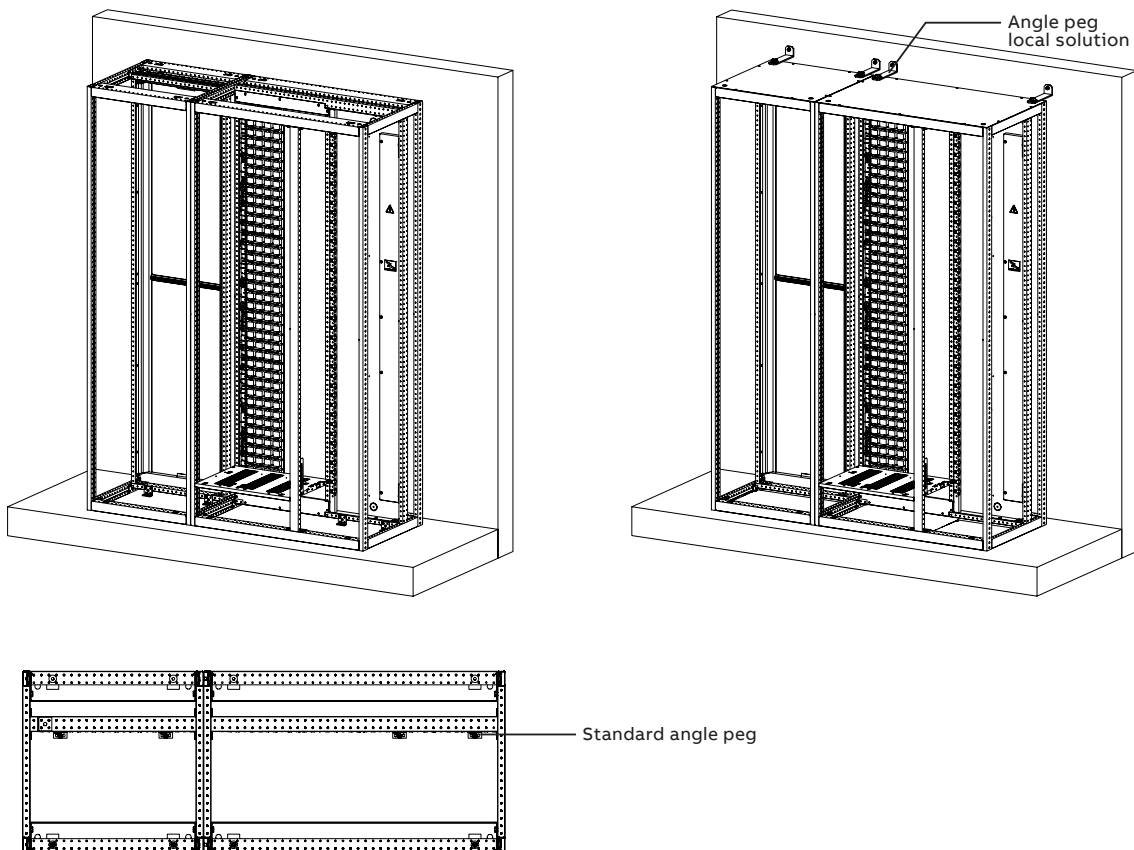


Figure 4-44 Fastening to foundation – concrete floors / each section fixed in 4 points front access design

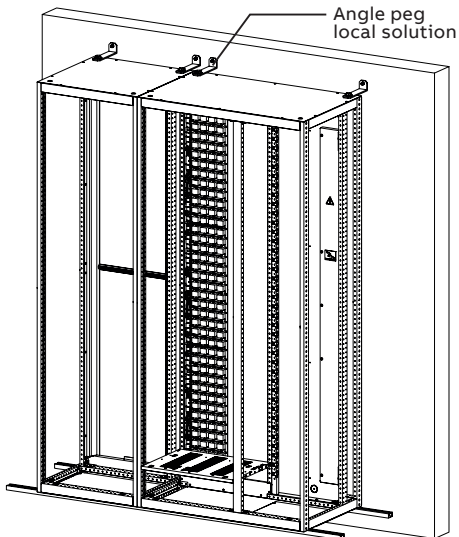


Figure 4-45 Fastening to foundation – HALFEN channel / each section fixed in 4 points

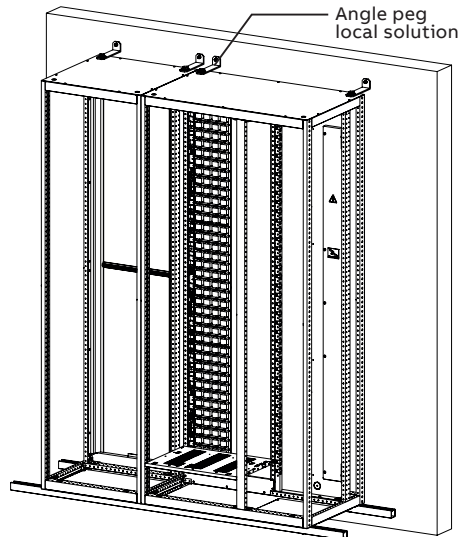


Figure 4-46 Fastening to foundation – UNISTRUT channel / each section fixed in 4 points

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 manufacturer's 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.

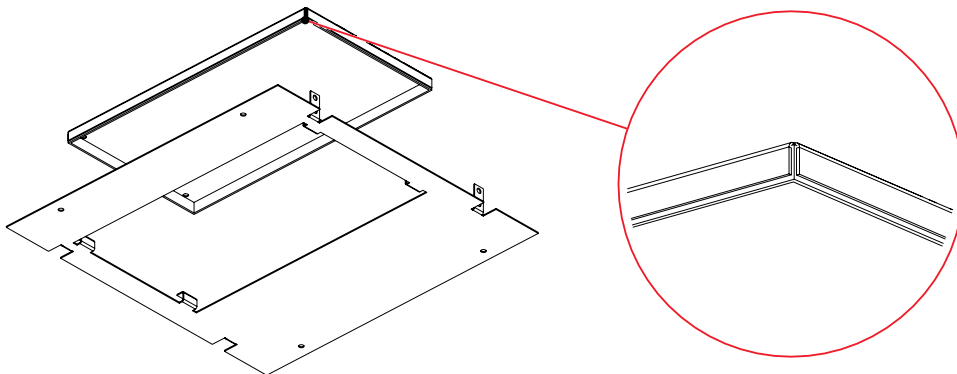


Figure 4-47 Bottom plate sealing

- 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.

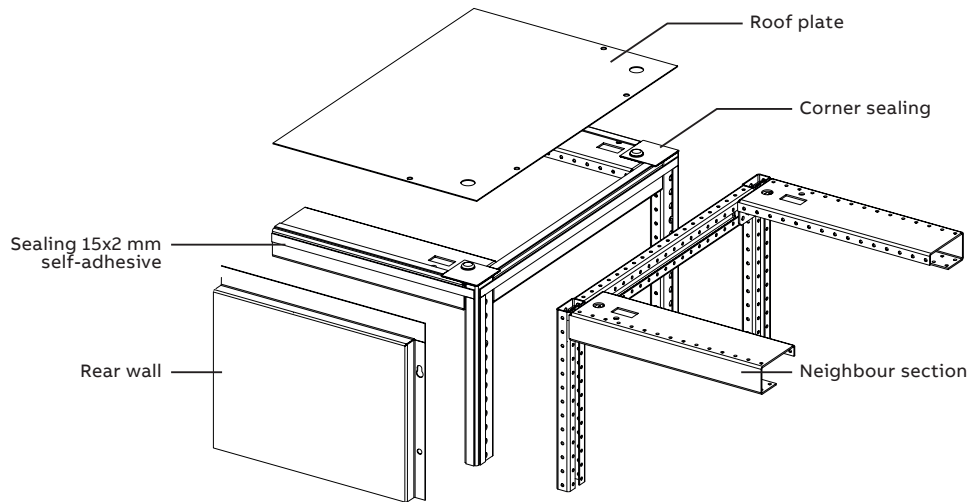


Figure 4-48 Frame sealing



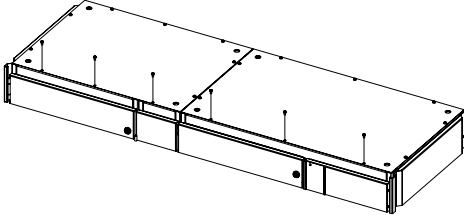
The cleaner Terokal R is inflammable. Follow the use instructions of the manufacturer.
Self adhesive sealing tape 15 x 2 mm GSIN 100021P0010

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

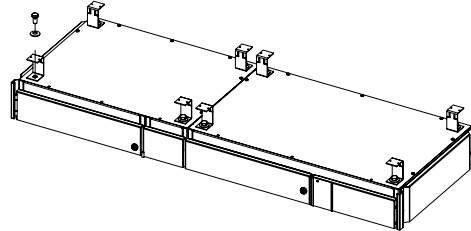
Raised roof plates shall be installed on site, all components are supplied as part of the project.



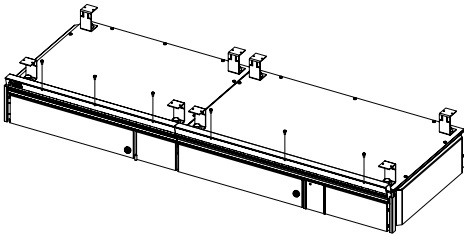
Please take care when installing the roof plates not to allow components to fall into the assembly.



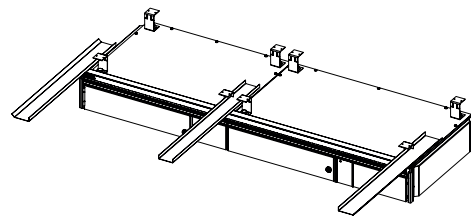
- 1** Demount front self tapping screw M6x10 and transporting angles from the metal mesh roof plate.



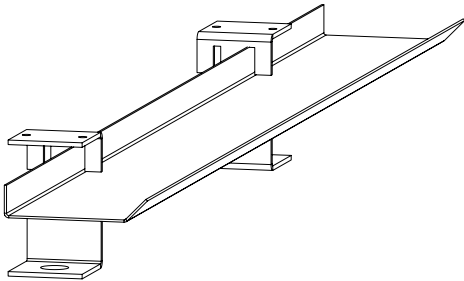
- 2** Mount the roof plate supports. Use the nut M16x30 and spring washer A16 from transporting angles. **Do not fully tighten.**



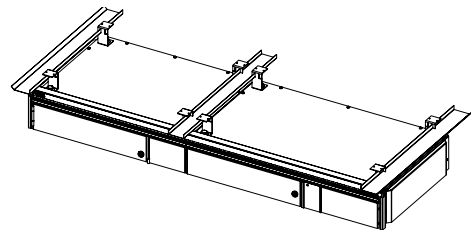
- 3** Mount the strip holders. Use self tapping screw M6x12.



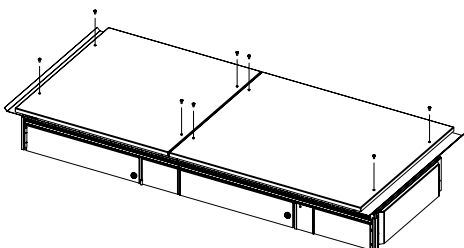
- 4** Slide the middle and end (left and right) gutters.



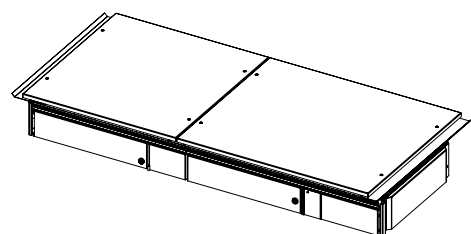
- 5** Detail of end gutter.



- 6** Once the gutters are correctly located, tighten the screws M16x30.

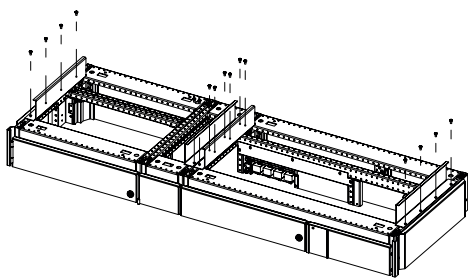


- 7** Mount the closed roof plates. Use self tapping screw M6x30 to fix the roof plates (4 pieces per section).

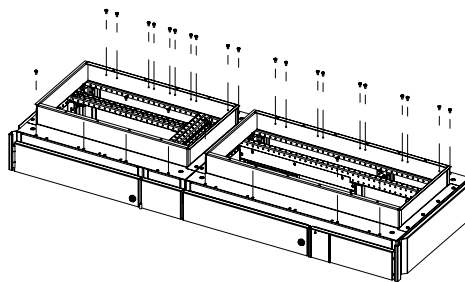


- 8** Raised roof plate IPx1 / x2 for section bottom entry.

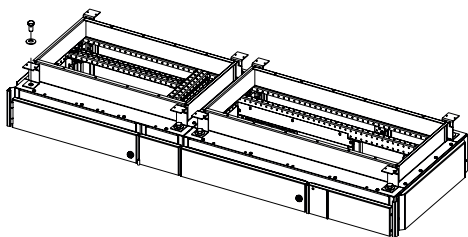
Raised roof plate IPx1/x2 installation steps with section top entry.



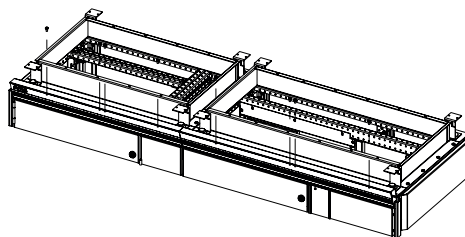
- 1** Demount transporting angles and start with mounting roof side plates. Fix with self tapping screws M6x10 (8 pieces per section).



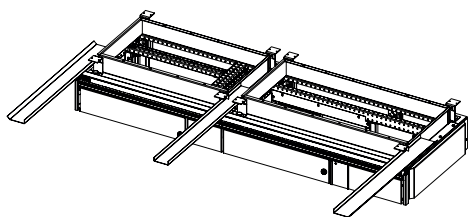
- 2** Continue with mounting the front and rear plates. Fix with self tapping screws M6x10 (14 pieces per section).



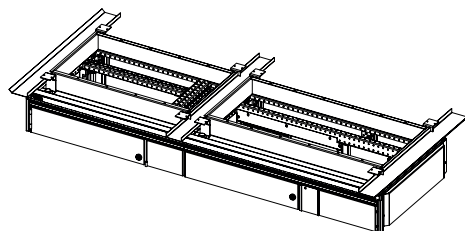
- 3** Mount the roof plate supports. Use the nut M16x30 and spring washer A16 from transporting angles. **Do not fully tighten.**



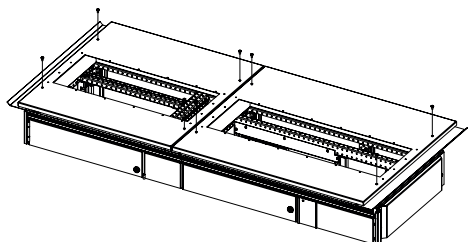
- 4** Mount the strip holders. Use self tapping screw M6x12.



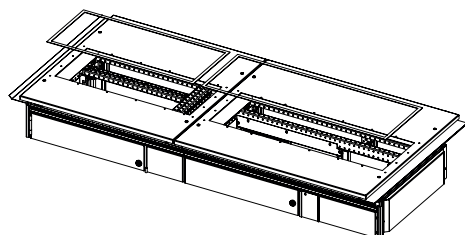
- 5** Slide the middle and end (left and right) gutters. For detail see the mounting instruction for section with bottom entry.



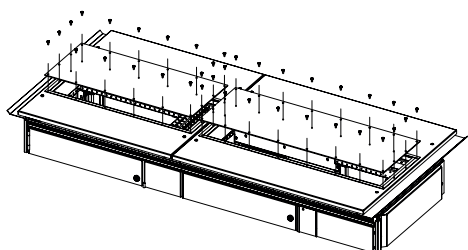
- 6** Once the gutters are correctly located, tighten the screws M16x30.



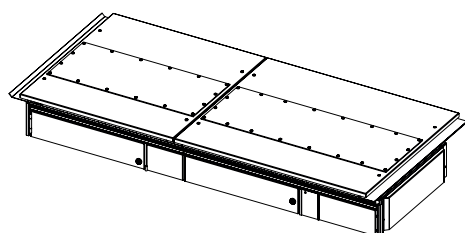
- 7** Place the roof plates with top entry cut outs. Use hexalobular self tapping screw M6x30 to fix the roof plates (4 pieces per section).



- 8** Clean and hare 15x2 mm self-adhesive sealing under the cover plate.

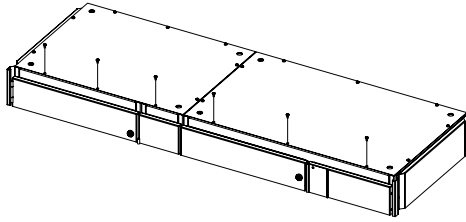


- 9** Mount the cover plate with prepared holes and glands for cable entrance. Fix with self tapping screw M6x12 (16 pieces per section).

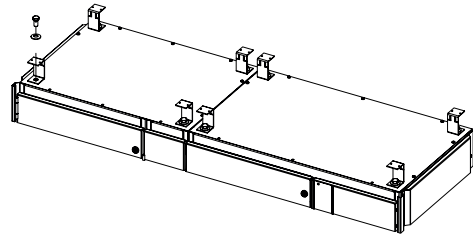


- 10** Raised roof plate IPx1 / x2 for section top entry.

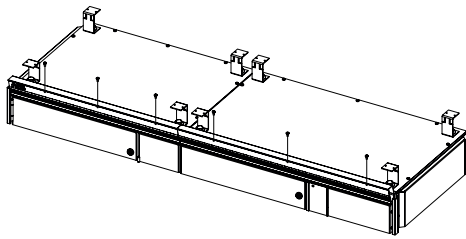
Raised roof plate IP43 installation steps with section bottom entry.



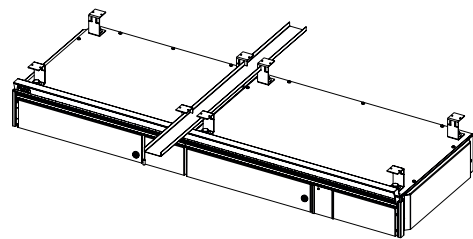
- 1** Demount front self tapping screw M6x10 and transporting angles from the metal mesh roof plate.



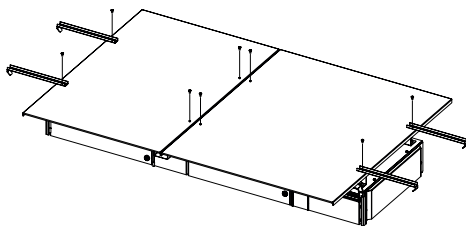
- 2** Mount the roof plate supports. Use the nut M16x30 and spring washer A16 from transporting angles. **Do not fully tighten.**



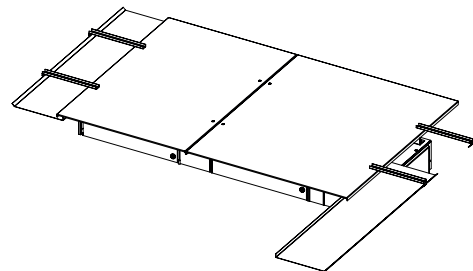
- 3** Mount the strip holders. Use self tapping screw M6x12.



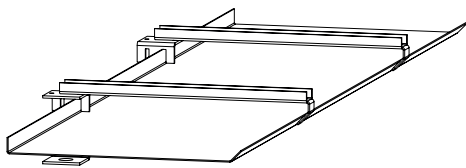
- 4** Slide the middle gutters. Once the gutters are correctly located, tighten the screws M16x30.



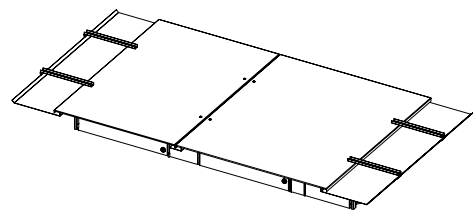
- 5** Mount the closed roof plates with gutter support. Use self tapping screw M6x30 to fix the roof plates (4 pieces per section).



- 6** Slide the end gutters. Once the gutters are correctly located, tighten the screws M16x30.

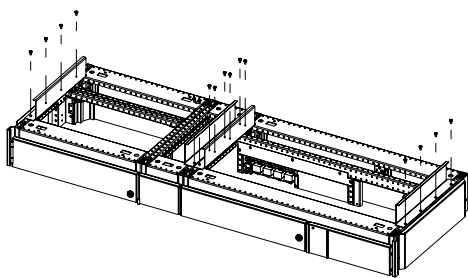


- 7** Detail of end gutter.

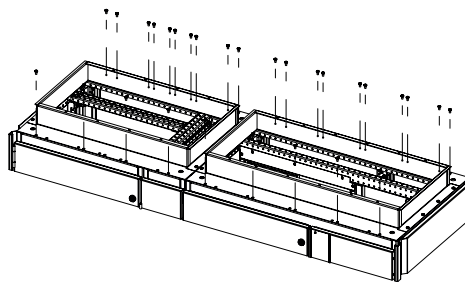


- 8** Raised roof plate IP43 for section bottom entry.

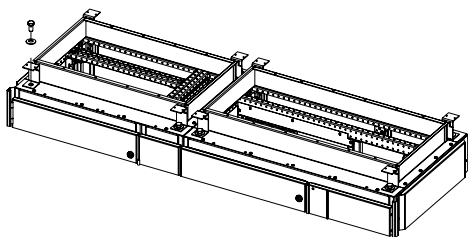
Raised roof plate IP43 installation steps with section top entry.



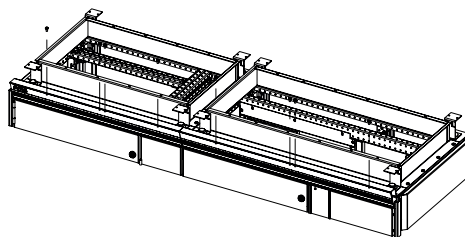
- 1** Demount transporting angles and start with mounting roof side plates. Fix with self tapping screws M6x10 (8 pieces per section).



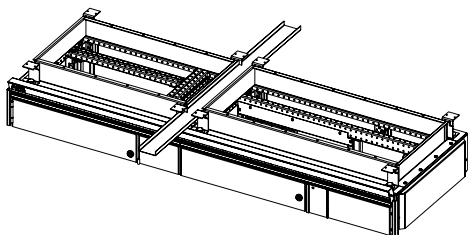
- 2** Continue with mounting the front and rear plates. Fix with self tapping screws M6x10 (14 pieces per section).



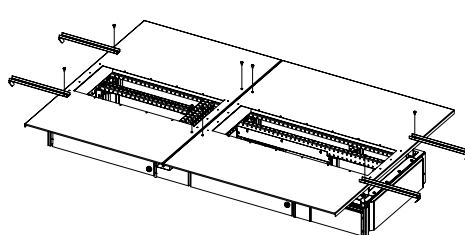
- 3** Mount the roof plate supports. Use the nut M16x30 and spring washer A16 from transporting angles. **Do not fully tighten.**



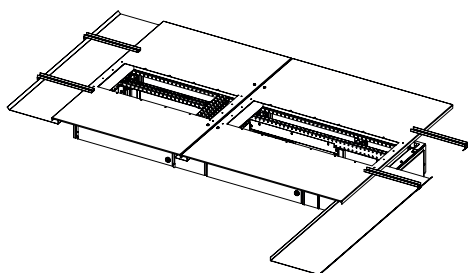
- 4** Mount the strip holders. Use self tapping screw M6x12.



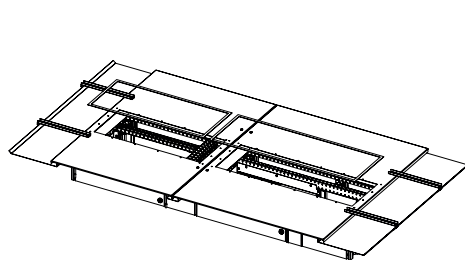
- 5** Slide the middle. Once the gutters are correctly located, tighten the screws M16x30.



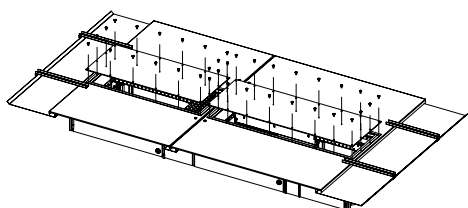
- 6** Place the roof plates with cut outs with gutter support. Use self tapping screw M6x30 to fix the roof plates (4 pieces per section).



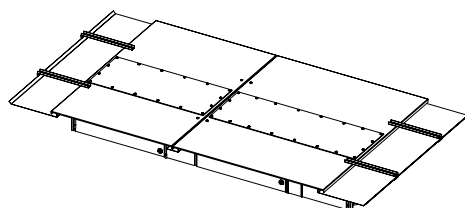
- 7** Slide the end gutters. Once the gutters are correctly located, tighten the screws M16x30.



- 8** Clean and apply the 15x2 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 4-49 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

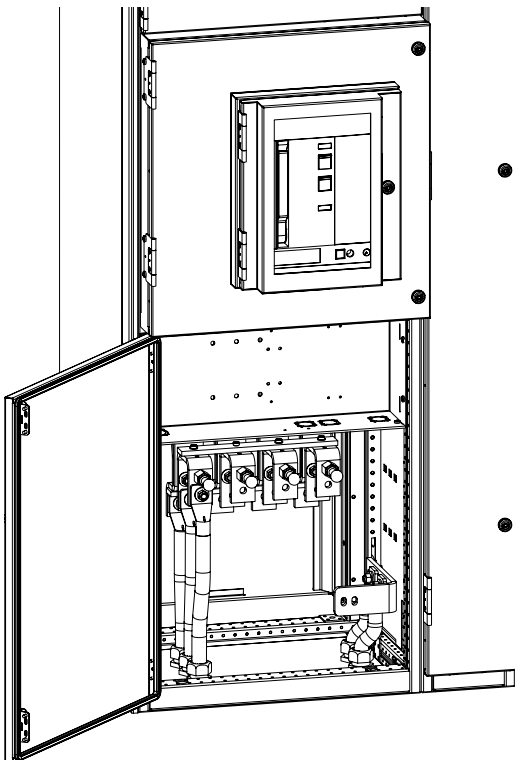


Figure 4-50 Example of cable connection in incoming / outgoing ACB unit

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.

Type of Emax2	Minimum recommended amount of cables							
	per 25% PE		per 50% PEN/N		per one phase or 100% N			
	300 mm ²	500/630 mm ²	300 mm ²	500/630 mm ²	300 mm ²	500/630 mm ²		
E1.2 630 A	1		2	1	4	2		
E1.2 800 A								
E1.2 1000 A								
E1.2 1250 A								
E1.2 1600 A	2	1	3	2	6	4		
E2.2 1600 A								
E2.2 2000 A								
E 2.2 800 A								
E2.2 1000 A			2	4	2	1	4	2
E2.2 1250 A								
E2.2 1600 A								
E2.2 2000 A								
E2.2 2500 A			2	2	4	3	8	6
E4.2 2000 A								
E4.2 2500 A								
E4.2 3200 A			3	2	6	4	12	7
E4.2 4000 A								
E6.2 4000 A	4	3	8	5	16	8		
E6.2 5000 A								
E6.2 6300 A								
E6.2 6300 A	6	4	12	7	24	12		

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.

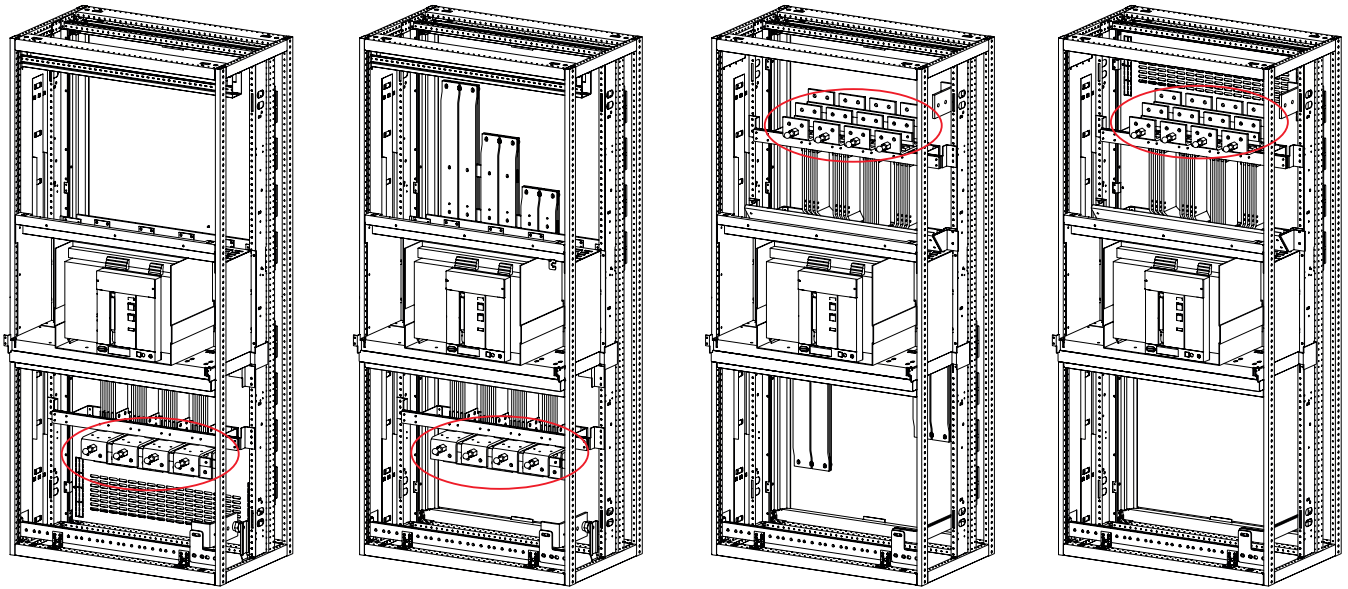


Figure 4-51 Location of cable bars acc. connection types

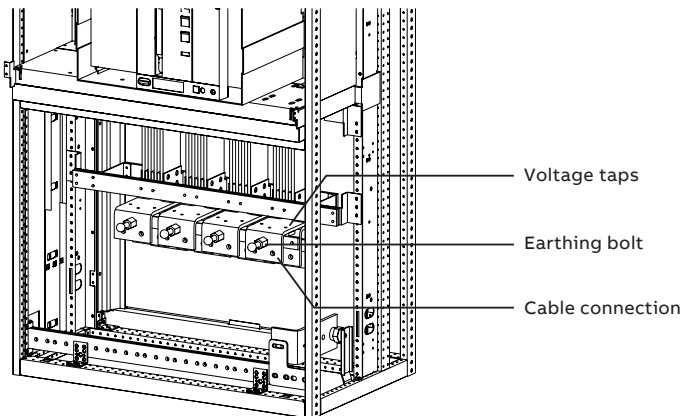


Figure 4-52 Main cable connections

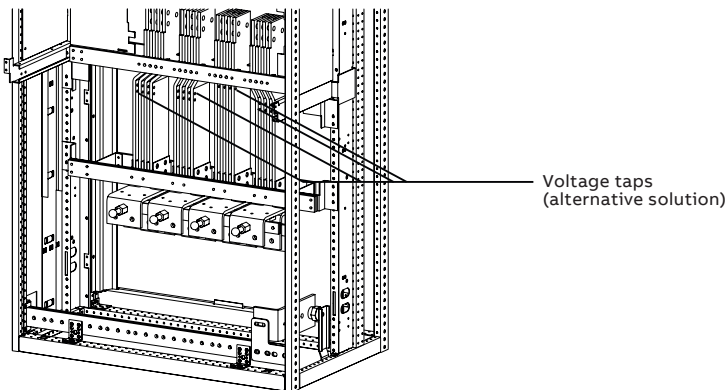


Figure 4-53 Location of voltage taps

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.

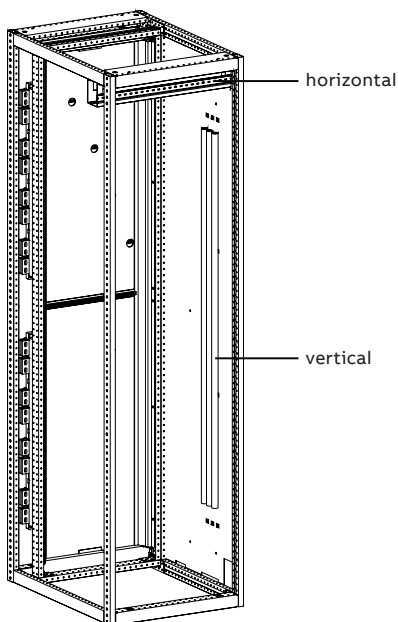


Figure 4-54 Position of vertical and horizontal wiring duct for customer external cables

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 recess 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

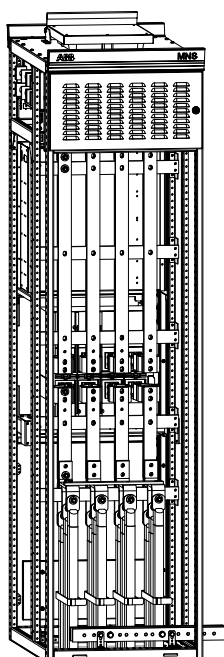


Figure 4-55 Example of cable connection in incoming / outgoing MNS Rear ACB unit

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 mm ²
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
E6.2 4000 A	12
E6.2 5000 A	18

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.

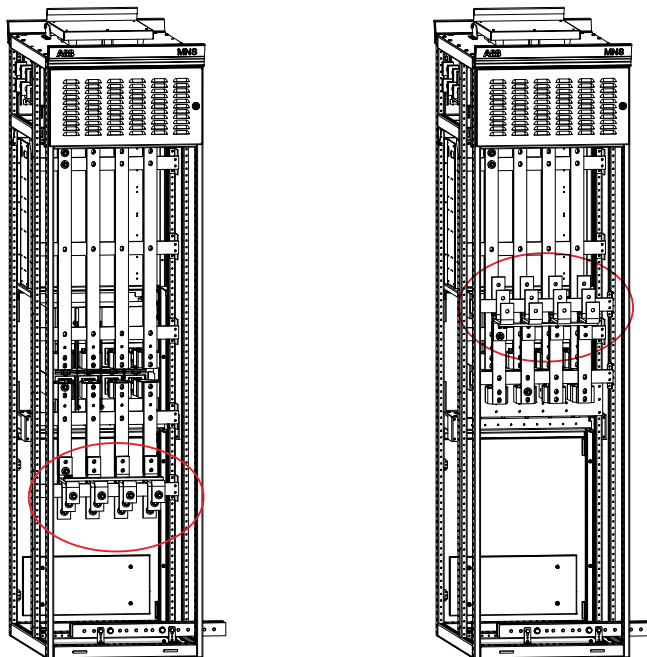


Figure 4-56 Location of MNS Rear cable bars acc. connection types

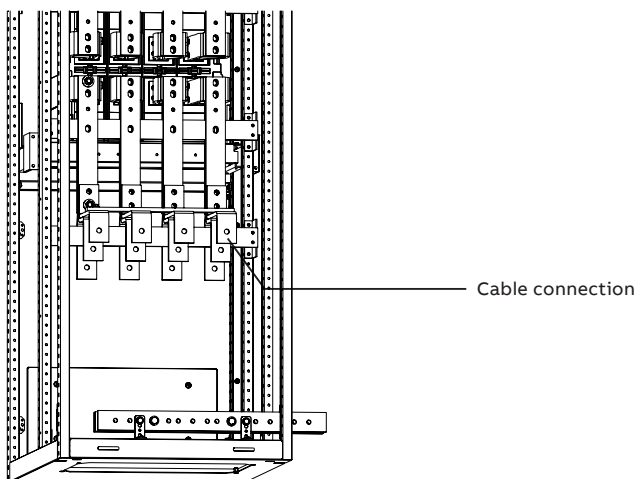


Figure 4-57 MNS Rear cable connections

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.

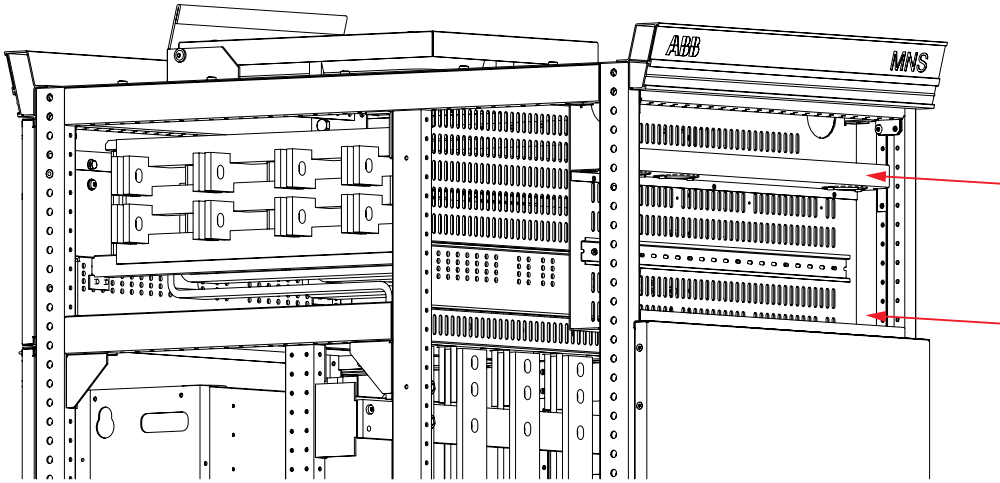


Figure 4-58 Position of MNS Rear control wiring duct for customer external cables. Two wiring ducts are available upper and lower.

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 securely 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 termination.
- 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 4-58.
- 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 [mm ²]	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 (incoming/outgoing)

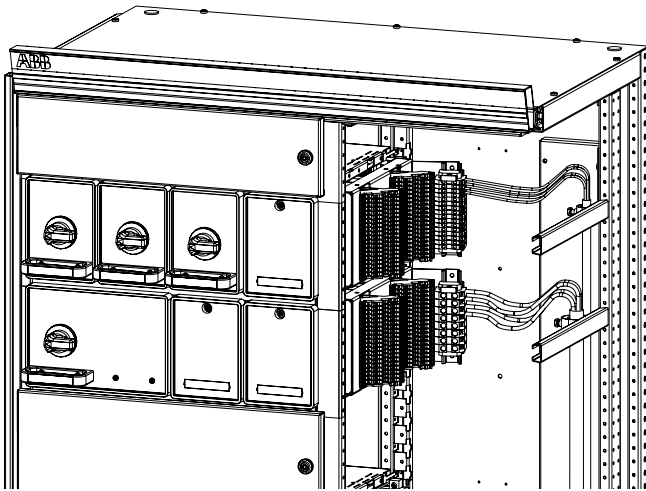


Figure 4-59 Example of cable runs, withdrawable module size 8E/4 and 8E/2

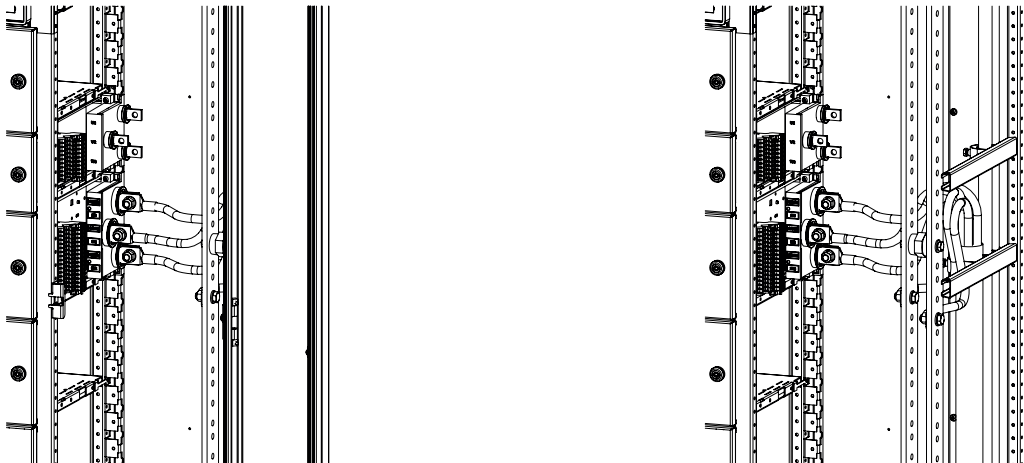


Figure 4-60 Example of cable runs, withdrawable module size ≥ 4E

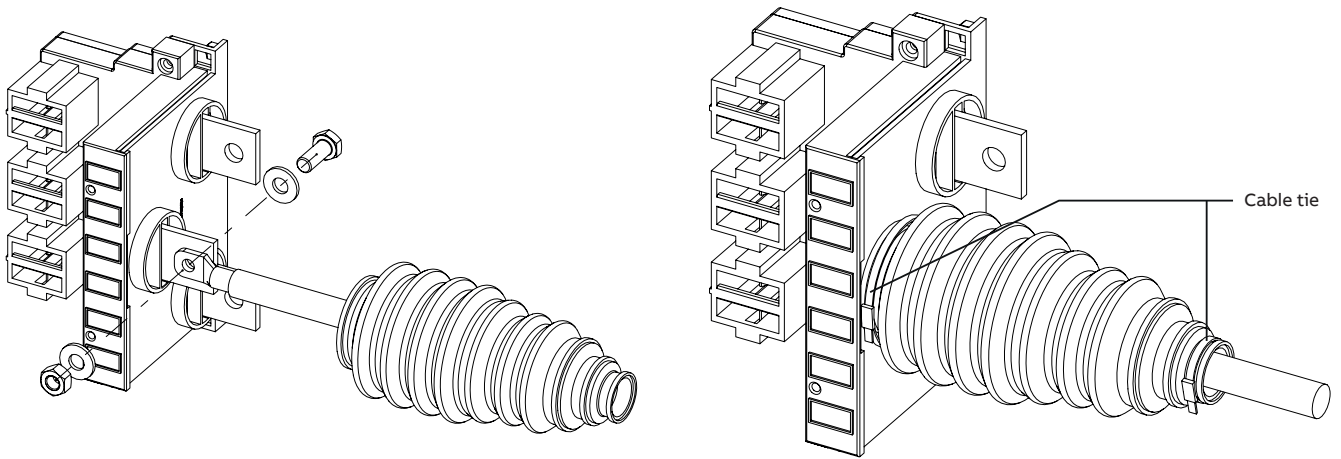


Figure 4-61 Cables provided with belows for $\geq 4E$ withdrawable modules

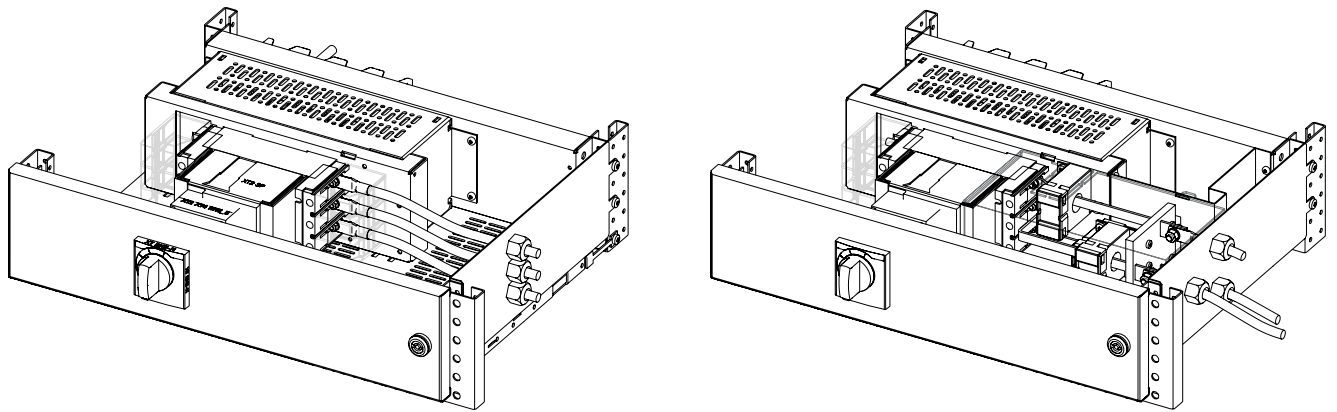


Figure 4-62 Example of plug-in module cable connection

Note: For Fixed type cable connections.

Termination inside the cable compartment is similar to Figure 4-58

Termination inside the module is similar to Figure 4-59

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

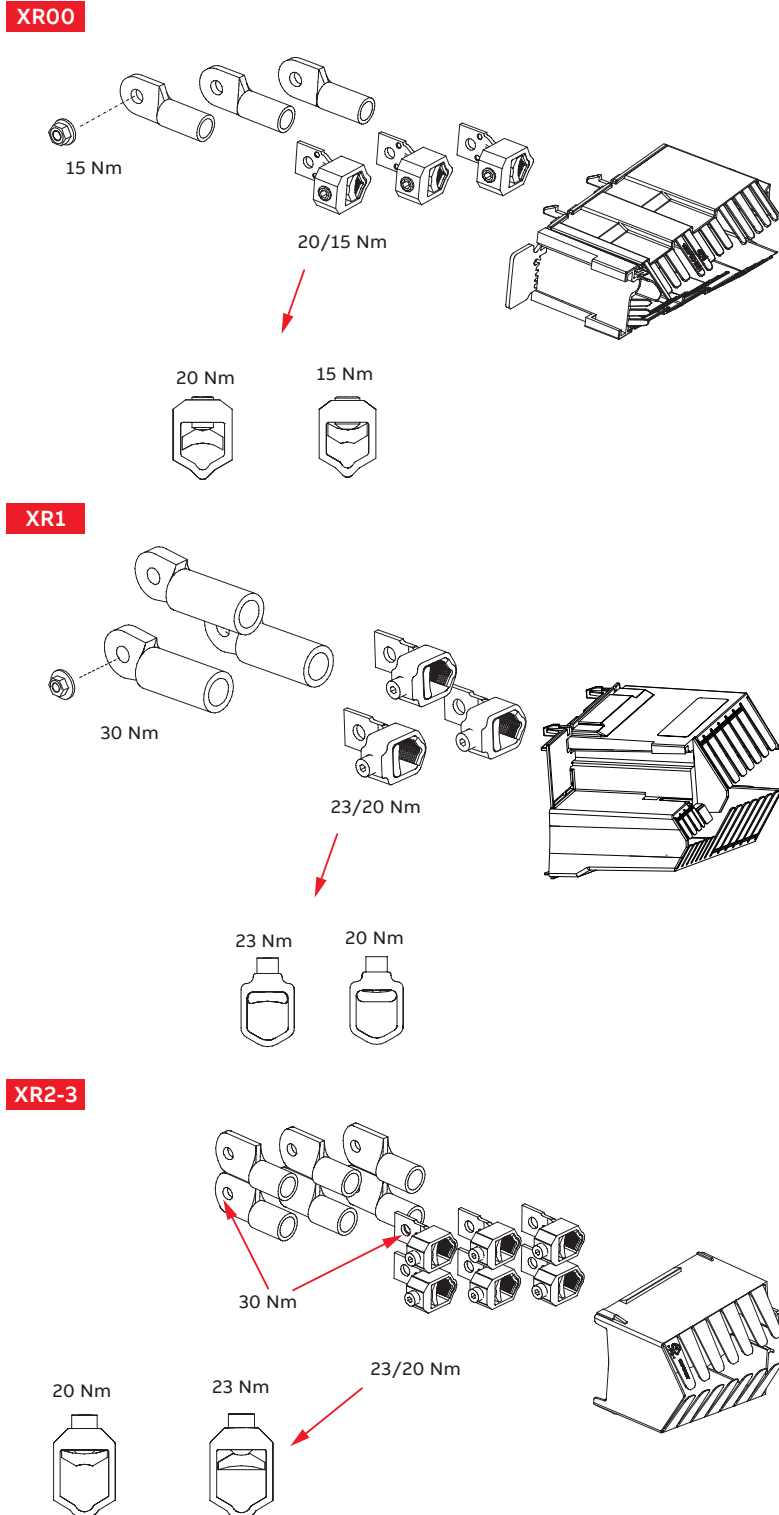


Figure 4-63 SlimLine modules cable connection

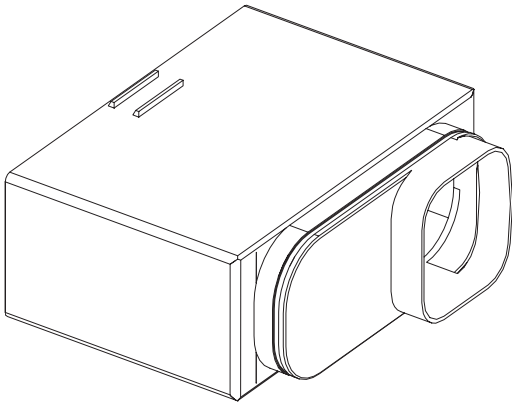


Figure 4-64 Additional cable protection shroud for neutral conductor in SlimLine module

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 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 may be directly at 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

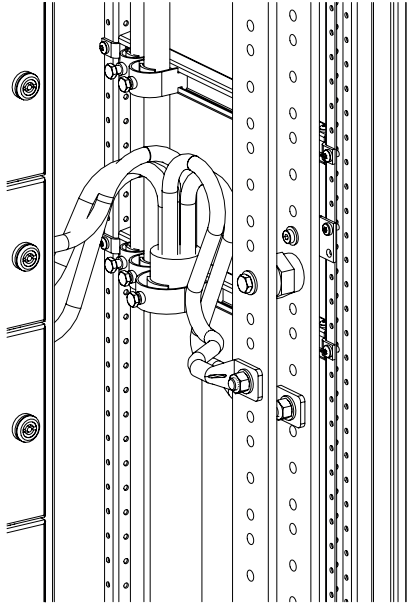


Figure 4-65 Example of front access protection and neutral conductor connection

Power and control cable installation for Rear access switchgear.

Torque values from Table 4-15 shall be observed.

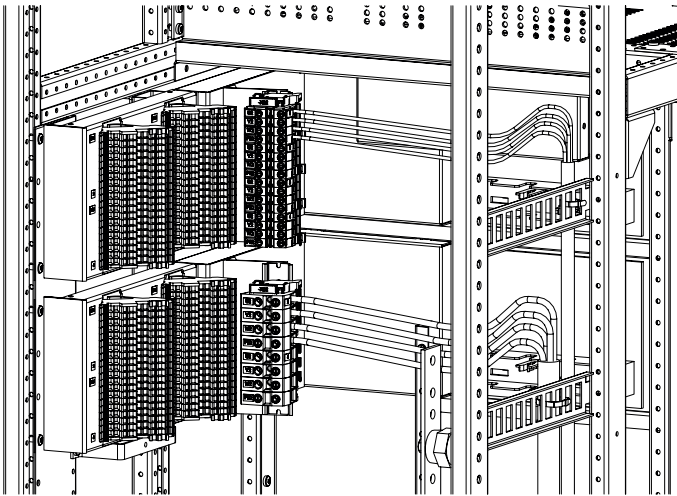


Figure 4-66 Example of MNS Rear cable runs, module sizes 8E/4 and 8E/2

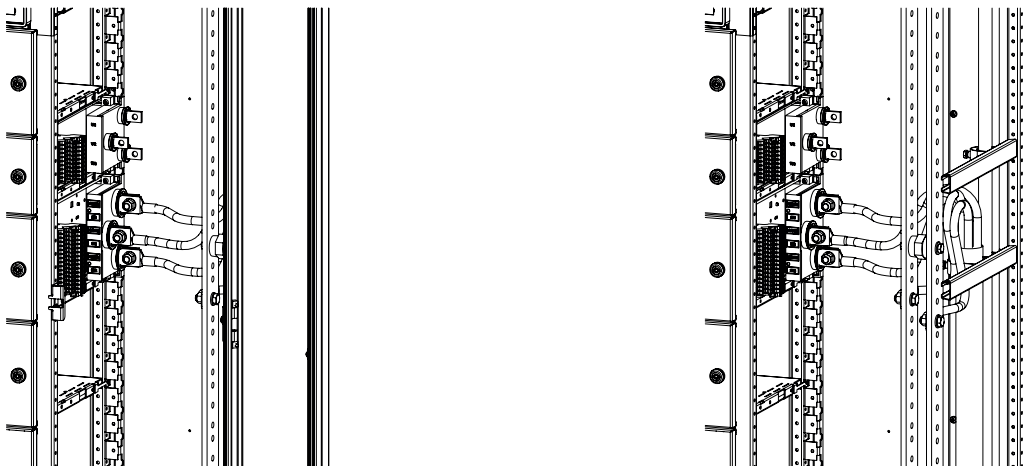


Figure 4-67 Example of cable runs, withdrawable module size $\geq 4E$

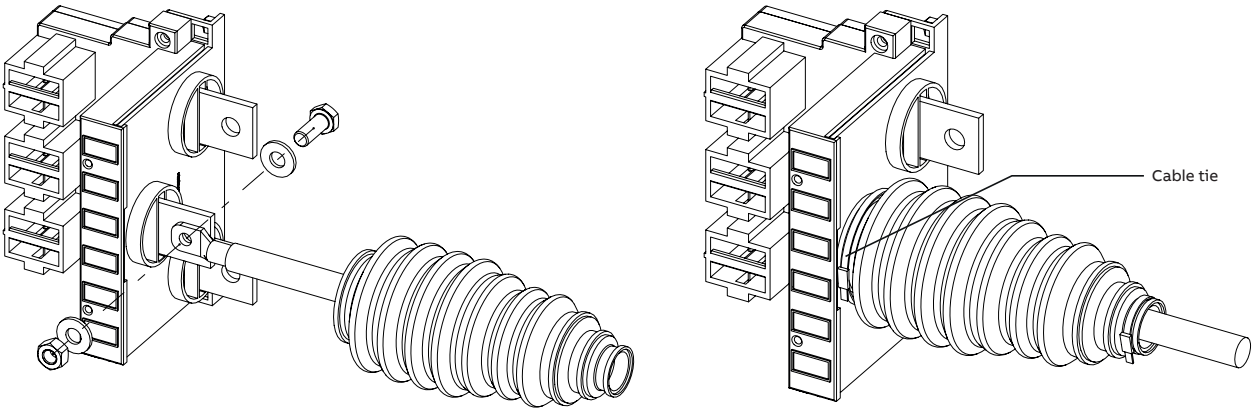


Figure 4-68 Cables provided with belows for $\geq 4E$ withdrawable modules

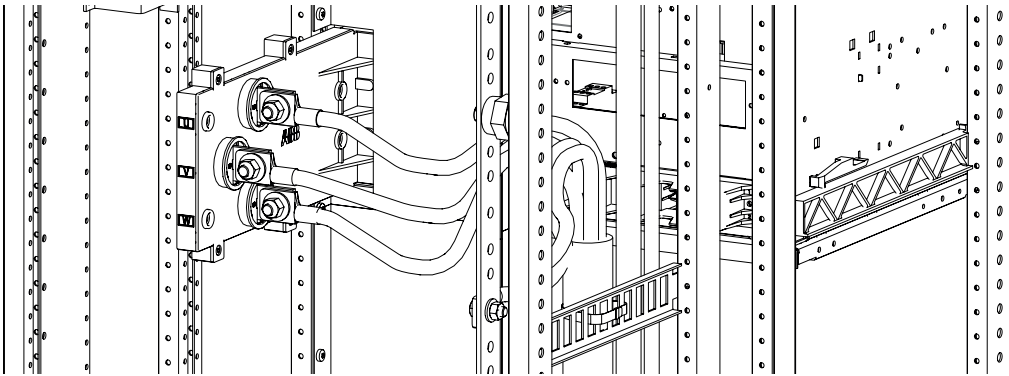


Figure 4-69 Example of MNS Rear cable runs, module size $\geq 4E$

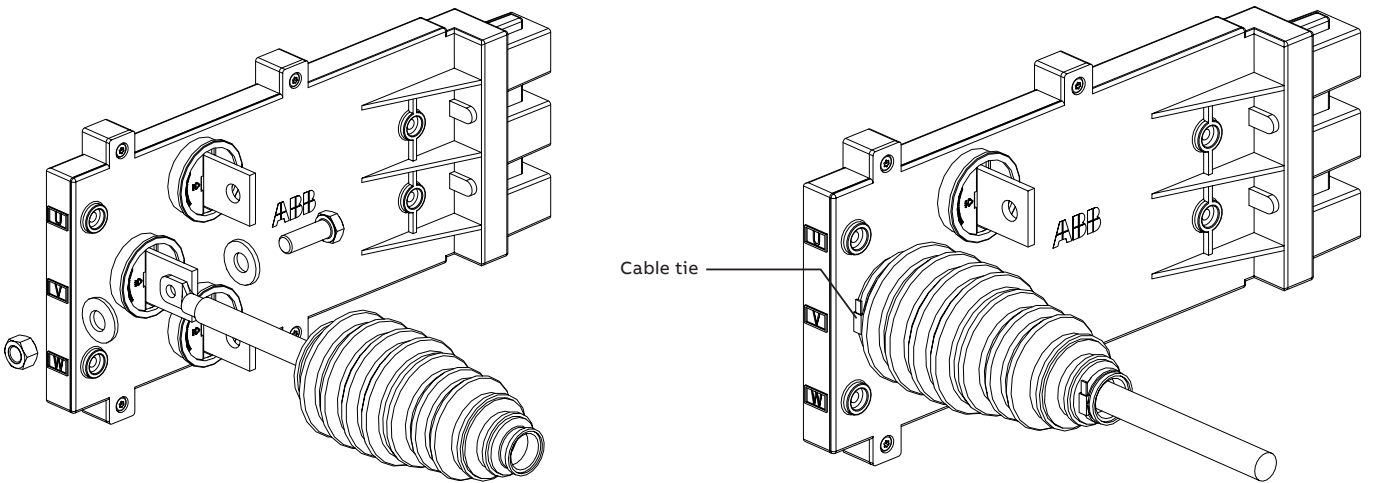


Figure 4-70 MNS Rear cables provided with belows for $\geq 4E$ modules

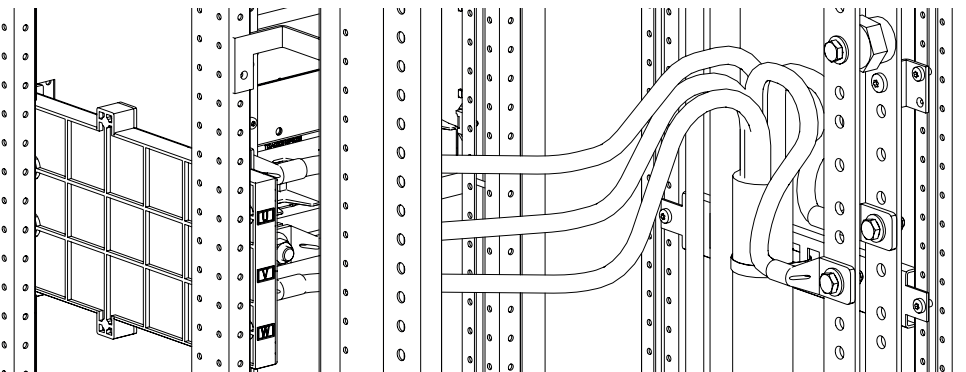


Figure 4-71 Example of MNS Rear access protection and neutral conductor connection

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 distribute particulates 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. length 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.

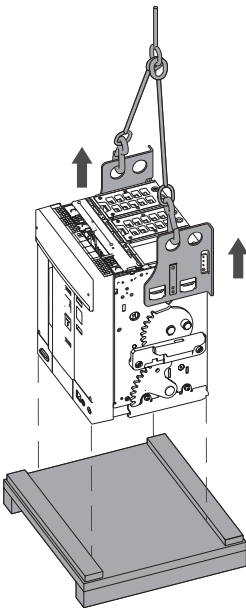


Figure 4-72 Top lifting of ACB withdrawable and fixed part



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 4-70.

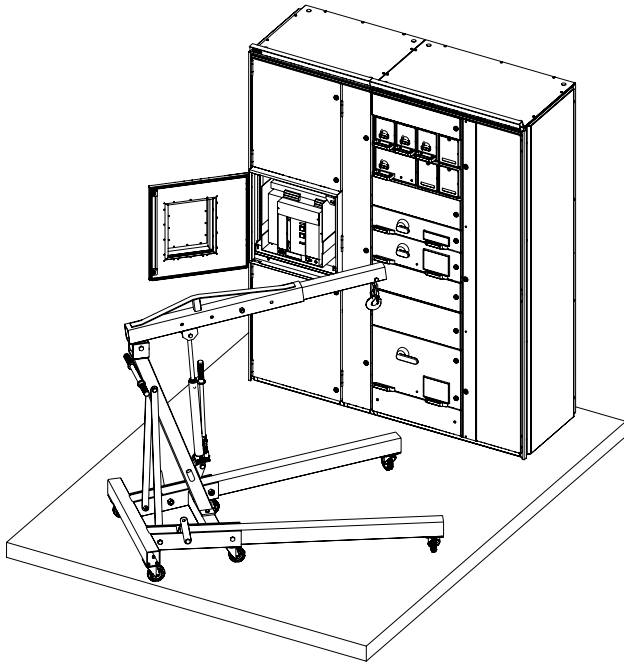


Figure 4-73 Installation of air circuit breaker Emax2 using lifting truck

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!.

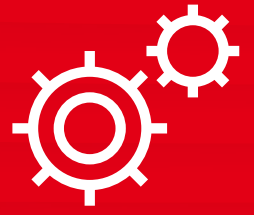
Steps to follow to check proper conditions of SPD and back-up protection:

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!



Commissioning

5.1	Introduction	119
5.2	Commissioning check lists	120
5.2.1	General commissioning checks according to IEC 61439-2	121
5.2.2	Commissioning checks on de-energized switchboard	121
5.2.3	Commissioning checks on energized switchboard	121

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 equipment 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 performed 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 performing 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 switchboard 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 regulations 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.



Operation

6.1	Normal service conditions	126
6.1.1	Ambient air temperature	126
6.1.2	Humidity conditions for indoor installations	126
6.1.3	Pollution degree	126
6.1.4	Altitude	126
6.2	Special service conditions	126
6.3	Opening of doors	127
6.3.1	IP protection cover	128
6.4	Special considerations when working on electrical equipment	130
6.4.1	Description of Emax2 – Low voltage air circuit-breaker	130
6.4.2	CT's	131
6.4.3	Racking IN/OUT withdrawable ACB	132
6.4.4	Auxiliary recess	133
6.4.5	Auxiliary recess with spring bolts	135
6.4.6	Auxiliary recess without spring bolts	136
6.5	Electrical equipment – Fixed modules operation	137
6.5.1	Fixed modules switch handle	138
6.6	Electrical equipment – Plug-in modules operation	139
6.6.1	Plug-in modules	139
6.6.2	Plug-in modules switch handle	140
6.7	Electrical equipment – SlimLine XR plug-in modules	141
6.8	Electrical equipment – Reactive power compensation modules	144
6.9	Electrical equipment – Withdrawable modules	145
6.9.1	Withdrawable units size 8E/4 and 8E/2	145
6.9.2	Withdrawable units size 4E up to 24E	146
6.9.3	Resetting circuit breakers in withdrawable modules	148
6.9.4	Opening the door of 4E-24E modules while still in operation	150
6.9.5	Padlocking of handles	151
6.9.6	Padlocking of doors	151
6.10	Operation of function units	153

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, chapter 7.1 Normal service conditions.

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.

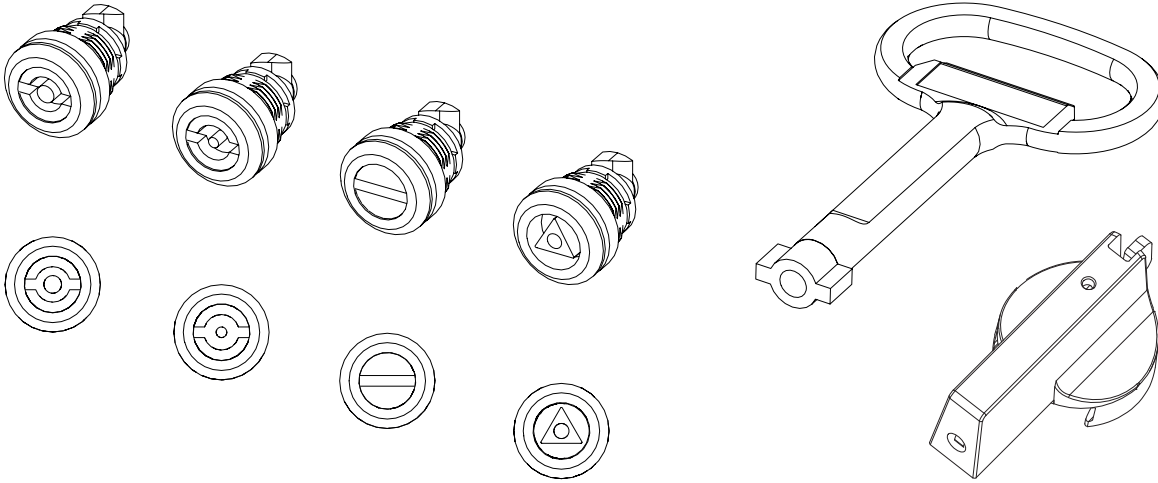


Figure 6-01 Locking alternatives used with MNS standard (left), double bit key and handle with key for slotted lock (right)



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

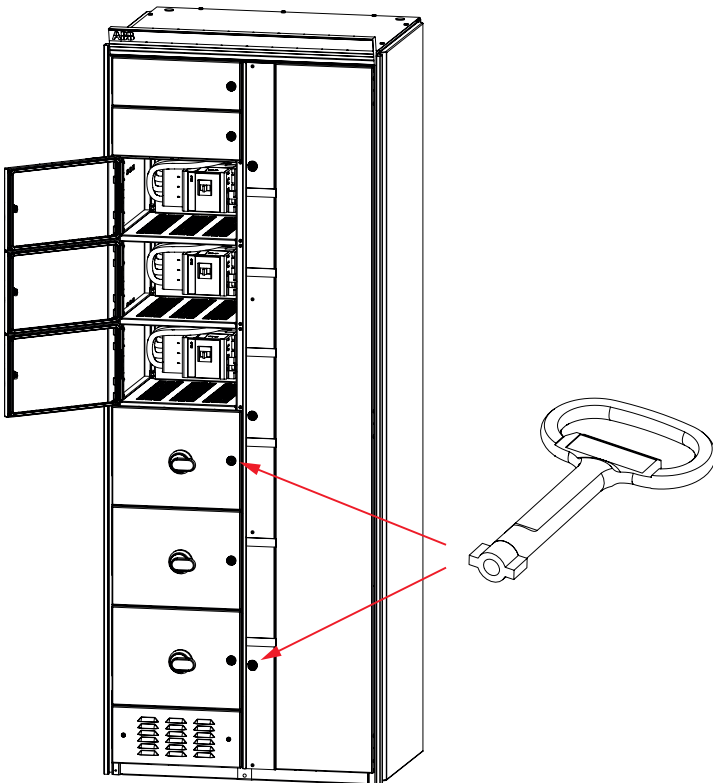


Figure 6-02 Opening of module door with 5 mm double bit key

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

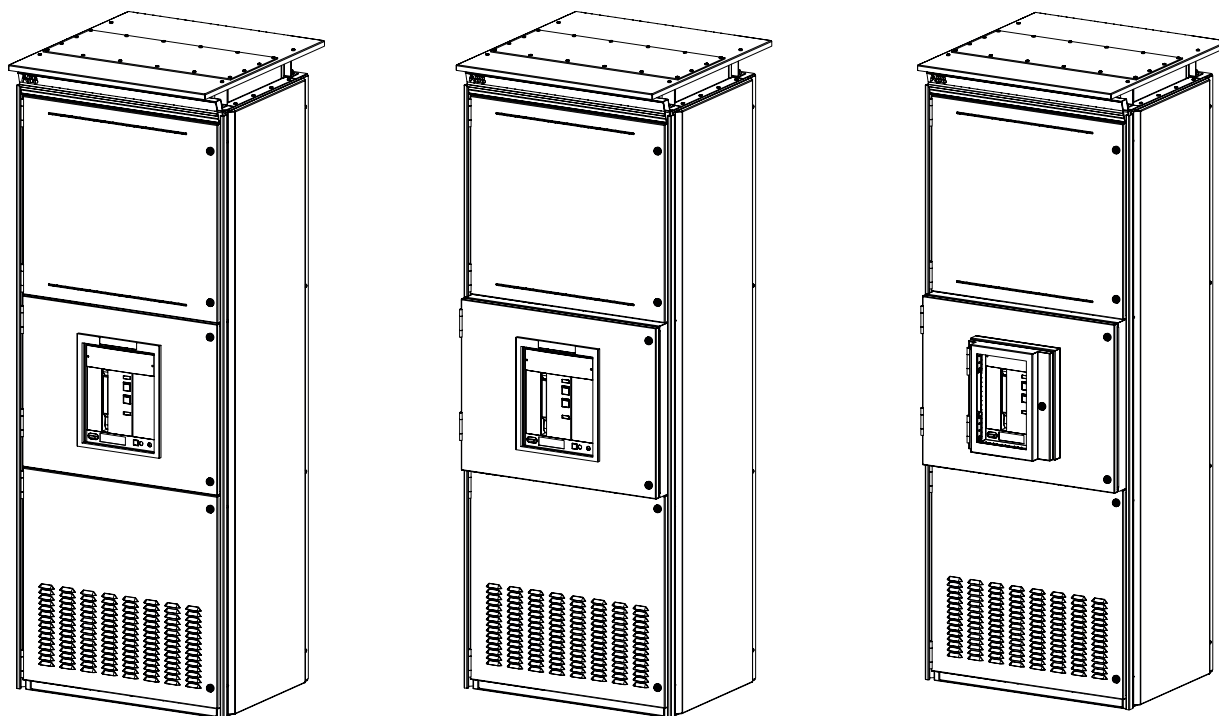


Figure 6-03 Typical ACB door (left) / typical ACB door with pagoda (middle) / typical ACB door with IP cover and pagoda

Note:

For ACB sections 1000 mm and 1200 mm wide split door designs may be utilised for the top and bottom door designs. The ACB compartment then utilises a cover. This covers is secured with four locks and if fitted with handles to aid with removal when required.

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.

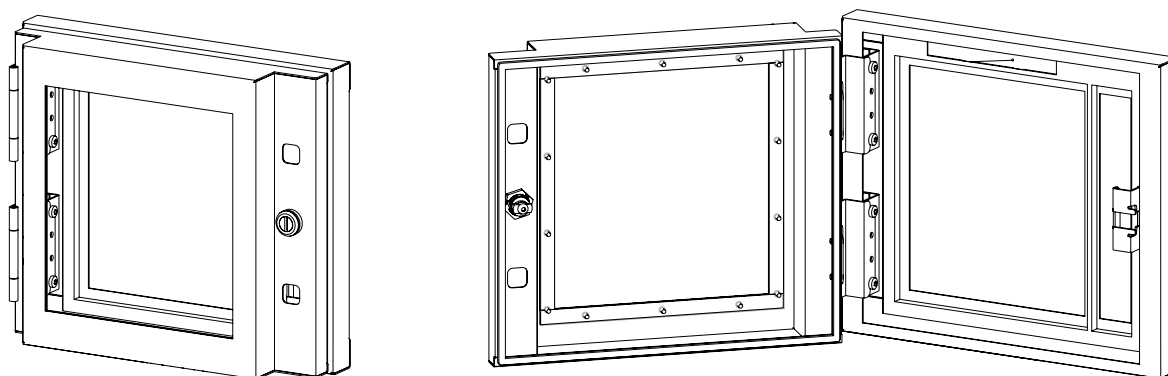


Figure 6-04 IP protection cover

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.

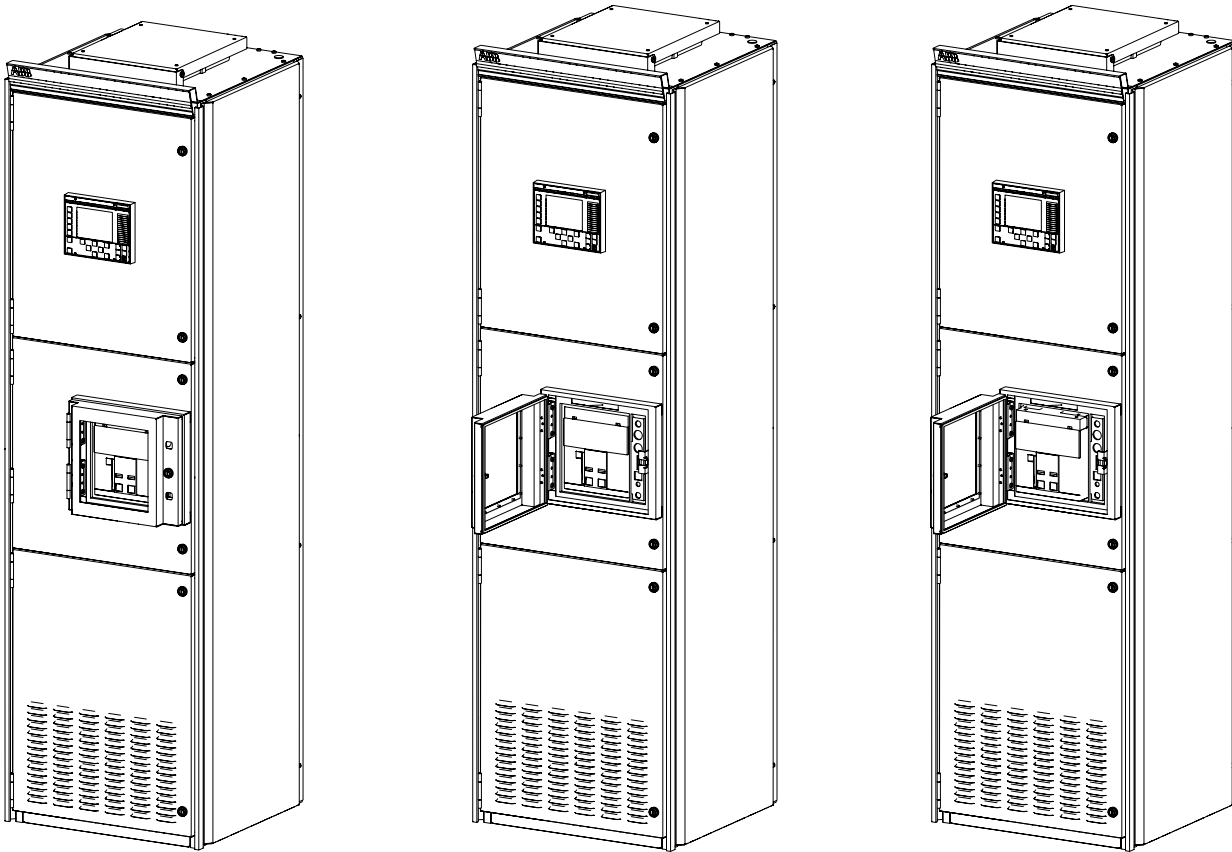


Figure 6-05 IP protection cover (closed / opened / opened with ACB in isolated position)

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

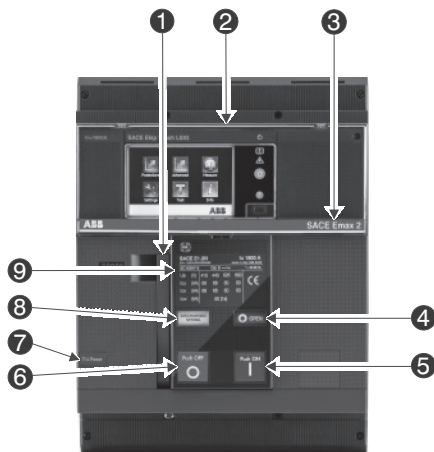
Emax E1.2	
Pos.	Description
1	Lever for manually loading the closing springs
2	SACE Ekip protection release
3	Name of the circuit-breaker
4	Open-closed signalling device
5	Closing pushbutton
6	Opening pushbutton
7	Release tripping mechanical signal
8	Spring loaded-unloaded signalling device
9	Electrical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

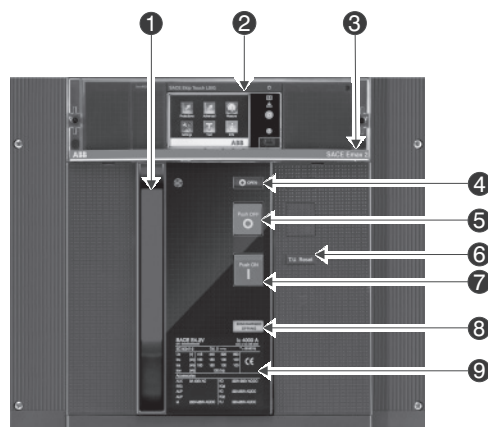
Table 6-01 Main components of the circuit breaker

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

Emax E1.2

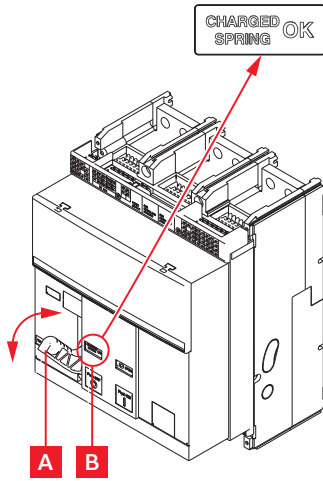


Emax E2.2 to E6.2

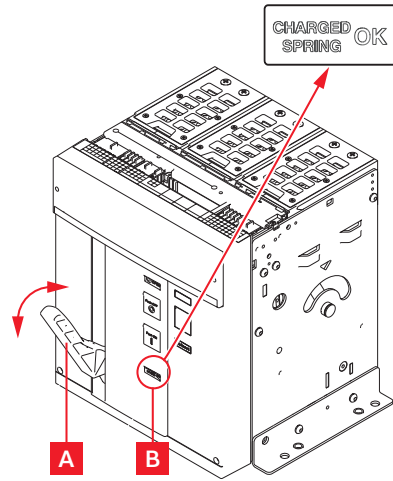


6.4.2 Manual operation

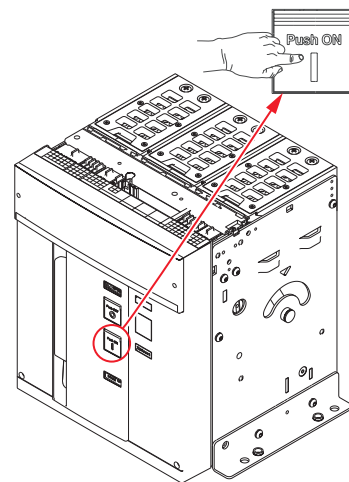
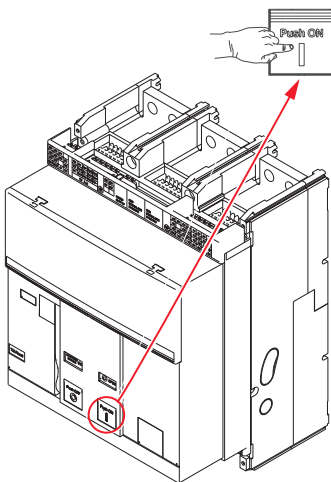
Emax E1.2



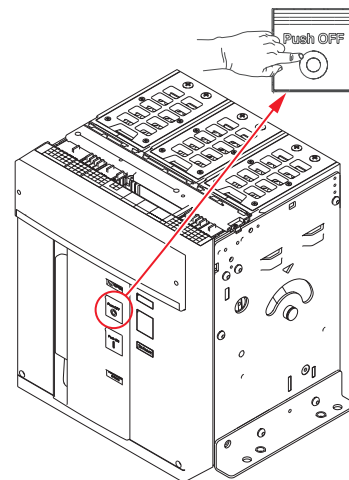
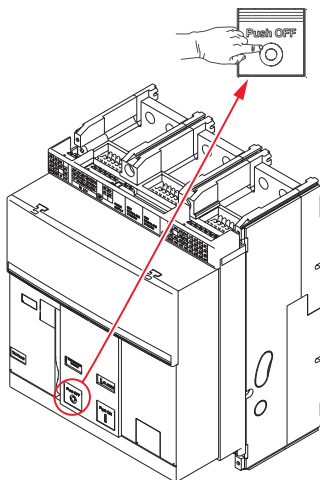
Emax E2.2 to E6.2



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.



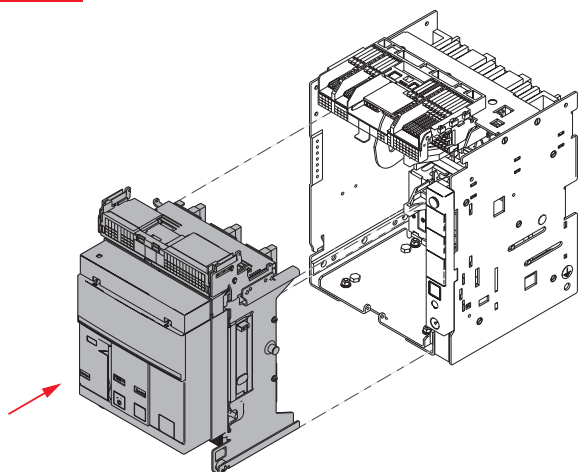
Manual closing of ACB – Press the closing push-button “I – Push ON” as indicated



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

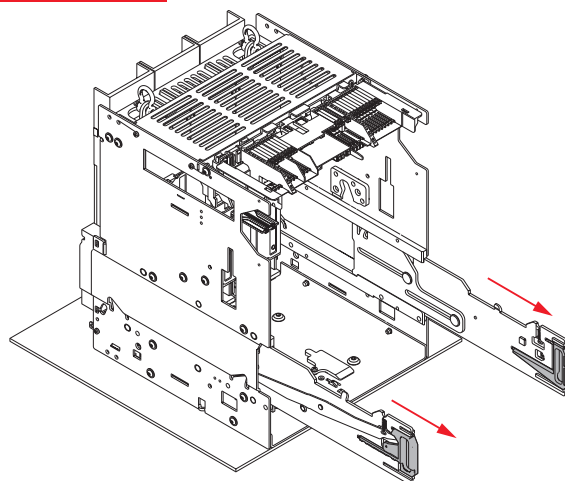
6.4.3 Racking IN/OUT withdrawable ACB

Emax E1.2

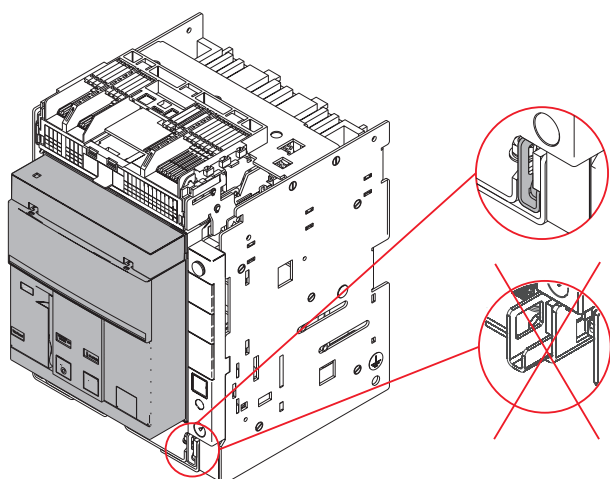


Position the moving part in the fixed part.

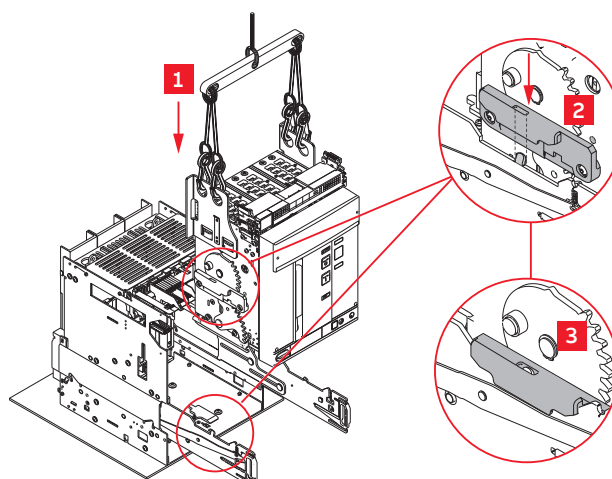
Emax E2.2 to E6.2



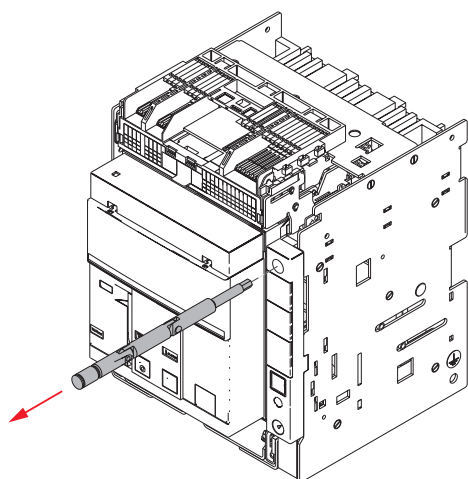
Position the moving part over the guides of the fixed part.



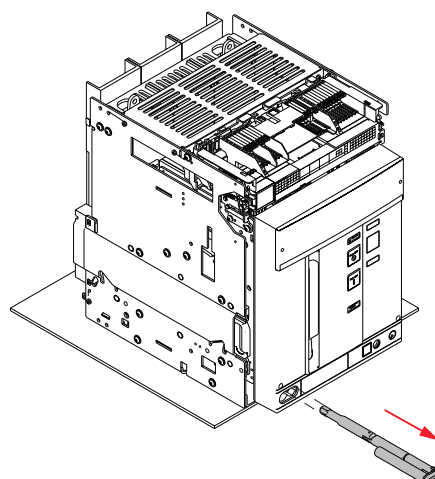
Push until it comes to a stop.



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

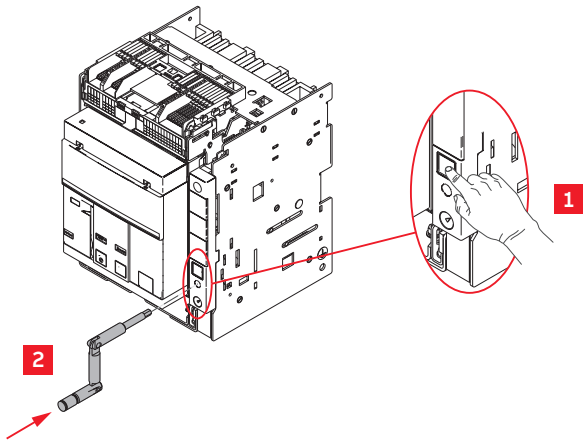


Extract the disconnection crank from its housing.

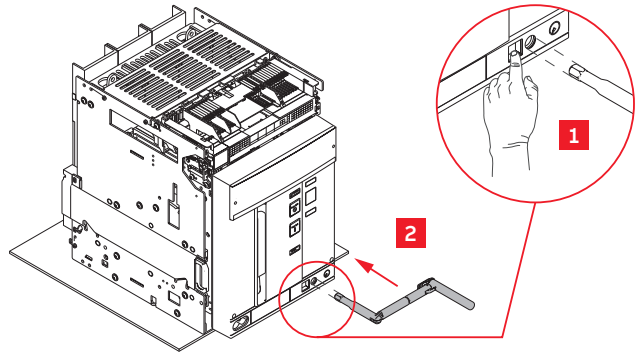


Extract the disconnection crank from its housing.

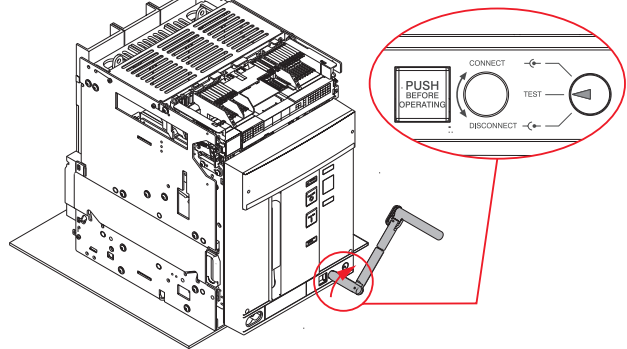
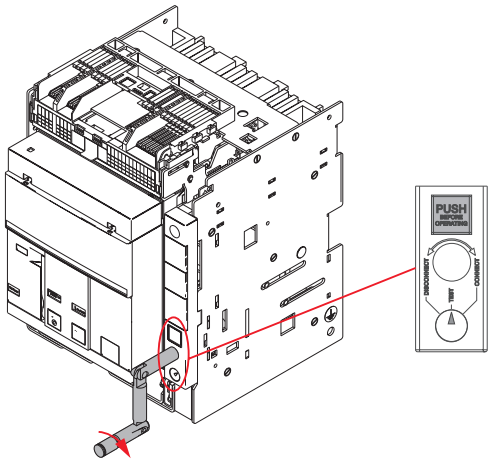
Emax E1.2



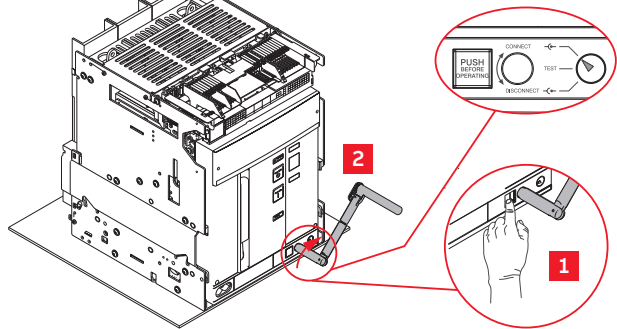
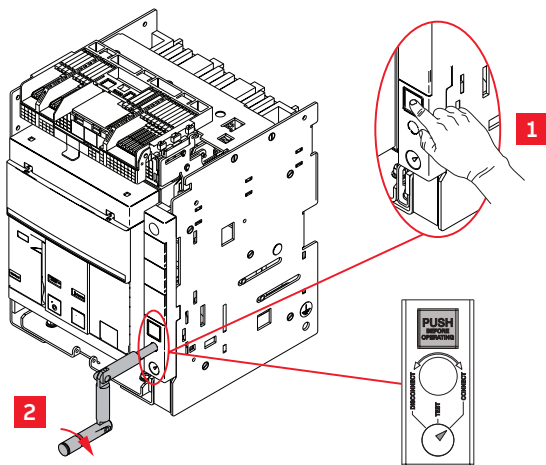
Emax E2.2 to E6.2



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.

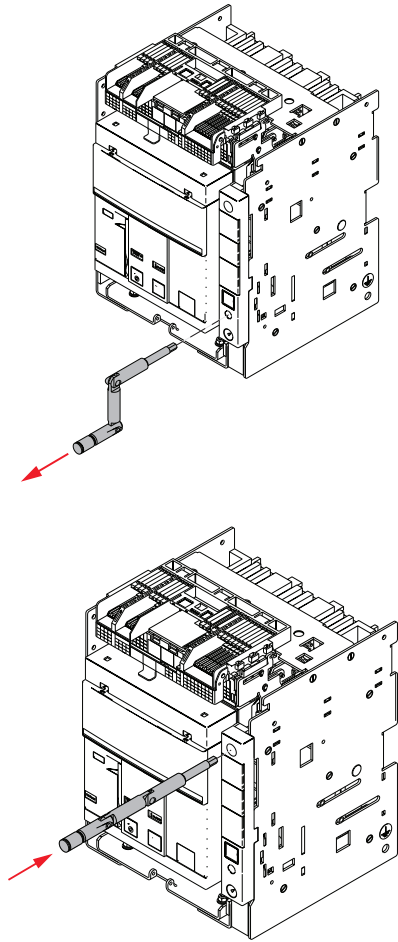


Turn the crank clockwise until the pushbutton comes out and the indicator shows that the circuit-breaker is in **TEST** position.

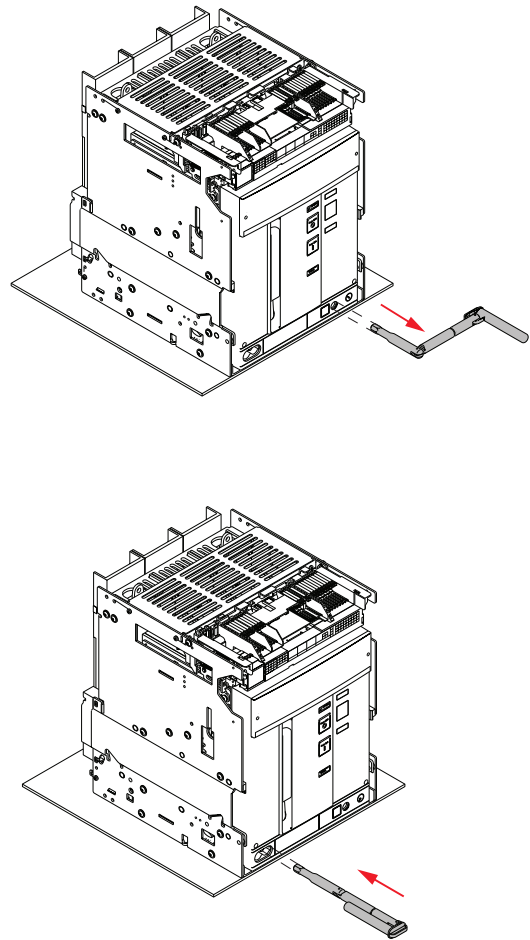


Press the lock button and then rotate the crank clockwise until the button comes out and the indicator shows that the circuit-breaker is in the **CONNECTED** position.

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

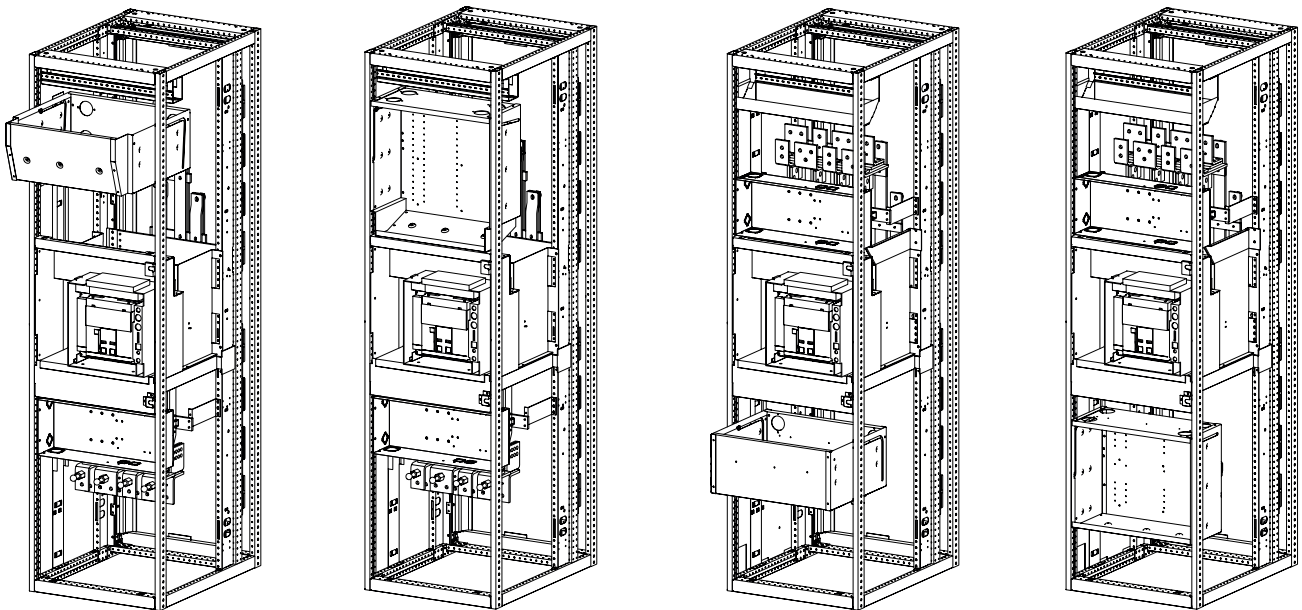


Figure 6-06 Top and bottom auxiliary recess in mounting and standard position



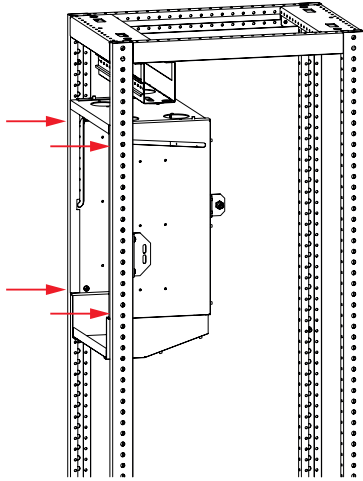
Be careful whilst moving the auxiliary recess. Carelessness may cause trapping of hands!
 Be careful whilst moving the auxiliary recess. The fully equipped auxiliary recess can weigh over 80 kg!
 Observe all safety rules for working on electrical equipment!

6.4.5 Auxiliary recess with spring bolts

Moving procedure steps for sections with vertical copper arrangement

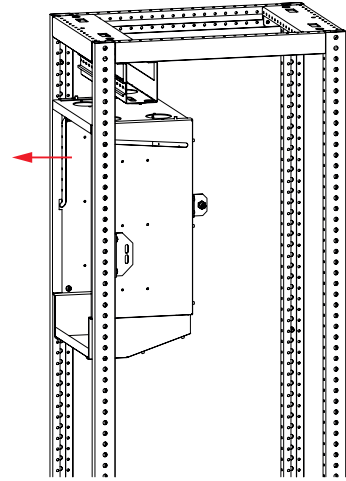
To achieve access to the rear area behind the auxiliary recess, follow the next steps. The guide rail is integrated into the auxiliary recess to ensure the path of moving process and prevent it from accidental falling. The auxiliary compartment is fixed to the C-profile by spring bolts. It can be placed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

1



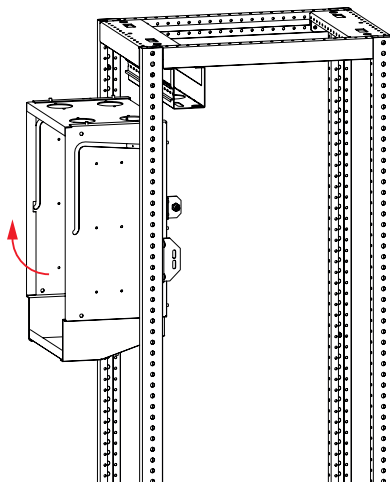
Step 1: Unscrew the four fixing screws.

2



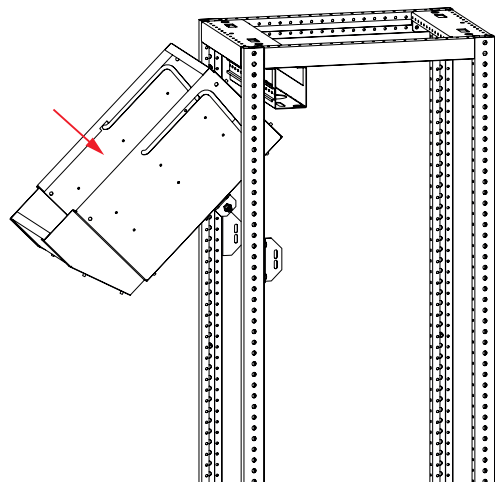
Step 2: Slide the recess out of the section with a forward motion.

3



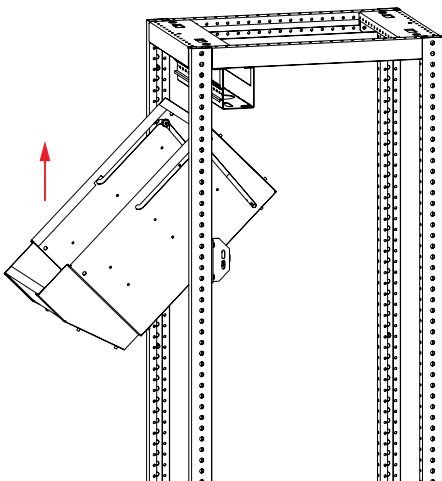
Step 3: Rotate from bottom with an upwards motion.

4



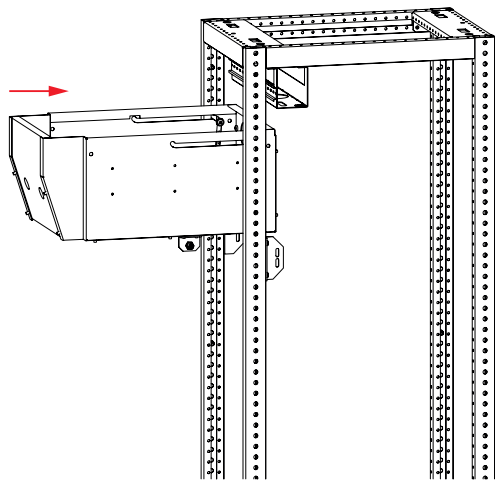
Step 4: The top of the recess rotates down.

5

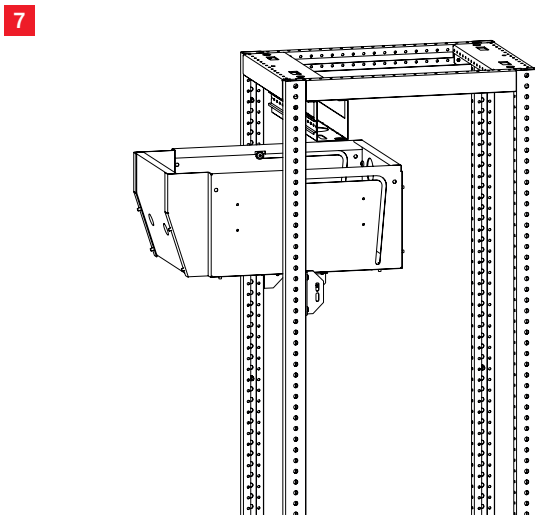


Step 5: It is then possible to move the recess upwards towards its final position.

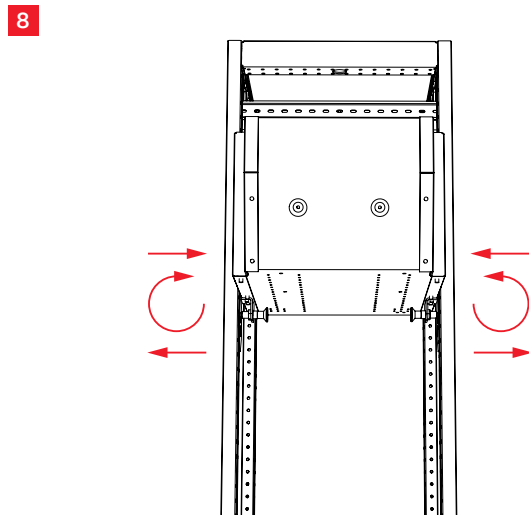
6



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



Step 7: Recess in the section.



Step 8: Fix the recess with the spring bolts.

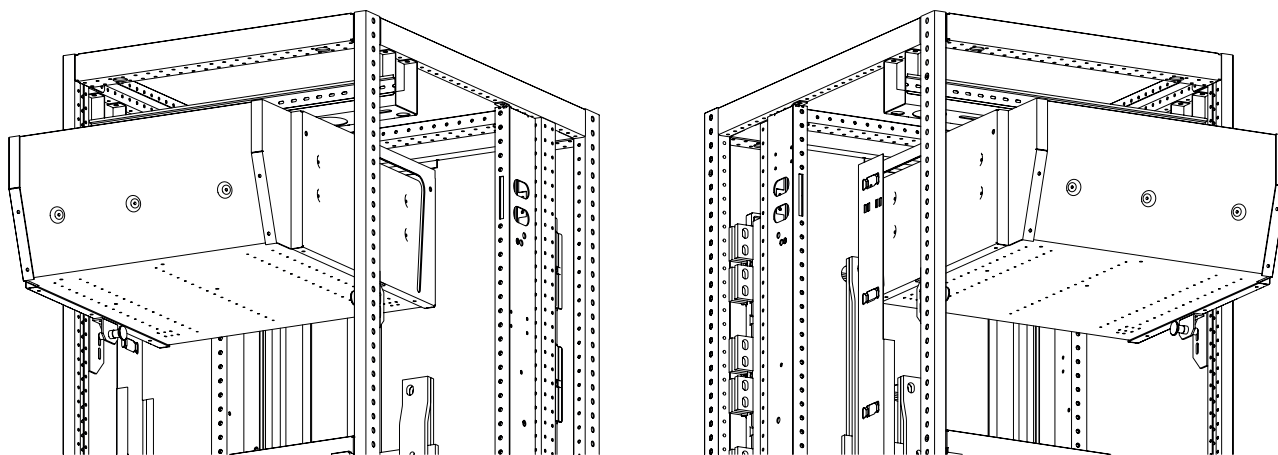


Figure 6-07 Fixing the recess with spring bolts / detail

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.

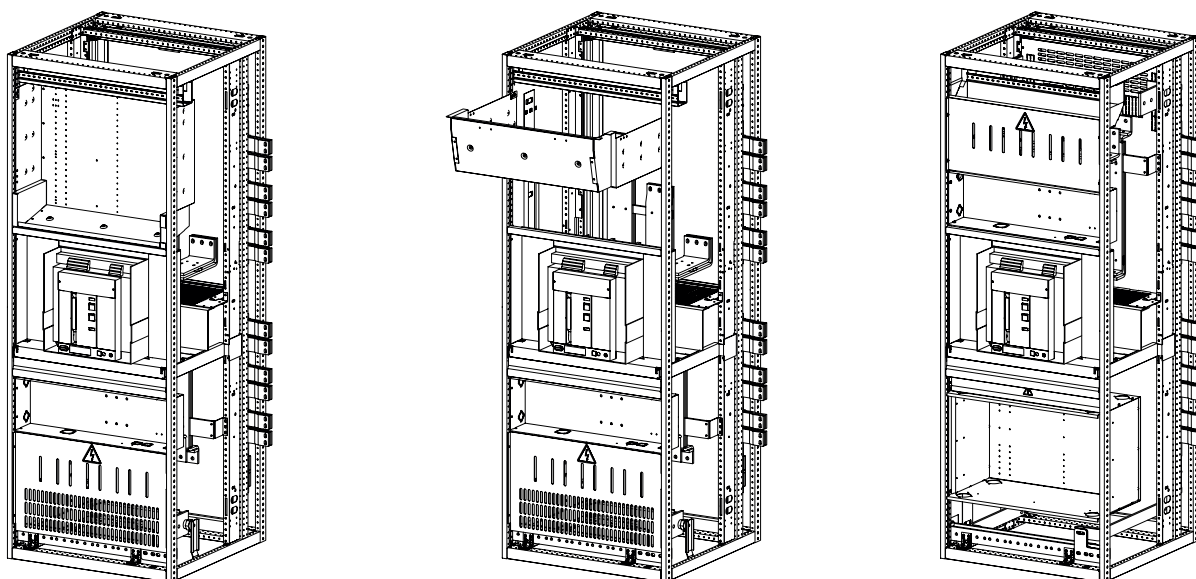


Figure 6-08 Top auxiliary recess in standard and mounting position and bottom auxiliary recess in standard position

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 10-01: 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.

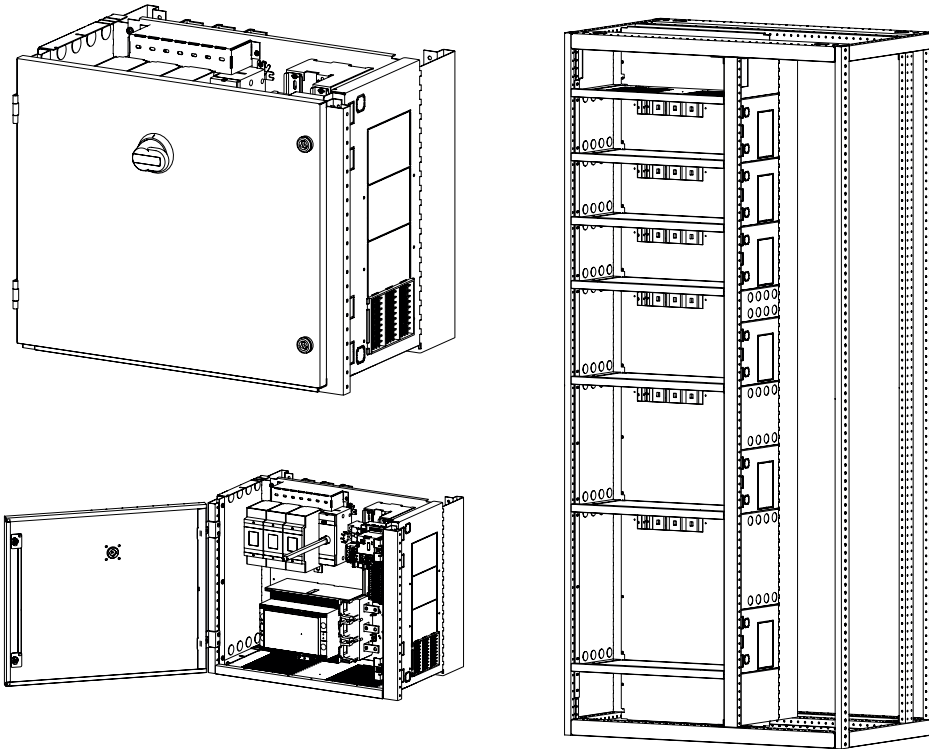


Figure 6-09 Fixed module example open and close (left), fixed empty section example (right)

6.5.1 Fixed modules switch handle

Table below illustrates basic positions of fixed module standard handles.

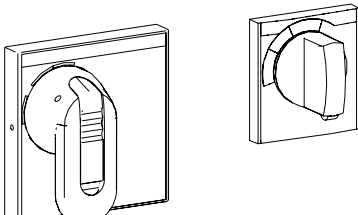
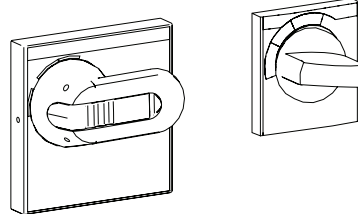
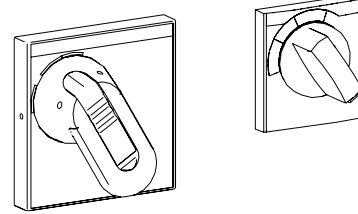
Position of the switch		Main and control circuits
	<p>ON</p>	<p>All main circuits are closed. Handle position has no influence on control circuits.</p>
	<p>OFF Can be locked with 3 padlocks, see 6.9.5</p>	<p>All main and control circuits are disconnected. Handle position has no influence on control circuits.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

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

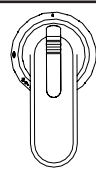
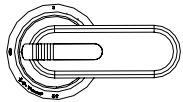
Position of the switch		Main and control circuits
	<p>ON</p>	<p>All main and control circuits are closed</p>
	<p>OFF Can be locked with 3 padlocks,</p>	<p>All main and control circuits are disconnected</p>

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.

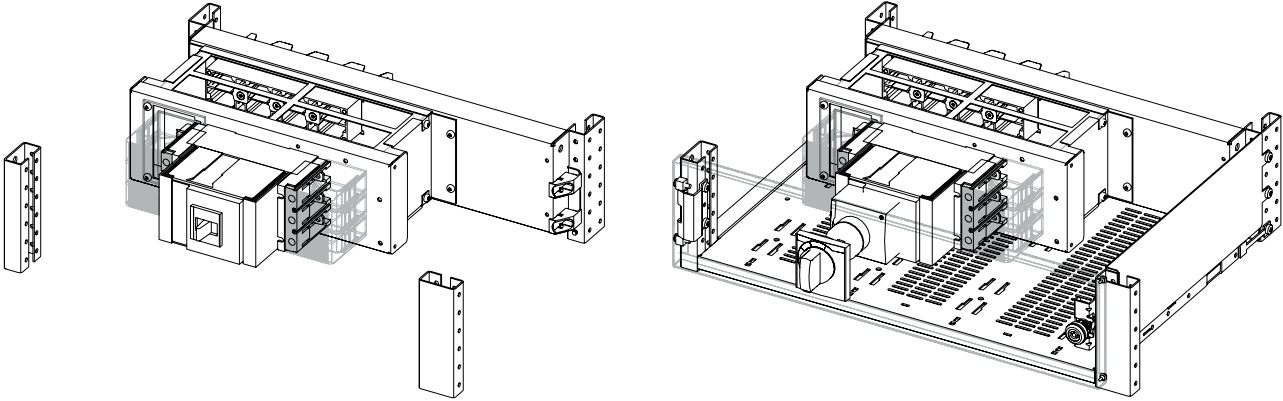


Figure 6-10 Plug-in module example with inside (left) and outside operation (right)

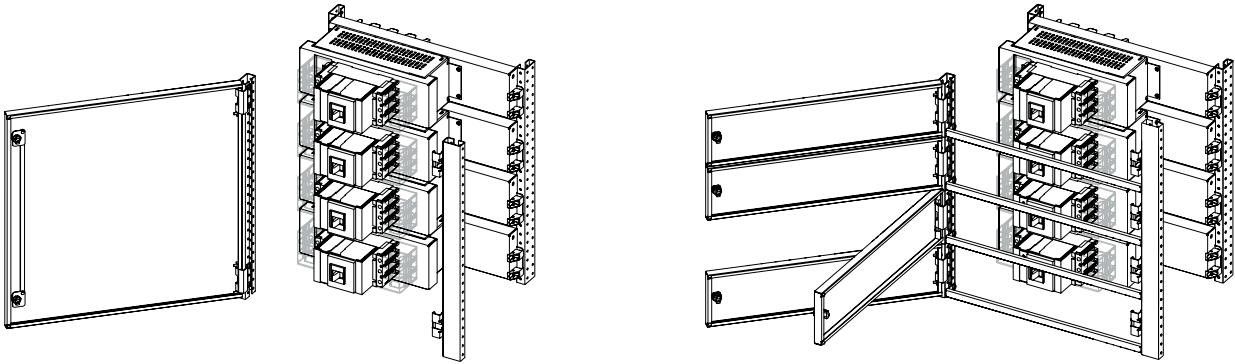


Figure 6-11 MNS section with plug-in modules with different door configuration

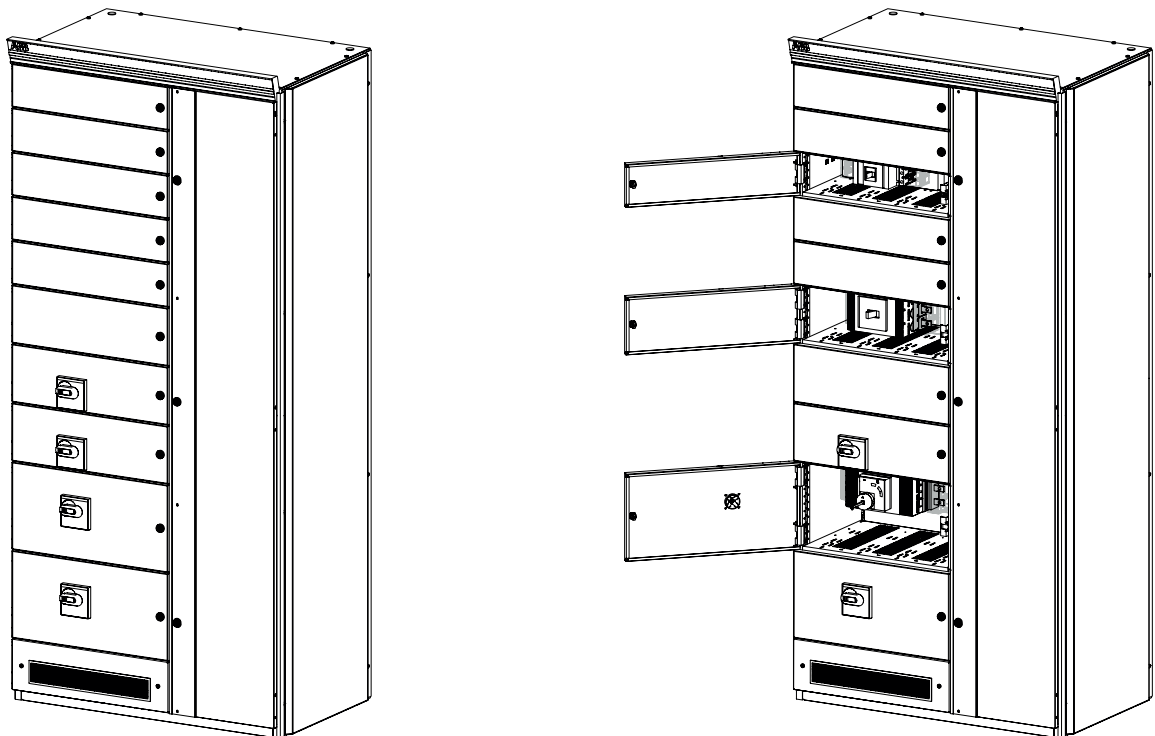


Figure 6-12 MNS section with plug-in modules (inside & outside operation)

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.

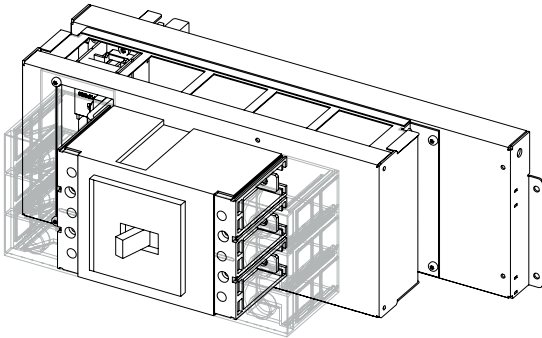


Figure 6-13 Operation directly with MCCB lever

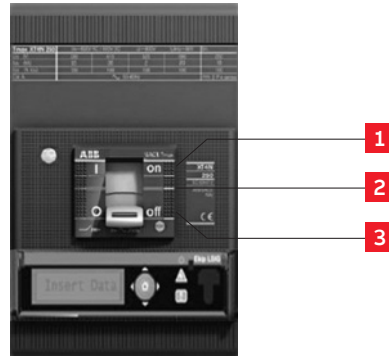


Figure 6-14 Generic facia from MCCB

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.

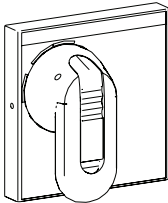
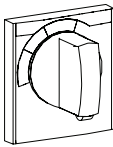
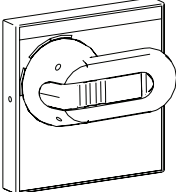
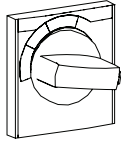
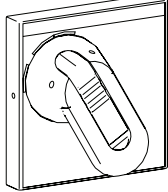
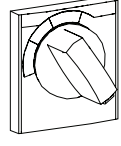
Position of the switch		Main and control circuits
 	<p>ON</p>	<p>All main circuits are closed. Handle position has no influence on control circuits.</p>
 	<p>OFF Can be locked with 3 padlocks, see 6.9.5</p>	<p>All main and control circuits are disconnected. Handle position has no influence on control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

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

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

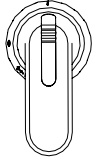
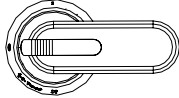
	Position of the switch	Main and control circuits
	ON	All main and control circuits are closed
	OFF Can be locked with 3 padlocks,	All main and control circuits are disconnected

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.

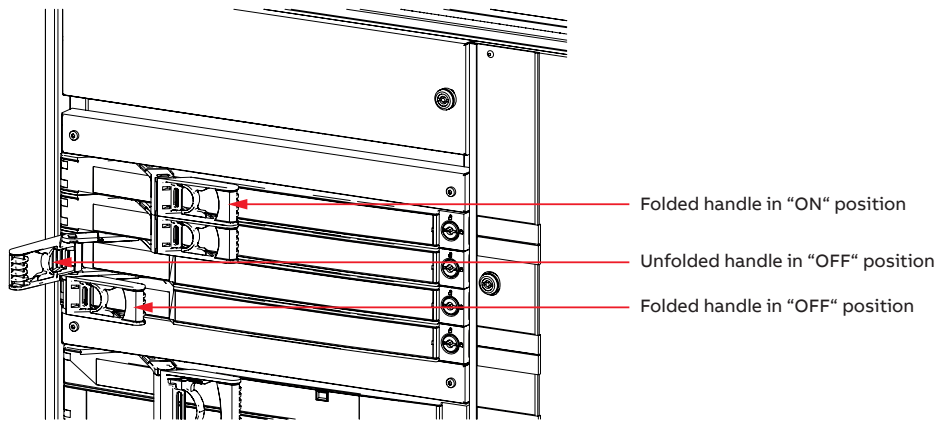


Figure 6-15 SlimLine folded handel in “ON” and in “OFF position”

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

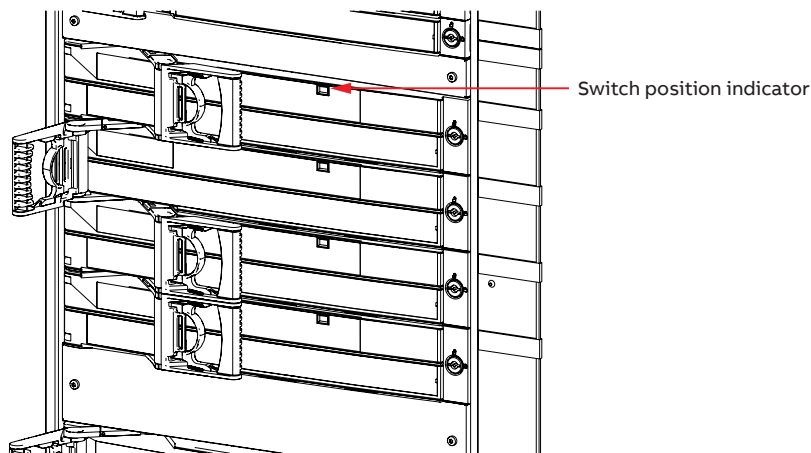


Figure 6-16 The true ON / OFF position is shown by the switch indicator in front.

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

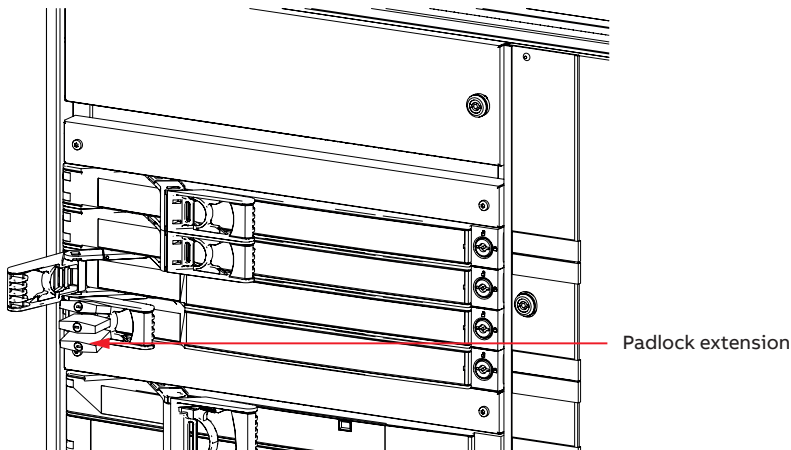
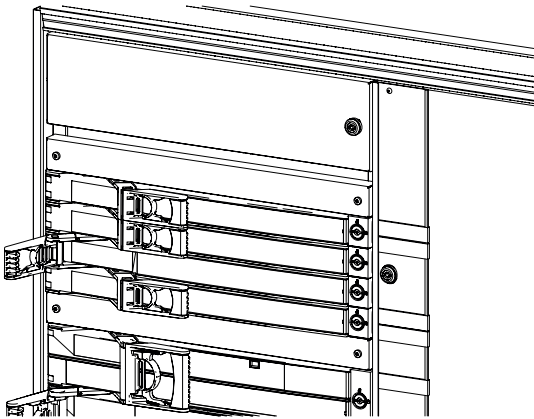


Figure 6-17 Padlocking the XR module

Replacement of the NH fuses in the XR

This procedure 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.

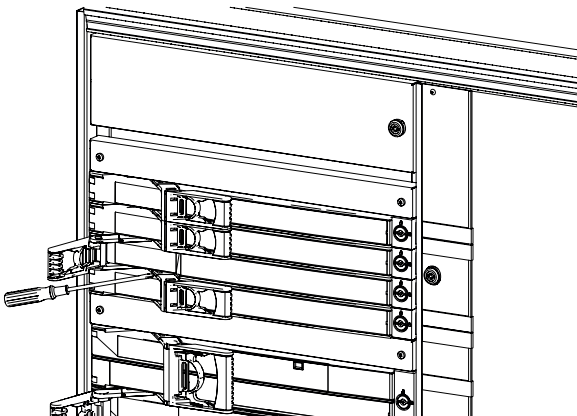


Figure 6-18 Replacement of the NH fuses in the XR

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.

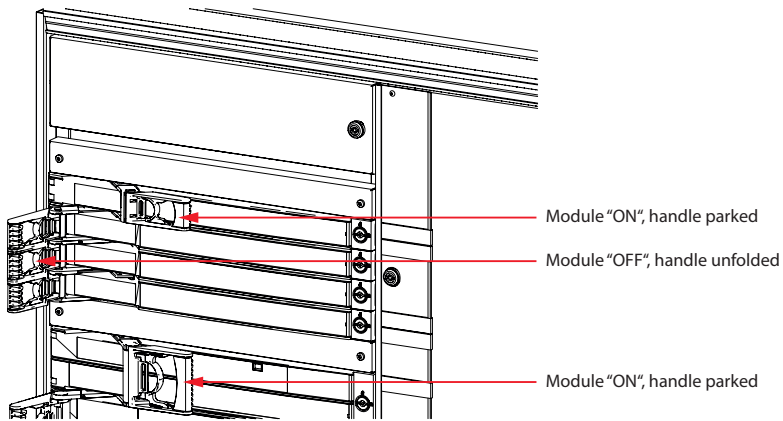


Figure 6-19 Replacement of the NH fuses in the XR

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.

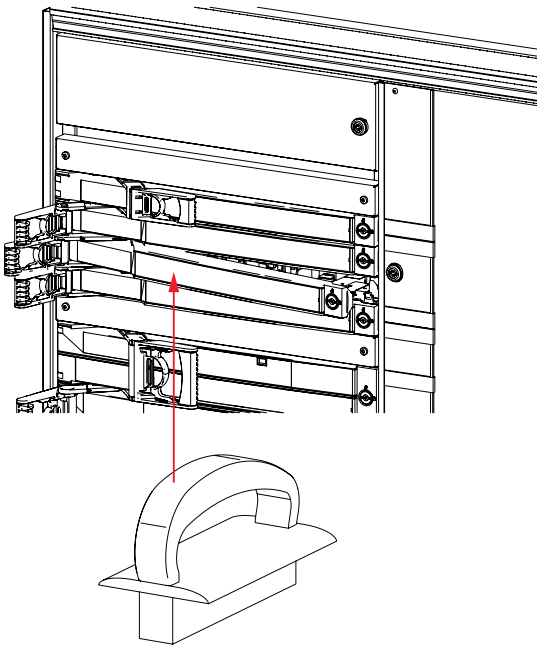


Figure 6-20 Replacement of the NH fuses in the XR shall be completed with the use of the tool shown above

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 automatically 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

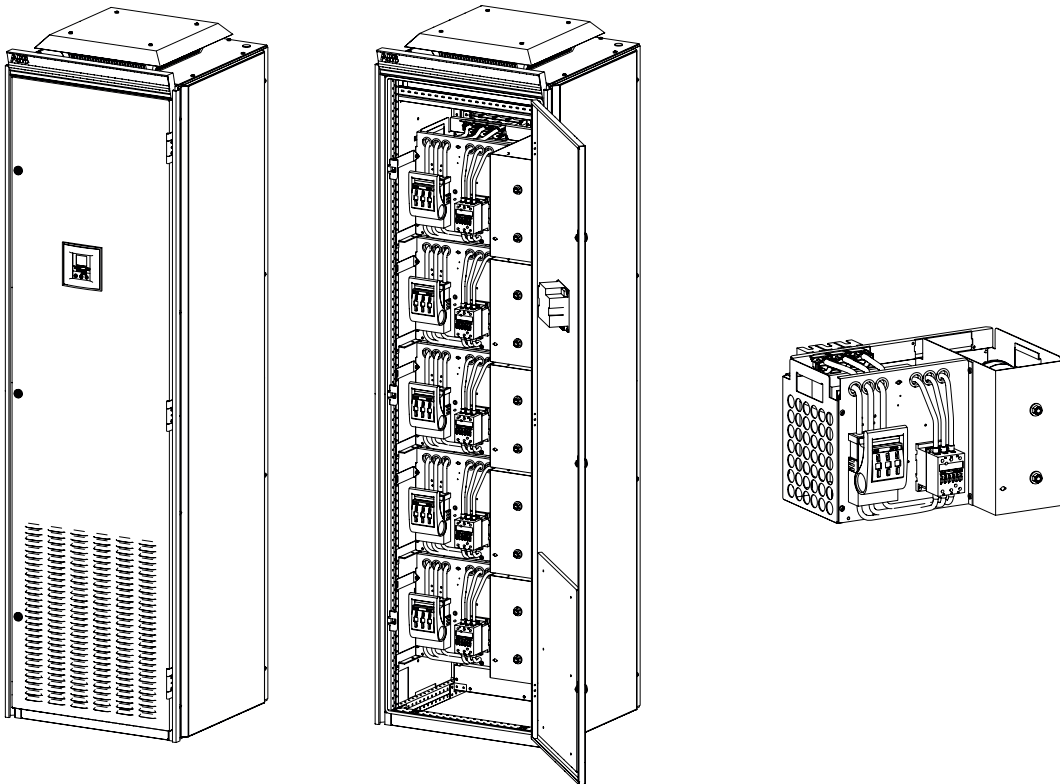


Figure 6-21 MNS section with reactive power compensation moduels

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.

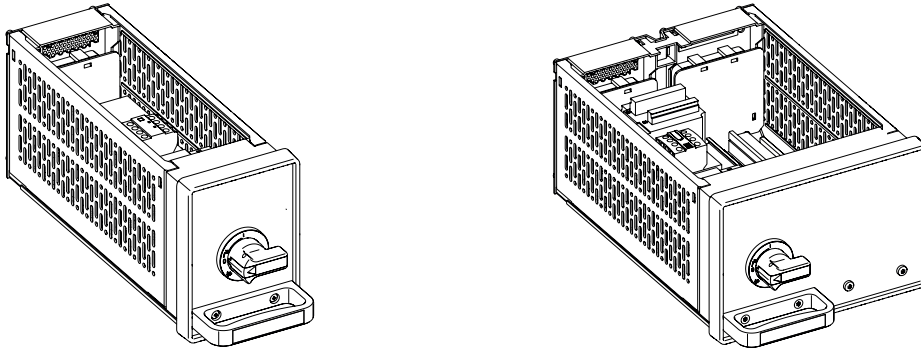


Figure 6-22 Example of small modules, size 8E/4 (on the left side) and 8E/2 (on the right side)

The handle for operating short-circuit protection 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”.

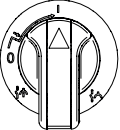
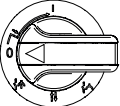
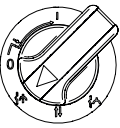
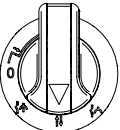
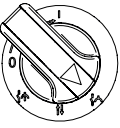
	Position of the switch	Position of the module and applicable degree of protection	Main and control circuits
	ON	in section corresponds with the degree of protection of the assembly, minimum IP 30	All main and control circuits are closed
	OFF Can be locked with 3 padlocks, see 6.9.5	in section corresponds 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.

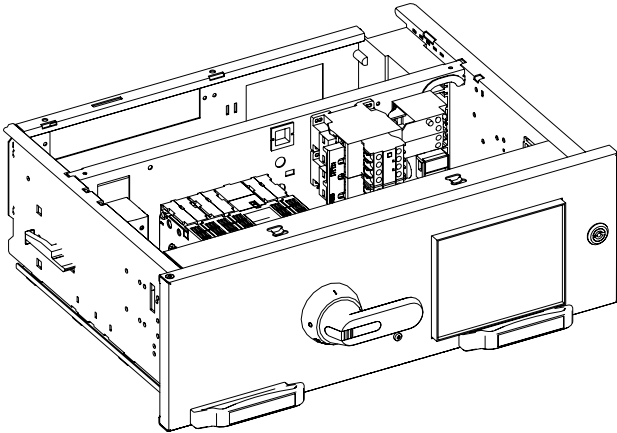


Figure 6-23 Example of standard module size 8E

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 main and control-circuits by moving the withdrawable module to the isolated position.

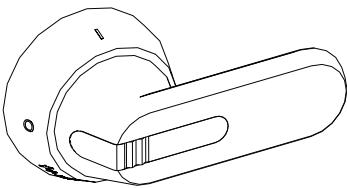


Figure 6-24 Operating handle for withdrawable modules $\geq 4E$

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 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 is 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.

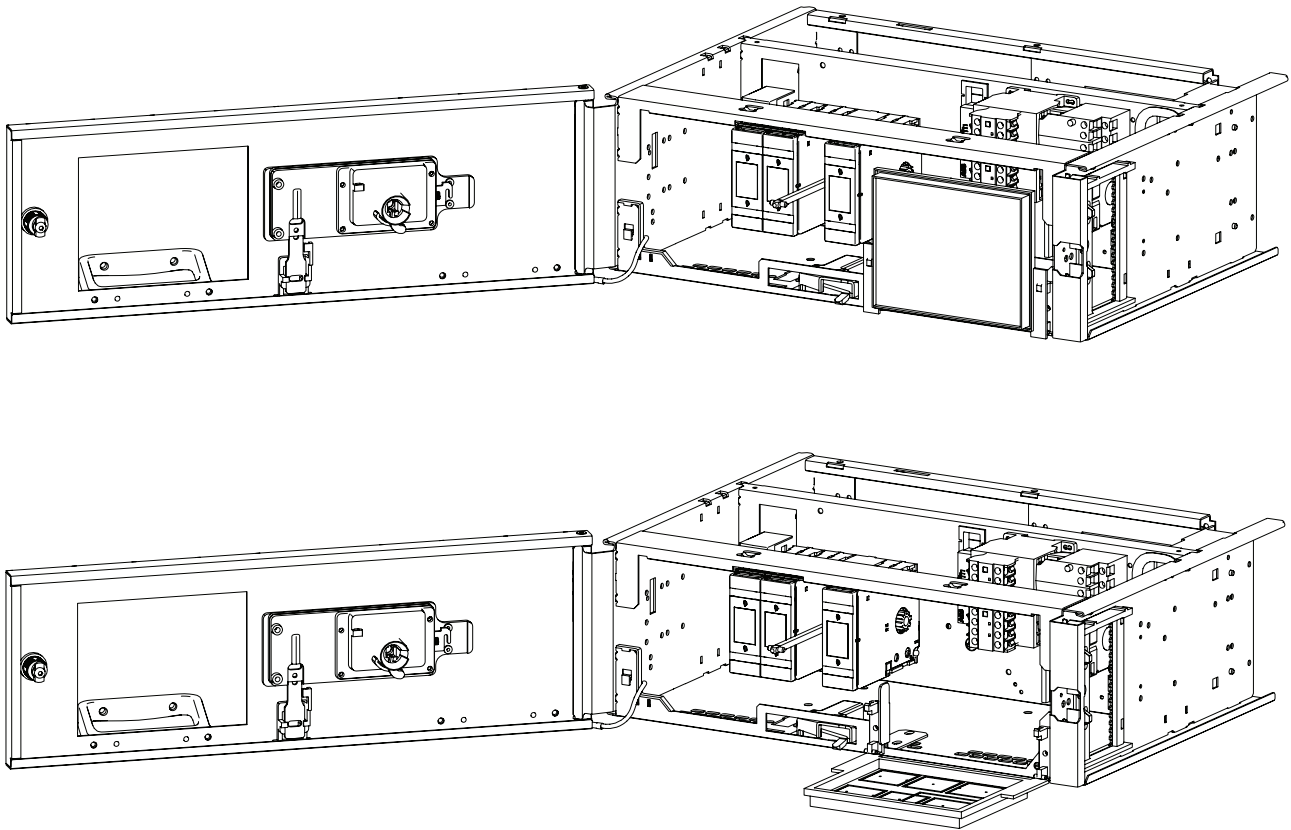


Figure 6-25 Withdrawable module door opening example

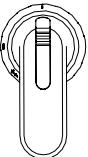
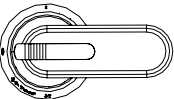

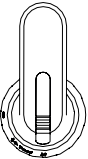
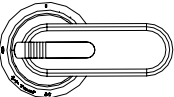
	Position of the switch	Position of the module and applicable degree of protection	Main and control circuits
	ON	in section corresponds with the degree of protection of the assembly, minimum IP 30	All main and control circuits are closed
	OFF Can be locked with 3 padlocks,	in section corresponds with 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	All main and control circuits are disconnected
	ISOLATED Position Can be locked with 3 padlocks	module removed from section 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

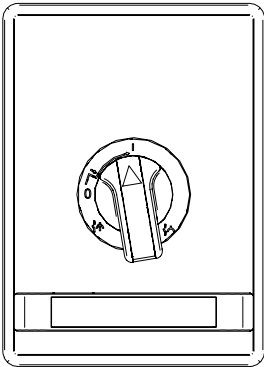
6.9.3 Resetting circuit breakers in withdrawable modules

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.

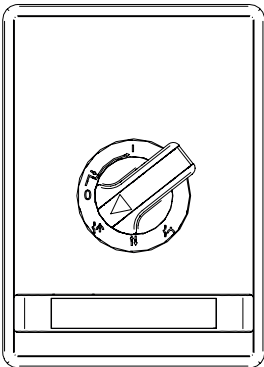


A clear release tripped indication can only be realized with an electrical signal (e.g. pilot lamp).

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

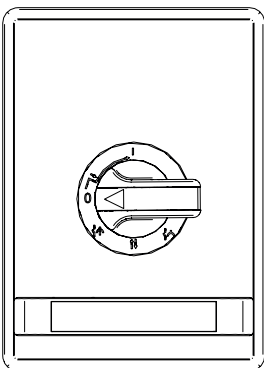


1. Position of tripped moulded-case circuit breaker may locate between “ON” and “OFF” or directly in “ON” position.



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.

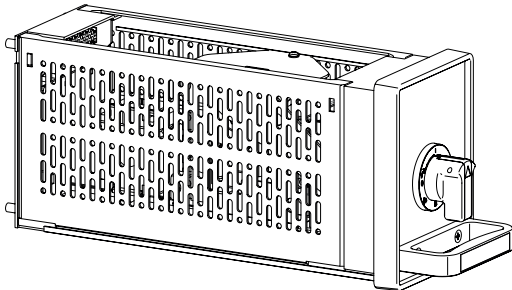
Figure 6-26 Reset operation in small modules, size 8E4 and 8E2, module drawn in



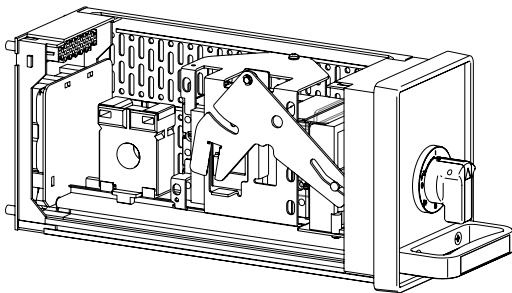
Failure to comply with the procedure above may require the module to be removed from the section and the MCCB switch to be reset directly.

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

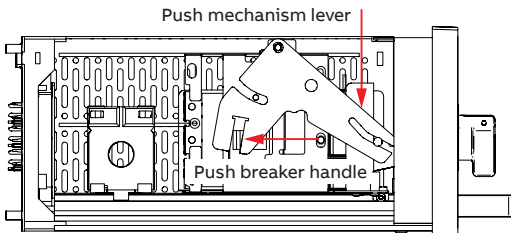
If the operation handle is not pressed continuously until reaching reset position as mentioned in previous chapter, the module interlocking mechanism is then blocked and the resetting the module with the handle is no longer possible. In this case, following steps need to be taken to reset the breaker.



1. Draw out withdrawable module



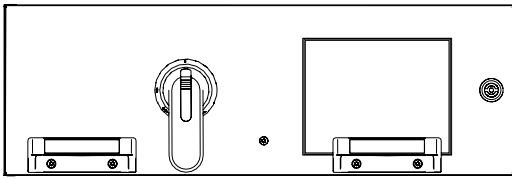
2. Remove the module left side wall-



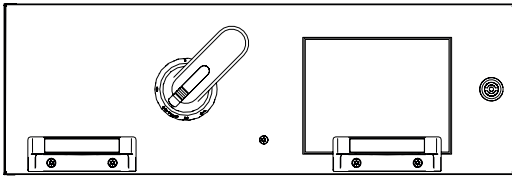
3. Reset circuit breaker by pushing breaker handle or mechanism lever

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

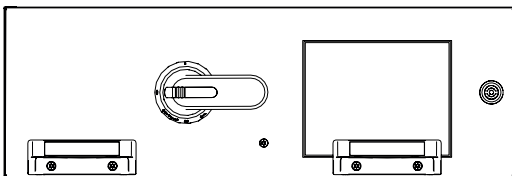
Resetting circuit breaker in withdrawable module, size 4E to 24E



1. Position of tripped 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 8E4 and 8E2

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.

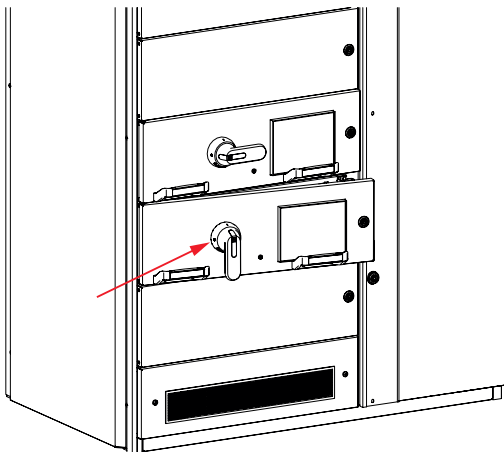


Figure 6-29 Module opening without disconnection

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.

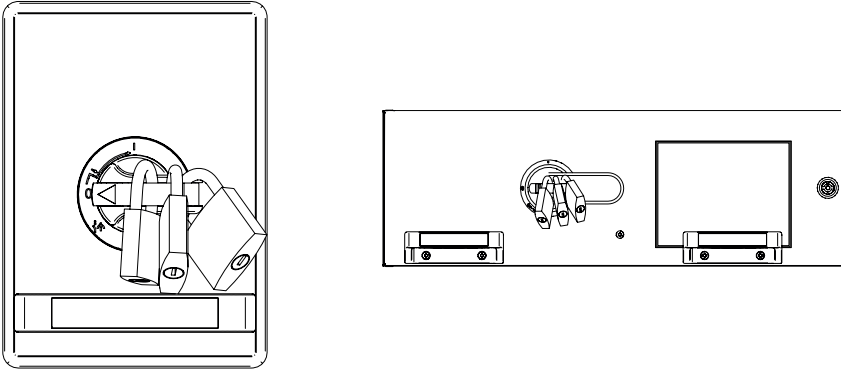


Figure 6-30 Padlocking small size (left) and standard size (right)

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

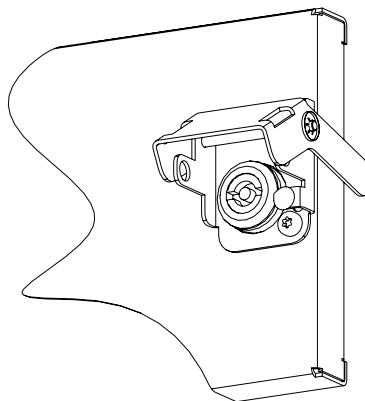
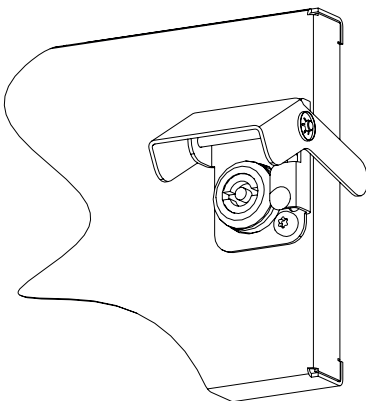
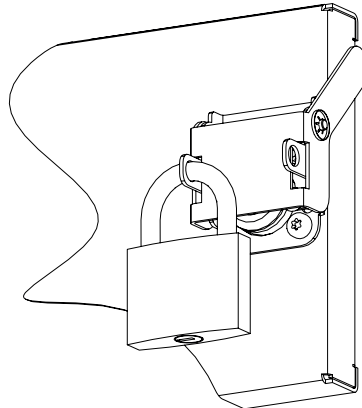
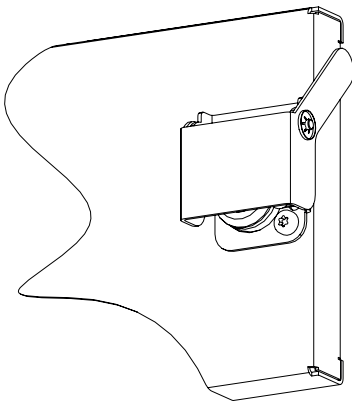
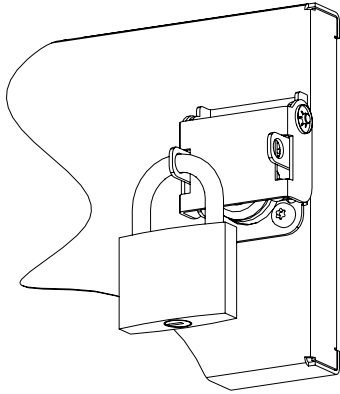


Figure 6-31 Lock covers for full size withdrawable modules

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.

Fixed, padlock only



Removable, padlock only

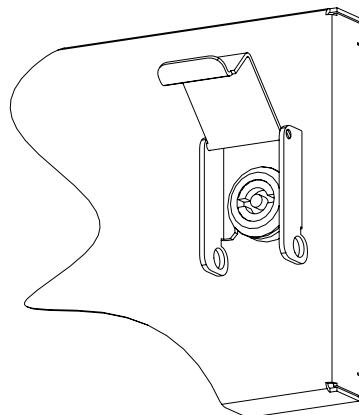
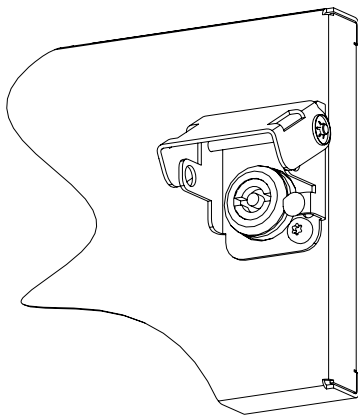
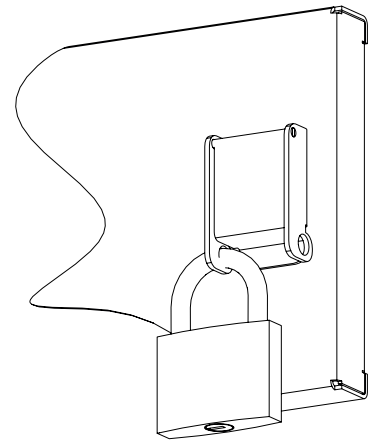
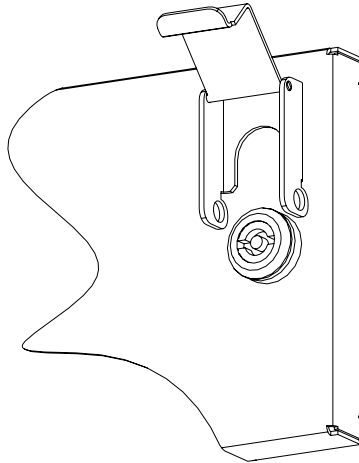


Figure 6-32 Lock covers for full size withdrawable modules

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.

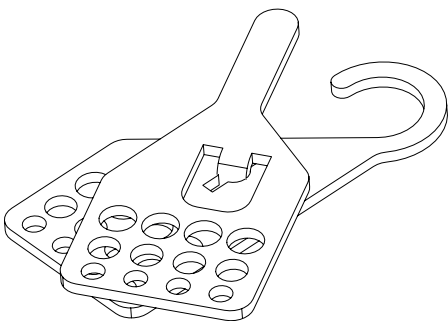


Figure 6-33 Padlock adapter

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

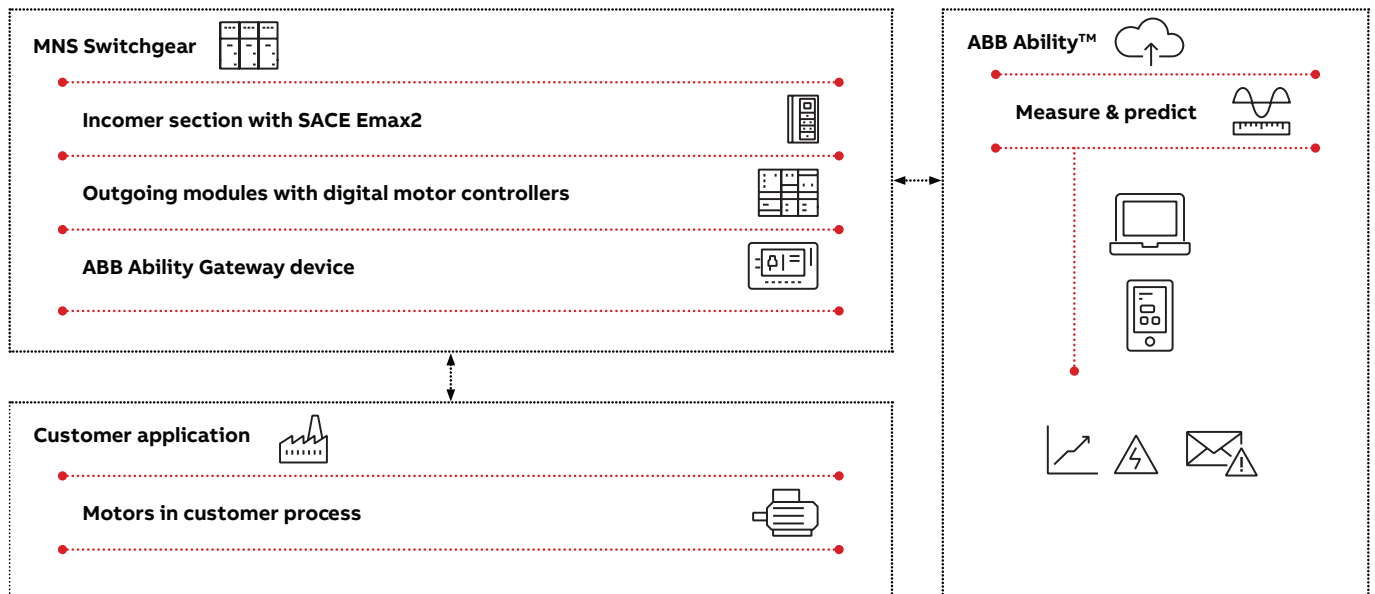


Figure 6-34 MNS Digital motor control operation



Maintenance

7.1	General	156
7.2	Maintenance practices	157
7.3	Preventive maintenance checks and intervals	158
7.4	Examination of MNS contact systems	160
7.4.1	Routine verification (Assembly manufacturer)	160
7.4.2	Examination on site	160
7.4.3	Regular visual check	160
7.4.4	Reduce downtime	161
7.4.5	Checking procedure	161
7.4.6	Checking correct installation of power contacts	161
7.4.7	Power contact types openings and tolerances	164
7.4.8	Exchange material	165
7.5	Examination of MNS power contact systems	165
7.5.1	Visual inspection	166
7.5.2	Inspection procedures	166
7.6	Greasing of contact areas	166
7.6.1	Greasing of power contacts	166
7.6.2	Greasing the fuse links	167
7.6.3	Required quantities	167
7.7	Predictive maintenance	167
7.7.1	Predictive maintenance services	167
7.7.2	Predictive maintenance online tools (mandatory)	168
7.8	Maintenance of door gaskets	168
7.9	List of cleaning materials and lubricators	169

Maintenance

7.1 General

MNS Low Voltage Switchgear assemblies are designed for a typical life time 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 life time expectation can be met
- The life time expectation is shorter than expected
- The life time 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 with ABB Switchgear Light Assesment tool available on the ABB Website. In addition to the above ABB also provides digital solutions to optimize maintenance procedure. For more information please visit www.abb.com/mns/service.

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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Room temperature between 5°C to 35°C Relative humidity $\leq 50\%$ at 40°C Air quality (salt, chemical substances) Dust Water ingress 	
A.3	Check room ventilation system	<ul style="list-style-type: none"> Air supply (ventilation, air conditioning) available (no obstruction, functioning) 	
A.4	Check switchgear ventilation	<ul style="list-style-type: none"> Cleanliness of ventilation louvres 	
A.5	Check condition of enclosure/ outside part of assembly	<ul style="list-style-type: none"> 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 legible 	
A.6	Documentation (drawings, parameter settings)	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Diversity/density factor of switchgear as per design criteria (number, size and location of modules, changes compared to initial design, design criteria 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 recommended 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	<ul style="list-style-type: none"> • Arrangement of modules in accordance with engineering and design documents • Contamination, e.g. dust • Surface of electrical contacts blackening • Loosened screws 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Arrangement of modules in accordance with engineering and design documents • Contamination, e.g. dust • Loosened screws • Cable routing and fixing, bending radii 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • See related installation, operation and maintenance instructions of manufacturer 	<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • Tightening marker present and correct • Color change at bolted connections • Cracks, dust • Signs of contamination or flashover, arc • Discharge marks • Correct installation of covers 	<ul style="list-style-type: none"> • Clean if required • Replace parts if required • Replace insulation material
B.6	Earth and Neutral busbar joints and related connections • Check busbar supports	<ul style="list-style-type: none"> • Loosened earthing connections • Tightening marker present and correct • Discolouring, corrosion • Cracks, dust 	<ul style="list-style-type: none"> • Clean if required • Replace parts if required
B.7	Busbars (main busbars, distribution busbars, connection between busbars, connection between busbars and circuit breakers)	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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	Required protection class	• IEC 60529 in line with project documentation	
C.4	Check efficiency of protective conductor connection	• Check continuity with signal test apparatus	
C.5	Function test of the control device	• In accordance with circuit diagram	• Check numbers of control connection cables if present.
C.6	Check measuring loops	• In accordance with circuit diagram	
C.7	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 require Klüberlectric KR44-102 grease to be applied. 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 for normal operation, see chapter 7.3 clause B, every 5 years or for heavy duty operation every two years for normal operation, which ever occurs earlier.

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. 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.

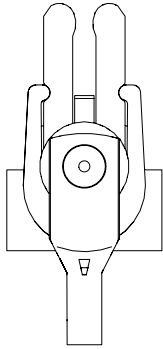
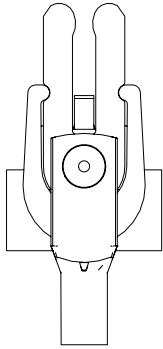
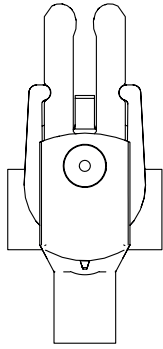
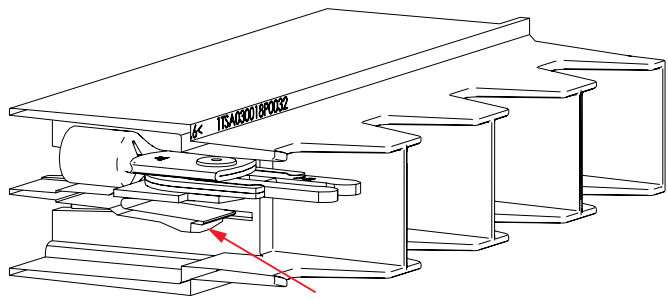
Conductor cross section	6 / 10 / 16 mm ²	35 mm ²	70 mm ²
Contact type			

Table 7-04 Power contacts conductor cross section

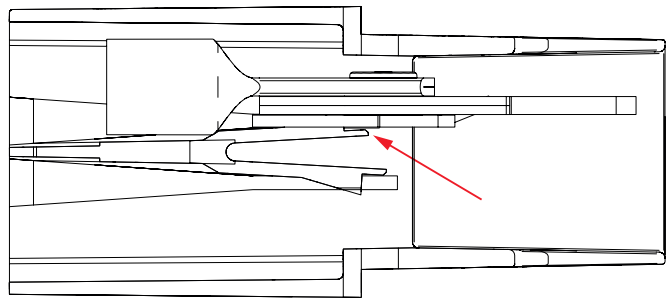
Contact mounting	Instruction
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It is possible to insert two main contacts per phase in the module incoming housing, the lower contact is turned 180° with respect to the upper contact.

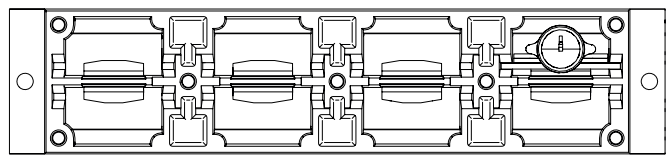
The graphic left indicates the correct location of the upper main contact

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.

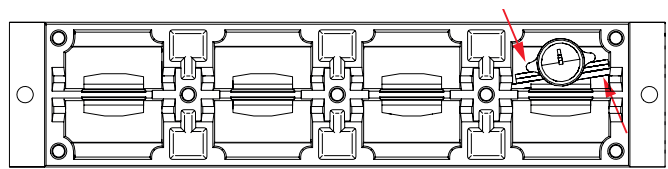


The detailed graphic shows the correct position for the upper locating tab when the contact is correctly inserted.

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.

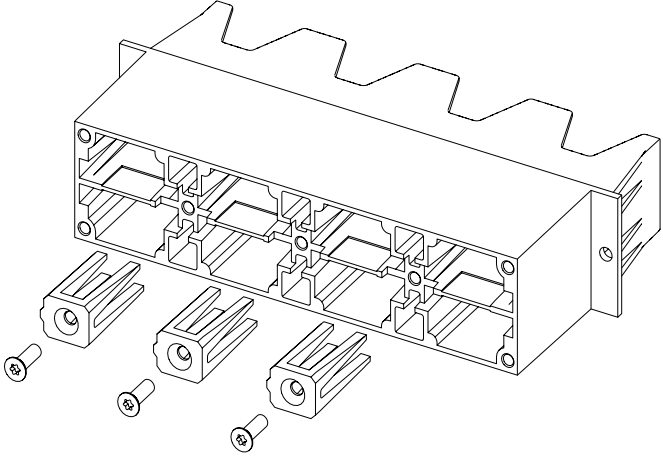
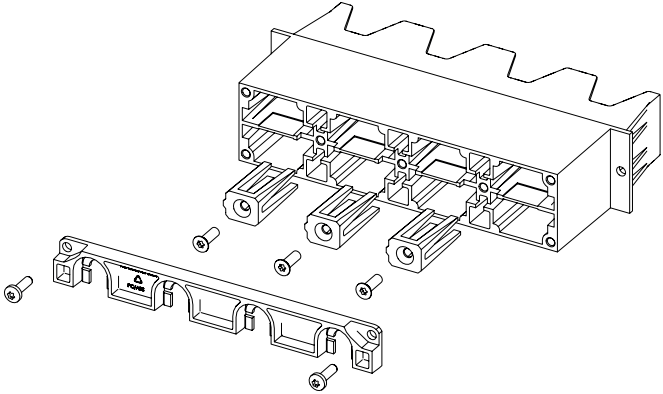
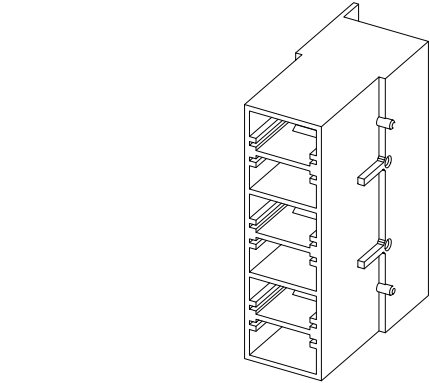


Shown left is incorrect location in the contact housing.

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
	<p>To further ensure that the contact is correctly mounted the insert shown left shall be fitted once the contacts have been inserted.</p> <p>The inserts shall be flush mounting with the housing and can only be inserted one way.</p>
	<p>For some plug-in solutions with smaller diameter cables the IP cover is fitted.</p>
	<p>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.</p> <p>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.</p>

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.

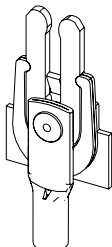
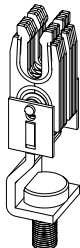
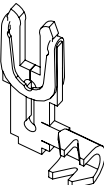
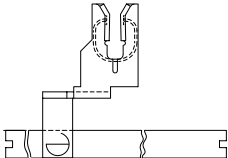
Contact type, visual ID	Contact type, part number ID and application	Contact opening following production	Contact opening during normal operation, wear and tear
	1TGB100101 Type 101 Power contact of: - withdrawable modules 6E – 24E - withdrawable modules 4E (incoming) - plug-in modules	3.95 ^{+0.05} _{-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!

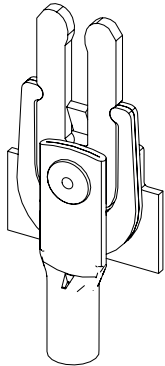
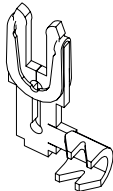
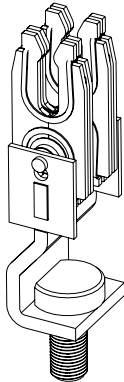
Application	Power contact of withdrawable modules 4E...24E and plug-in modules	Power contact of small withdrawable modules 8E/4 and 8E/2 and of full size withdrawable modules 4E	Power contact of withdrawable modules ≥16E and plug-in modules
Contact type			

Table 7-07 Power contacts according application

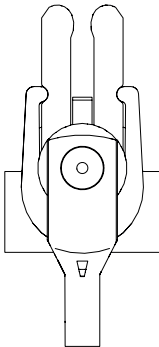
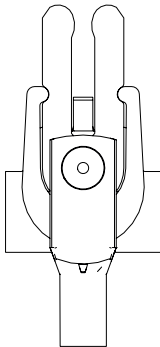
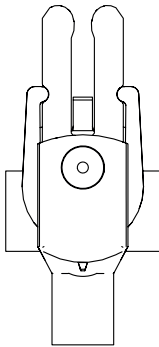
Conductor cross section	6 / 10 / 16 mm ²	35 mm ²	70 mm ²
Contact type			

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, whichever 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 '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
- 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

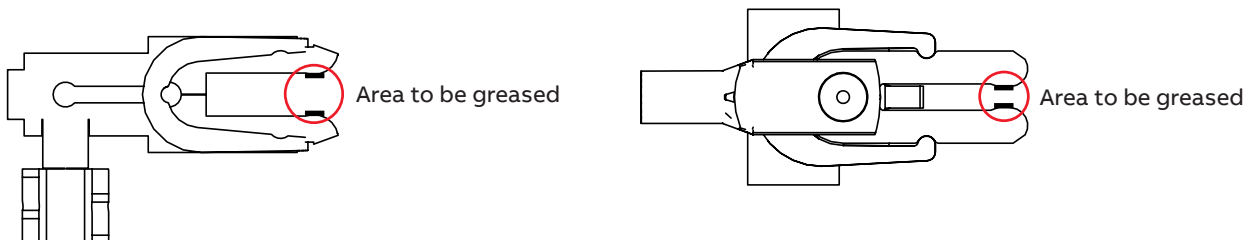


Figure 7-01 Power contacts for withdrawable modules size 8E/4 and 8E/2 (left) size 4E to 24E (right)

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 Predictive maintenance

A predictive maintenance routine is based upon the analysisation of the conditions both internal and external of the assembly. Visual inspection as part of preventive maintenance is not sufficient to perform such task. Additional information is collected using sensors and intelligent electronic devices installed as part of the MNS power switchgear assembly. 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.

Tools and services that support predictive maintenance for MNS Digital switchgear assemblies are available. These tools or components are integrated within the assembly to provide on-line 24/7 information that can provide warnings of immediate failures. The solution enables the possibility to identify conditions that may otherwise not be detected during preventive maintenance or as part of a one-time inspection.

7.7.1 Predictive maintenance services

Predictive maintenance services can be provided by ABB Service:

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



To conduct IR monitoring requires the switchgear to be energised therefore safe working practices shall be followed. IR monitoring is generally 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 measurements provide 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.

7.7.2 Predictive maintenance online tools

Predictive maintenance online tools that can be installed for continuous monitoring are typically electronic devices and sensors that provide additional information.



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.

1. Temperature Monitoring Systems (TMS) monitor the temperature of busbars and busbar connections. The TMS can provide alarms for fluctuations in temperature caused by unbalanced loads, as well as constant monitoring where the temperature level can be utilised to initiate a preventative maintenance task.
2. Power Quality Monitoring Systems (PQM) offer 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.
3. Intelligent Electronic Devices (IED) such as electronic trip units for air circuit breaker or separate protection devices can provide further information regarding the health of the circuit breaker.
4. Intelligent Motor and Feeder Protection Devices (MCU/FCU) such as MNS Digital provides not only motor and load protection. Additional electrical parameters monitored such as power, voltage and operating states enable further determination of maintenance needs for the switchgear as well as connected loads.
5. ABB Ability Condition Monitoring Device Edge Gateway is an online condition monitoring unit supported with the functionality from MNS Digital. It provides online information that is collected by the intelligent devices, 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.

ABB Ability Condition Monitoring Device Edge Gateway can be installed as a temporary monitoring solution or as continuous monitoring system and added non-intrusive to an existing switchgear assembly that complies with technical requirements.

Online conditions monitoring with MService which covers the following main functions:

- Collection of operational data of the supervised modules
- Collection of all alarms and trips generated in the supervised modules
- Collection of maintenance warnings derived from additional assessment logic related to the supervised modules.
- Display of the MNS Digital 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 Condition Monitoring Device Edge Gateway can supervise all modules in MNS Digital, which are connected to the internal switchgear communication bus. This includes:

- Motor starter and feeder modules (all sizes), which are equipped with measuring and communication IED's
- Circuit breakers connected to the switchgear communication with the interface MConnect.

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 Omnigloss 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.

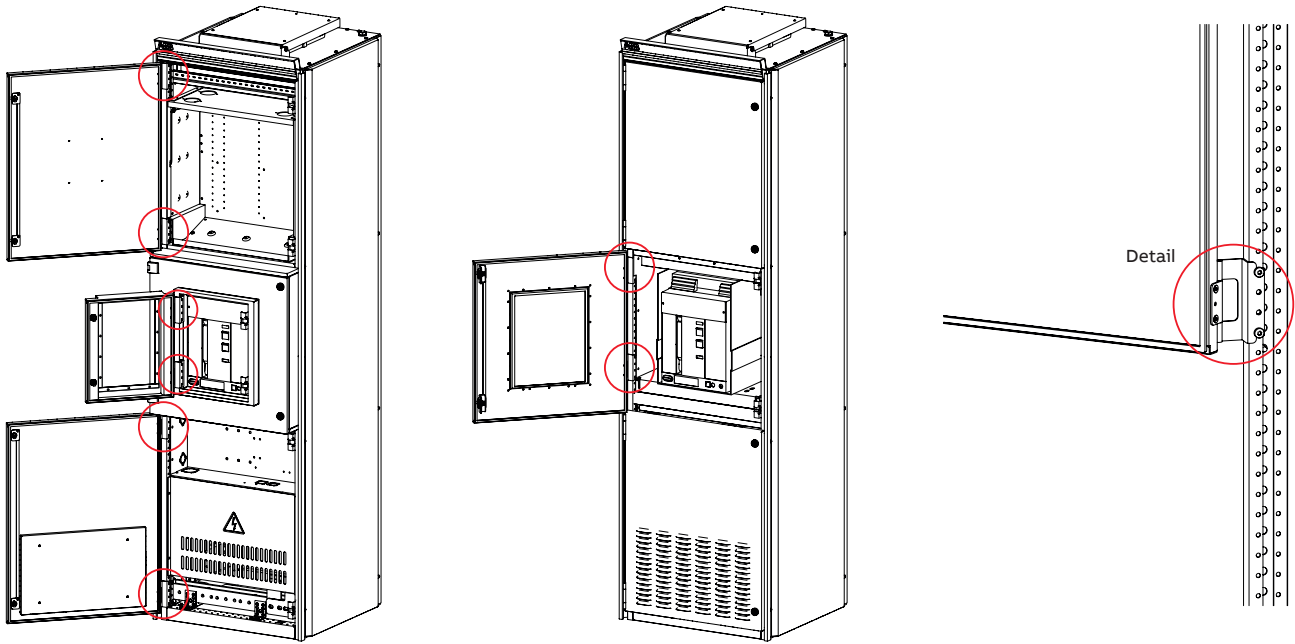


Figure 7-02 Sealing to be lubricated

7.9 List of cleaning materials & lubricators

Lubricant

- Molykote Omnigliss spray – manufacturer Dow Corning

Contact grease

- KR 44-102 – manufacturer Klübelectric

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



Extension and upgrade

8.1	Extensions	172
8.1.1	Extension of MNS 3.0	172
8.1.2	Section extension to the left for front access switchgear	174
8.1.3	Extension of 3rd party switchgear	175
8.2	Upgrades	176
8.2.1	MNS 2.0 to MNS 3.0	176
8.2.2	INSUM 1 to MNS Digital	176
8.2.3	INSUM 2 to MNS Digital	176

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.

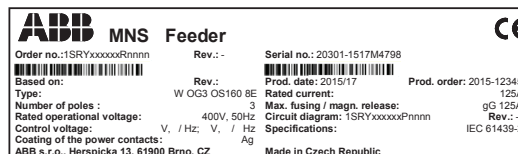
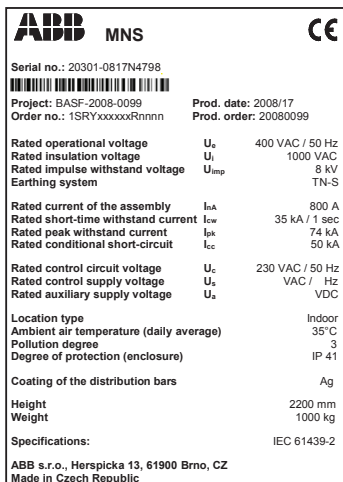


Figure 8-01 Example of ABB section (left) and modul marking (right)

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.

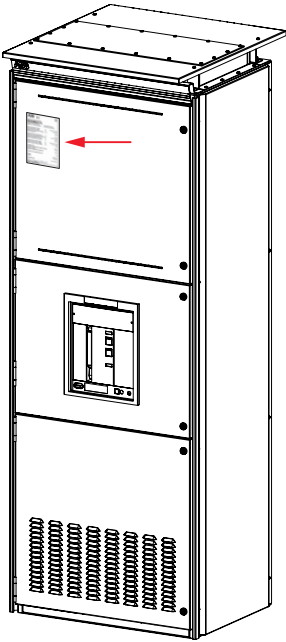


Figure 8-02 Switchgear marking is placed on or inside of the ACB top door (switchgear incommenr)

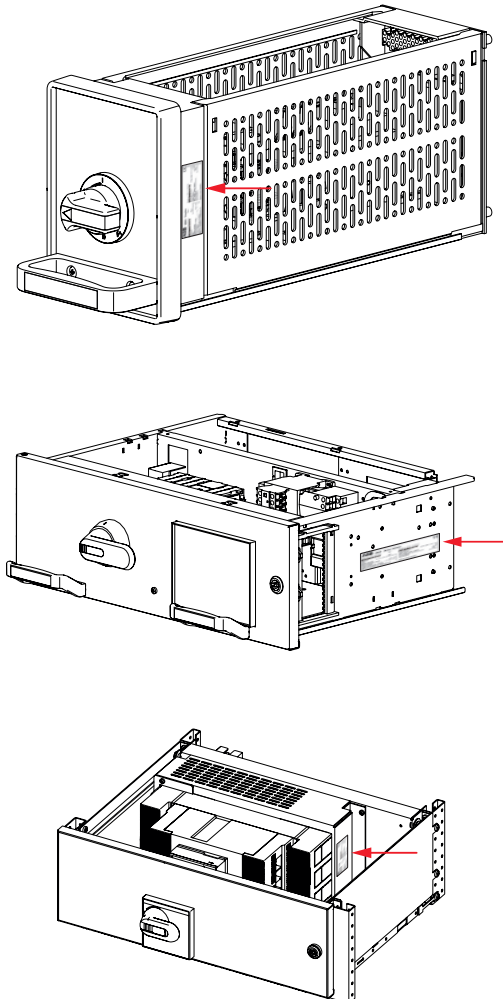


Figure 8-03 Module marking: small module (top), standard module (middle) and plug-in module (bottom)

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.

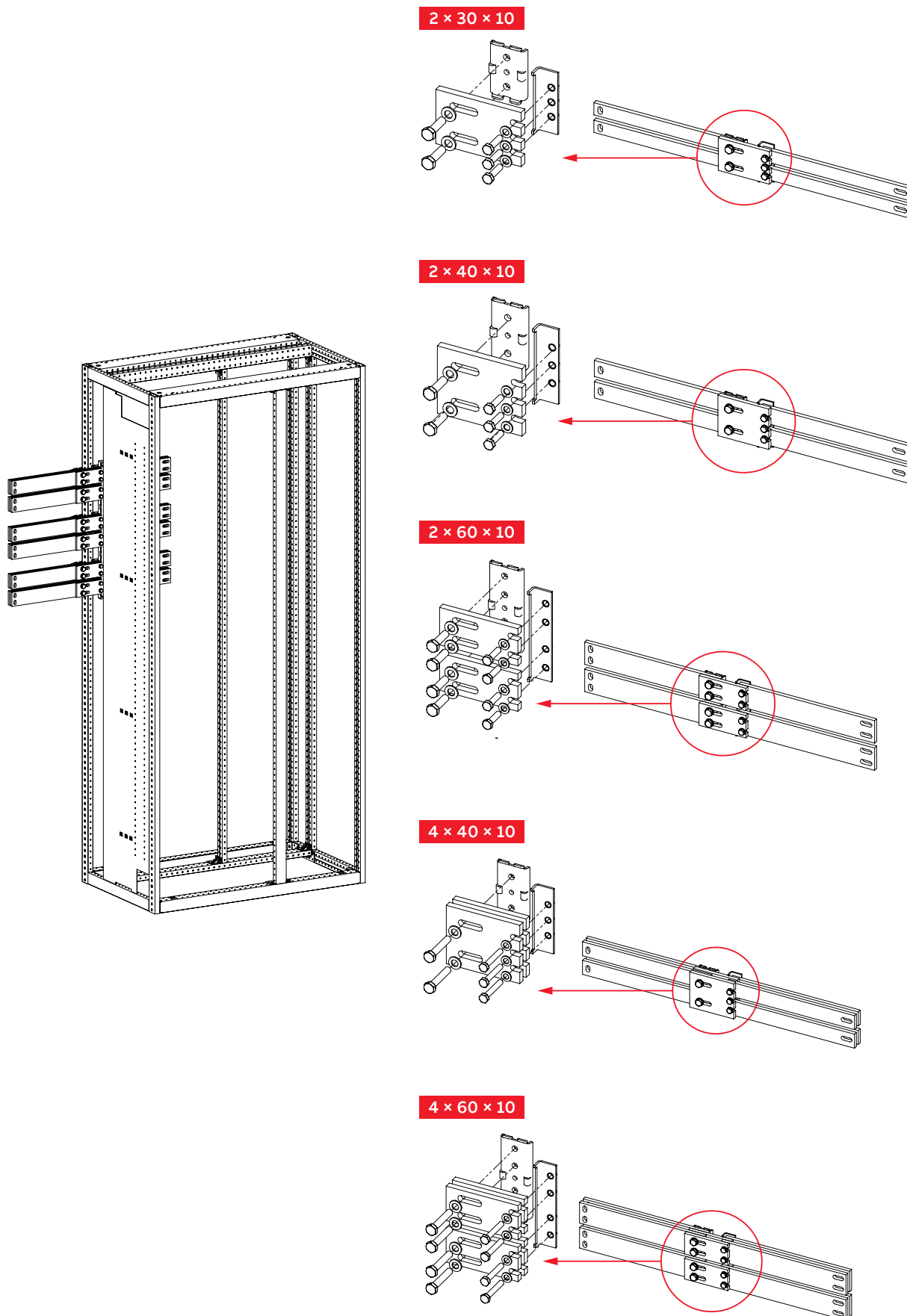


Figure 8-04 Generic extension examples

8.1.3 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.

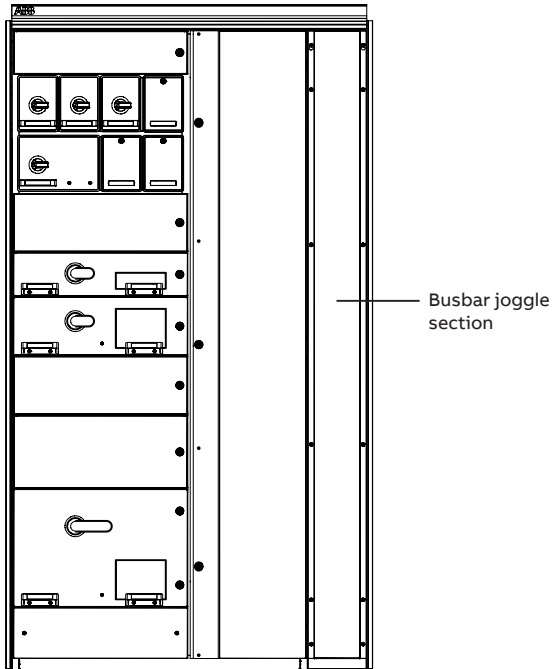


Figure 8-05 Switchgear marking is placed on or inside of the ACB top door (switchgear incommer)

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.

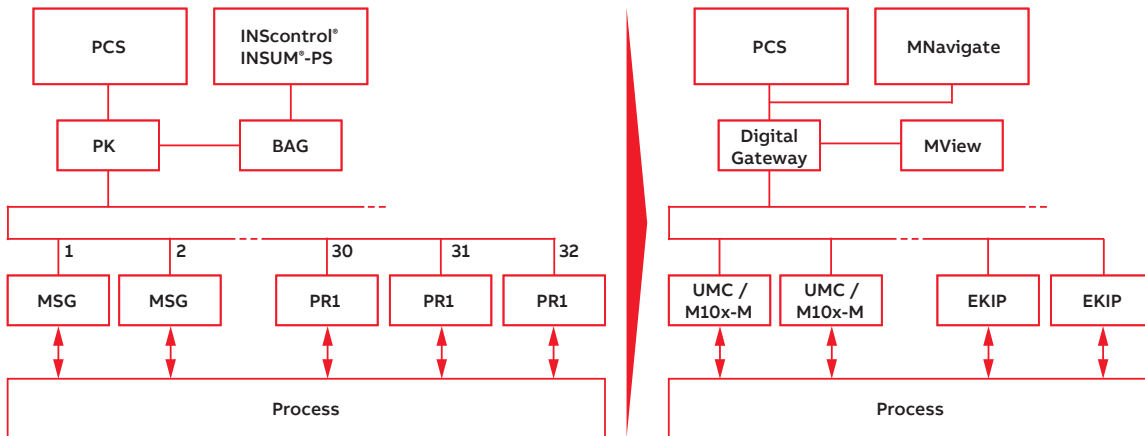


Figure 8-06 Typical ABB upgrade solution from INSUM 1 to MNS Digital

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.

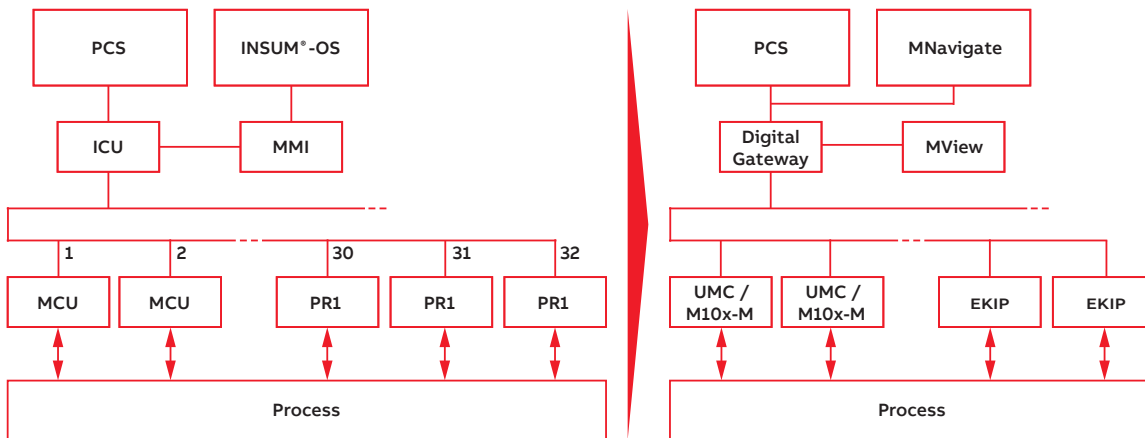
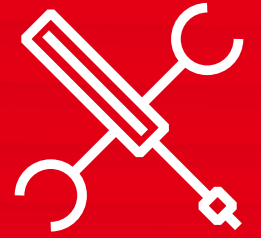


Figure 8-07 Typical ABB upgrade solution from INSUM 2 to **MNS Digital**

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.



Repair, spares and consumables

9.1	Damage to paint work	180
9.2	Mechanical damage	180
9.3	Spares and consumables	180

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 cleaning: linen cloth (lint-free), abrasive paper (grade 400)
- For painting: brush or lambskin paint roller
- For repair: scraper

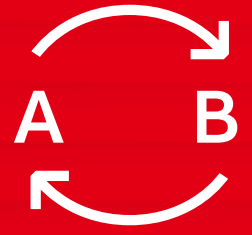
9.3 Spares and consumables

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

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10



Re-configuration of switchgear

10.1	Fixed - technique	184
10.1.1	Removing a module	184
10.1.2	Plug-in and withdrawable modules	184
10.1.3	Plug-in modules	185
10.2	Replacement of withdrawable module	186
10.3	Conversion and change of withdrawable module compartments	187
10.3.1	Example 1: Retrofit of 1×16E into 4×8E/4 and 2×8E/2	189
10.3.2	Example 2: Retrofit of 1×24E into 3×8E	190
10.3.3	Example 3: Retrofit of 6×8E/2 into 1×24E	191
10.3.4	Example 4: Retrofit of 3×8E into 1×24E	192
10.4	Replacing switchgear	193

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-energised 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 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.

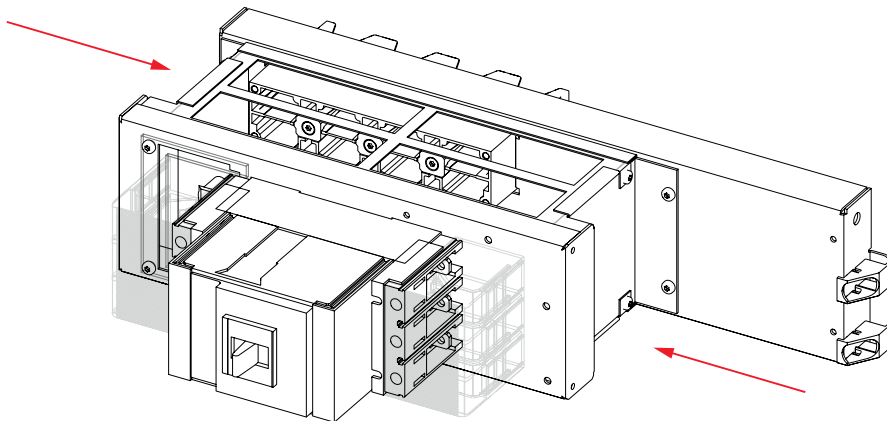


Figure 10-01 Plug-in modules integrated handles



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.

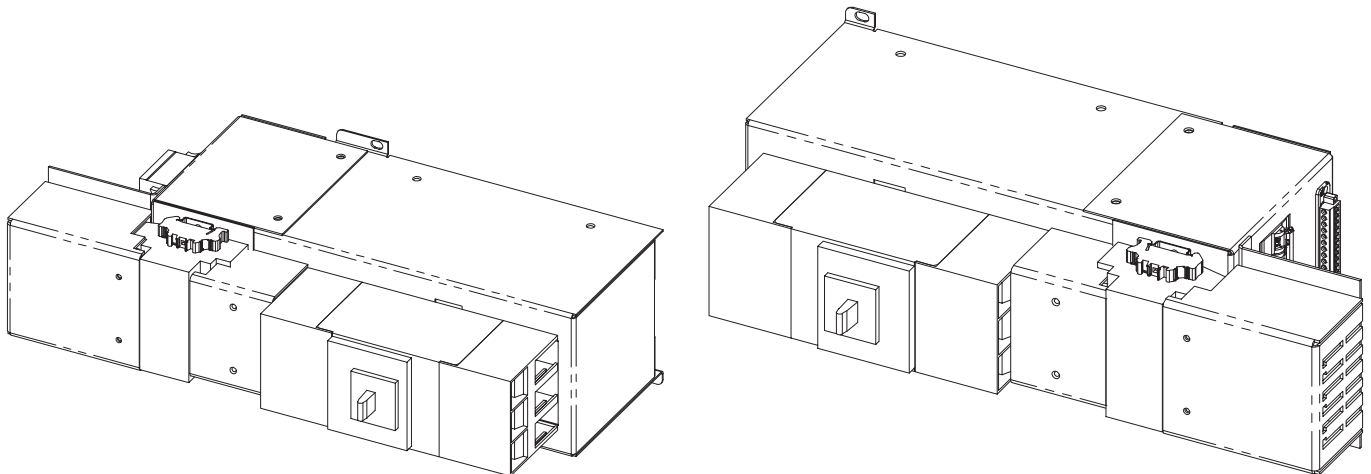


Figure 10-02 Compact module left side mounting

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.



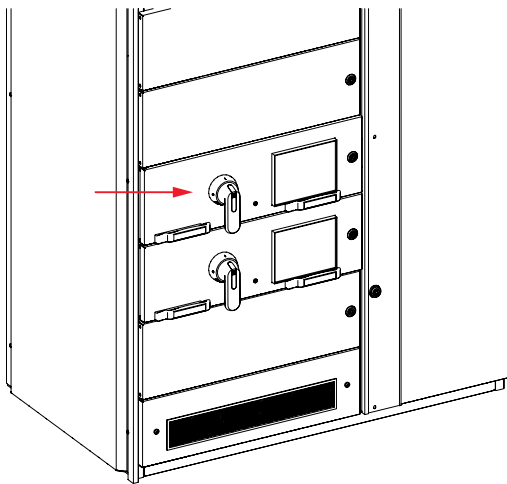
With the interlocking switch handle in the move position, withdrawable modules size 8E/4 and 8E/2 can be withdrawn without stop. The modules sizes 4E up to 24E have to be withdrawn up to the stop position, then released to be removed completely (see Figure 10-02).

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 10-01). The interlocking mechanism can be found at the side of the switch handle.

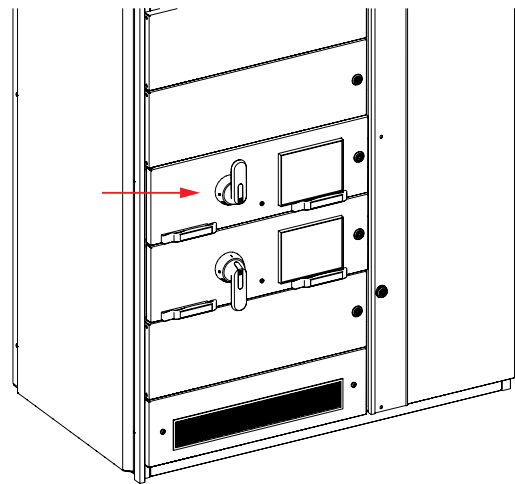
For conversion or modification of complete withdrawable module units, e.g. replacement of one large unit through several smaller units or vice versa, the frame-mounted compartment has to be exchanged, too (see chapter 10.3).

1



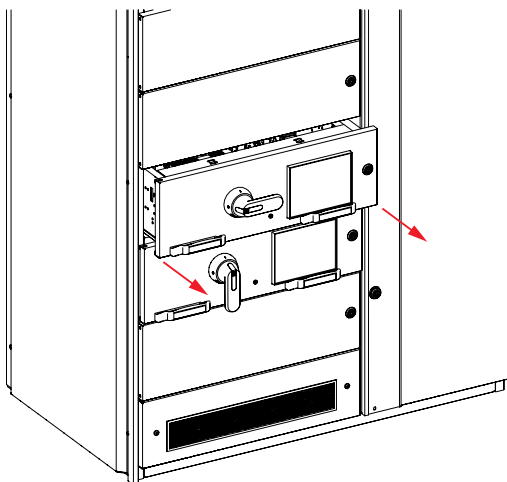
Module in ON-position.

2



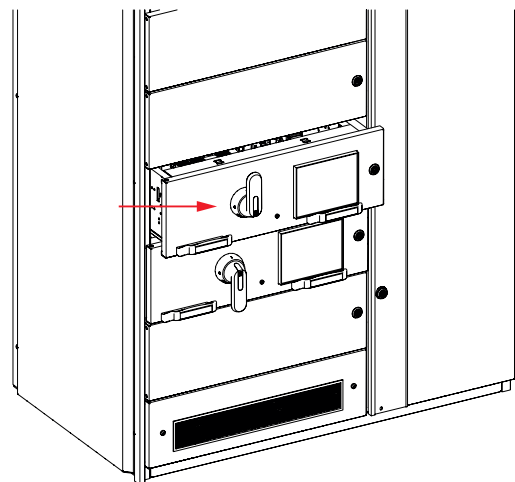
Switch the module to MOVE-position.

3

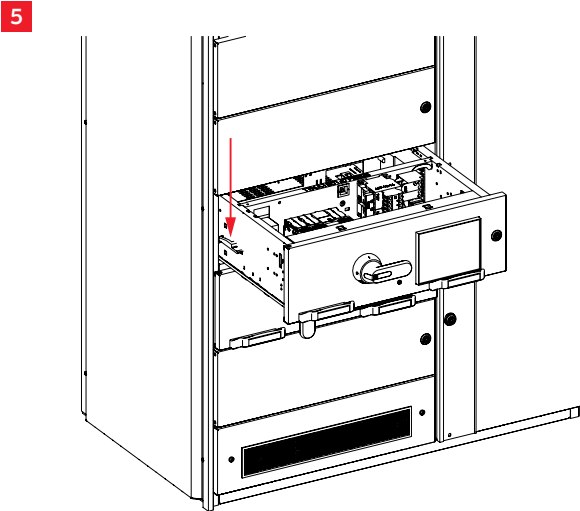


Draw the module out from section. The handle will automatically switch to OFF-position. Module is in isolated position.

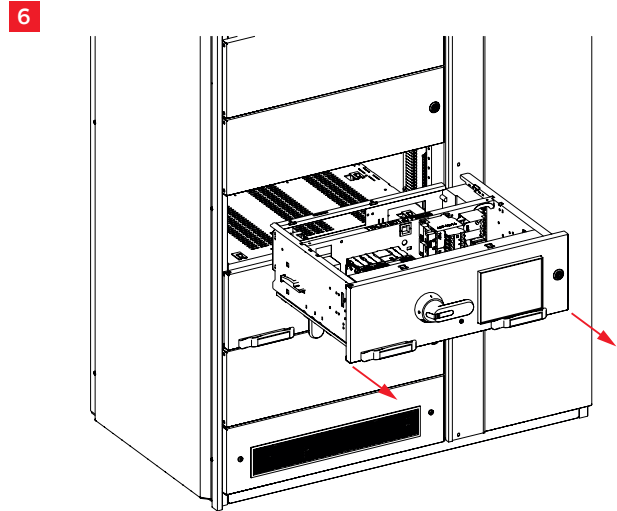
4



Switch the handle again to MOVE-position.



Draw the module out from section. Unlock the protection mechanism on the left side of the module.



Remove the module completely 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 10-04). Should there be any doubt with respect to this please contact your local ABB representative.

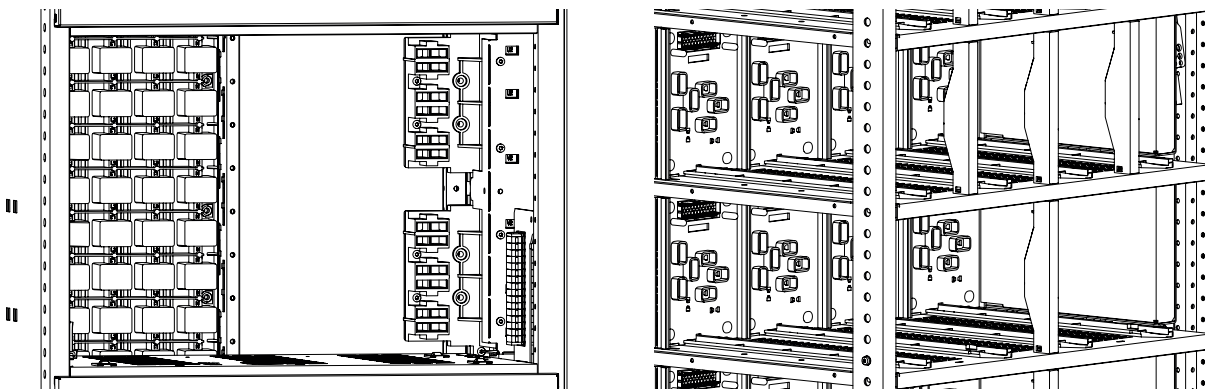


Figure 10-04 Withdrawable module compartment size 8E with outgoing cable connection unit (left)
Conversion to withdrawable module compartments size 8E/4 and 8E/2 (right)

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.

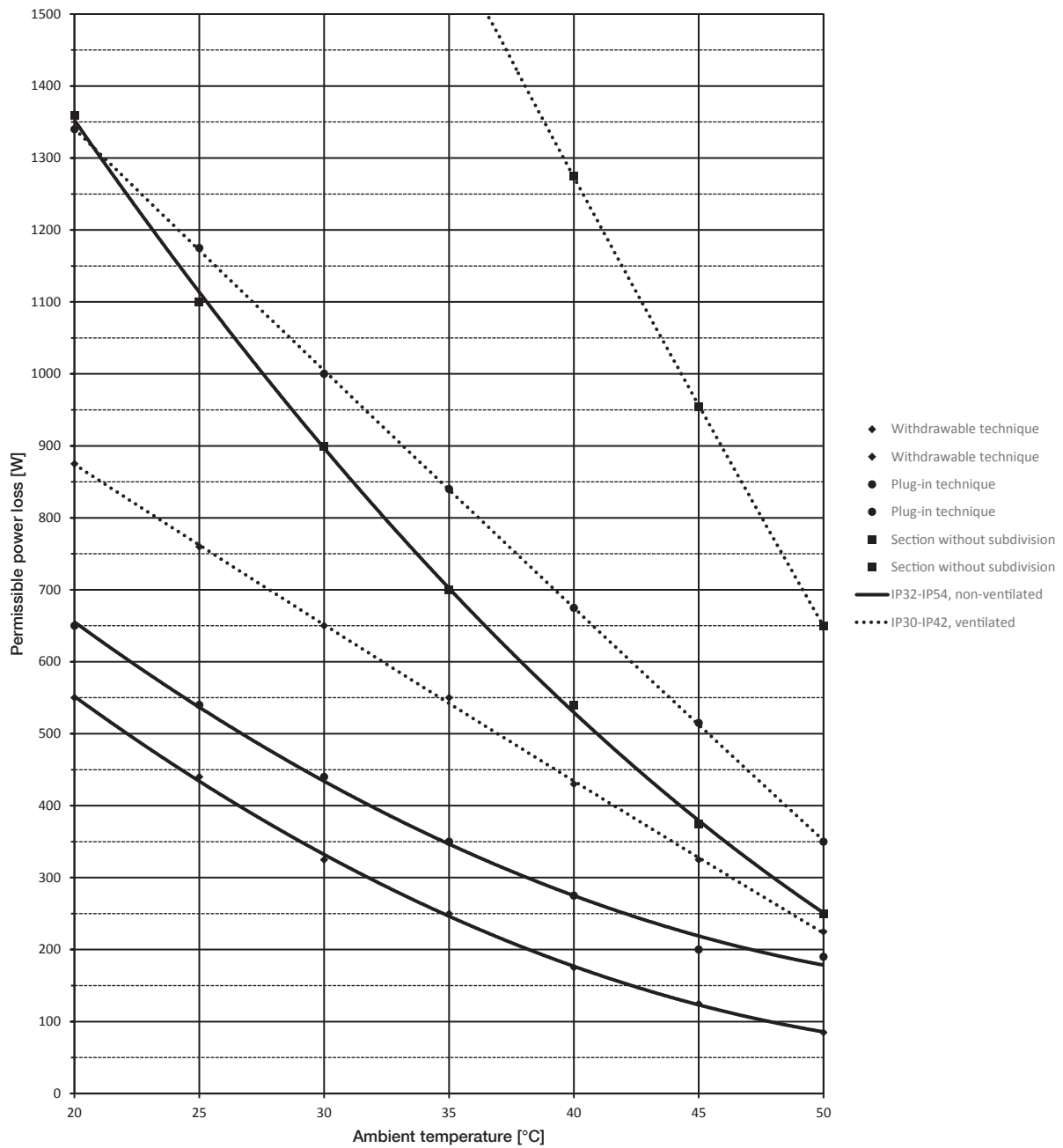


Figure 10-05 Standard values of maximum admissible effective power loss for sections with 600 mm equipment compartment width

10.3.1 Example 1: Retrofit of 1×16E into 4×8E/4 and 2×8E/2

Example: Retrofit 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 lower 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 covered 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-energised. 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 recycling of 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.	

Figure 10-01 Replacing switchgear check list



End of life

11.1	Service solution	196
11.2	Personnel skills needed	196
11.3	Infrastructure and equipment needed	197
11.4	Recycling and disposals	197

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 disposal

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



Attachments and checklists

12.1	Maintenance and inspection checklist	200
12.2	Related documents references	201
12.3	Abbreviations	201
12.4	Appendix	202
12.4.1	List of figures	202
12.4.2	List of tables	205

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	<input type="checkbox"/>	N/A <input type="checkbox"/>
Control circuit breakers switched to operation position	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Current transformer links in the correct operation position	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Wiring termination secured	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Protection shroud/barrier in the operation position	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Protection relay settings verified	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Electrical functionality check completed	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
ACB compartment			
Protection relay settings verified	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Wiring termination secured	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
ACB movement function checked	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
ACB operation interlocks verified	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Protection shroud/barrier in operation position	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Electrical functionality check completed	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
ACB service to recommendation by ABB			
Number of operation cycle exceeded	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
ACB contact wear alarm indicated	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Other alarm indicated	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Contact grease condition inspected	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Surge Protection Device (SPD) compartment			
Backup fuse disconnecter closed	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Backup fuses present/not blown	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Backup circuit breaker not tripped	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Surge Protection Device (SPD) indicator healthy	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Cable connection compartment			
Cable connection tightness checked	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Cable entry point sealed to site requirement	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Protection shroud/barrier in operation position	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Switchboard overall cladding			
All doors secured	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Roof plate secured	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Ventilation mesh cleaned	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Passage way cleared	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Rusted sections treated	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
IP rating of the section is maintained	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Operation observations / Any Yes in this group requires immediate investigation!			
High switchboard surface temperature	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Abnormal noise generated	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>
Vibration	Yes	<input type="checkbox"/>	N/A <input type="checkbox"/>

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 maintenance instructions for the installer and the end user	1SDH000999R0002
2	E2.2 / E4.2 / E6.2 – Installation, operation and maintenance instructions for the installer and the end user	1SDH001000R0002
3	SlimLine XR Switch Disconnecter 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

Figure 2-01	MNS 3.0 front access switchgear	13
Figure 2-02	MNS Rear access switchgear	13
Figure 2-03	Circuit breaker section	15
Figure 2-04	Outgoing section	15
Figure 2-05	Compact outgoing section	15
Figure 2-06	Rear circuit breaker section	15
Figure 2-07	Rear outgoing section	15
Figure 2-08	Assembly arrangements (from left): standard / duplex / back to back arrangement	16
Figure 2-09	MNS Rear assembly arrangement	16
Figure 2-10	Incoming / outgoing circuit breaker section	17
Figure 2-11	MNS Rear ACB section and module section	17
Figure 2-12	MNS frame & enclosure	18
Figure 2-13	"Q" Profile, "C" profile and detail of "C" profile	18
Figure 2-14	MNS Rear frame & enclosure	19
Figure 2-15	Front access modules and cable compartment	19
Figure 2-16	MNS Rear modules	20
Figure 2-17	Air circuit breaker sections	20
Figure 2-18	Main busbar arrangement and N/PEN front distribution	20
Figure 2-19	ACB copper connection to main busbar	21
Figure 2-20	MNS Rear main busbar arrangement and PE/N/PEN rear distribution	22
Figure 2-21	MNS Rear ACB copper connection to main busbar	23
Figure 2-22	MFSW location in front access section located to the left	24
Figure 2-23	MFSW location in rear access section	24
Figure 2-24	Exploded view with front and rear MFSW components and the distribution bars	24
Figure 2-25	Distribution bars	24
Figure 2-26	Top view of distribution bars	25
Figure 2-27	Metal separation wall MSW	25
Figure 2-28	MNS Rear distribution bars	26
Figure 2-29	Top view of MNS Rear distribution bars	26
Figure 2-30	Fixed distribution bar system	27
Figure 2-31	Power contacts used in MNS switchgear for different cable cross-sections	28
Figure 2-32	Sotax contacts are used for higher current application	28
Figure 2-33	Characteristics of functional unit design	29
Figure 2-34	ACB section bottom entry configuration and top entry configuration	30
Figure 2-35	Positions for optional earthing switch solutions	30
Figure 2-36	Sections with cable top entry and bottom entry	31
Figure 2-37	SPD with fuse backup protection XLP0, XLP1 and MCB backup protection	31
Figure 2-38	MNS Front access switchgear with double stacked ACBs	31
Figure 2-39	MNS Rear ACB section configuration	32
Figure 2-40	MNS Rear access double stacked ACB	32
Figure 2-41	MNS Rear access triple stacked ACB	32
Figure 2-42	Fixed module size 12E	33
Figure 2-43	DBB connection with busbars	33
Figure 2-44	DBB connection with cables	33
Figure 2-45	Multi-Function Separation Wall (MFSW) in section	34
Figure 2-46	Compact module left side / right side mounting	35
Figure 2-47	Exploded view	35
Figure 2-48	Multi-Function Separation Wall (MFSW) in section	36
Figure 2-49	Basic plug-in energy distribution module	37
Figure 2-50	Energy distribution module with optional CT's	37
Figure 2-51	Exploded view of plug-in module cable connection to main contacts	39
Figure 2-52	Exploded view of plug-in module with copper connection to main contacts	39
Figure 2-53	Exploded view of plug-in module with optional separation components	39
Figure 2-54	IP cover clip for all modules up to 250 A	40
Figure 2-55	Ergonomic design for improve module handling	40

Figure 2-56	Module location guides and rails for larger modules	40
Figure 2-57	Fixing of the plug-in modules to the section	40
Figure 2-58	Detail of captive screw holder	40
Figure 2-59	SlimLine XR Seeries	41
Figure 2-60	Exploded view and optinal accessories of XR00	41
Figure 2-61	Exploded view and optinal accessories of XR1	42
Figure 2-62	Exploded view and optinal accessories of XR2-3	42
Figure 2-63	Reactive power compenstation module (RPC module)	43
Figure 2-64	Examples of 8E/4 and 8E/2 modules	44
Figure 2-65	Withdrawable module compartment for 4 units size 8E/4	44
Figure 2-66	MNS Rear withdrawable module compartment for 4 units size 8E/4	45
Figure 2-67	Examples of full withdrawable modules	46
Figure 2-68	Withdrawable module compartment for units size 4E ... 24E	46
Figure 2-69	MNS Rear withdrawable module compartment for unit size 4E...24E and with control plug system	47
Figure 3-01	Module side handle	52
Figure 3-02	Inner dimensions of 40' high cube container	53
Figure 3-03	Packing for normal road transport	53
Figure 3-04	Packing for MNS Rear switchgear	53
Figure 3-05	Wooden parts dimensions	54
Figure 3-06	Transport marking	55
Figure 3-07	Seaworthy packing procedure, steps 1, 2 & 3	56
Figure 3-08	Seaworthy packing procedure, steps 4 & 5	57
Figure 3-09	Seaworthy packing procedure, steps 6, 7 & 8	58
Figure 3-10	Seaworthy packing procedure, steps 9 & 10	59
Figure 3-11	Reinforcement for horizontal transport	60
Figure 3-12	Example of horizontal transport	60
Figure 3-13	Fork-lift transport	62
Figure 3-14	Roller transport (only for weight of transport units up to 1200 kg)	62
Figure 3-15	Transport with a hand-pulled truck	63
Figure 3-16	Arrangement of lifting angles (plan view of MNS section)	64
Figure 3-17	Crane transport packed and unpacked sections	64
Figure 3-18	Transport by truck	65
Figure 4-01	Example of switchgear room layout	70
Figure 4-02	Section minimum clearances	72
Figure 4-03	Section minimum clearances for raised roof plate IPx1/IPx2 with left mounted doors	72
Figure 4-04	Section minimum clearances for raised roof plate IP43 with left mounted doors	73
Figure 4-05	Section minimum clearances for pressure reliev roof (flap roof) with left mounted doors	73
Figure 4-06	Front access section minimum clearances for escape routes	74
Figure 4-07	MNS Rear access section minimum clearances for escape routes	74
Figure 4-08	The difference of front access assemblies minimum clearances according escape route direction	75
Figure 4-09	The difference of MNS Rear access assemblies minimum clearances according escape route direction	76
Figure 4-10	Example of section foot print extension parts – Front access	77
Figure 4-11	Example of section foot print extension parts – Rear access	78
Figure 4-12	Example of section hight extension parts	79
Figure 4-13	Floor cutouts for MNS Rear sections	81
Figure 4-14	Busbar partition plate and fixing hole locations	82
Figure 4-15	Rear access busbar partition plate and fixing hole locations	82
Figure 4-16	Connection points (threads installed in frame) with detail of connection	83
Figure 4-17	Lifting holes plug	84
Figure 4-18	Example of busbar conection – main busbar connection	84
Figure 4-19	Generic busbar dimension in mm	
Figure 4-20	Main busbar overlapping ranges in mm	
Figure 4-21	Copper to copper	85
Figure 4-22	Aluminium to aluminium	85
Figure 4-23	Copper to aluminium	85
Figure 4-24	Example of MNS Rear busbar connection – main busbar connection	85
Figure 4-25	MNS Rear main busbar connection	86

Figure 4-26	Example of busbar connection – busduct connection	86
Figure 4-27	Example of section high extension parts	86
Figure 4-28	PE / PEN busbar connection	87
Figure 4-29	Example of busbar connection – busduct connection for MNS Rear switchgear	88
Figure 4-30	Example of busbar connection of MNS Rear switchgear to medium-voltage transformer	88
Figure 4-31	MNS Rear PE/PEN bar connection	88
Figure 4-32	Bolt with WSH-ESLOK spot coating	89
Figure 4-33	Bolt with LOCTITE spot coating	89
Figure 4-34	Isolated busbar connection cover	90
Figure 4-35	Detail dimensions of mounting holes	91
Figure 4-36	Typical installation mounting holes A, B and C	91
Figure 4-37	Weld seam position	92
Figure 4-38	Fastening to foundation – concrete floors	92
Figure 4-39	Fastening to foundation – HALFEN channel	93
Figure 4-40	Fastening to foundation – UNISTRUT channel	93
Figure 4-41	HALFEN / UNISTRUT positions for Duplex	94
Figure 4-42	HALFEN / UNISTRUT positions for Back to Back	94
Figure 4-43	Installation on false floors	95
Figure 4-44	Fastening to foundation – concrete floors / each section fixed in 4 points front access design	96
Figure 4-45	Fastening to foundation – HALFEN channel / each section fixed in 4 points	96
Figure 4-46	Fastening to foundation – UNISTRUT channel / each section fixed in 4 points	96
Figure 4-47	Bottom plate sealing	97
Figure 4-48	Frame sealing	97
Figure 4-49	Danger sign “KEEP OFF”	102
Figure 4-50	Example of cable connection in incoming / outgoing ACB unit	102
Figure 4-51	Location of cable bars acc. connection types	104
Figure 4-52	Main cable connections	104
Figure 4-53	Location of voltage taps	104
Figure 4-54	Position of vertical and horizontal wiring duct for customer external cables	105
Figure 4-55	Example of cable connection in incoming / outgoing MNS Rear ACB unit	105
Figure 4-56	Location of MNS Rear cable bars acc. connection types	106
Figure 4-57	MNS Rear cable connections	106
Figure 4-58	Position of MNS Rear control wiring duct for customer external cables	107
Figure 4-59	Example of cable runs, withdrawable module size 8E/4 and 8E/2	108
Figure 4-60	Example of cable runs, withdrawable module size $\geq 4E$	108
Figure 4-61	Cables provided with bellows for $\geq 4E$ withdrawable modules	109
Figure 4-62	Example of plug-in module cable connection	109
Figure 4-63	SlimLine modules cable connection	110
Figure 4-64	Additional cable protection shroud for neutral conductor in SlimLine module	111
Figure 4-65	Example of front access protection and neutral conductor connection	112
Figure 4-66	Example of MNS Rear cable runs, module sizes 8E/4 and 8E/2	112
Figure 4-67	Example of cable runs, withdrawable module size $\geq 4E$	112
Figure 4-68	Cables provided with bellows for $\geq 4E$ withdrawable modules	113
Figure 4-69	Example of MNS Rear cable runs, module size $\geq 4E$	113
Figure 4-70	MNS Rear cables provided with bellows for $\geq 4E$ modules	113
Figure 4-71	Example of MNS Rear access protection and neutral conductor connection	115
Figure 4-72	Top lifting of ACB withdrawable and fixed part	116
Figure 4-73	Installation of air circuit breaker Emax2 using lifting truck	115
Figure 6-01	Locking alternatives used with MNS standard, double bit key and handle with key for slotted lock	127
Figure 6-02	Opening of module door with 5 mm double bit key	127
Figure 6-03	Typical ACB door / typical ACB door with pagoda / typical ACB door with IP cover and pagoda	128
Figure 6-04	IP protection cover	128
Figure 6-05	IP protection cover (closed / opened / opened with ACB in isolated position)	129
Figure 6-06	Top and bottom auxiliary recess in mounting and standard position	134
Figure 6-07	Fixing the recess with spring bolts / detail	136
Figure 6-08	Top auxiliary recess in standard and mounting position and bottom auxiliary recess in standard position	136
Figure 6-09	Fixed module example open and close and fixed empty section example	137
Figure 6-10	Plug-in module example with inside and outside operation	139

Figure 6-11	MNS section with plug-in modules with different door configuration	139
Figure 6-12	MNS section with plug-in modules (inside & outside operation)	139
Figure 6-13	Operation directly with MCCB lever	140
Figure 6-14	Generic facia from MCCB	140
Figure 6-15	SlimLine folded handel in "ON" and in "OFF position"	141
Figure 6-16	The true ON / OFF position is shown by the switch indicator in front	141
Figure 6-17	Padlocking the XR module	142
Figure 6-18	Replacement of the NH fuses in the XR	142
Figure 6-19	Replacement of the NH fuses in the XR	143
Figure 6-20	Replacement of the NH fuses in the XR shall be completed with the use of the tool shown above	143
Figure 6-21	MNS section with reactive power compensation moduels	144
Figure 6-22	Example of small modules, size 8E/4 and 8E/2	145
Figure 6-23	Example of standard module size 8E	146
Figure 6-24	Operating handle for withdrawable modules $\geq 4E$	146
Figure 6-25	Withdrawable module door opening example	147
Figure 6-26	Reset operation in small modules, size 8E4 and 8E2, module drawn in	148
Figure 6-27	Reset operation in small modules, size 8E4 and 8E2, module drawn out	149
Figure 6-28	Reset operation in modules, size 8E4 and 8E2	150
Figure 6-29	Module opening without disconnection	150
Figure 6-30	Padlocking small size and standard size	151
Figure 6-31	Lock covers for full size withdrawable modules	151
Figure 6-32	Lock covers for full size withdrawable modules	152
Figure 6-33	Padlock adapter	152
Figure 6-34	MNS Digital motor control operation	153
Figure 7-01	Power contacts for withdrawable modules size 8E/4 and 8E/2 and size 4E to 24E	166
Figure 7-02	Sealing to be lubricated	169
Figure 8-01	Example of ABB section and modul marking	172
Figure 8-02	Switchgear marking is placed on or inside of the ACB top door (switchgear incommer)	173
Figure 8-03	Module marking: small module, standard module and plug-in module	173
Figure 8-04	Generic extension examples	174
Figure 8-05	Switchgear marking is placed on or inside of the ACB top door (switchgear incommer)	175
Figure 8-06	Typical ABB upgrade solution from INSUM 1 to MNS Digital	176
Figure 8-07	Typical ABB upgrade solution from INSUM 2 to MNS Digital	177
Figure 10-01	Plug-in modules integrated handles	185
Figure 10-02	Draw out of withdrawable module	186
Figure 10-03	Withdrawable module compartment size 8E with outgoing cable connection unit Conversion to withdrawable module compartments size 8E/4 and 8E/2	187
Figure 10-04	Standard values of maximum admittable effective power loss for sections with 600 mm equipment compartment width	188

Table 12-04 List of figures

12.4.2 List of tables

Table 1-01	Typical warning signs and labels	7
Table 2-01	Technical data of MNS 3.0 switchgear	12
Table 2-02	Normal service conditions acc. IEC 61439-1, section 7.1	14
Table 2-03	Form of separation for plug-in modules	38
Table 3-01	General overview of standard module solutions (customer specific solutions not mentioned)	50
Table 3-02	Approximate weights per 3 and 4 pole ACB sections (incomming feeders and couplers)	51
Table 3-03	Approximate weights per 3 or 4 pole MNS Rear ACB sections	51
Table 3-04	Approximate weights of modules per size (customer specific solutions not mentioned)	52
Table 3-05	Guide values for permissible rope loading	63
Table 4-01	Section minimum clearances	71
Table 4-02	Additional dimensions to calculate exact section footprint	77
Table 4-03	Additional dimensions to calculate exact MNS Rear section footprint	78
Table 4-04	Additional dimensions to calculate exact section hight	79
Table 4-05	Floor cut-outs for standard, back to back and duplex sections	80
Table 4-06	Main busbar connection material	84

Table 4-07	MNS Rear main busbar connection material	86
Table 4-08	PE/PEN bar connection material	88
Table 4-09	Torque values of busbar & PE/PEN connections	88
Table 4-10	MNS Rear PE/PEN bar connection material	89
Table 4-11	Recommendation of section foundation fixing in earthquake environment	96
Table 4-12	Torque values of power cable connections – ACB section (incoming / outgoing)	103
Table 4-13	Minimum recommended amount of cables	104
Table 4-14	Maximum cable quantity per phase or for MNS Rear ACB solutions	107
Table 4-15	Torque values of power cable connections – module section (incoming/outgoing)	109
Table 4-16	Torque values of standard power cable connections for SlimLine modules	111
Table 4-17	PE / N / PEN abbreviation acc. to IEC 61439-1 / VDE 0660 part 500	112
Table 6-01	Main components of the circuit breaker	130
Table 6-02	Fixed modules switch handle – handle positions for circuit breaker	138
Table 6-03	Fixed modules switch handle – handle positions for fuse switches	138
Table 6-04	Plug-in modules switch handle – handle positions for circuit breaker	140
Table 6-05	Plug-in modules switch handle – handle positions for fuse switches	141
Table 6-06	Small withdrawable module operation positions	145
Table 6-07	Large withdrawable module operation positions	147
Table 7-01	Recommended preventive maintenance (regularly, non-intrusive)	158
Table 7-02	Recommended preventive maintenance (based upon conditions, intrusive)	159
Table 7-03	Functional units intrusive maintenance	160
Table 7-04	Power contacts conductor cross section	162
Table 7-05	Main contact installation instructions	162
Table 7-06	MNS contacts openings and tolerances	164
Table 7-07	Power contacts according application	165
Table 7-08	Power contacts conductor cross section	165
Table 8-01	Checklist of the extension of MNS 3.0 and / or MNS 2.0	172
Table 10-01	Replacing switchgear check list	193
Table 11-01	Recommended method of raw material disposal	197
Table 12-01	Maintenance and inspection checklist	200
Table 12-02	List of related documents references	201
Table 12-03	List of abbreviations	201
Table 12-04	List of figures	202
Table 12-05	List of tables	205

Table 12-05 List of tables

Additional information

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