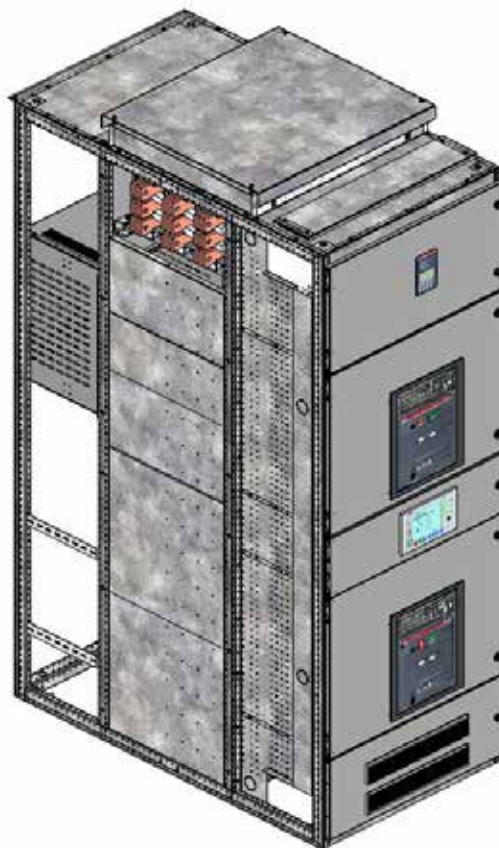


# MNS R Low Voltage Switchgear

## Construction, commissioning, operation and maintenance

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## **Consequences deriving from non-compliance**

ABB declines all liability for the following events:

- Negligent handling of the low-voltage switchgear system and non-compliance with the safety and operating regulations as amended from time to time.
- Insufficient maintenance, non-compliance with the recommendations given herein or makeshift repairs by personnel without the necessary training or adequate equipment.
- Damages due to transport.
- Improper use.
- Modifications to the low-voltage switchgear systems performed by unauthorized personnel.



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# 1 Technical Description

## 1.1 Technical data

<b>Standards</b>		Low-voltage switchgear and controlgear assemblies	IEC 61439 -1 and -2
		Power switchgear and controlgear assemblies	EN 61439-1 and -2
<b>Test certificates</b>		ABB SACE ACAE LOVAG CESI	
<b>Electrical data*</b>	Rated voltages	Rated insulation voltage Ui	1000 V 3~, 1500 V-
		Rated operating voltage Ue	690 V 3~, 750 V-
		Rated impulse withstand voltage Uimp	6 / 8 / 12 kV, depending on equipment
		Overvoltage category	II / III / IV
		Degree of pollution	3
		Rated frequency	up to 60 Hz
	Rated currents	<b>Main Busbars:</b>	
		Rated current Ie	up to 8000 A
		Rated peak withstand current Ipk	up to 330 kA
		Rated short-time withstand current Icw	up to 150 kA
		<b>Power Center Distribution busbars:</b>	
		Rated current Ie	up to 4000 A
		Rated peak withstand current Ipk	up to 264 kA
		Rated short-time withstand current Icw	up to 120 kA
		<b>Motor Control Center Distribution busbars:</b>	
		Rated current Ie	up to 1500 A
		Rated peak withstand current Ipk	up to 220 kA
		Rated short-time withstand current Icw	up to 100 kA
<b>Mechanical characteristics</b>	Dimensions	Sections and frames	DIN 41488
		Standard height	2200 mm
		Standard width	300, 400, 600, 800, 1000, 1200 mm
		Standard depth	1025, 1200, 1400, 1600mm
		Basic grid size	E = 25 mm acc. to DIN 43660
	Surface protection	Frame	Zinc or Alu-zinc coated
		Internal subdivision	Zinc or Alu-zinc coated
		Transverse section	Zinc or Alu-zinc coated
		Enclosure	Zinc or Alu-zinc coated and Powder coated RAL 7035, light grey
	Degrees of protection	According to IEC 60529 or VDE 0470 part 1	Up to IP 54
	Plastic components	Halogen-free, self-extinguishing, flame retardant, CFC-free	IEC 60707, DIN VDE 0304 part 3
	Internal subdivision	Equipment compartment - equipment compartment	
		Busbar compartment - cable compartment	
		Busbar compartment - equipment compartment	
		Equipment compartment - cable compartment	
		Compartment bottom plates	
<b>Extras</b>	Paint finish	Enclosure	Special colours (standard RAL 7035)
	Busbar system	Busbars	Sheathed
			Silver or tin galvanized
	Special qualification	Test certificates	See test certificates listed above

\* Design verification by testing: When an assembly has previously been tested in accordance with IEC 60439-1, and the results fulfil the requirements of IEC61439 -1 / -2, verification of these requirements need not to be repeated.

\*\* Depending on the electrical equipment.

## 1.2 Basic Structure of the switchgear

### 1.2.1 Typical side section

The basic structure of the frame (steel C-sections, 2mm thick, with holes at 25 mm intervals), comprises (see fig.1):

- Equipment compartment.
- Busbar compartment.
- Cable compartment.

The equipment compartment comprises:

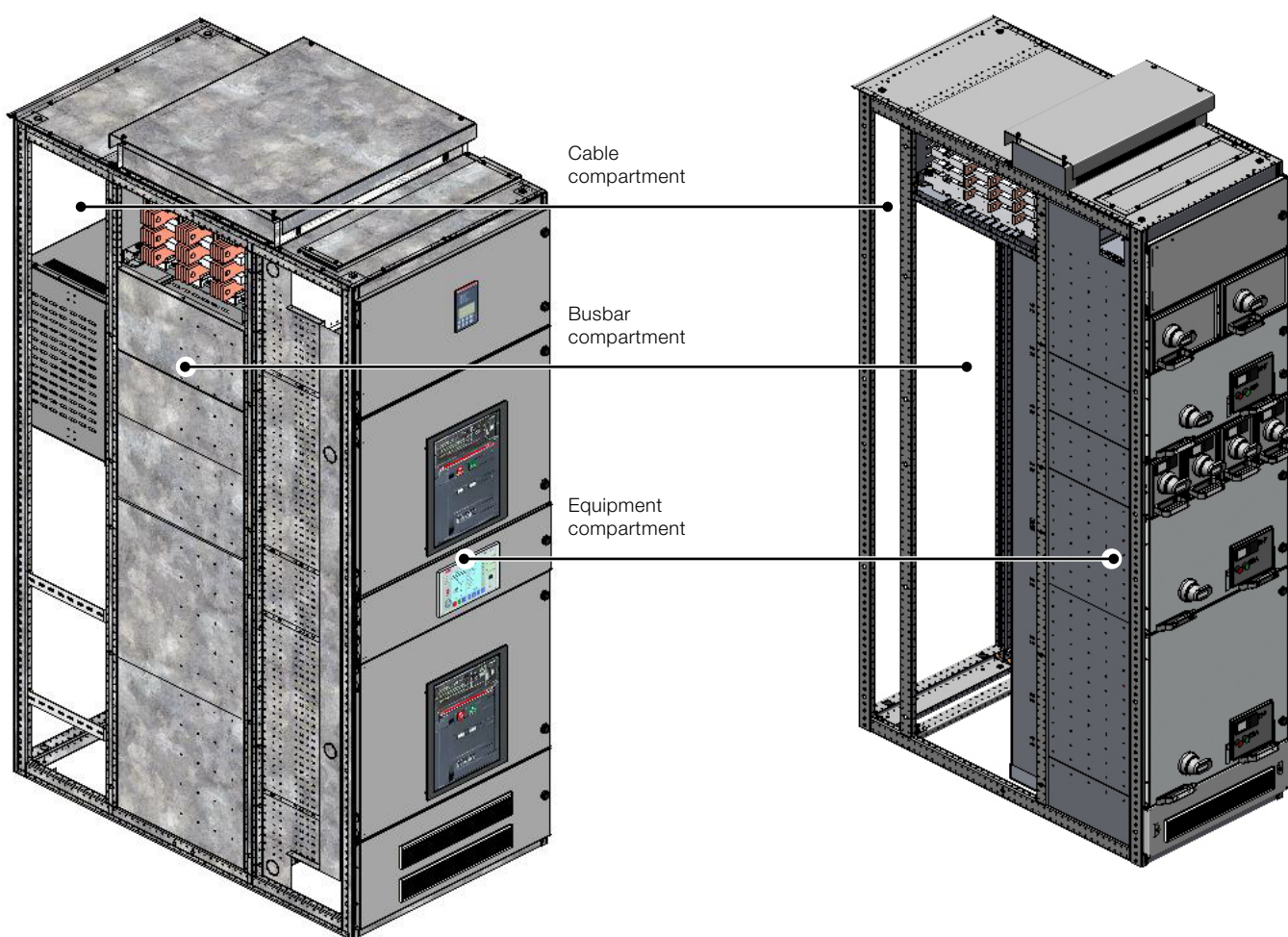
- Main circuit breakers.
- Auxiliary devices.
- Terminal boards.

The busbar compartment comprises:

- Main busbars.
- Distribution busbars.
- Vertical busbar for MCC.

The cable compartment comprises:

- Input and output cables.
- Auxiliary accessories (connectors, auxiliary terminal boards, etc.).



MNS R Power Center

MNS R Motor Control Center

Fig. 1 Typical construction for MNS R and MCC

MNS R uses up to three busbar systems located in the busbar compartment. The position of the main busbar in the cubicle can be center, top and bottom depending on which types of modules are installed in the cubicle. There are two types of main busbar systems: standard type or multi-level busbar type (see fig. 2).

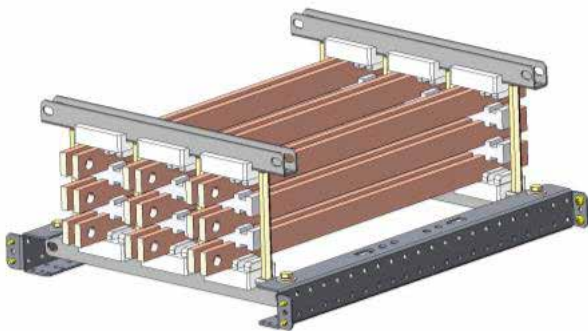
## 1.3 Distribution busbars

### 1.3.1 Distribution busbars

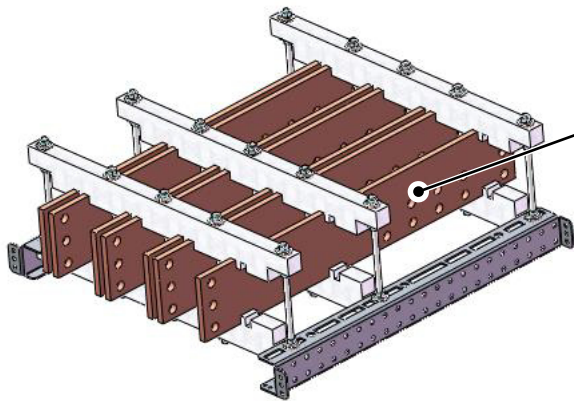
The distribution busbars are the connection between the busbars and the outgoing units.

The busbars can be installed in a single section along the whole length of the compartment, or at an appropriate level for particular versions (see fig. 3-4).

- In fixed and plug-in module versions they are installed vertically in the busbar compartment.
- In plug-in and withdrawable module versions, the busbars are embedded into the multifunctional wall made of insulating material (degree of protection IP 20), held in place and arc-proof covered. In this solution, the grid for contacting is 4E.



Multi-level busbar



Standard busbar

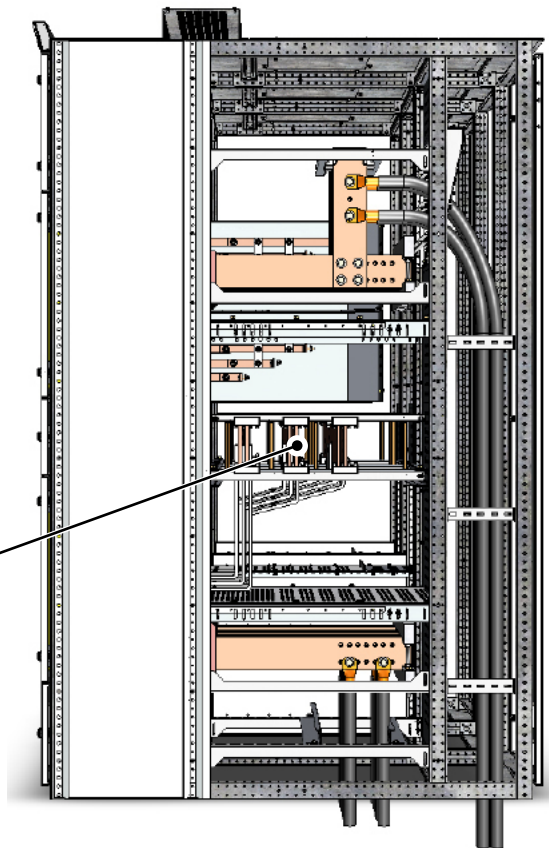


Fig. 2 Typical busbar arrangement



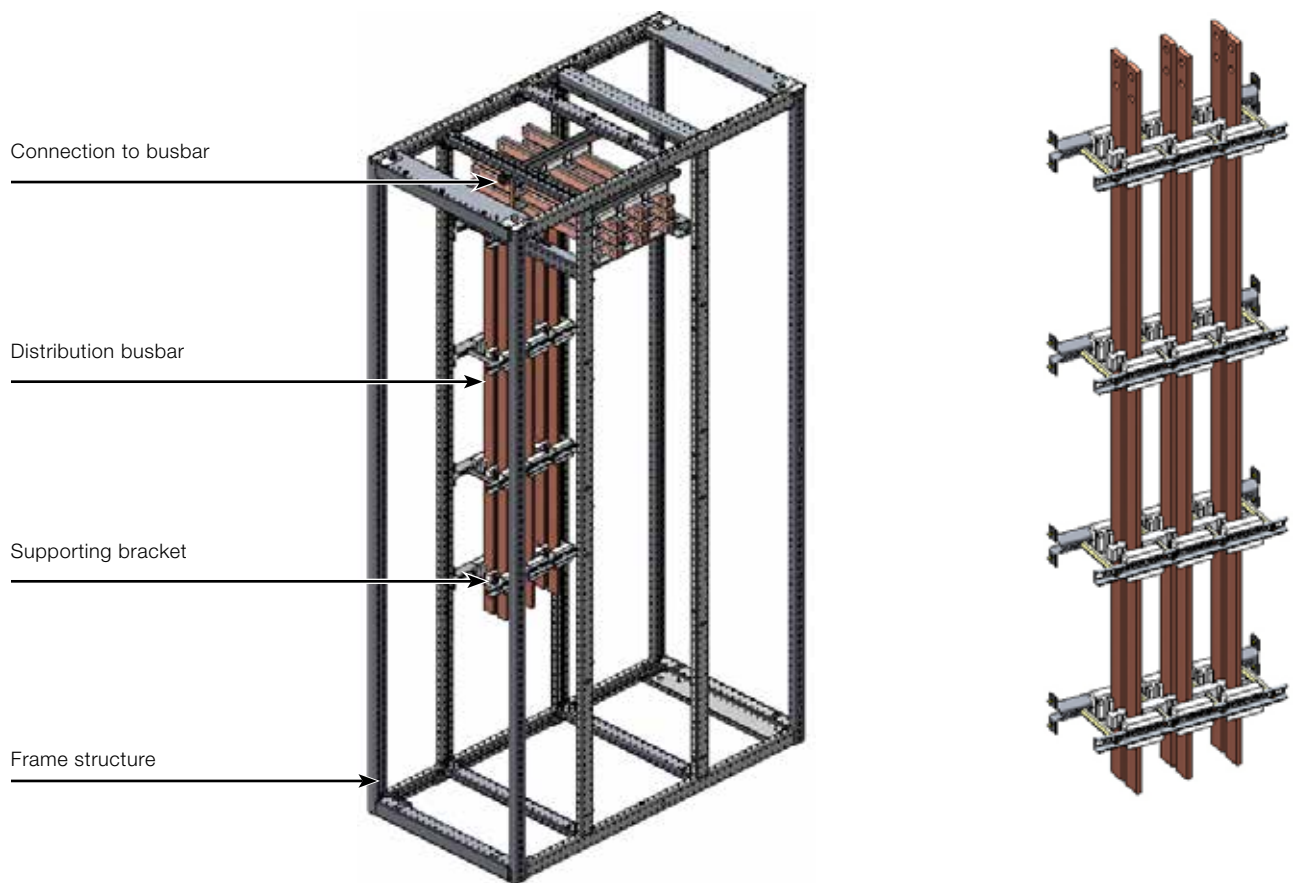


Fig. 3 MNS R Power Center distribution busbars

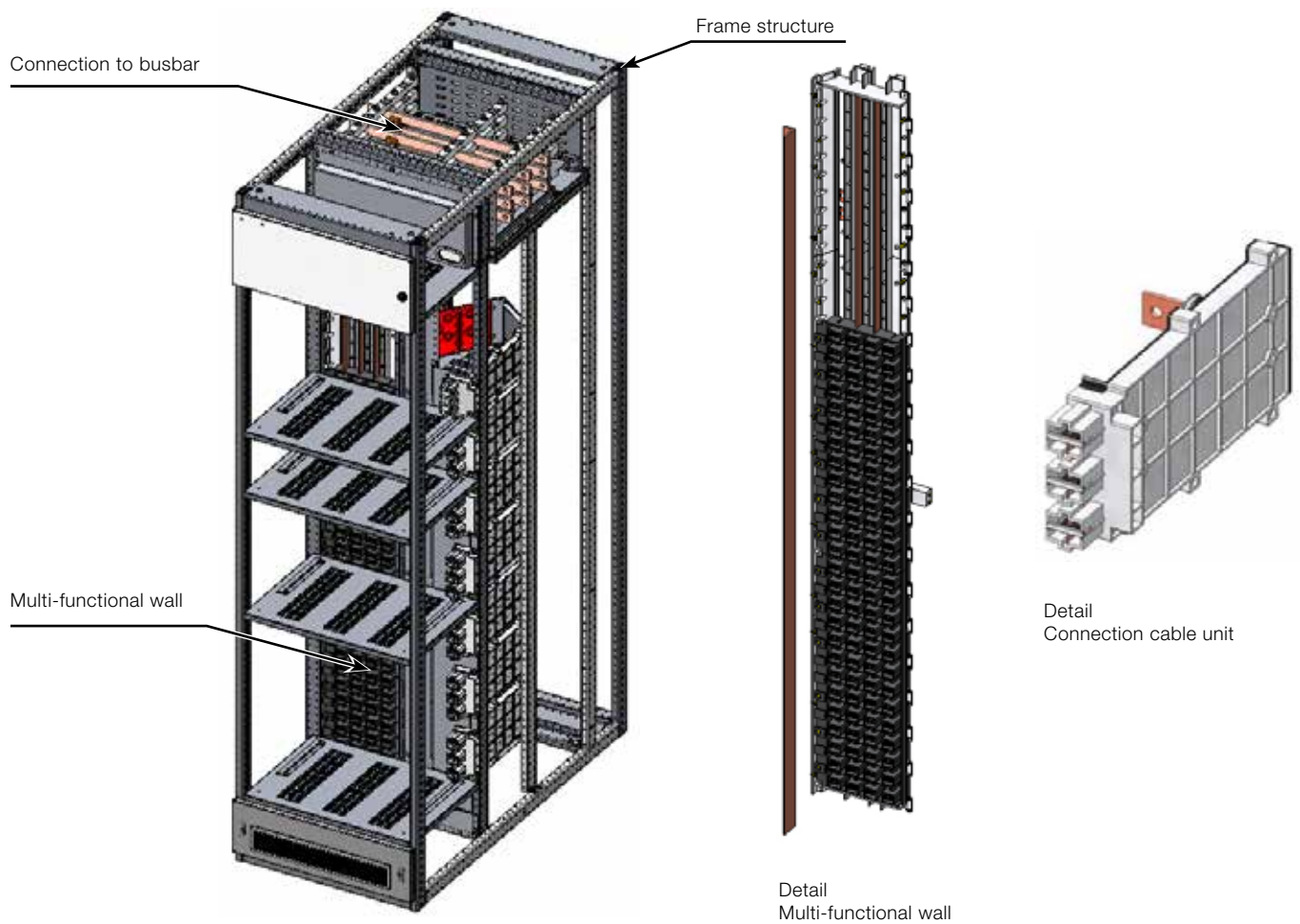


Fig. 4 MNS R Motor Control Center distribution busbars

### 1.3.2 Distribution busbar reinforcement

Distribution busbar reinforcement is provided if the rated current of the distribution busbars is over 750 A, and/or for short circuit ratings over 65 kA (see fig. 5).

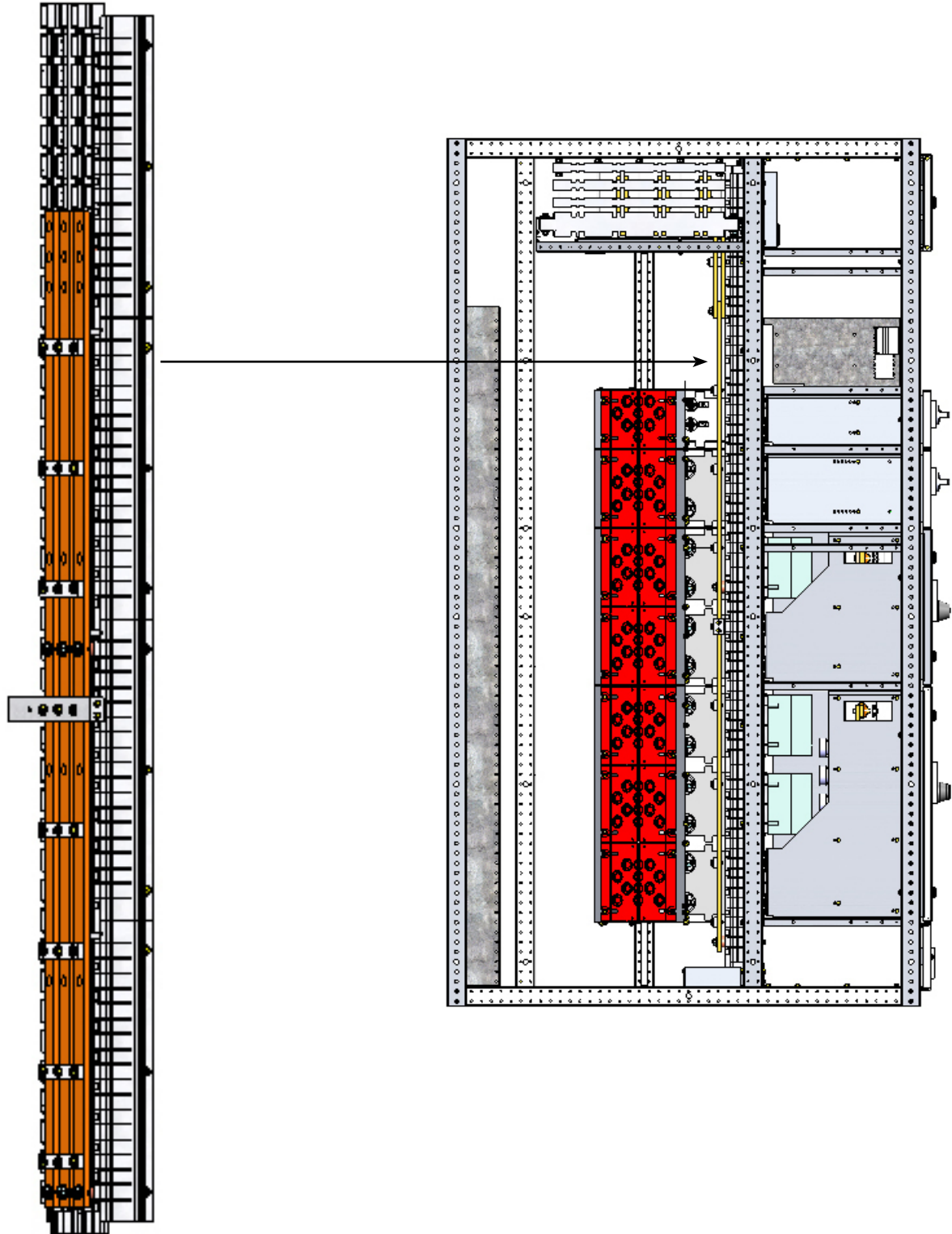


Fig. 5 Distribution busbar reinforcement for MNS R Motor Control Center

## 1.4 Modular add-on parts

The equipment belonging to a functional unit is housed in a single module.

Standard versions feature:

- Direct connection to busbar
- The withdrawable technique
- The plug-In technique.

### 1.4.1 Direct connection to busbar

The circuit breaker or the circuit breaker cradle is connected to the busbar by the copper cable kit (see fig. 6).

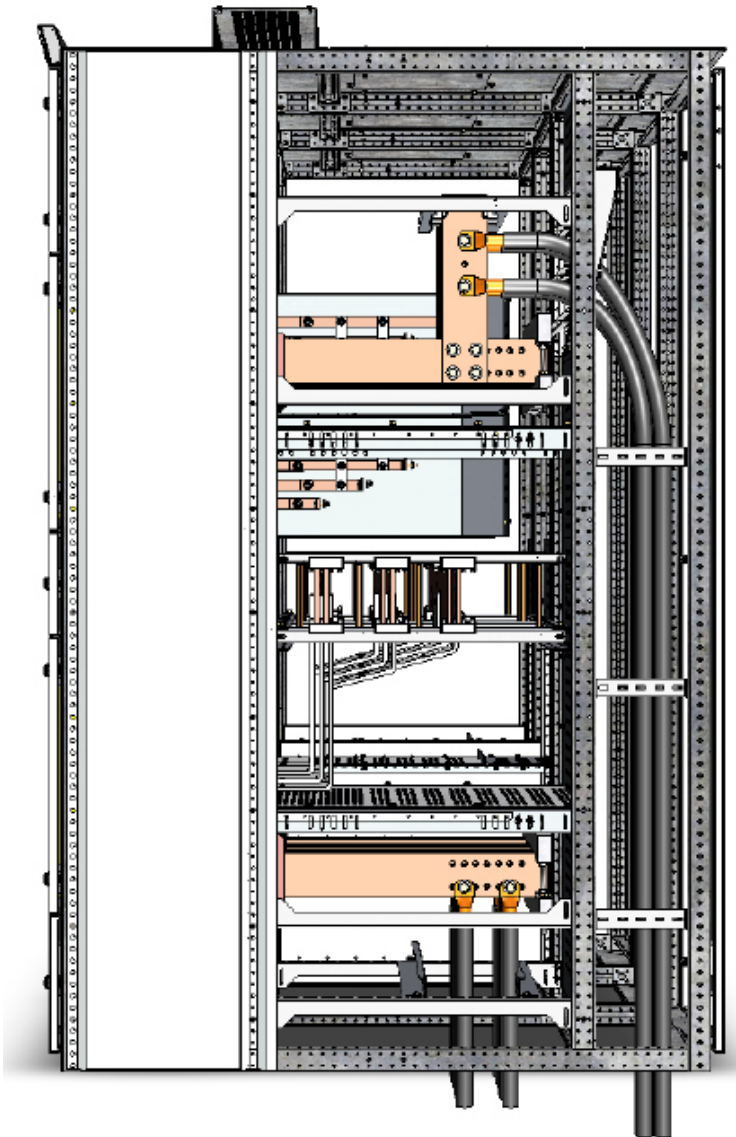


Fig. 6 Typical MNS R system ACB solution

### 1.4.2 Withdrawable technique

Withdrawable units comprise:

- the withdrawable module (see fig. 7-8-10-11),
- the frame-mounted module compartment (see fig. 9).

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

One **600 mm width** equipment compartment can contain:

- size 8E/4                      4 withdrawable modules
- size 8E/2                      2 withdrawable modules
- sizes 6E to 24E              one withdrawable module

Empty spaces are closed off by front covers (see spare parts list).

Size 8E/4 and 8E/2 withdrawable compartments comprise (see fig. 7-8):

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

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

The condapter consists of:

- Conductor busbars for the incoming feeder connection of the withdrawable modules.
- Outgoing contacts with connection to the power terminals (in the cable room).
- Power terminals including the PE terminals.
- Control terminal for 8E/4 modules: 20 poles.
- Control terminal for each 8E/2 module: with one control plug: 20, or 40 poles.

Electrical connections to the withdrawable module are the plug-and-socket type.

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

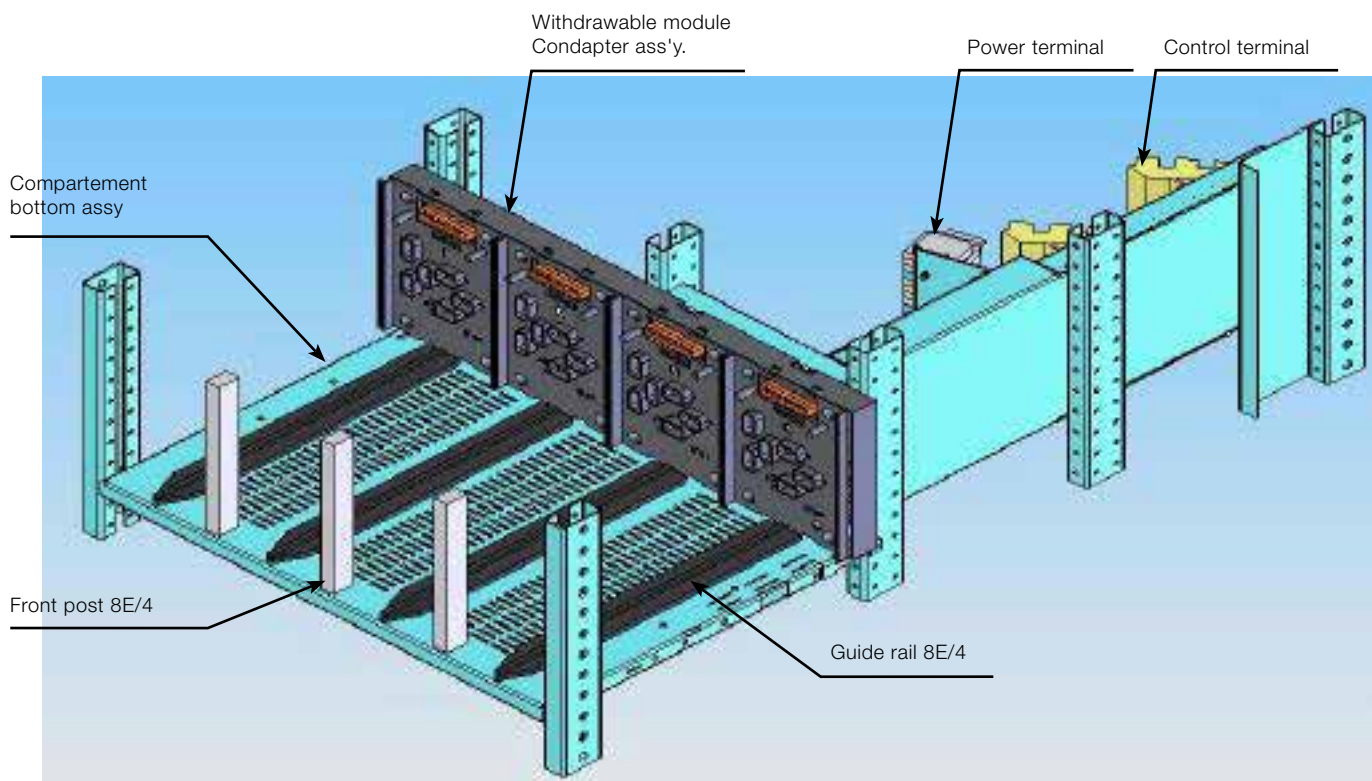
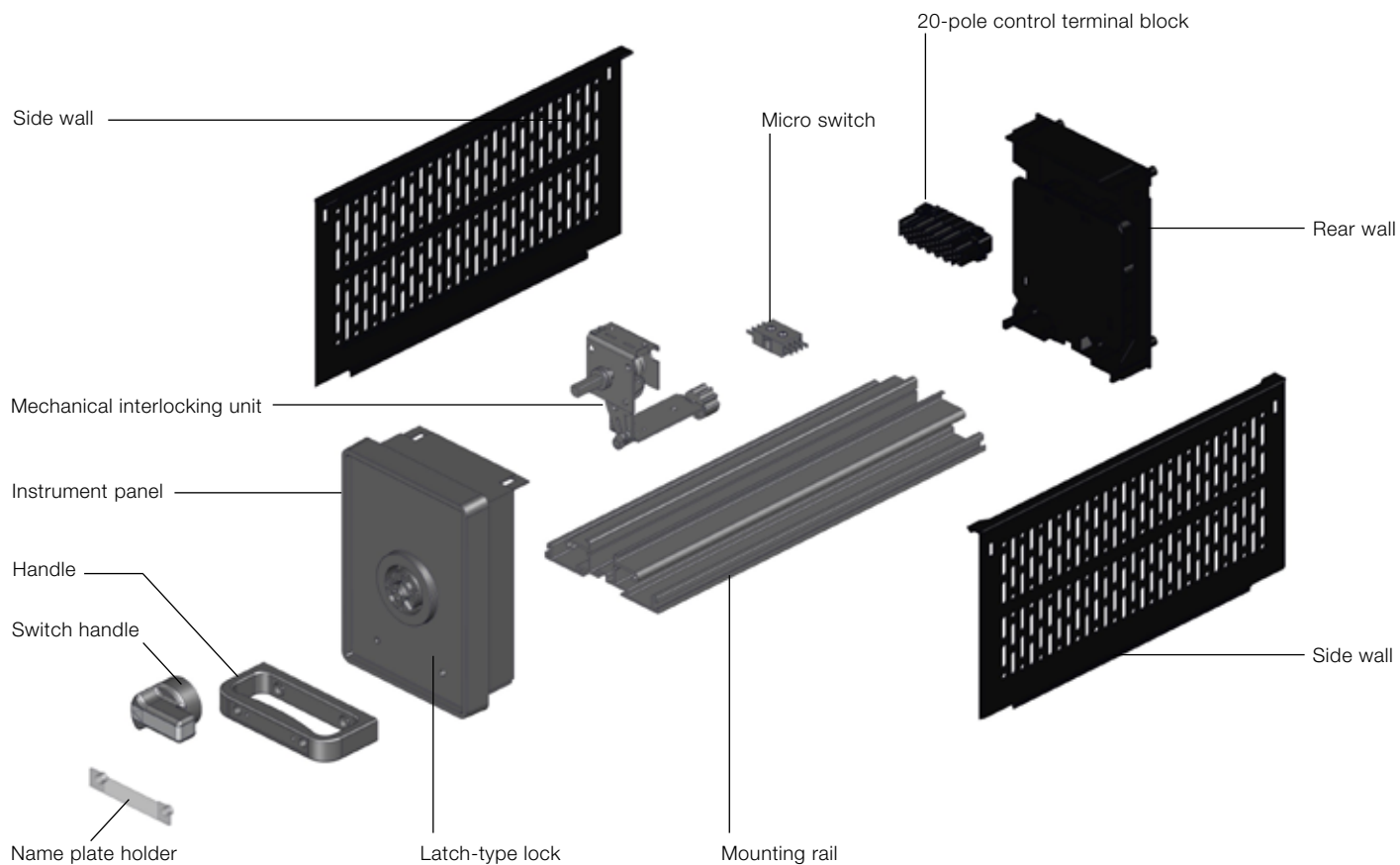
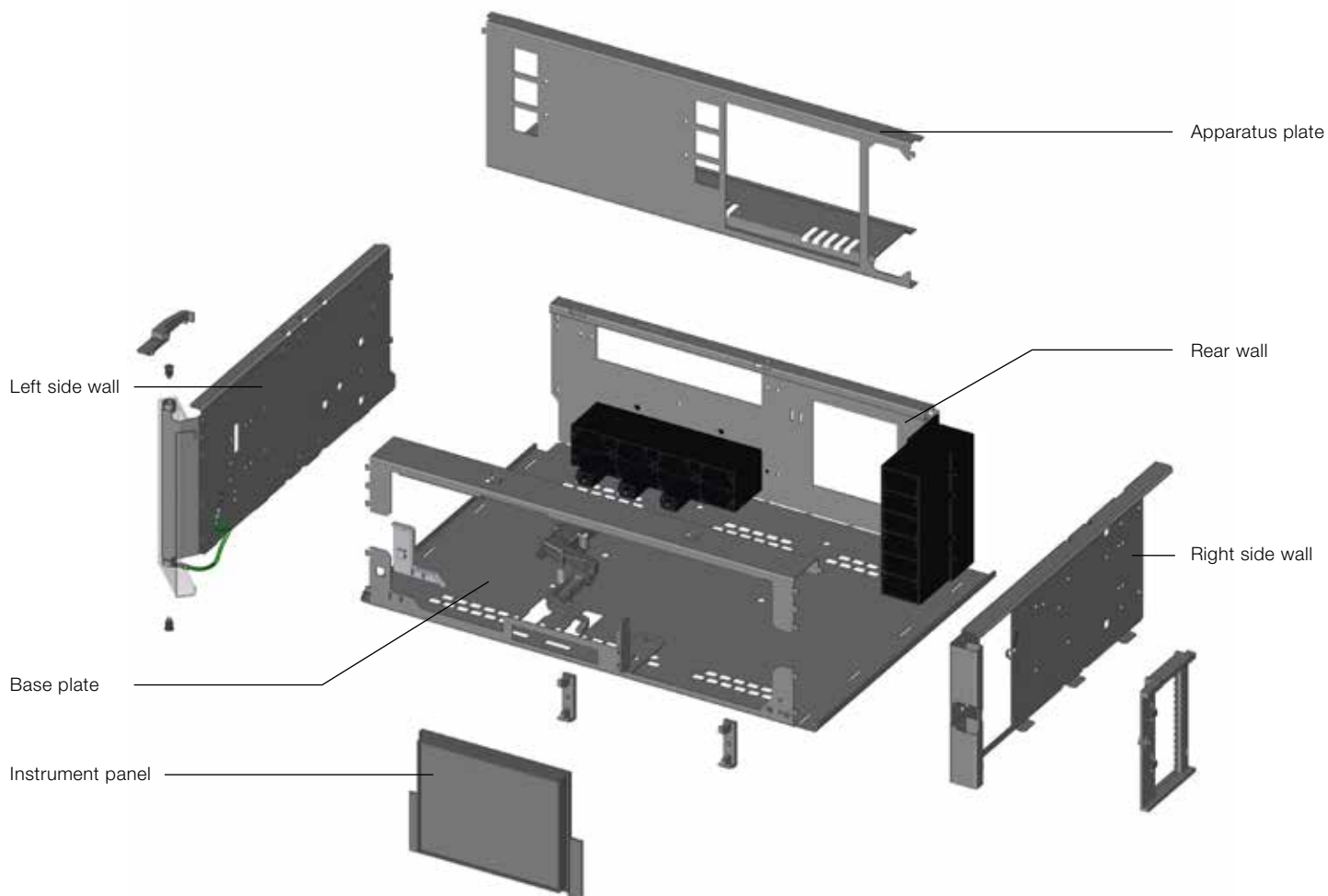


Fig. 7 Withdrawable module compartment for 4 units - size 8E/4





**Fig. 8** Size 8E/4 empty withdrawable unit size (without electrical equipment)



**Fig. 9** > 6E empty withdrawable unit (without electrical equipment)

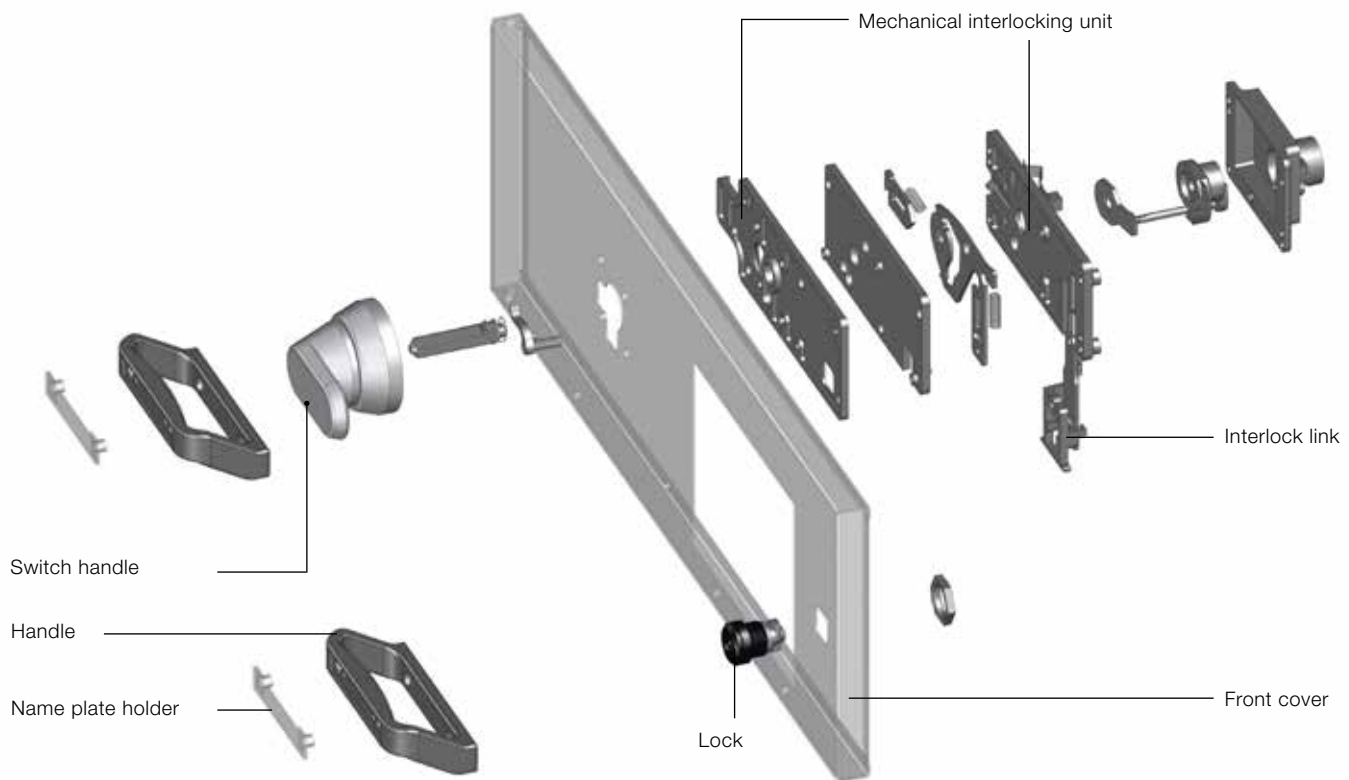


Fig. 10 Withdrawable module door with interlock for 6E ... 24E

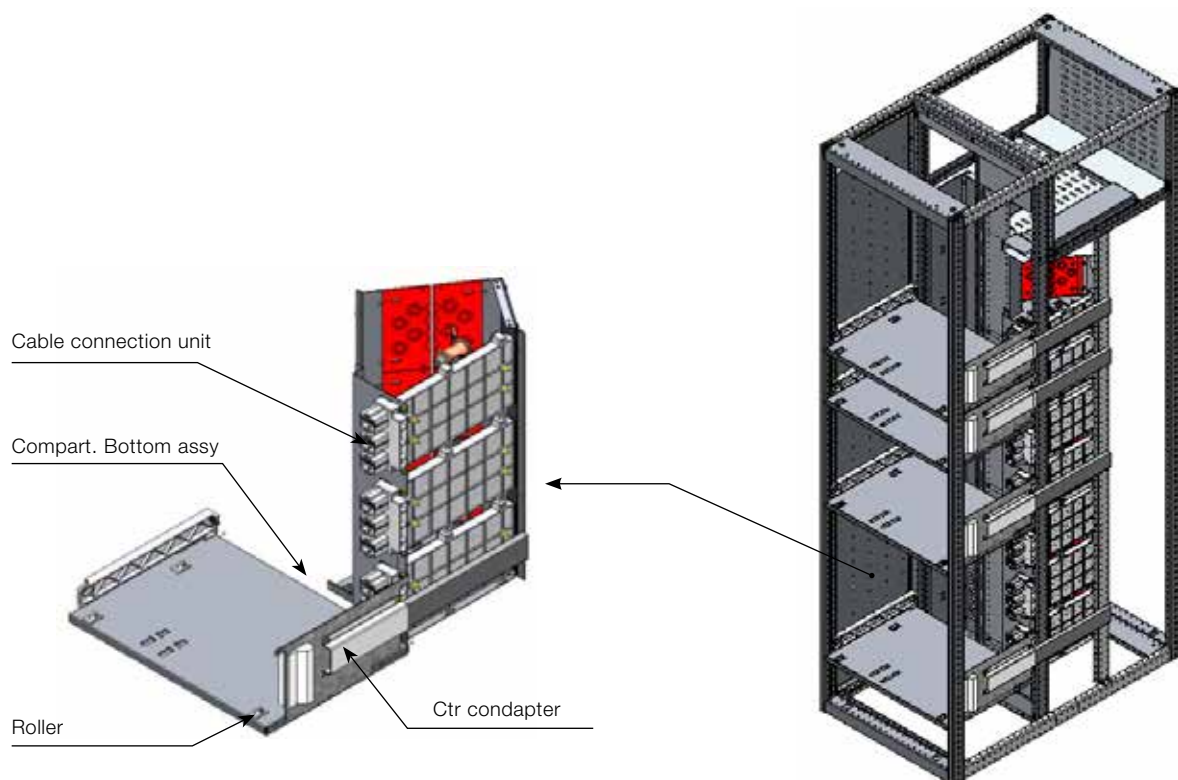


Fig. 11 Withdrawable module compartment for units size 6E ... 24E

Size 6E ... 24E withdrawable module compartments comprise (see fig. 9-10-11):

- Compartment bottom plate with roller.
- Guide rail.
- Sheet metal side wall with the outgoing control plug.
- Outgoing cable connection unit.

The uppermost withdrawable module compartment is covered by a bottom plate. The top cover for the lower compartments is the bottom plate of the compartment above.

The withdrawable module feeder is directly connected to the distribution busbar system via the contact devices of the withdrawable modules. Outgoing cables are connected by plug-in-contacts to the outgoing cable connection unit (main circuit) and by terminal blocks (auxiliary circuit). The outgoing cable connection units are fastened directly to the frame.

A hinged instrument panel made of insulating material for the measuring, operating and indicating instruments is also provided for size 6E to 24E withdrawable modules. It is installed on the unit itself and protrudes through an opening in its the hinged front cover.

Consult chapter 4 for details about the operating components.

### 1.4.3 Plug-in technique

Plug-in units comprise:

- rear plug-in compartment (see fig. 12)
- rear plug-in module (see fig. 13).

Standard sizes are 6E, 8E, 12E, 16E, 24E, (E = 25 mm).

One 600 mm width equipment compartment can house:

- sizes 6E to 24E one rear plug-in module

Sizes 6E ... 24E rear plug-in compartments comprise (see fig. 12):

- Compartment bottom plate
- Guide
- Sheet metal side wall with the outgoing control plug
- Outgoing cable connection unit.

The uppermost rear plug in the module compartment is covered by a compartment bottom plate. The top cover of the lower compartment is the bottom plate of the compartment above.

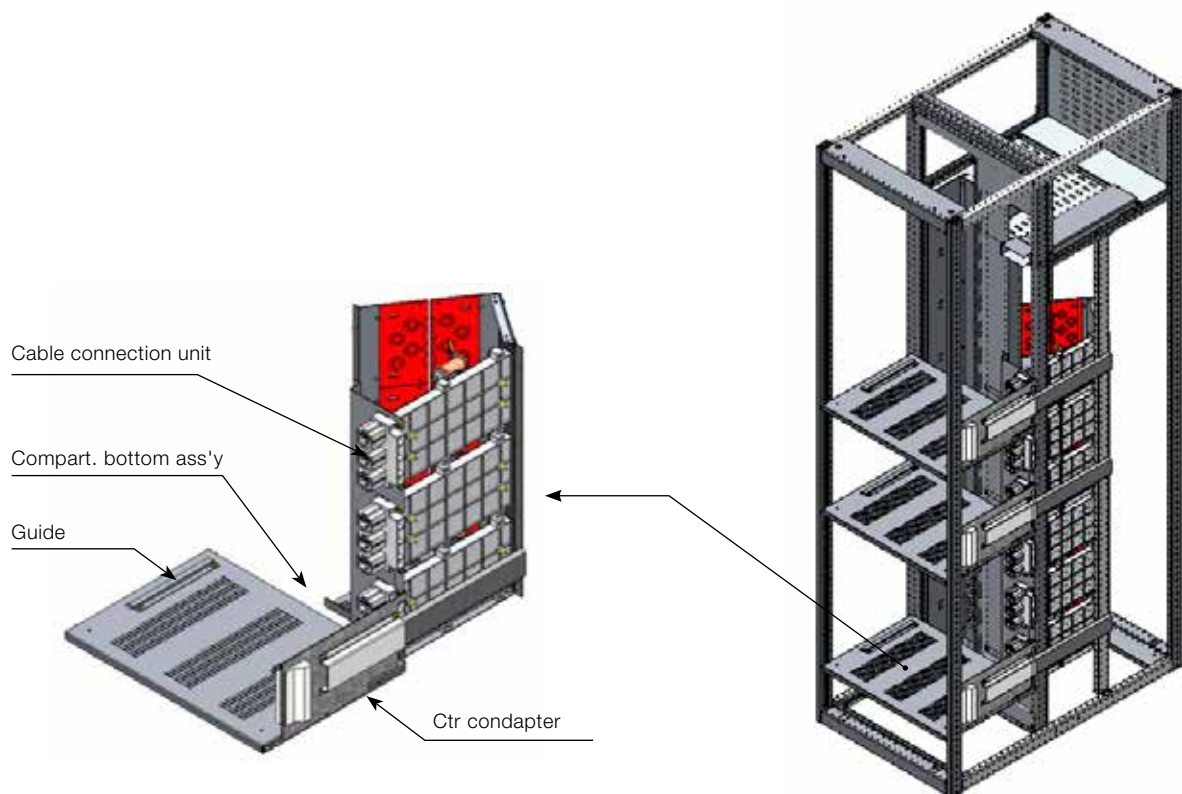


Fig. 12 Plug-In compartment for units size 6E ... 24E

The plug-in modules are fastened directly to the compartment bottom plate by screws.

The plug-in module feeder is directly connected to the distribution busbar system by the contact device of the plug-in modules. Outgoing cables are connected by plug-in contacts to the outgoing connection unit (main circuit) and by terminal blocks (aux circuit). The outgoing cable connection units are fastened directly to the frame.

The modules are racked-in/out with a special tool.

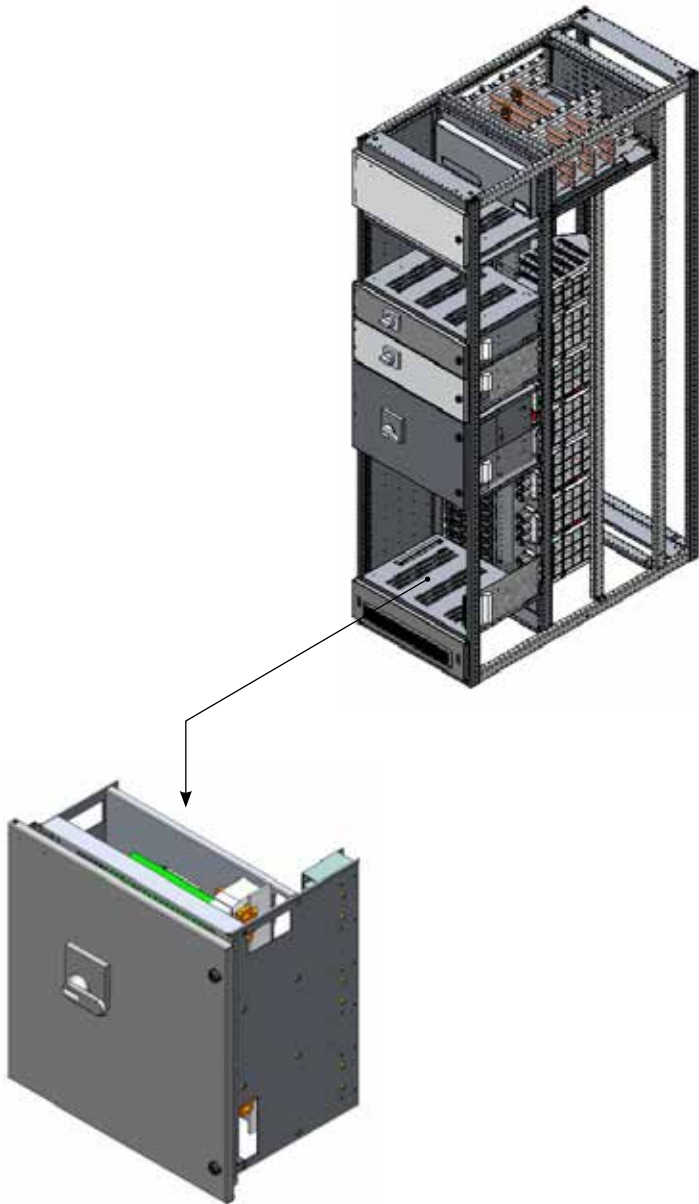


Fig. 13 Plug-In Module (fixed MCCB)

#### 1.4.4 Capacitor Bank

MNS reactive power compensation in plug-in modules complies with the regulations governing type-tested factory-built switchgear and controlgear assemblies in accordance with VDE 0660 Part 500, EN 61439-1 and IEC 60439-1 standards. The standards cover three series of modules for 400 V, 415 V, 525 V and 690 V ratings. Fuse-disconnectors or -bases, contactors, control terminals and reactive power controllers are installed on the front side if necessary (see fig. 14-15).

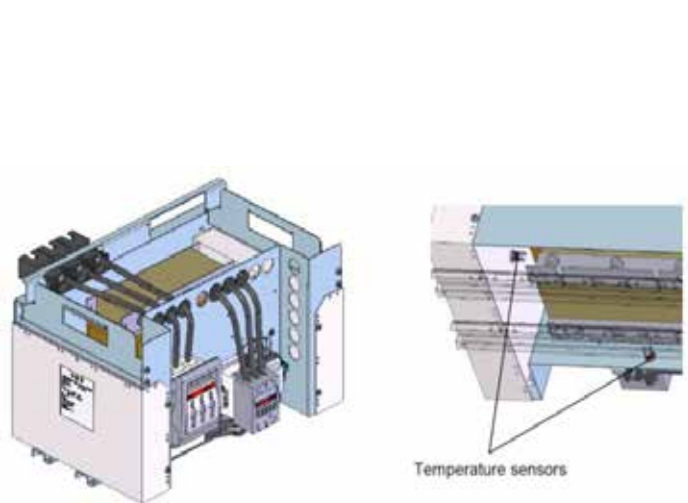


Fig. 14 MNS plug-in-modules with CLMD capacitors

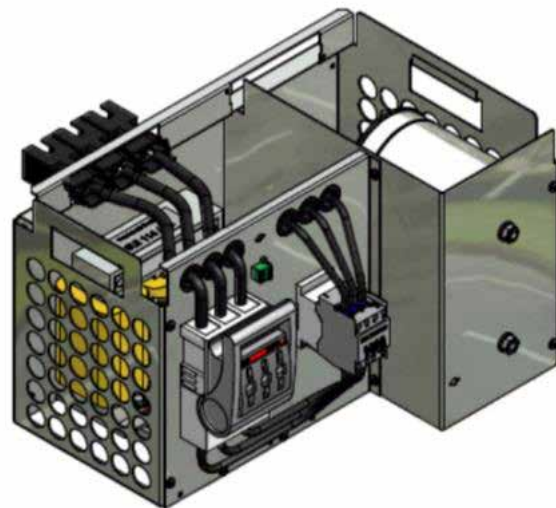


Fig. 15 MNS plug-in-modules with MKPgG capacitors



## 2. Packing and Transport

### 2.1 General

MNS R switchgear is delivered either in single cubicles or in shipping units no more than 2.4 meters in length, depending on the type of equipment installed and the space available for handling the switchgear at the construction site.

In the absence of special instructions from the customer, the switchgear is delivered in standard packaging, according to ABB internal instructions, and a suitable method of shipping is chosen.

### 2.2 Packing

The cubicles are protected by suitable packaging during transport and intermediate storage (if applicable).

The standard packaging comprises:

- PE-sheeting
- pallet
- plastic straps
- wooden crate (if necessary)

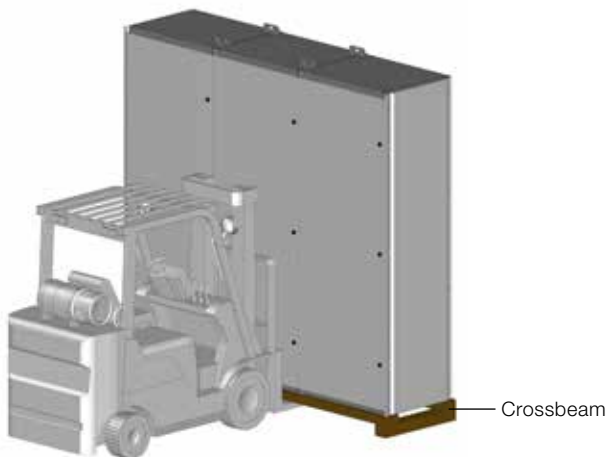


Fig. 16 Fork-lift transport



Transporting by manual lift truck is dangerous as the apparatus can overturn. For this reason, the distance between the crossbeams or pallets and the bottom must not exceed 3 mm (see Figure).

### 2.3 Delivery and Unloading Operations

Cranes or lift trucks must be used for unloading the equipment. The load must be placed on a level surface.

#### 2.3.1 Unloading

By means of lift trucks (see fig. 16-17).

By means of lifting and sliding devices (see fig. 16-17).

- If necessary, by means of rollers (min. 3 pieces). The wooden crossbeams must be removed for roller transport (only for units weighing up to 1200 kg) (see fig. 16).
- The switchgear compartments must only be transported in the vertical position.
- Tilting and canting must be avoided.

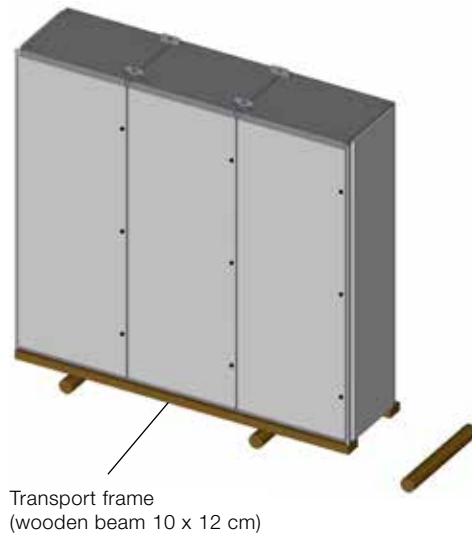


Fig. 17 Roller transport (only for transporting units weighing up to 1200 kg)

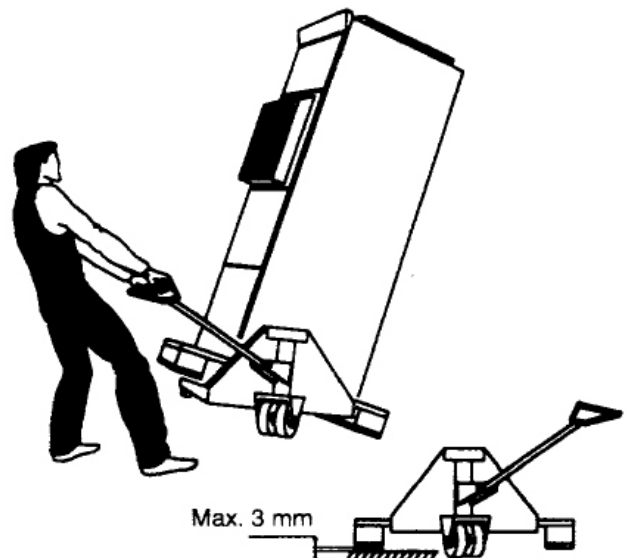


Fig. 18 Transporting by manual lift truck

### 2.3.2 Transporting by crane

- When a crane is used to transport the apparatus, the compartments and relative units must be equipped with lifting profiles.
- The lifting devices must not be fixed to the frame sections.
- The angle between the lifting cable and crane hook must not exceed 120° (see fig. 19-20).
- The lifting devices can be removed once the apparatus has been installed.
- The fastening holes for the lifting apparatus must be covered with GMN 775 502 P18 plugs.

Approximate acceptable weights of loads lifted by cable

Cable diameter  mm	Acceptable load for a 4-cable device, angle between cable and crane hook		
	Hemp cable DIN 83325  kg	Perlon cable DIN 83330  kg	Steel cable DIN 15060 (160 kg/mm <sup>2</sup> )  kg
8	-	-	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	-	-

For a 90° angle, the acceptable load is approximately 40% more than the values shown in the table.

### 2.3.3 Packaging of switchgear components

The following devices and materials must be delivered packed separately from the switchgear, regardless of the transport method used:

- withdrawable air circuit breaker,
- withdrawable moulded case circuit breaker with over 1,000 A rated current,
- fuses,
- transformers and reactors weighing more than 25 kg, in the case of floor mounted units weighing more than 100 kg,



Fig. 19 Crane transport, transport unit unpacked

- costly precision instruments for measuring and indicating,
- fluorescent tubes,
- modules with single phase control power transformers over 2 kVA,
- spare withdrawable and P-/R-modules,
- withdrawable modules weighing  $\geq 30$  kg.

## 2.4 Storage

The nature and length of time intermediate storage lasts depends on the type of packaging.

Standard packaging:

- After arrival, the apparatus must be stored in places where no condensation can form.
- Unpack immediately.
- Leave the door open for several hours so as to acclimatize the equipment.
- Cover the panels with plastic sheeting for longer storage periods.
- Check for condensation before installing the equipment.

Packaging for transportation by sea/export (on request):

- Protection against moisture is only guaranteed if the packaging is undamaged.
- Intermediate outdoor storage is possible.
- 6-12 month storage is possible, depending on the storage environment conditions, if the goods are wrapped in heat sealed protective sheeting and the packaging is undamaged.

If the storage period is lasts longer, the drying agent must be renewed and the plastic covering must be sealed again.

### 2.4.1 Spare Module Storage

- In a dry place.
- Modules must be stored in their undamaged original packaging.
- Modules must not be subjected to sudden temperature changes.
- Boxes must be stored with the top side pointing upwards.
- Do not store size  $\geq 16E$  modules on top of each other.

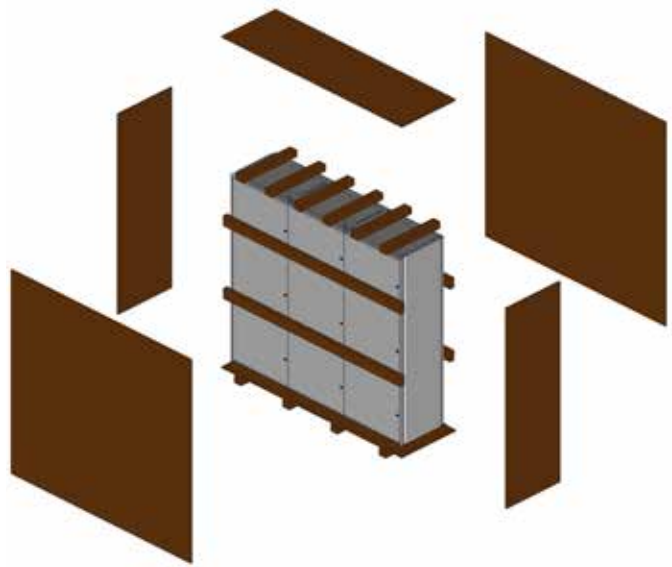


Fig. 20 Crane transport, transport unit in box

## 3 Construction

### 3.1 Inspection on Delivery

After the goods arrive, check to make sure that:

- none of the components is damaged;
- the goods are free from damage (otherwise, assess the extent of the damage, the cause and possible responsibilities).

When damage is discovered, proceed as follows:

- Record the visible damage on the delivery note.
- Inform ABB Sace (directly or through the supplier or sales representative).
- Notify the forwarding agent in writing within one week if concealed damage is discovered.

Following delivery of the apparatus, complaints about damage or for other reasons must indicate the year of construction of the switchgear and the number of the order confirmation sent by ABB Sace, as indicated on the enclosed supply documents.



**ABB declines all liability for loss of supply documents or failure to lodge claims.**

### 3.2 Installation

The best internal conditions, adequate illumination and free access to the switchgear must be guaranteed. It is advisable to heat the room so as to avoid sudden temperature changes, a high degree humidity and the formation of condensation. To correctly install the switchgear, it is important to construct the frame with care. It must be prepared in advance, before the installation date, as indicated in the design document.

#### 3.2.1 Construction and Connection of the Cubicles

Proceed as follows to install the switchgear units:

- The units to be installed must be aligned with care. Check that they are in the vertical position. Doors and panels must not be distorted or stressed. Assembly can begin from the right or left.
- The frames must be screwed together (see fig. 21). Threaded rivets are pre-installed for fixing the C-profiles together.

Use an electric or pneumatic screwing device to initially fasten the threaded rivets.

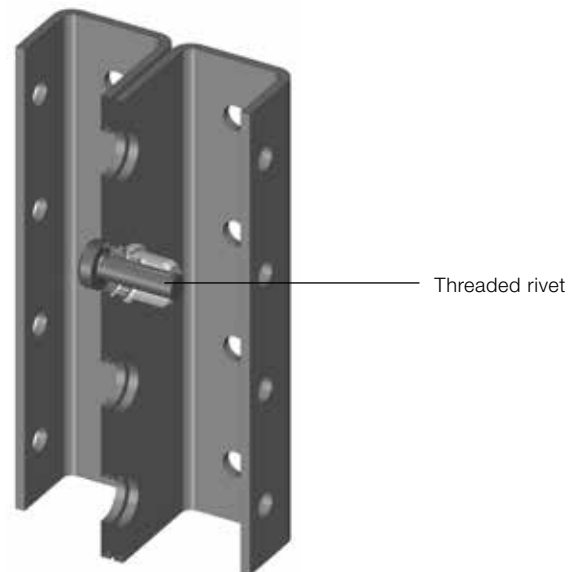


Fig. 21 Frame connection

## 3.3 Cable and Busbar Connection

Comply with the tightening torque values given in the table in Sect. 5.11 for all connections, especially those made with standard components.

Circuit breakers and main switching devices are normally connected by cables or busbars.

- Power and control cables must be fastened to cable mounting rails.
- Power and control cables are connected to:
  - Terminal boards
  - Connection busbars
  - Outgoing cable connection units.

If the outgoing busbar connections must be disassembled or replaced, comply with the following instructions before re-installing:

- Check that the connection contact surface is flat and clean.
- Remove burrs, dents and oxidation with a file or rough cloth. In case of busbars with special protective coatings, the coating must be restored after the above-mentioned tools have been used.
- Remove any grease with a cloth and solvent.

### 3.3.1 Busbar Connection (see fig. 24a-b)

Before assembling, carefully clean the busbar contact area with a cloth soaked in solvent.

- Make sure that the busbar is properly aligned.
- Match the coupling elements
- Lock the joints by means of the coupling elements, bolts and nuts supplied.

Protective and neutral busbars must be screwed together where divided for transportation purposes (connecting elements are included).

The busbar points of connection are accessed from the rear. If installation is performed correctly, the holes will match. Drilling is not allowed since it produces chips.

The contact surfaces do not need any particular treatment. Consult Sect. 5.11 for the tightening torque values.

### 3.3.2 Protective Conductor Connection (see fig. 25)

All switchgear compartments are normally equipped with an earth busbar the section of which will depend on the short-circuit level of the switchgear.

The earth busbar is installed in the rear side of the switchgear (at the bottom). The earth busbar joint of each unit divided for shipping purposes must be connected in the following way:

- Remove any traces of oxidation from the contact surfaces of the busbars using a file or emery cloth.
- Remove any grease with a cloth and solvent.
- Join the the earth busbars using the screws, washers and nuts supplied.

The switchgear must be earthed by means of a copper conductor with a cross-section no less than the earth busbar.

The doors are earthed by means of yellow-green copper conductors (minimum cross-section 2.5 mm<sup>2</sup>).

No connection is necessary, if no energized elements are connected to the door ( $\leq 50$  V AC or  $\leq 120$  V DC).

In all cases, protective conductor connections screwed onto painted surfaces should be secured with serrated contact washers. Any screw locking method 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.

### 3.3.3 Protection Degree

The sections must be sealed in the place of installation depending on the required protection degree.

- For IP X2 or IP 5X degrees of protection, the bottom plate covers (flanges) must be sealed, if this has not already been done by the manufacturer. 15 x 2 mm (GSIN100021P0010) self-adhesive sealing material must be used to seal the bottom plate. This must be applied after cleaning (see below), to the inside bend of the flanges, and must overlap 3 mm over the bend (see fig. 22).
- For IP X1 or IP 4X degrees of protection, the frames between the sections (section/ section) must be sealed where divided for transport, unless this has already been done in the factory.

The following measures must be taken:

- The connection sides of the frame sections in question must be cleaned with cleaner and an oil- and grease-free cloth.
- After the cleaner has dried, 15 x 2 mm self-adhesive sealing tape (GSIN100021P0010) must be applied to the C-sections, 3 mm away from outer edge (see fig. 23).

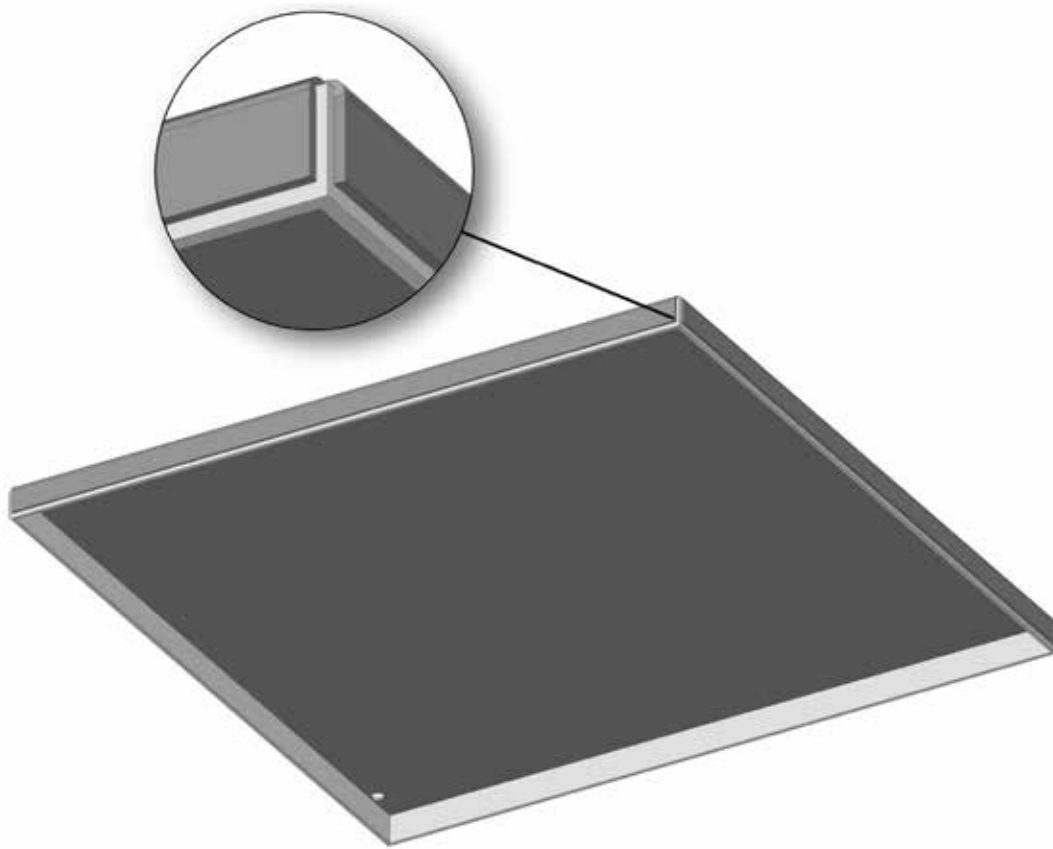


Fig. 22 Seals on bottom plate cover

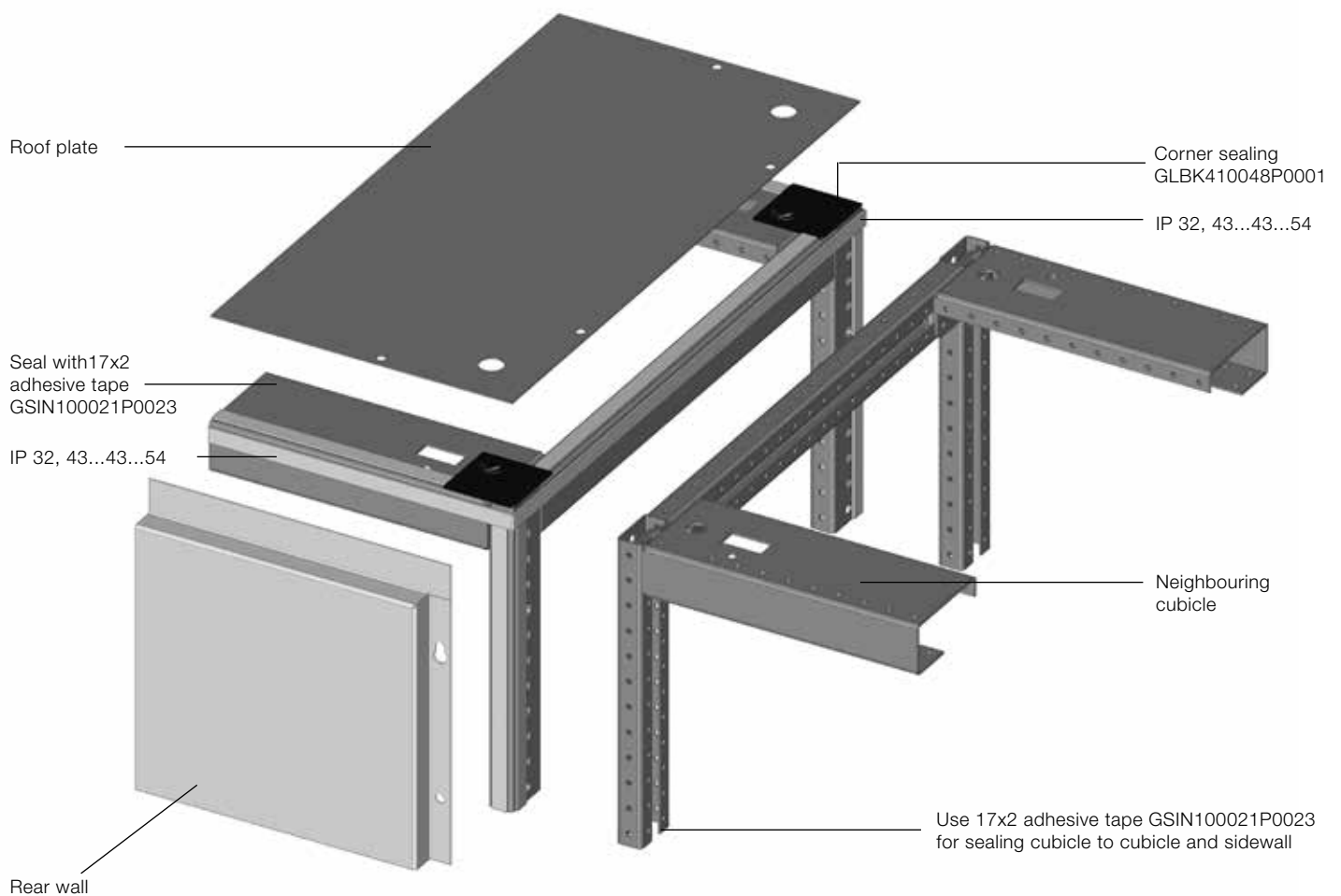


Fig. 23 Seals between adjacent compartments and roof

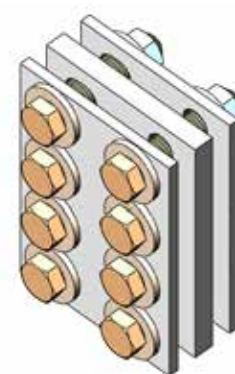
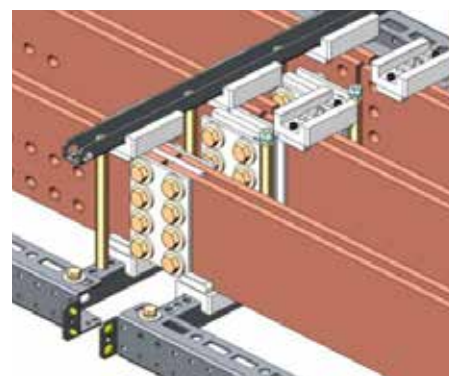
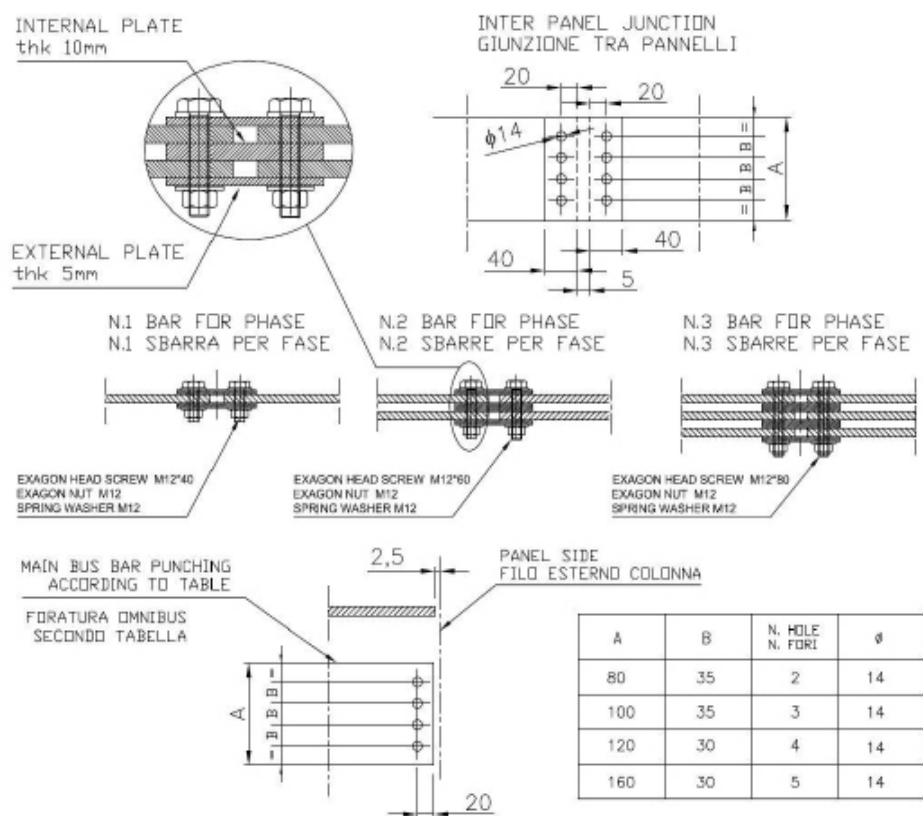


Fig. 24a Standard busbar connections

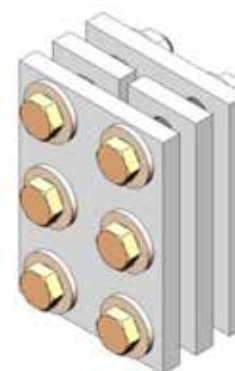
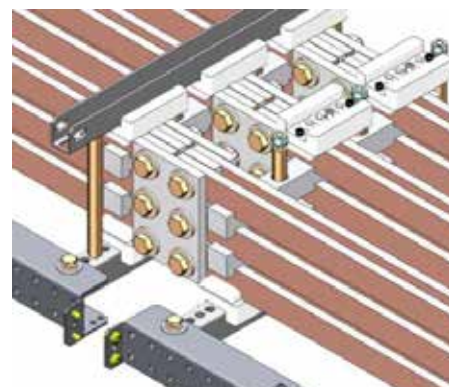
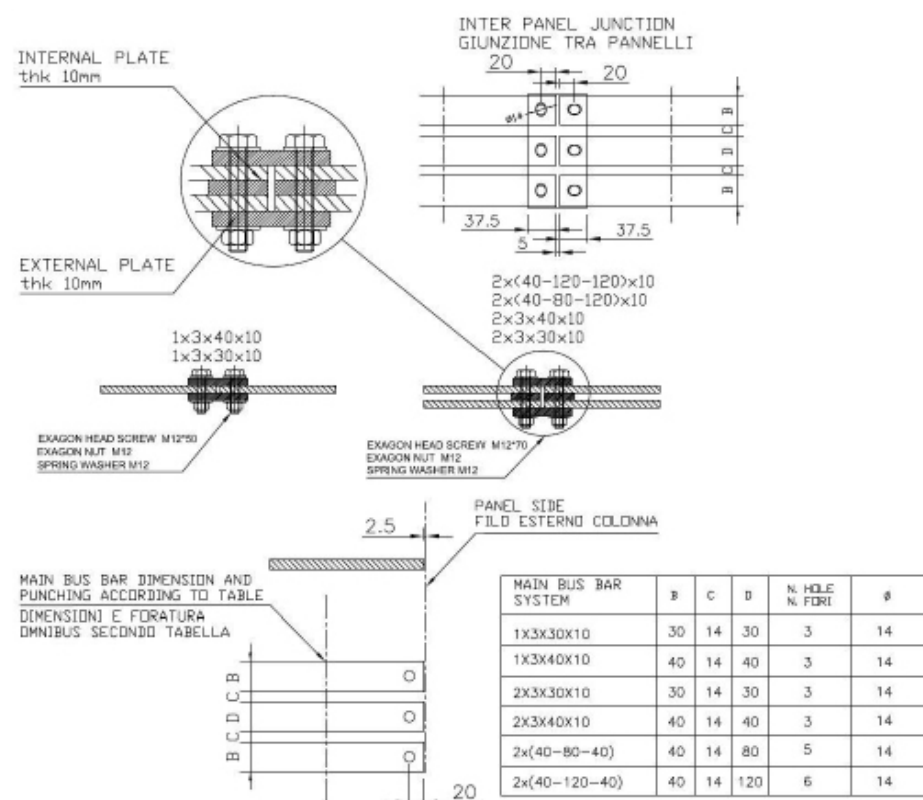


Fig. 24b Multi-level busbar connections



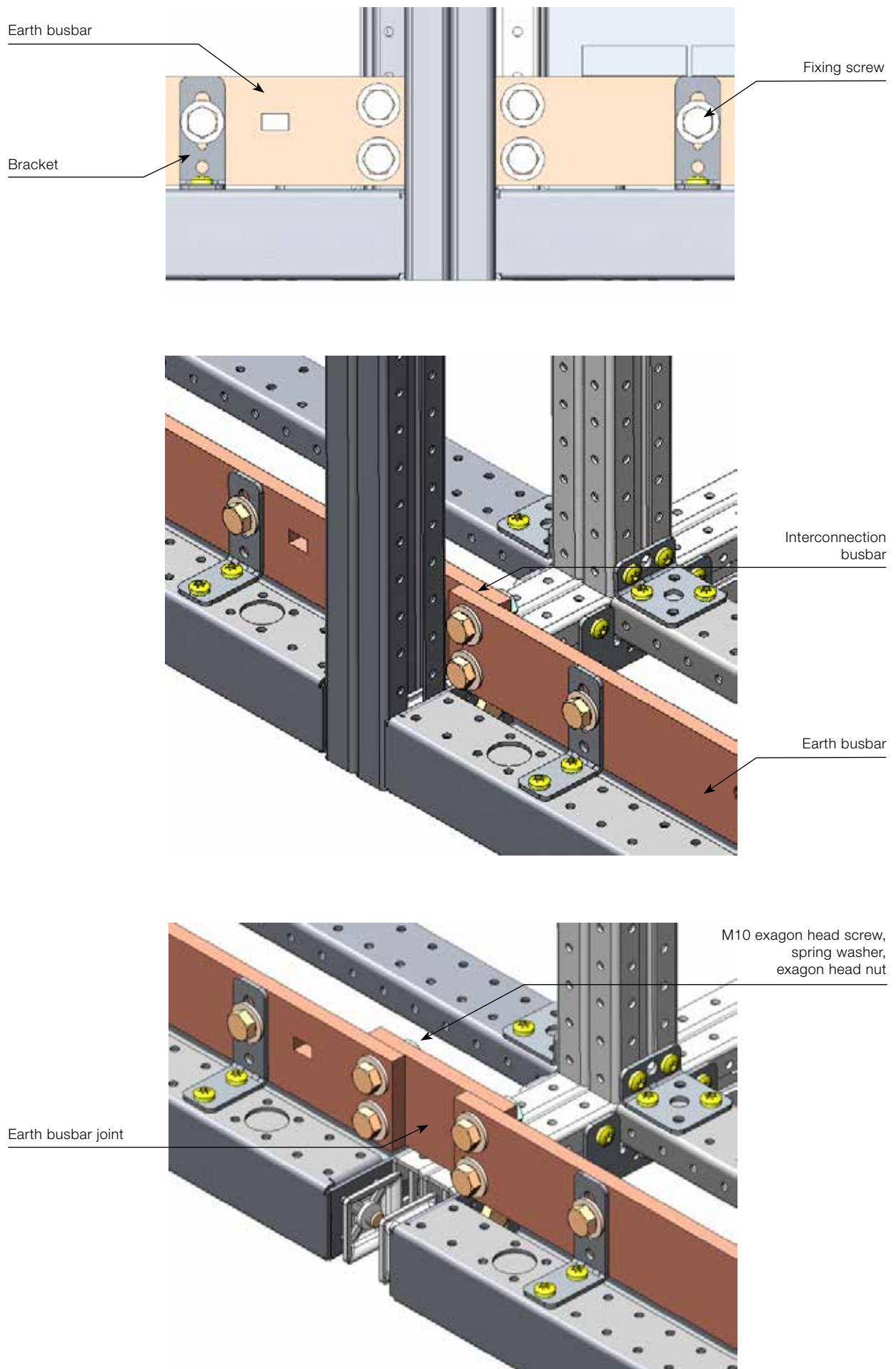


Fig. 25 Earth busbar connection detail

3.4 Additional information about switchgear positioning

The distance from the wall (front and rear) should comply with the following rules:

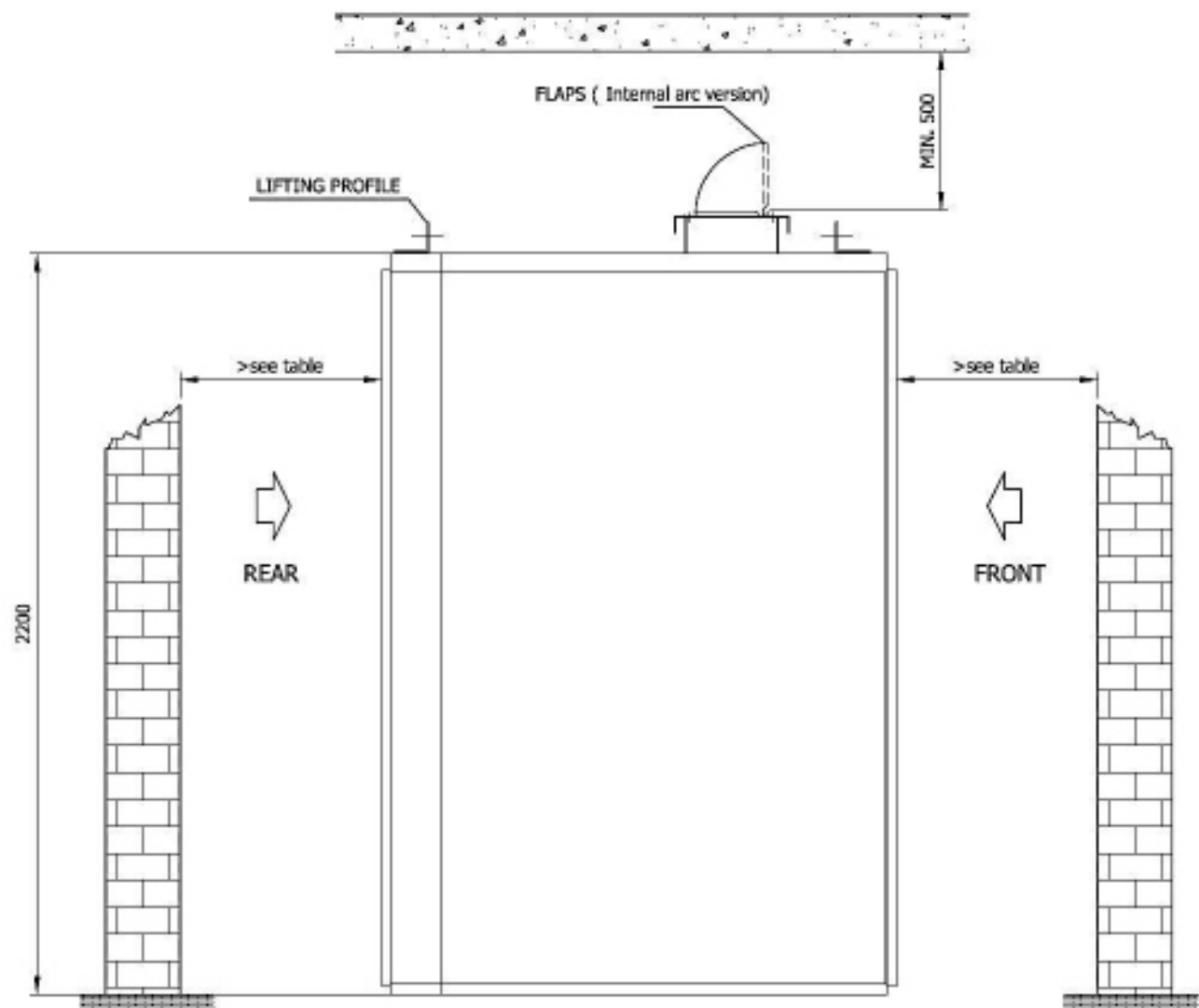
- it must be more than the width of the largest panel
- it must be at least 800 mm to allow normal operations
- it must comply with the safety regulations for emergency/ evacuation plans (see fig. 26-27).

The last compartment (right) must be installed 150 mm away from the wall.

The last left compartment must be at least 150 mm away from the left wall, so that the doors can be opened at an angle of over 90°.

For internal arc-proof cables, the upper edge of the tallest cubicle end must be at least 500 mm away from the ceiling (see fig. 26).

Side view



Panel width [mm]	Min space Front [mm] *	Min space Rear [mm]**
600	1000	800
800	1000	800
1000	1000	800
1200	1200	800

\* A lift truck may be required to remove and insert the breaker of the ACB withdrawable version.

In this case, the space required for lift truck manoeuvres must also be assessed.

\*\* 2 x 500 width rear doors are provided for 1000mm width panels  
2 x 600 width rear doors are provided for 1200mm width panels

Fig. 26 Free space around the frame



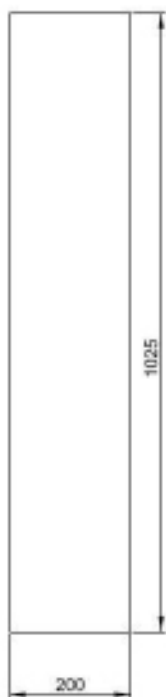
### 3.5 Cuts in the floor

If the floor must be cut on-site to accommodate supply cables and wires, measurements must be taken as shown in the diagrams below (all measurements in mm).

Depth 1025 mm

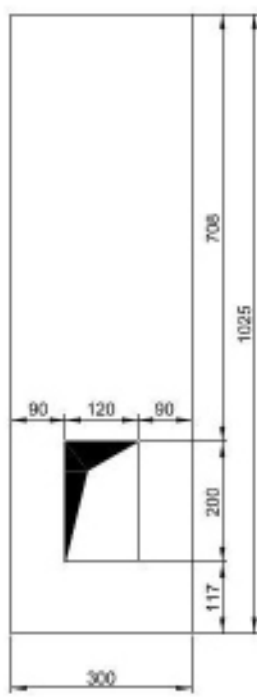
Busbar compartment 525 mm

Panel width 200 mm



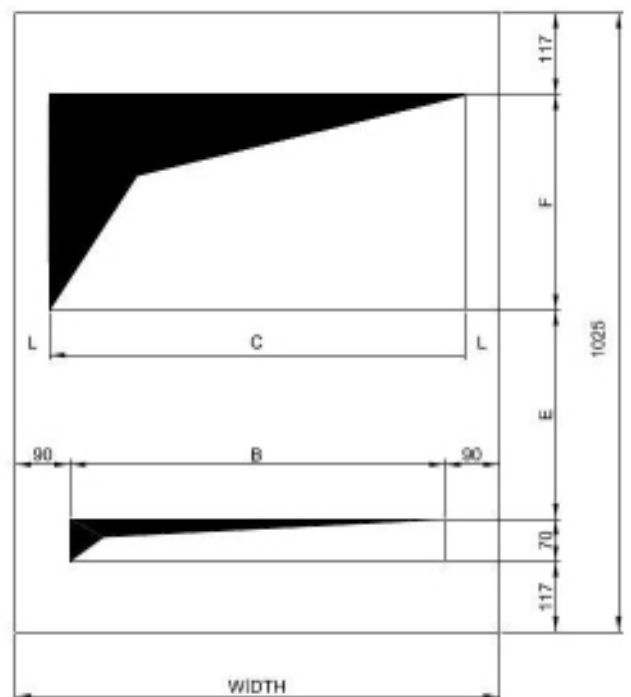
FRONT

Panel width 300 mm



FRONT

Panel width  $\geq 400$  mm



FRONT

Depth 1025 mm						
Width [mm]	B.C.	B	C	E	F	L
200	525	-	-	-	-	-
300	525	-	-	-	-	-
400	525	220	240	336	385	80
600	525	420	488	347	374	56
800	525	620	688	347	374	56
1000	525	820	888	336	385	56
1200	525	1020	1088	336	385	56

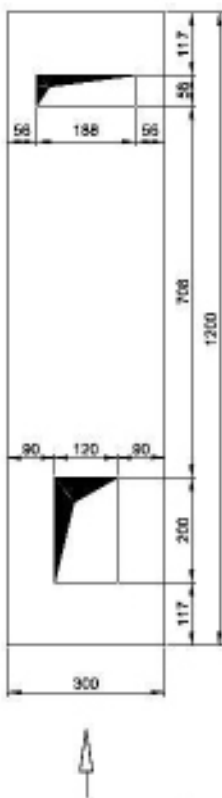
Depth 1200 mm  
Busbar compartment 525 mm

Panel width 200 mm



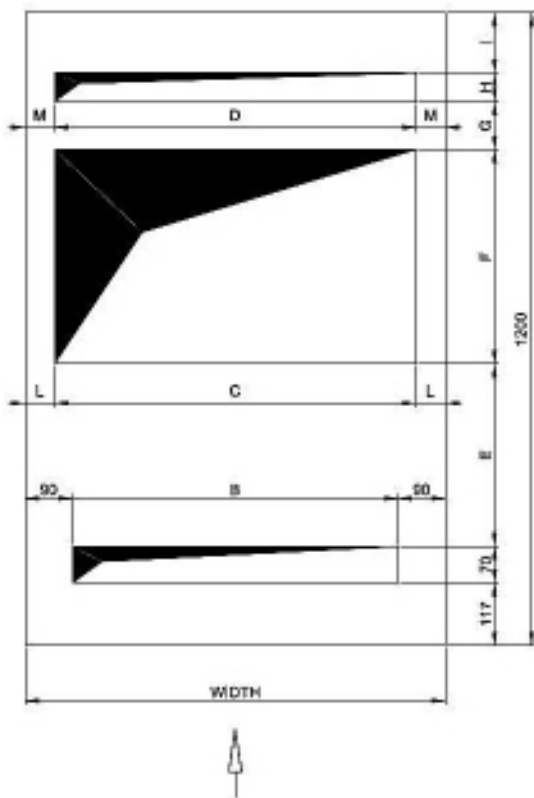
FRONT

Panel width 300 mm



FRONT

Panel width ≥ 400 mm



FRONT

Depth 1200 mm												
Width [mm]	B.C.	Note	B	C	D	E	F	G	H	I	L	M
200	525	-	-	-	-	-	-	-	-	-	-	-
300	525	-	-	-	-	-	-	-	-	-	-	-
400	525	-	220	240	220	336	440	62	58	117	80	90
600	525	-	420	488	488	347	408	91	55	112	56	56
800	525	-	620	688	688	347	408	91	55	112	56	56
1000	525	-	820	888	820	336	440	62	55	112	56	90
1200	525	-	1020	1088	1020	336	440	62	55	112	56	90
600	525	MCC REAR	420	488	488	440	310	96	55	112	56	90

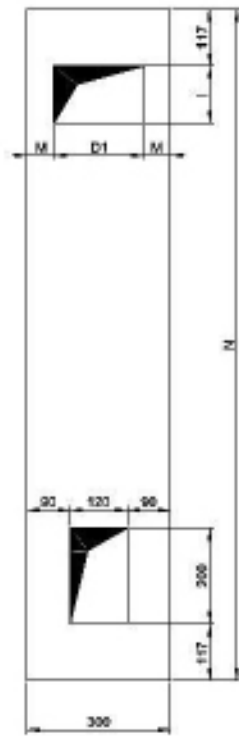
Depth 1400-1600 mm  
Busbar compartment 525-650 mm

Panel width 200 mm



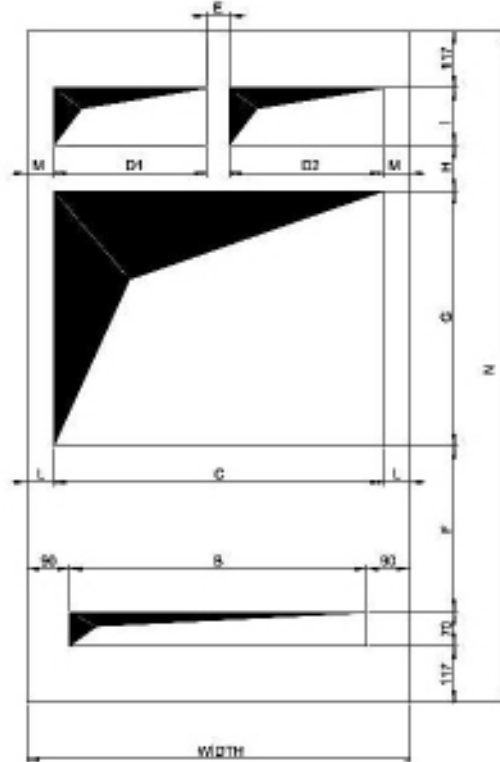
FRONT

Panel width 300 mm



FRONT

Panel width ≥ 400 mm



FRONT

#### Depth 1400 mm

Width [mm]	B.C.	Note	B	C	D1	D2	E	F	G	H	I	L	M	N
200	525		-	-	-	-	-	-	-	-	-	-	-	1400
	650		-	-	-	-	-	-	-	-	-	-	-	1400
300	525		220	240	188	-	-	-	-	-	120	-	56	1400
	650		220	240	188	-	-	-	-	-	120	-	56	1400
400	525		220	240	220	-	-	340	440	76	240	80	90	1400
	650		220	240	220	-	-	392	508	76	120	80	90	1400
600	525		420	488	220	220	48	347	408	96	245	56	56	1400
	650		420	488	220	220	48	347	533	96	120	56	56	1400
800	525		620	688	320	320	48	347	408	96	245	56	56	1400
	650		620	688	320	320	48	347	533	96	120	56	56	1400
1000	525		820	888	420	420	48	340	440	76	240	56	56	1400
	650		820	888	420	420	48	392	508	76	120	56	56	1400
1200	525		1020	1088	520	520	48	340	440	76	240	56	56	1400
	650		1020	1088	520	520	48	392	508	76	120	56	56	1400
600	525	MCC REAR	420	488	220	220	48	445	310	96	245	56	56	1400

#### Depth 1600 mm

Width [mm]	B.C.	Note	B	C	D1	D2	E	F	G	H	I	L	M	N
200	525		-	-	-	-	-	-	-	-	-	-	-	1600
	650		-	-	-	-	-	-	-	-	-	-	-	1600
300	525		220	240	188	-	-	-	-	-	320	-	56	1600
	650		220	240	188	-	-	-	-	-	320	-	56	1600
400	525		220	240	220	-	-	340	440	76	440	80	90	1600
	650		220	240	220	-	-	392	508	76	320	80	90	1600
600	525		420	488	220	220	48	347	408	96	445	56	56	1600
	650		420	488	220	220	48	347	533	96	320	56	56	1600
800	525		620	688	320	320	48	347	408	96	445	56	56	1600
	650		620	688	320	320	48	347	533	96	320	56	56	1600
1000	525		820	888	420	420	48	340	440	76	440	56	56	1600
	650		820	888	420	420	48	392	508	76	320	56	56	1600
1200	525		1020	1088	520	520	48	340	440	76	440	56	56	1600
	650		1020	1088	520	520	48	392	508	76	320	56	56	1600
600	525	MCC REAR	420	488	220	220	48	445	310	96	445	56	56	1600

### 3.6 Methods for Fastening to Foundation

Installation of switchgear with cables entering from the bottom requires a foundation with an opening or a cable duct. Compartments can be installed directly on the floor or preferably on a base frame which is:

- Embedded in the concrete floor
- Fixed on supports on a raised floor.

Comply with the following instructions when constructing the base frame:

- The base frame should be aligned and checked by a qualified ABB SACE operator (on customer's request).
- The horizontal tolerance must not exceed  $\pm 1$  mm over a length of 1 m.
- The frame must not wobble ( $\square \mid 2 / 1000$  according to DIN ISO 1101).

During the installation operations, the switchgear is welded or screwed to the base frame.

- The welded joint length on the front and rear sides of each cubicle, should not be less than 20 mm. Each weld should be adequately treated to protect it against corrosion (by a coat of paint).

If the switchgear is installed on a raised floor, make sure that:

- The tolerance is the same as that of a base frame.
- The foundation base must be solid, so that the tolerance values do not change if it settles (especially when insulation layers and adhesives are used).
- The bearing capacity of the raised floor must be  $p=20$  kN/m<sup>2</sup> (compression load from top to bottom).

The switchgear is welded or screwed to the raised floor when installed.

- The length of the welded joint on the front and rear sides of each cubicle should not be less than 20 mm. Each weld should be adequately treated to protect it against corrosion (by a coat of paint).

The switchgear has three available anchor points, see fig. 28.

The base frame could be a standard UPN profile or a HALFEN profile.

Fixing points A and B may be used if the switchgear is anchored to the floor or UPN profile. Only fixing point C may be used if the profile is the HALFEN type.

Installation drawings illustrating the different anchor points are given in figs. 29-30-31.

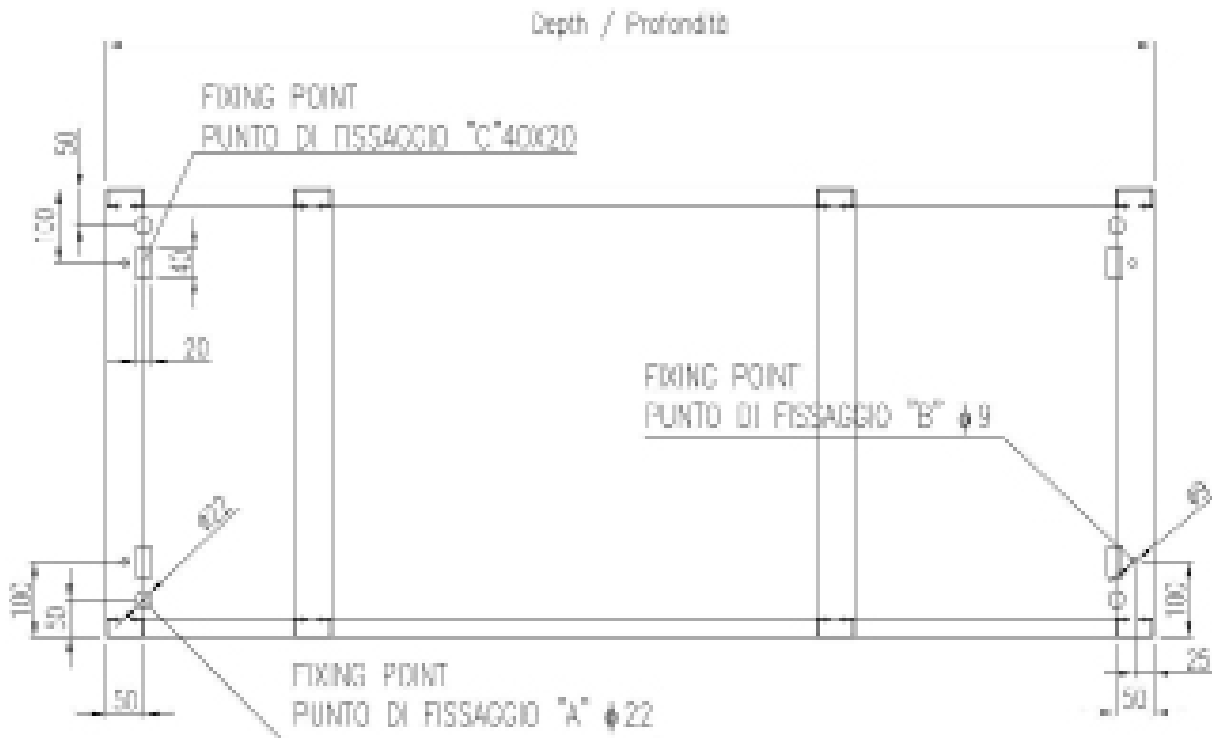
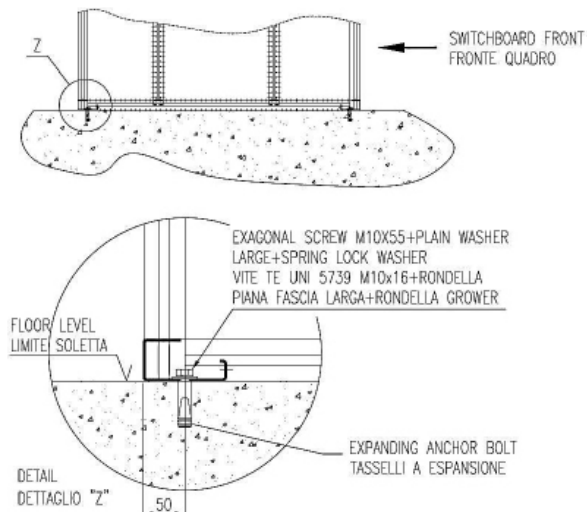


Fig. 28 Switchgear with three anchor points

ANCHORING THE SWITCHBOARD TO THE FLOOR – ANCHOR POINT A  
 QUADRO FISSATO CON VITI A PAVIMENTO – Punto di fissaggio A



ANCHORING THE SWITCHBOARD TO THE FLOOR – ANCHOR POINT B  
 QUADRO FISSATO CON VITI A PAVIMENTO – Punto di fissaggio B

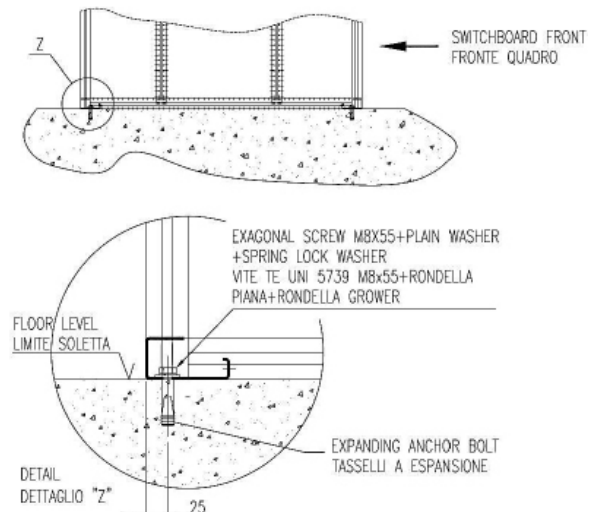
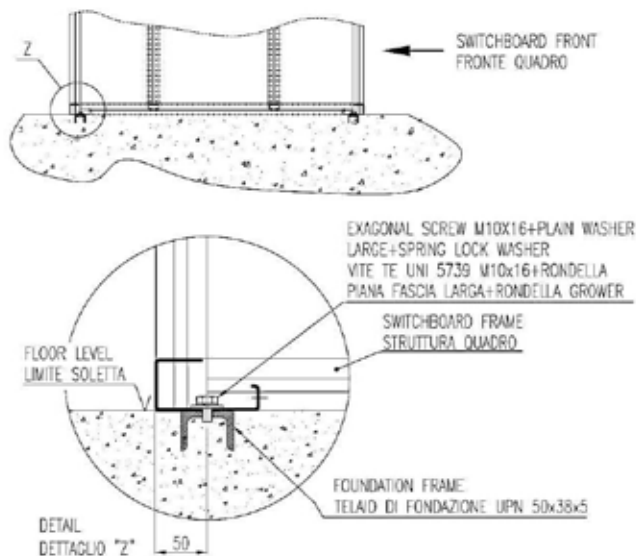


Fig. 29 Anchoring the switchgear to the floor

ANCHORING THE SWITCHBOARD TO UPN PROFILE – ANCHOR POINT A  
 QUADRO FISSATO CON VITI SU TELAIO UPN – Punto di fissaggio A



ANCHORING THE SWITCHBOARD TO UPN PROFILE – ANCHOR POINT B  
 QUADRO FISSATO CON VITI SU TELAIO UPN – Punto di fissaggio B

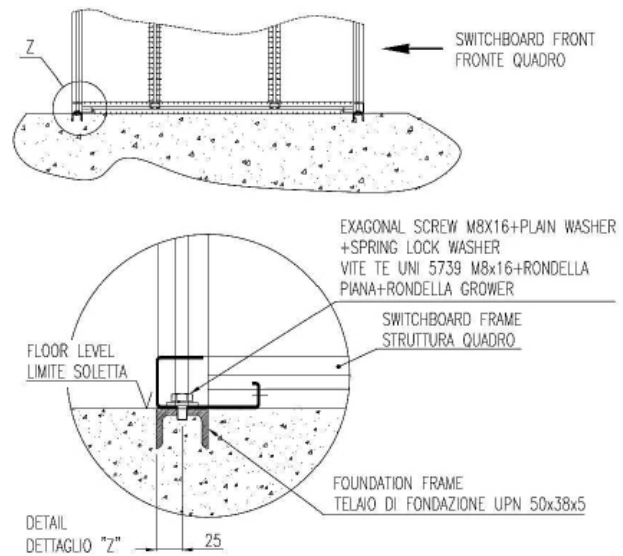


Fig. 30 Anchoring the switchgear to the UPN profile

ANCHORING THE SWITCHBOARD TO THE HALFEN PROFILE – ANCHOR POINT C  
 QUADRO FISSATO CON VITI A SU TELAIO HALFEN – Punto di fissaggio C

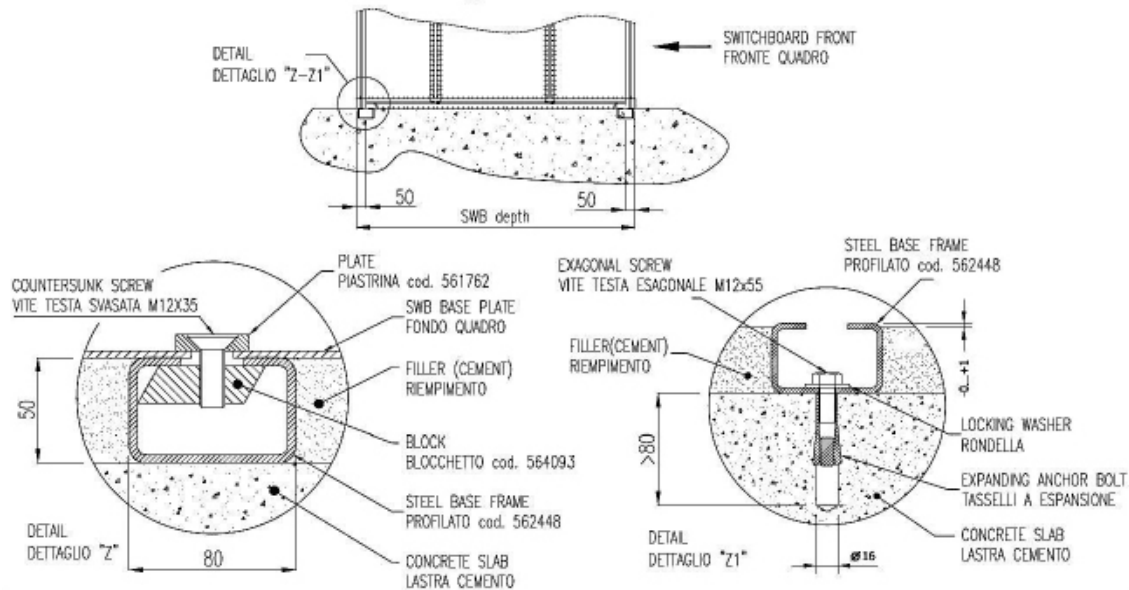


Fig. 31 Anchoring the switchgear to the halfen profile

## 3.7 Cable connections, wiring

### 3.7.1 Connection to circuit breaker and load-break switches

Circuit breaker and load break switches are equipped with standard cable connection sets (see figs. 32, 33, 34).

The outgoing cable must be fastened to the cable support with a plastic seal.

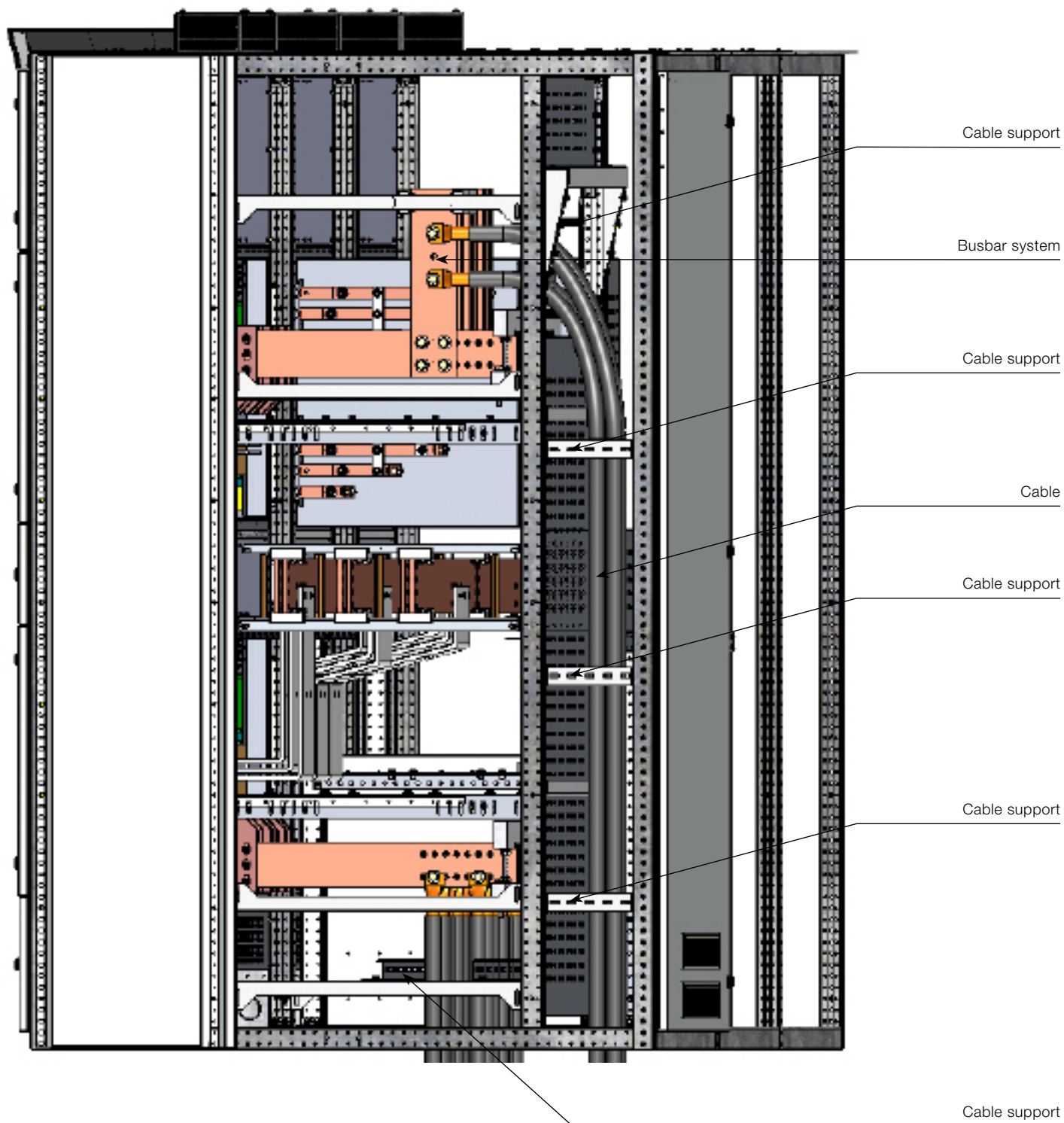


Fig. 32 Typical cable connection from Emax to busbar and cable

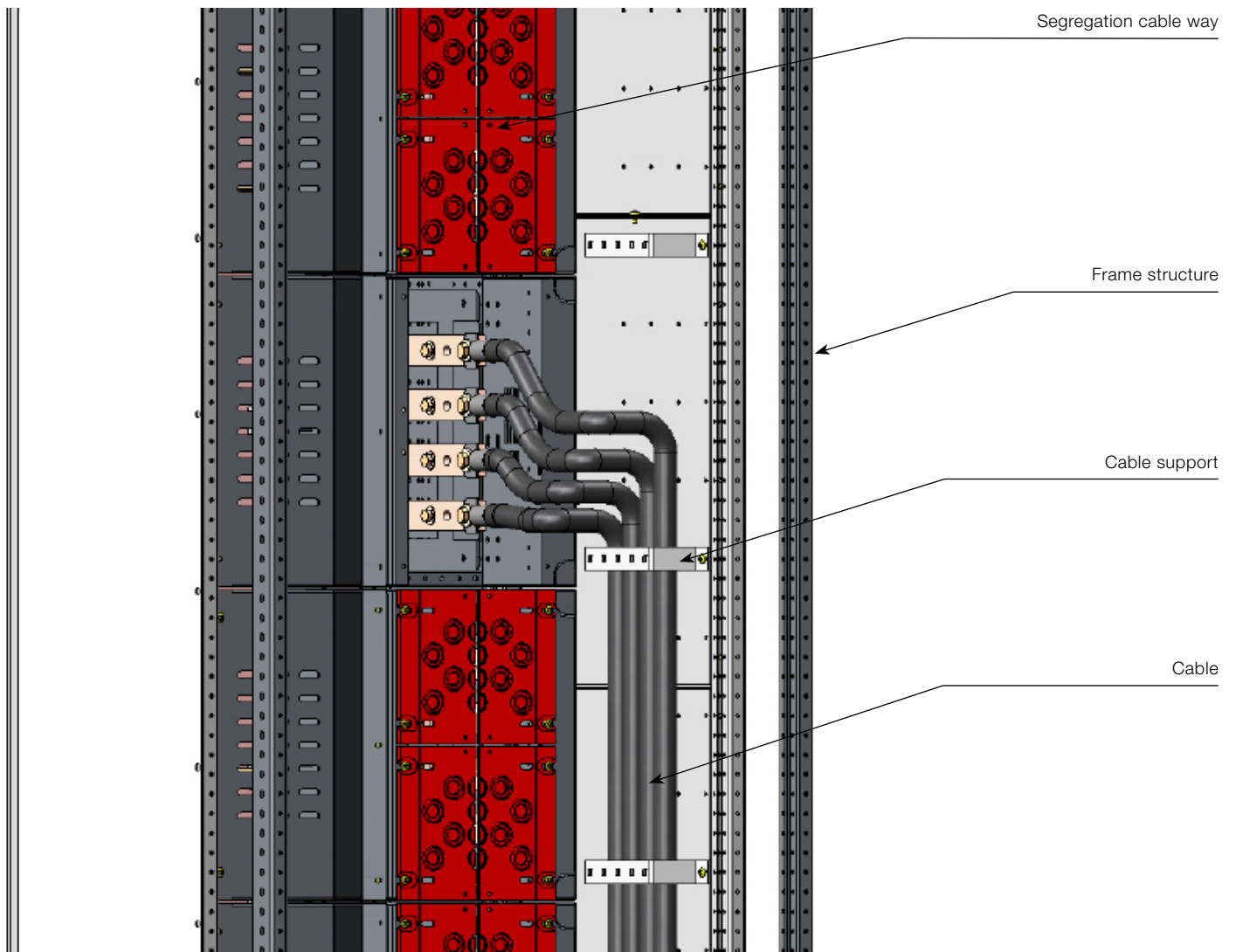
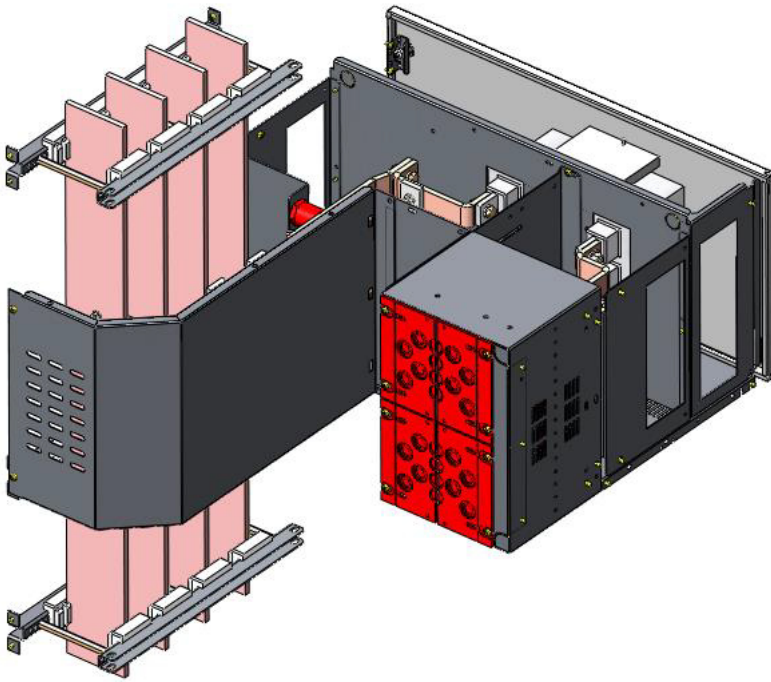


Fig. 33 Typical cable connection from fixed module



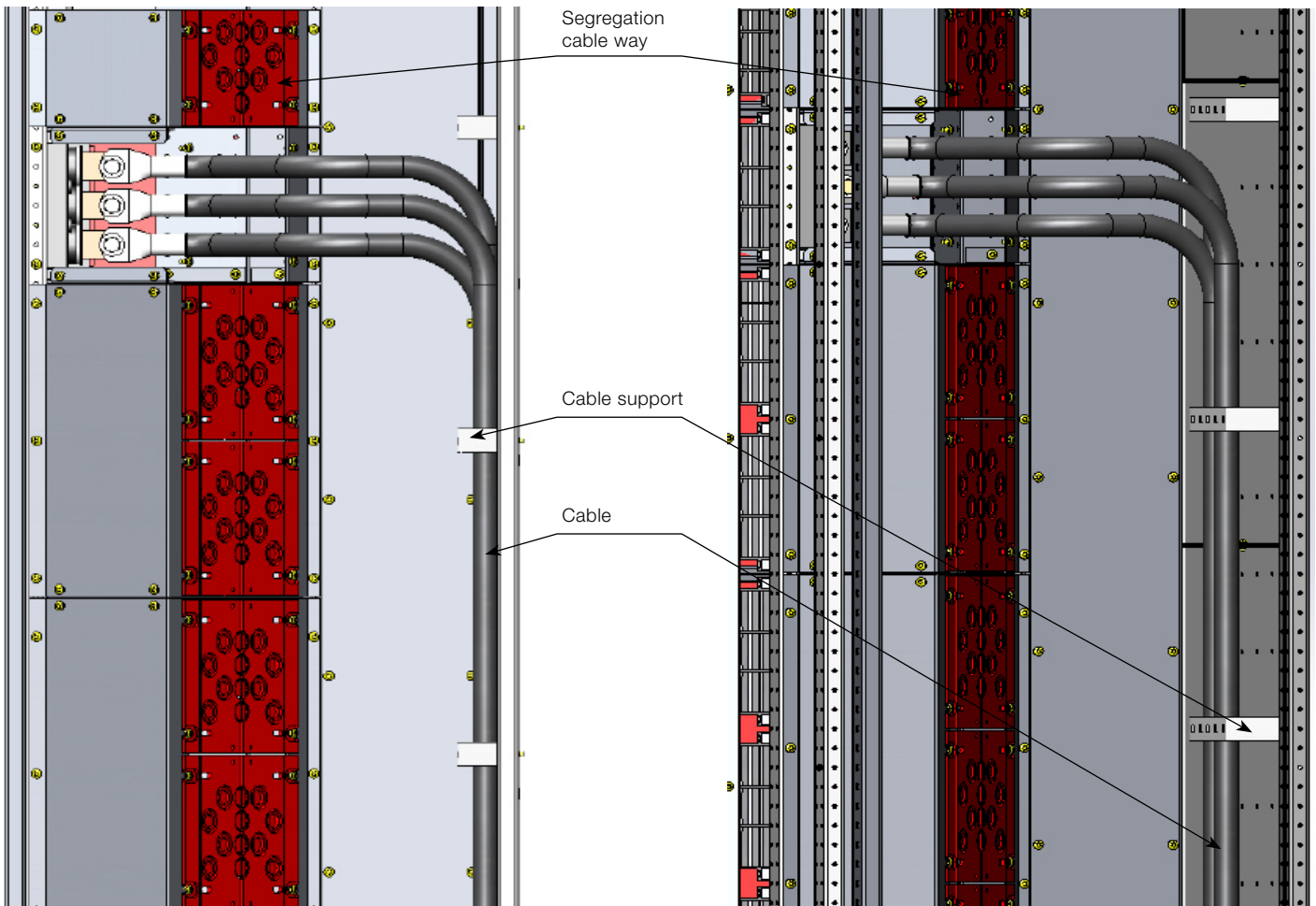
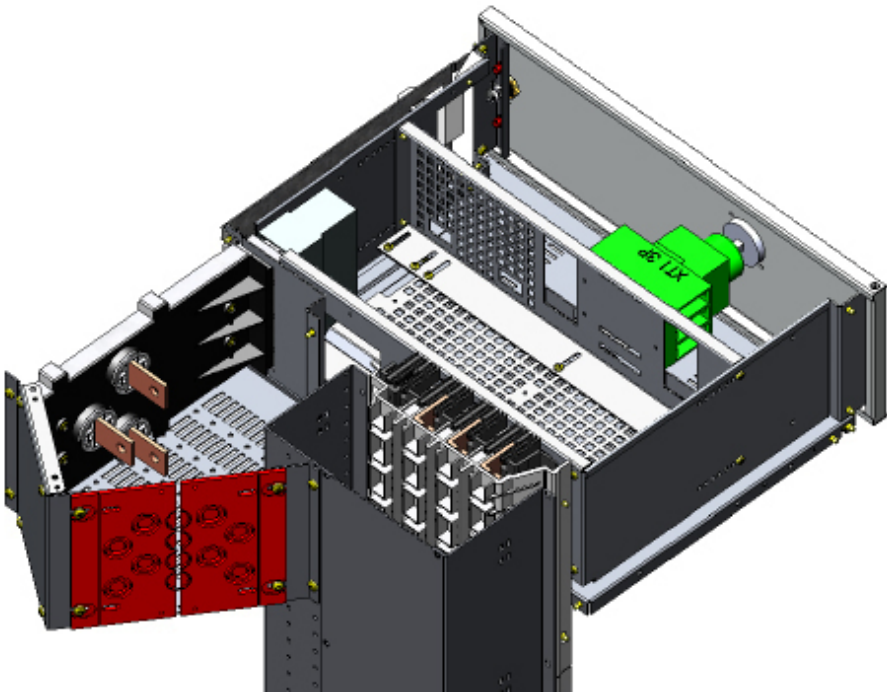


Fig. 34 Typical cable connection from MNS R Motor Control Center



### 3.7.2 Cable connection, wiring

#### Types of cable lugs

Two types of cable lugs are considered: normal and contained palm type, see following table for dimension details.

The maximum number of cables that can be connected to the incoming/outgoing busbar in the standard configuration are given in the following tables. Special cable connections can be designed to comply with specific customer requirements.

Make connection between terminal and lug using a screw, spring washer and nut.

Screw size depends on cable section:

Use M8 screws for cable sections up to 70 mm<sup>2</sup>

Use M10 screws for cable sections up to 150 mm<sup>2</sup>

Use M12 screws for cable sections up to 300 mm<sup>2</sup>

Use M16 screws for 400 mm<sup>2</sup> cable sections and over. In this case, standard busbar hole must be enlarged from 13 mm to 17 mm.

Cable section [mm <sup>2</sup> ]	B [mm]	
	Normal lugs	Contained palm
16	15	-
25	15	-
35	17	-
50	19	11.5
70	21	11.5
95	25	15.5
120	28.5	19
150	31.5	19
185	35.5	24.5
240	39	31
300	51	31
400	56.5	-
500	61.6	-
630	72	-
800	80	-

ACB cable connection

Cable section [mm <sup>2</sup> ]	Breaker						
	E1	E2 1250 1600	E2 2000	E3 1250 1600	E3 2000 2500 3200	E4	E6
95	14	14	14	14	14	14	14
120	8	8	8	8	8	8	8
150	8	8	8	8	8	8	8
185	8	8	8	8	8	8	8
240	8	8	4	8	8	8	8
300	4	4	2	4	4	4	4
400	4	4	2	4	4	4	4
500	4	4	2	4	4	2	4
630	2	2	2	4	2	2	4
800	2	2	2	2	2	2	2

Table 1 Max number of cables with standard cable lugs type – Emax

Cable section [mm <sup>2</sup> ]	Breaker			
	E1.2	E2.2	E4.2	E6.2
95	14	14	14	14
120	8	8	8	8
150	8	8	8	8
185	8	8	8	8
240	8	8	8	8
300	4	4	4	4
400	4	4	4	4
500	4	4	2	4
630	2	2	2	4
800	2	2	2	2

Table 2 Max number of cables with standard cable lugs type – Emax.2

Cable section [mm <sup>2</sup> ]	Breaker						
	E1	E2 1250 1600	E2 2000	E3 1250 1600	E3 2000 2500 3200	E4	E6
95	14	14	14	14	14	14	14
120	14	14	14	14	14	14	14
150	14	14	14	14	14	14	14
185	14	14	14	14	14	14	14
240	8	8	4	8	8	8	8
300	8	8	4	8	8	8	8

Table 3 Max number of cables with contained palm cable lugs type – Emax

Cable section [mm <sup>2</sup> ]	Breaker			
	E1.2	E2.2	E4.2	E6.2
95	4	14	14	14
120	4	14	14	14
150	4	14	14	14
185	4	14	14	14
240	4	8	8	8
300	4	8	8	8

Table 4 Max number of cables with contained palm cable lugs type – Emax.2

## MCCB cable connection

Breaker	Position	Type of cable lug	Max number of cables and cross section for phase [mm <sup>2</sup> ]
XT1	Horizontal	Normal	2x25(M8)
		Contained palm	1x50(M8)
XT2-XT3-XT4	Horizontal	Normal	2x70(M8)
		Contained palm	2x150(M8)
T2	Horizontal	Normal	2x25(M8)
		Contained palm	2x50(M8)
T3	Horizontal	Normal	2x70(M8)
		Contained palm	2x150(M8)
T4	Horizontal	Normal	2x70(M8)
		Contained palm	2x150(M8)
T4 320	Horizontal	Normal	1x95(M8) / 2x70(M8)
		Contained palm	2x150(M8)
T5 400	Horizontal	Normal	1x185(M10) / 2X150(M10)
		Contained palm	1x240(M10) / 2X185(M10)
T5 630	Horizontal	Normal	1x240(M12) / 2X185(M12)
		Contained palm	1x240(M12) / 2X185(M12)
T6 630 / 800	Horizontal	Normal	2x240(M12)
		Contained palm	2x240(M12)
T7 / X1	Horizontal	Normal	2x240(M12) / 4*240**(M12)
		Contained palm	2x240(M12) / 4*240**(M12)
T6 630 / 800	Vertical	Normal	2x300(M12) / 3x300*** (M12)
T7 / X1	Vertical	Normal	2x300(M12) / 4x300*** (M12)

(\*) T7-X1 800/1000A Copper section 1 (one) 50x10

(\*) T7-X1 1250/1600A Copper section 2x50x10 ph/ 50x10 N

(\*\* ) Only for T7-X1 1250/1600A (to be assessed case by case depending on depth/width)

(\*\*\*) For bottom vertical position

## Withdrawable module cable connection

Module size	Poles	Inc [A]	Max number of cables and cross section for phase [mm <sup>2</sup> ]
8E4	3	45	1x6
8E4	4	45	1x6
8E2	3	63	1x35
8E2	3	63	1x35
8E2	4	63	1x35
8E2	4	63	1x35
8E2	6	45	1x6
8E2	8	45	1x6
8E2	6	45	1x6
8E2	8	45	1x6
6E	3	250	2x120 (M10)
≥8E	3	160	2x120 (M10)
≥8E	3	250 / 400	2x240(M12)
≥16E	3	630	4x240(M12)
6E	4	250	2x120 (M10)
≥8E	4	250	2x120 (M10)
≥16E	4	400	2X240 (M12)
≥24E	4	630	4X240 (M12)
≥8E	6	160	2x120 (M10)

## Plug in module cable connection

Module size	Poles	Inc [A]	Max number of cables and cross section for phase [mm <sup>2</sup> ]
6E	3	250	2x120 (M10)
8E	3	160	2x120 (M10)
8E	3	250 / 400	2X240 (M12)
16E	3	630	4x240 (M12)
6E	4	250	2x120 (M10)
8E	4	250	2x120 (M10)
16E	4	400	2X240 (M12)
24E	4	630	4x240 (M12)

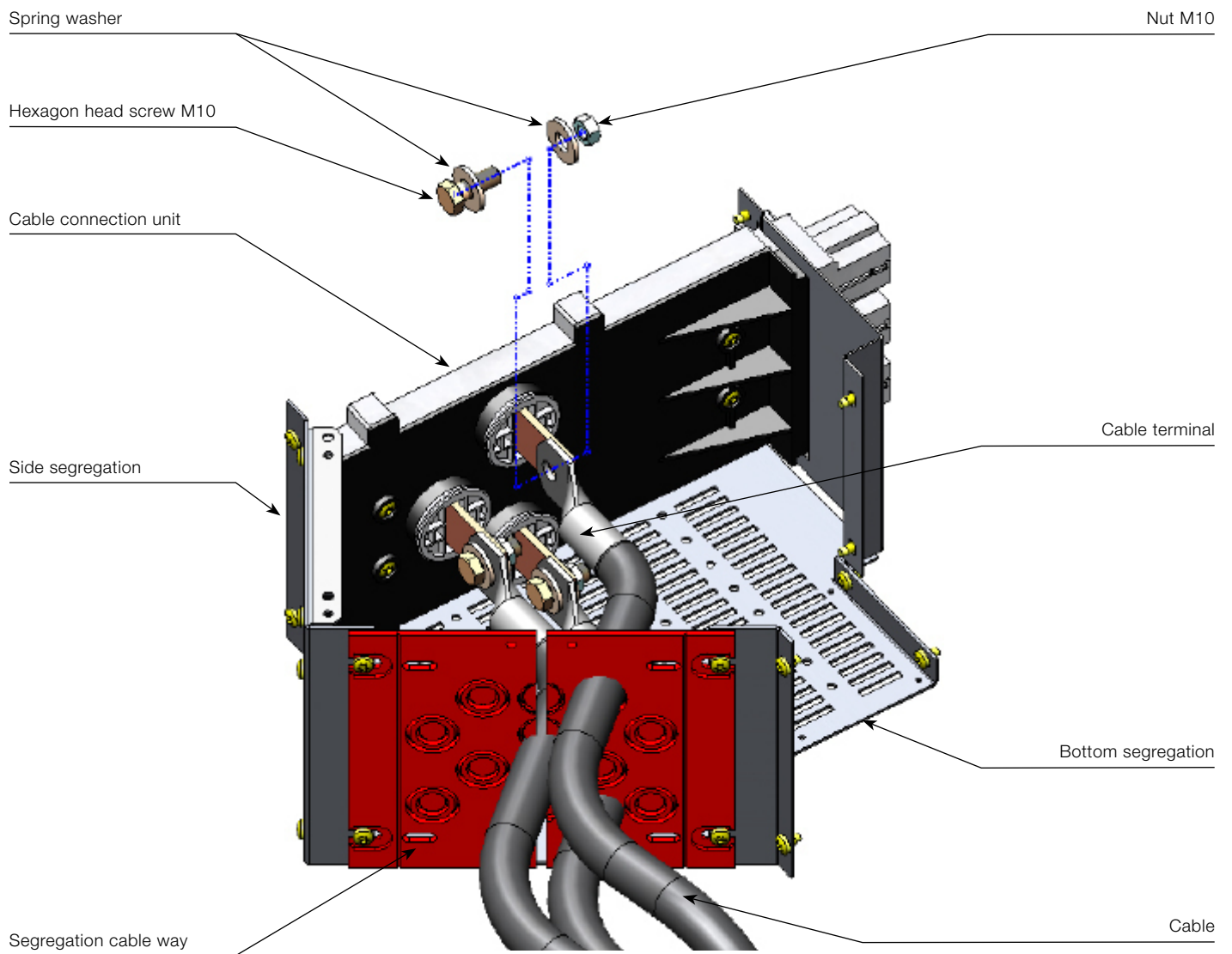


Fig. 35 Typical cable connection

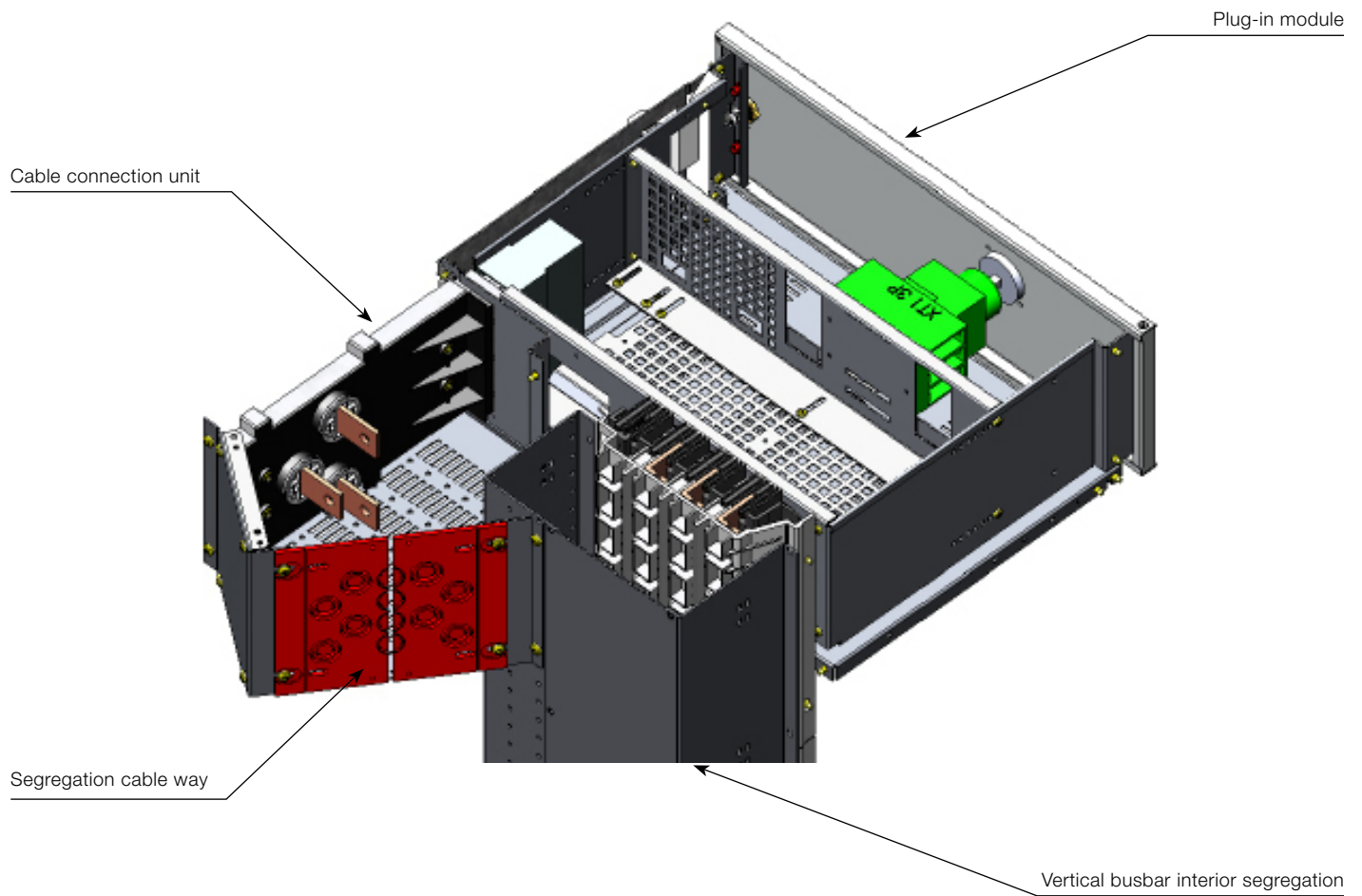


Fig. 36 Typical cable connection for plug-in modules and Mcc modules

### 3.8 Protective conductor connection

Protective conductors must be connected as follows:

- Up to 63 A:
  - To the PE terminal of the withdrawable module condapter or the plug-in, disconnectable or railable module.
- Up to 100 A:
  - To the vertical section located at front right (see fig. 37) using an M6 screw.
- Over 100 A:
  - To the vertical PE connection busbar, installed front right in the cable compartment as a screw connection or using a terminal mounting rail.

The green and yellow conductor (colour marking over entire length) may only be used as a 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 earthing regulator or as a connector for the shielded earth.

**In all cases, protective conductor connections screwed onto painted surfaces should be secured with serrated contact washers.** Any means of locking the screws is permissible for fastening connections screwed into 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 mm<sup>2</sup>).

The connections are not required if no live ( $\leq 50$  V AC or  $\leq 120$  V DC) equipment is installed on the doors.

Continuous connection of protective conductor circuits to inactive metal parts of the building (in accordance with IEC 60439 or DIN VDE 0100 Part 540) must be made in accordance with the conditions in the construction site.

### 3.9 Neutral conductor connection

The neutral conductors must be connected to the insulated neutral busbar installed parallel to the protective conductor busbar or to the neutral connection busbar, by screws or using a terminal mounting rail.

In all cases the connection must be made at the height of the relevant module and allocation must be clearly distinguishable. In other cases, e.g. for control cables, cross referencing will be necessary.

#### Key to abbreviations

Component	Abbreviation acc. to IEC 60439-1 / VDE 0660 part 500
Protective earth conductor	PE
Neutral conductor	N
Neutral conductor with protective function	PEN

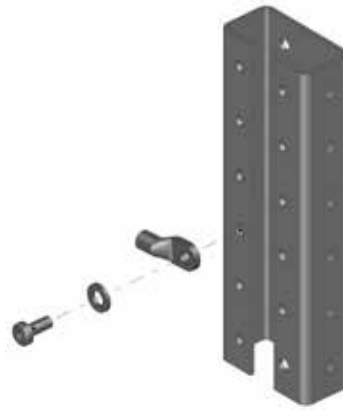


Fig. 37 Protective conductor connection to C-section vertical structural bar

### 3.10 Final Preparations

- Remove the safety devices used for transporting the heavy components of the apparatus.
- Assemble the equipment, i.e. circuit breakers, fuses, lamps, meters. The various components are labelled. Comply with the enclosed assembly instructions.
- Remove foreign materials, such as tools, packaging material and residuals.
- Clean the insulating parts with an antistatic cloth. Do not use carbon tetrachloride, trichlorethylene or hydrocarbon solvents.
- Close the doors.

### 3.11 Checking Operations

- Check busbar connection to units separated for transportation purposes. Tightening torque, Sect. 5.11.
- Check base frame fastening.
- Check that the required protection degree is obtained, especially for the bottom closing part.
- General visual inspection: appearance, completeness, labels, foreign materials in the switchgear, and dirt.
- Check that the cable and wiring connections have been completely and correctly made.

## 4. Start up and Operation

### 4.1 Start up

Follow the detailed inspection instructions before energizing the switchgear.

Item	Operation	Note
1. Compartment	<ul style="list-style-type: none"><li>– Visually inspect internal and external parts for possible damage; remove any foreign material (i.e. test tools left after assembly)</li><li>– Carefully clean the insulating parts, remove any trace of moisture</li><li>– Remove dust or dirt from the air-intake grilles</li></ul>	
2. Power circuit connections	Check tightening and continuity	
3. Earth busbar and relative connections	Check tightening and continuity	
4. Insulation	Measure the insulation resistance of the power circuit (phase-phase and phase-earth), auxiliary circuit and anticondensate heater. The value measured must be at least > 100 Mohm	<ul style="list-style-type: none"><li>– The insulation resistance value is strongly influenced by environmental conditions</li><li>– The switchgear must NOT be put into service if the insulation resistance is too low, for example lower than 1 Mohm</li><li>– If the low insulation resistance value is due to humidity, turn on the anticondensate heater (after having performed the inspections described in step 8, and set the thermostat to a higher value). Use provisional heaters if necessary</li></ul>
5. Circuit breakers	<ul style="list-style-type: none"><li>– Before putting into service, perform all the necessary operations described in the instructions of each circuit breaker</li><li>– Check the devices and accessories required for operation. In the case of key-locked circuit breakers (open or closed), each circuit breaker must be equipped with only one key. Put the circuit breakers into the service position</li></ul>	
6. Protective release device	Make sure that calibration is correct according to the selective diagrams of the installation	
7. Auxiliary circuits	According to the diagram, check the functionality and operation logic sequences of the auxiliary circuits	Check the setting of each switchgear relay before performing this inspection
8. Anticondensate heater	<ul style="list-style-type: none"><li>– Energize the circuit</li><li>– Adjust the thermostat to the highest temperature allowed</li><li>– Check that the heater temperature rises</li><li>– Adjust the thermostat so that the temperature inside the switchgear is always higher than the outside ambient temperature (approximately 35 °C)</li></ul>	

- In the case of particular apparatus configurations, the previous inspections may need to be integrated with others suggested by the technician responsible for the apparatus itself.
- Check that the secondary winding of the current transformer is connected to the relative protective and/or measuring current circuit, then remove any possible short-circuit connections.
- If the secondary winding of the voltage transformer must be connected to external equipment of the switchgear, check for the following conditions so as to avoid overloads or short-circuits in the voltage transformers:
  - Make sure that the total consumption of the equipment is not higher than the transformer capacities.
  - Check for incorrect connections (also provisional) in the measuring circuit or connections that fail to comply with the connection of the switchgear and other units (supply switchgear, subswitchgear, control or operating consoles, etc.).
  - Check that only one phase of the secondary winding of the voltage transformer is earthed.
- At the end of the preliminary test, proceed with the following operations:
  - Open and isolate all the circuit breakers
  - Remove any testing connections
    - Close all doors of the circuit breakers and measuring cells
    - Check for internal metal segregations (according to the segregation form of the construction design) of the external closing panels
  - Check that the different mechanical and electrical interlocks (which may have been deactivated to perform the starting test with the switchgear de-energized) have been restored.
- Energize the control circuit
- Close the circuit breakers (according to the system), and ensure that any related function operates properly
- Make sure that the auxiliary instruments operate correctly



**Comply with the general safety rules**

## 4.2 Operation

### 4.2.1 Size 8E/4 and 8E/2 withdrawable units

Size 8E/4 and 8E/2 withdrawable units comprise:

- One or two profile sections for mounting snap-on components,
- a rear wall with integrated power contacts inclusive of wiring and with one 20-pole control plug in the case of size 8E/4 modules, one or two 20- or 40-pole control plugs in case of size 8E/2 modules,
- a front panel made of insulating material with knockouts for mounting measuring, operating and indicating instruments,
- side walls.

If certain standard load-break switches and circuit breakers are used, the handle for operating them also activates the electrical and mechanical interlocks. A microswitch with 2 NO and 2 NC contacts is provided for electrical interlocking.

	Position of switch	Position of module	Main and control circuits
	ON	in section	All main- and control-circuits are closed
	OFF Can be locked with 3 padlocks	in section	All main- and control-circuits are disconnected
	TEST Can be locked with 3 padlocks	in section	All main-circuits are disconnected, the control-circuits are closed
	MOVE Position	in section - Isolated Position - not in section	All main- and control-circuits are disconnected
	ISOLATED Position Can be locked with 3 padlocks	The module is drawn 30 mm out of the section	All main- and control-circuits are disconnected and the isolating distance is obtained

**Fig. 38 Description of operating handle positions for 8E/4 and 8E/2 modules**

The switch handle can only be moved from the “OFF” to “ON” position after the handle has been depressed (push-to-turn operation).

The switch handle can be locked in the “OFF” and “TEST” positions and the isolated position with up to three padlocks (see fig. 40). The withdrawable unit can be prevented from being withdrawn by an additional mechanical lock (protection against theft) to be installed in the front cover.

Switch handles of withdrawable units that are not used must be moved to the “OFF” or “ISOLATED” position.

Resetting circuit breakers in withdrawable modules

When moulded-case circuit breakers are tripped by faults, the switch handle may turn to an intermediate position between “ON” and “OFF”.

The function of the circuit breaker can only be re-established by a reset. Reset the fault by turning the switch handle from the intermediate position to the “OFF” position and further to the stop point.

After this, the circuit breaker can be switched on again.

- 1. Turn the switch handle from “ON” to “OFF”.
- 2. Press the switch handle down and turn it counter-clockwise to the stop point.
- 3. When released, the switch handle swings back to the “OFF” position.
- 4. The circuit breaker is ready to be switched on.

Note:

A clear release tripped indication can only be achieved by an electrical signal (e. g. pilot lamp or audible signal).

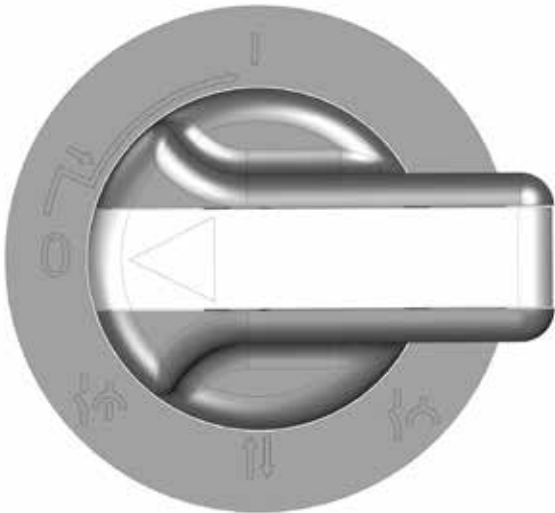


Fig. 39 Switch operating handle for size 8E/4 and 8E/2 withdrawable modules with position markers



Fig. 40 Size 8E/4 withdrawable module with 3 padlocks

4.2.2 Sizes 6E to 24E withdrawable units

Sizes 6E to 24E withdrawable units are made of sheet steel components which form the supporting frame for the electrical components and contact elements. The hinged front cover allows easy access to the built-in components from the front side. The front cover can only be opened with a key in the isolated, test or OFF-positions of the withdrawable unit. Only one lock need be opened if a parallel coupling is installed. The front cover can only be opened with a screwdriver when the operating handle is in the “ON” position.



Live parts could be touched if the front cover is opened while the operating handle is in the “ON” position.

The withdrawable unit can be equipped with an instrument panel made of insulating material where measuring, operating and indicating instruments can be installed. The hinged instrument panel is installed on the withdrawable unit and projects through a cutout in the front cover. 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. Tilting down the instrument panel improves access to the equipment in both the withdrawable unit and the instrument panel.

The main switch is operated by the operating handle, which is also used for mechanical and the electrical interlocking. A microswitch with up to 2 NO and 2 NC contacts is provided for electrical interlocking.

	Position of switch	Position of module	Main and control circuits
	ON	in section	All main- and control-circuits are closed
	OFF Can be locked with 3 padlocks	in section	All main- and control-circuits are disconnected
	TEST Can be locked with 3 padlocks	in section	All main-circuits are disconnected, the control-circuits are closed
	MOVE Position	in section - Isolated Position - not in section	All main- and control-circuits are disconnected
	ISOLATED Position Can be locked with 3 padlocks	The module is drawn 30 mm out of the section	All main- and control-circuits are disconnected and the isolating distance is obtained

Fig. 41 Description of operating handle positions for 6E to 24E modules



In the test position, a test function of the control circuit of moulded case circuit breakers cannot be performed with the motor operating.

Secure breaking of the main circuit is achieved in the OFF-position due to the isolating characteristics of the main switching devices used. In addition, it is necessary to ensure that the customer achieves secure isolation of the main- and control-circuits by moving the withdrawable module to the isolated position.

#### Resetting circuit breakers in withdrawable modules

When moulded-case circuit breakers trip due to faults, the switch handle may set to an intermediate position between "ON" and "OFF".

The circuit breaker function can only be re-established by a reset. Reset the fault by turning the switch handle from the intermediate position to the "OFF" position and further to the stop point.

After this, the circuit breaker can be switched on again.

1. Turn the switch handle from "ON" to "OFF", and then to the stop point.
2. When released, the switch handle will swing back to the "OFF" position.
3. The circuit breaker is ready to be switched on.

#### Note:

A clear release tripped indication can only be achieved by an electrical signal (e. g. pilot lamp or audible signal).

#### Moving the withdrawable module

The withdrawable unit can only be moved if the operating handle is in the "MOVE" position. This ensures that a withdrawable module cannot be moved under load.

To move a withdrawable unit, the operating handle must be set to the "MOVE" position, after which the unit can be pulled out by means of the two handles. When the unit starts moving, the operating handle immediately switches back to the "OFF" position and the withdrawable unit interlocks after 30 mm in the isolated position. In this position the main and control contacts are disconnected.

To move the withdrawable unit further, the operating handle must be switched to the "MOVE" position again. After this, the withdrawable module can be pulled out further.

Before the withdrawable unit has been completely removed from the section, it interlocks again to avoid being pulled out from the section in an uncontrolled way. Press down the lever on the left side of the withdrawable unit (see fig. 46) to release this safety stop. If the withdrawable unit to be moved is installed in a high position in the section, the safety stop can be released by supporting the unit with the right hand from below and releasing the lever with the left hand.



Fig. 42 Size 8E withdrawable module



Fig. 43 Size 16E withdrawable module

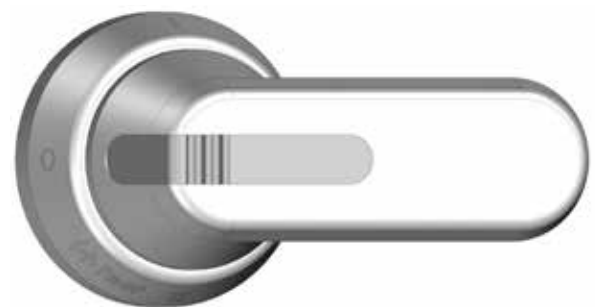


Fig. 44 Switch operating handle for size 4E to 24E withdrawable modules with position markers

After this, the withdrawable unit can be completely removed from the section.



**Depending on their size, withdrawable units are very heavy. Comply with the safety regulations at all times.**

- After the withdrawable unit has been moved halfway from the withdrawable module compartment, the operator must take hold of it from below, under the sides (applicable to size 4E and 8E withdrawable units).
- Size 12E withdrawable units and larger should be withdrawn by two persons. To do this, the operators must each stand at one side of the unit and take hold of it from below (12E) or by the hand grips on the side walls (> 12E).
- Withdrawable units should not be left longer than necessary in the safety stop position because the centre of gravity is already beyond the section in this position. Failure to comply with this instruction can cause mechanical damage to the withdrawable unit.



**Withdrawable units in the isolated position or in the safety stop position must not be used as climbing aids since this could endanger persons and/or damage the switchgear itself.**

The test position can be obtained without moving the withdrawable unit by turning the operating handle to the “TEST” position.

The operating handle can be locked in the “OFF” and “TEST” positions by using up to three padlocks. Removal of the unit can be inhibited by an additional mechanical lock (protection against theft) which can be installed in the front cover. The operating handle must be in the “OFF” position when withdrawable units are not being used.

#### 4.2.3 8E to 24E plug-in units

Plug in modules are fastened directly to the compartment bottom plate using a screw.

The plug in module feeder connection to the distribution busbar system is made directly via the contact device of the plug-in modules themselves. Outgoing cables are connected via plug-in contacts to the out-going connection unit (main circuit) and via terminal blocks (aux circuit). The outgoing cable connection units are fastened directly to the frame. A special tool is used to rack the modules in/out (see fig. A)

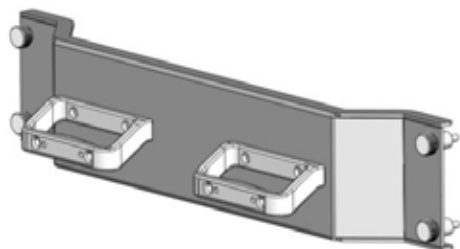
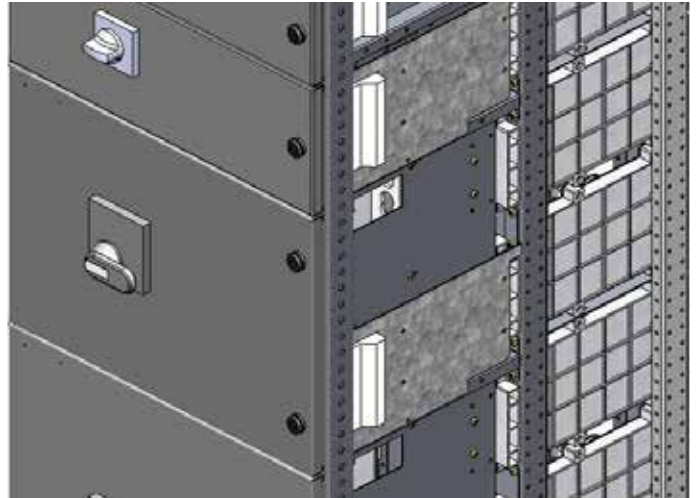


Fig. A Special tool for racking-out the module

Please refer to the instruction label affixed to the special tool and the steps illustrated here for instructions on how to use the special tool and perform the plug-in module extraction procedures:

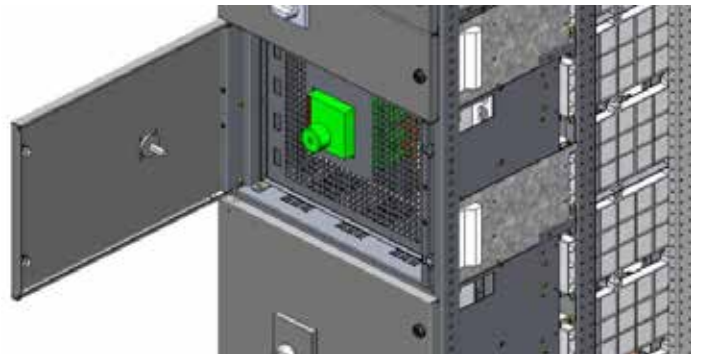
#### STEP 1

**Switch off the breaker**



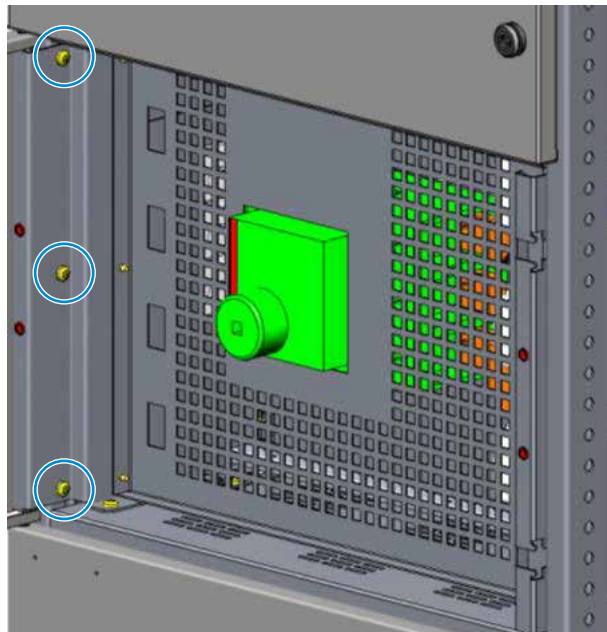
#### STEP 2

**Open Door**



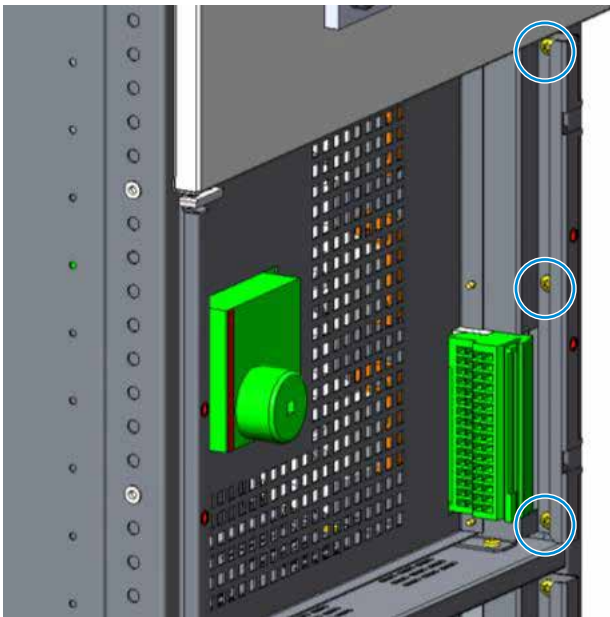
#### STEP 3

**Unscrew highlighted screws**



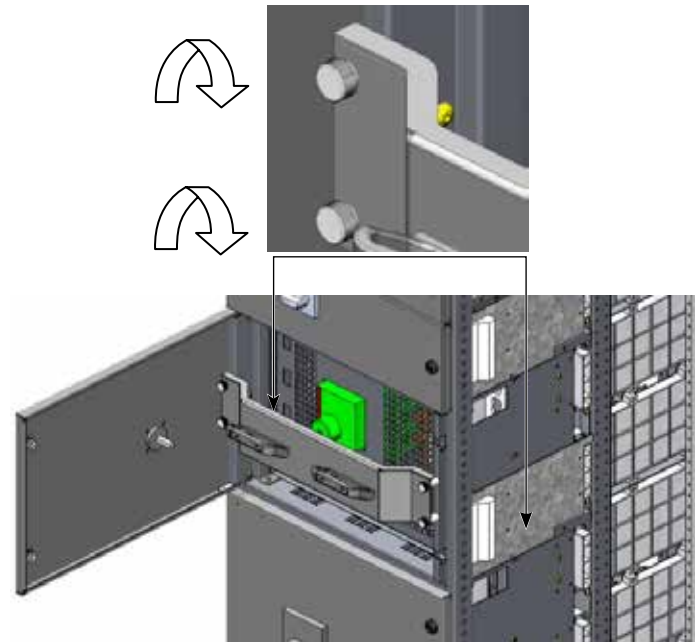
#### STEP 4

Unscrew highlighted screws and unplug the terminal block



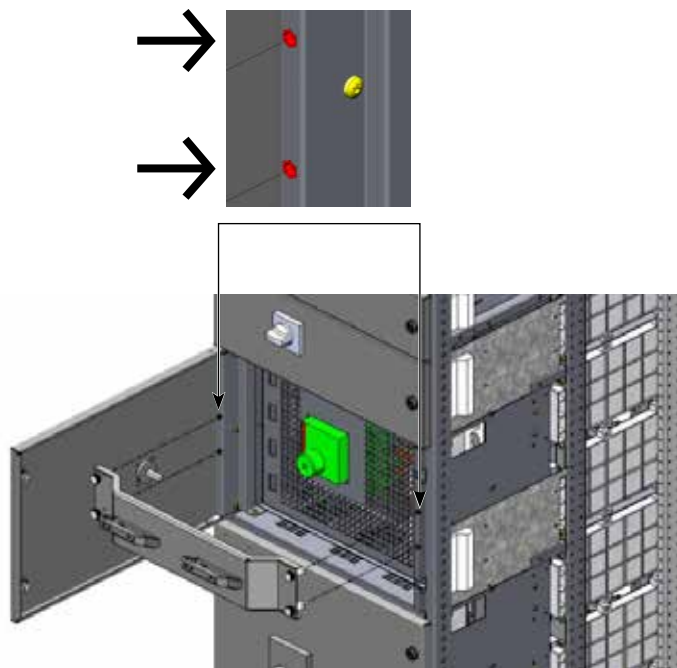
#### STEP 6

Screw the knobs into the fixing points specified in step 5



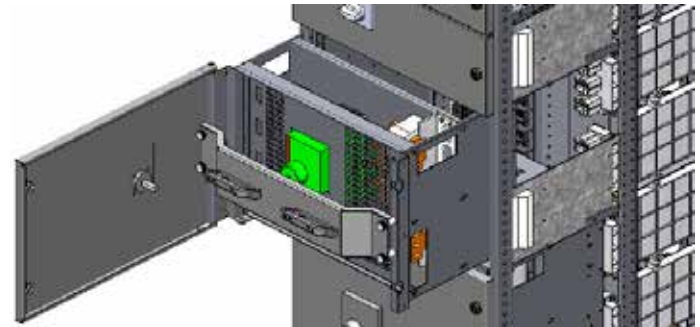
#### STEP 5

Position the removal tool near the highlighted fixing points



#### STEP 7

Extract the plug-in module



### 4.3 Special information

When the installation is operating, make sure that:

- the doors and the front covers of the withdrawable modules are closed,
- the withdrawable modules are interlocked,
- the ventilation louvers are not obstructed or clogged.

## 5. Maintenance and Spare Parts

### 5.1 General



**Maintenance work, such as replacing fuses etc., must only be carried out by suitably trained personnel in compliance with the safety rules.**

The following regulations must be observed when working on switchgear sections:

- The national and international safety rules (e.g. VDE 0105, regulations for the operation of power installations) and specific maintenance instructions of the installed devices.



**When making modifications to sections it may be necessary to interrupt the operation of adjacent parts of the installation, depending on the extent of the work and the type of design. The heat balance may change when modifications are made inside the sections. Do not exceed the permissible temperature-rise limit inside the switch panel. Please contact your ABB branch if in doubt.**

After fault situations, checks are to be carried out just as before commissioning.

### 5.2 Withdrawable technique

The following description refers to the standard modules. Ask for a separate description if the modules differ from the standard version.

The multi-functional wall is installed between the busbar and the equipment compartment. It covers the complete height and width of the equipment compartment and performs the following functions:

- It houses the distribution busbars.
- It fastens and covers the distribution busbars by means of the distribution busbar cover.
- It protects against the formation and propagation of arc faults.

The contact openings of the distribution bar covers comply with protection degree IP 20, thus conversion is possible without having to interrupt the operation of the section (see fig. 52).

The withdrawable module can be changed or removed and replaced in the compartment during maintenance without isolation.

With the interlocking switch handle in the move position, size 8E/4 and 8E/2 withdrawable modules can be withdrawn without stopping. Size 6E to 24E modules must be withdrawn up to the stop position, released and then removed completely.

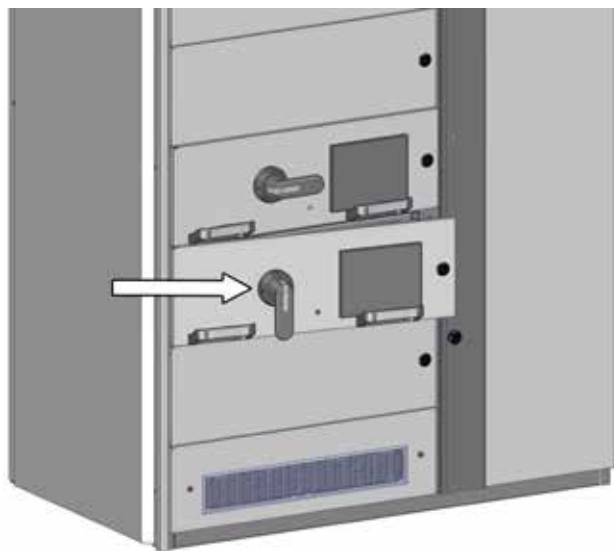


Fig. 45 Unlatching the front cover of a withdrawable module by means of a screwdriver



**Live parts could be touched if the front cover is opened while the operating handle is in the "ON" position.**

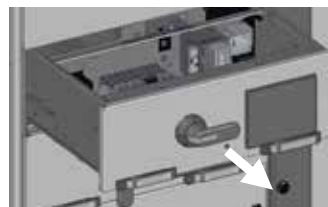
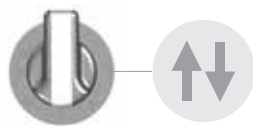
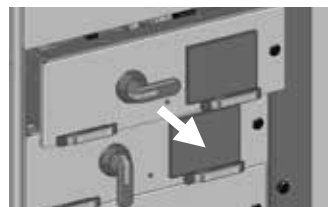
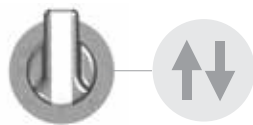


Fig. 46 Withdrawal of a withdrawable module



The main fuses in withdrawable modules with hinged front covers are accessible after the main switching device has been turned OFF and after the front cover has been unlatched. The front cover can only be unlocked by means of a tool, e.g. a screwdriver (see fig. 45) when the module is in the operating position.

The interlocking mechanism is situated at the side of the switch handle.

The frame-mounted compartment must also be changed (see figs. 52/53) in order to convert or modify complete withdrawable module units, e.g. replacement of one large unit with several smaller units or vice versa.

### 5.3 Plug-in technique



**The heat balance may change when modifications are made inside the switchgear sections. Do not exceed the permissible temperature rise inside the switchgear section (contact ABB).**

#### Plug-in modules

Plug-in modules can be changed or removed and replaced in the compartment during maintenance without isolation (see figs. 47-48-49-50-51).

Proceed as follows to remove a module:



- Isolate the modules
- Open the breaker
- Protect against reclosing
- Verify isolation from supply
- Perform earthing and short-circuiting
- Provide a barrier between adjacent live parts
- Disconnect control cables
- Remove module fastening screws and carefully pull module out of the section
- If necessary, empty slots must be covered with blanking plates (please contact your ABB supplier).

Work through the above steps in reverse order to install the modules.

If a plug-in module has been removed, grease the guide before insertion to facilitate the operation.



Fig. 47 Switch off the breaker

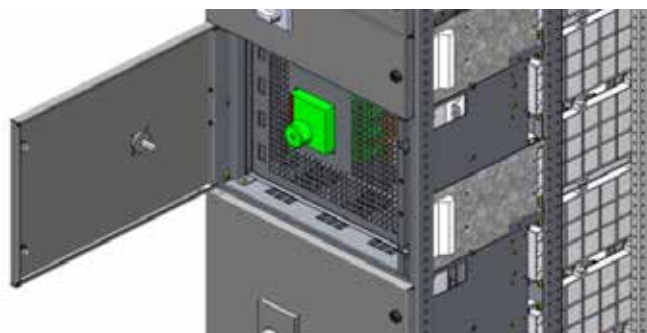


Fig. 48 Open Door

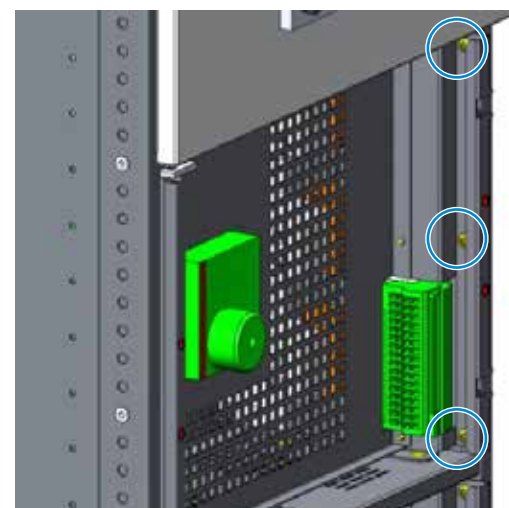
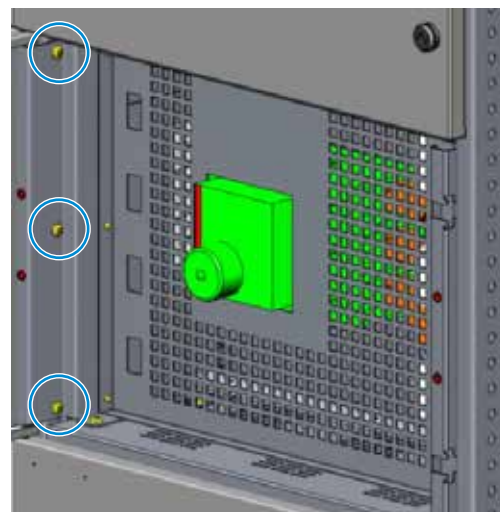


Fig. 49 Unscrew highlighted screws and unhook terminal block

## 5.4 Converting and changing withdrawable module compartments



Before converting and/or changing a withdrawable module compartment, the withdrawable module below the withdrawable module compartment in question must be removed from the section. Prevent small parts from falling through by applying an appropriate cover as a bottom plate for the withdrawable module compartment.



The heat balance may change when modifications are made inside the switchgear sections. Do not exceed the permissible temperature rise inside the switchgear section (contact ABB).

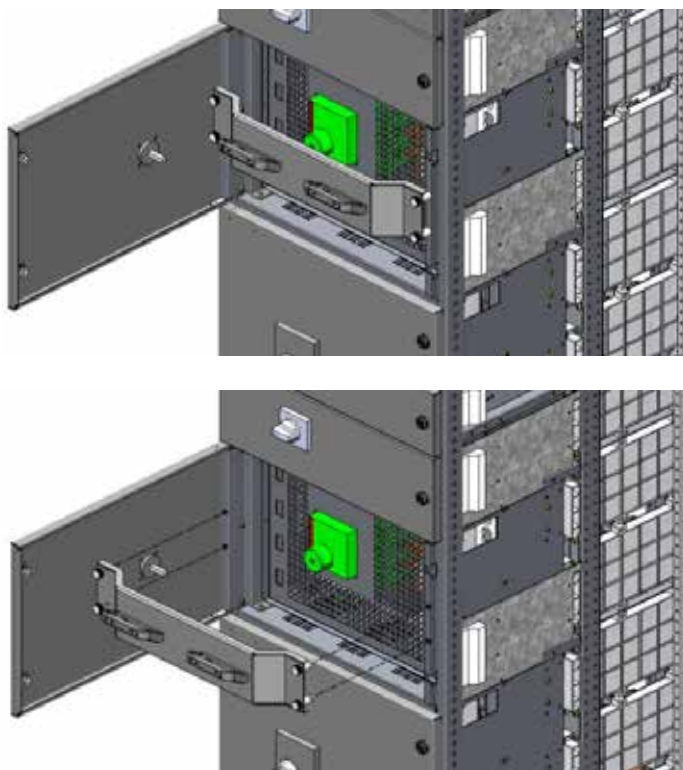


Fig. 50 Screw in the tool knobs

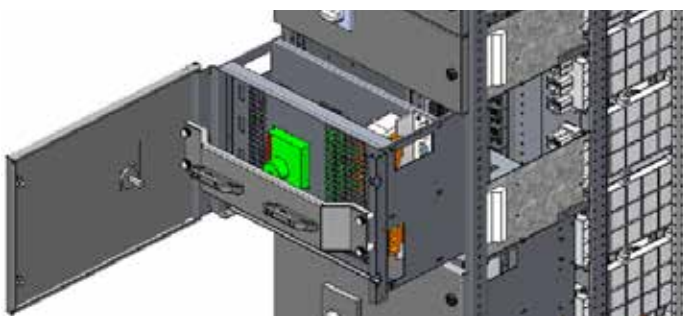


Fig. 51 Extract the plug-in module

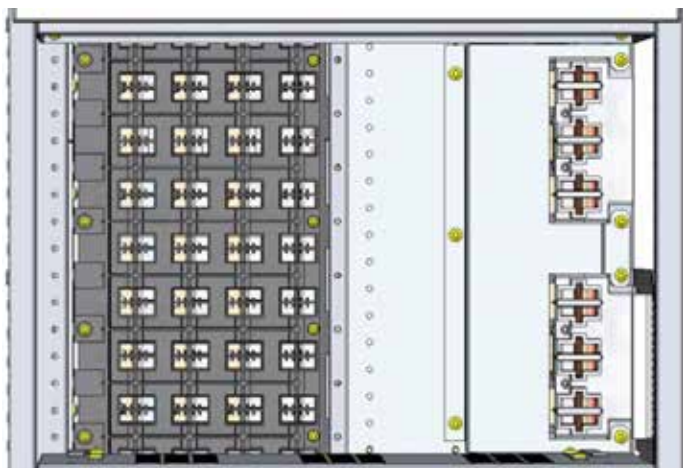


Fig. 52 Size 8E withdrawable module compartment with outgoing cable connection unit, 2E-distribution busbar cover



Fig. 53 Conversion to size 8E/4 and 8E/2 withdrawable module compartments

#### 5.4.1 Example 1: Conversion of one size 16E unit (height 400 mm) into four 8E/4 size units (height 200 mm) and two 8E/2 units (height 200 mm)

Conversion must be performed in the following sequence:

##### Disassembly (see fig. 52)

- Pull out the withdrawable unit.
- Disconnect the power cables after the protective cover has been removed. Thanks to the protective covers on the adjacent cable connection units, work inside the cable compartment can be performed without danger (see fig. 35).
- Disconnect the control wiring.
- Remove the control terminal block and its support, situated in the lower right hand side of the cable compartment.
- The left guide rail on the lower compartment bottom plate has to be removed.
- Remove the cable connection unit (see fig. 35).

##### Re-assembly (see figs. 7 and 53)

- Install a new compartment bottom plate 200 mm from the top and bottom of the old compartment and fix it with screws.
- Install a withdrawable unit condapter in the back of each of the two newly created compartments (see fig. 7), one for four size 8E/4 withdrawable units, one for two size 8E/2 withdrawable units.



**When installing a withdrawable unit condapter, make sure that an earthing connection is established at the lower right screw connection by using a bushing (GLBL210021P0001) and a washer A 6.4 (9ADA312-6) (see fig. 7).**

- 8 plastic guide rails must be installed, four for each compartment bottom plate.
- 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.
- Connect the power cables and control wiring.
- Insert four size 8E/4 withdrawable modules into the upper compartment and two size 8E/2 withdrawable units into the lower compartment.

Contact the nearest ABB-sales office or representative should new material be required.

#### 5.4.2 Example 2: Conversion of one size 24E unit (height 600 mm) into three size 8E units (height 200 mm each)

Conversion must be performed in the following sequence:

##### Disassembly

- Pull out the withdrawable unit.
- If required, change the power cable or leave it for one of the size 8E units if suitable.
- Disconnect the control wiring or leave it for one of the size 8E units if desired.
- The compartment bottom plate with the guide rail and the top compartment bottom plate remain unchanged.

##### Re-assembly

- Install 2 outgoing cable connection units (see fig. 35 for details).
  - Insert two new compartment bottom plates with a distance of 8E each and fix them with screws.
  - The newly installed bottom plates must be equipped with the left guide rail and rollers, and covers must be installed.
  - Between the newly installed compartment bottom plates, one control terminal block support for withdrawable module compartments with one or two 16-/20-pole terminal blocks must be installed on the right hand side (in the cable compartment). If only one terminal block per support is required, it must be installed in the upper part of the cut-out in the support. The lower part must be covered by a cover plate.
  - Connect the power cables with their protective covers and also the control wiring.
  - Insert three new size 8E withdrawable units.
- Contact the nearest ABB sales office or representative should new material be required.

#### 5.4.3 Example 3: Conversion of 6 size 8E/2 units (height 200 mm) into one size 24E unit (height 600 mm)

Conversion must be performed in the following sequence:

##### Disassembly

- Pull out the 6 withdrawable units.
- Disconnect the power and control cables and wiring.
- Disassemble the two middle compartment bottom plates with front posts and guide rails (see fig. 7).
- Remove the guide rail and front post from the lower compartment bottom plate (see fig. 7/9).
- Take out the 3 withdrawable module condapters with their terminal blocks (see fig. 7).

##### Re-assembly

- Install one outgoing cable connection unit depending on the module design. Two outgoing cable connection units can be installed, depending on the current and whether a star-delta unit is used.
- Install the left guide rail on the lower compartment bottom plate (see fig. 9).
- Install the roller and cover in the compartment bottom plate (see fig. 9).
- Install the 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, install it in the upper part of the support and use a cover for the lower part of the support.
- Connect the power cable and protective cover (see fig. 35) and control wiring. An additional protective cover is required for parallel connection of two outgoing cable connection units.
- Insert the new size 24E withdrawable unit.



#### 5.4.4 Example 4: Conversion of three size 8E units (height 200 mm) into one size 24E unit (height 600 mm)

Conversion must be performed in the following sequence:

##### Disassembly

- Pull out the 3 withdrawable units.
- Disconnect the power cables after the protective cover has been removed (see fig. 35). Thanks to the protective covers on the adjacent outgoing cable connection units, work inside the cable compartment can be performed without danger.
- 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 into one or two 16-/ 32-pole control terminal blocks. When converting from two control terminal blocks to one, the remaining one must be at the top of the support while the space below must be covered with a cover.
- Dismantle the two middle compartment bottom plates with their guide rails. The lower bottom plate need not be changed (see fig. 9).
- Remove one or two of the outgoing cable connection units, depending on the module design. Change the outgoing cable connection unit when necessary. Two outgoing cable connection units must either remain or be changed, depending on the current or whether a star-delta unit is required.

##### Re-assembly

- Connect the power cable and protective cover, and the control wiring (see fig. 35).
  - Insert the new size 24E withdrawable unit.
- Contact the nearest ABB sales office or representative should new material be required.

## 5.5 Examination of MNS contact systems within the scope of plant revisions

According to the applicable national and international standards and provisions (e.g. DIN 57 105 part 1/ VDE 0105 part 1; BGV A2), electrical plants must be maintained in an orderly condition by their operator.

All the relevant MNS manufacturing instructions and MNS product information sheets must be observed and complied with during work in connection with the tasks required for the aforementioned purpose, as well as all the relevant safety regulations and provisions in force.

These include:

- "Installation of power contacts"
  - "Greasing of power contacts"
  - "Tightening torques of bolted connections"
- which are also described in this chapter.

Each module (withdrawable / plug-in module, fused SR elements, or withdrawable module condapter) is subject to the following mandatory visual inspections prior to installation in the section (before first installation in the workshop as well as after each revision).

Visual inspection of the contact system should include the following items:

- Damage (e.g. worn silver or tin plating, signs of overheating, etc.) to the contacting surfaces of the MNS contacts and their counterparts (distribution busbars, withdrawable module condapter, outgoing cable connection unit).
- Contacts, movable and correctly fitted into position in the rear wall of the withdrawable module or contact apparatus housing.
- Misshapen contacts (bent), mechanical damage.
- Medium-force fitting of the contact spring (withdrawable modules 8E/4 and 8E/2) into its specified position.
- Swollen insulation behind crimping.
- Contacts greased.

If in doubt, measure the contact force using a special testing device.

Also if in doubt, measure the contact clearance with a slide gauge or standard gauge. The value should be no more or less than  $4.7^{+0.05}_{-0.2}$  mm.




**Please note:**

Due to construction, the size of the contact opening for  $\geq 4E$  contacts need not be checked (e.g. using a gauge block).

If faults are detected, it is advisable to replace the contacts, complete with the real wall for withdrawable modules 8E/2 and 8E/4 or the entire contacting system and/or to inform the ABB Service department in order to establish and coordinate further measures.



**Disconnect the section from the power supply before checking the distribution busbars or the withdrawable module condapters!**

Contact type	Specification/ application	Contact force		Contact opening A
		after production	during normal operation	
	1TGB 100101 R...  Power contact of withdrawable modules 4E...48E and plug-in modules	50...90 N	min. 40 N *	not applicable
	GLBS 200520 R...  Power contact of small withdrawable modules 8E/4 and 8E/2 and of withdrawable modules 4E (outgoing)	40...100 N	min. 33 N *	$4.7^{+0.05}_{-0.2}$ mm
	GLBS 200502 R... reinforced (values for earlier types on request)  Power contact of withdrawable modules 4E...48E and plug-in modules	90...120 N	min. 73 N *	$4.7^{+0.05}_{-0.2}$ mm

\* Contact to be changed if contact force is below the given value

**Fig. 54 Contact force and contact opening check list**

### 5.5.1 Maintenance procedure

#### 5.5.1.1 Regular visual inspection:

It is advisable to visually check the MNS power contacts after every 100 mechanical movements of the withdrawable modules or every 2 years, whichever occurs earlier. If any of the faults described below is detected, it is advisable to change the power contacts including, the connected cables. Counter-parts need only to be changed if specific damage is visible, as below.

#### 5.5.1.2 Checking procedure:

- Before performing visual checks:
  - Check the colour of the contact grease. Discoloured contact grease (red-brown to black) is a first sign of overheating damage.
  - Clean the grease from the power contacts.
- Check for visible damage to the power contact system, its contact surface and their counter parts. Damage includes:
  - Discoloured contact grease (red-brown to black).
  - Worn silver or tin plating / visible bare copper on contact tips or tracks.
  - Melted spots on contact tips or in contact tracks.
  - Signs of overheating, such as discolouring due to heat.
  - Insulation of connected cables broken, melted or swollen. Any other signs of overheating.
  - Plastic parts broken, melted or swollen. Any other signs of overheating.
- Check that the contacts are movable and properly fitted in position in the contact housing.
- Check that the contacts have not become misshapen, bent or damaged.
- Check that the power contact spring is still in its original position, properly fixed and not loose.
- Check that the connected cables are smoothly routed and that the correct bend radii have been maintained.

After the visual inspections or replacements have been made, the power contacts must be greased as described in sect. 5.6.

#### 5.5.1.3 Additional checks in case of doubt:

If there is no visible damage but one of the following situations is discovered:

- The power contact has been in use for more than 1000 operating cycles or more than 10 years.
- No grease on the power contacts. Dark, discoloured (red-brown to black), burnt or visibly melted contact grease.
- It is advisable to measure the contact pressure according to ABB guidelines. Please contact ABB Service for assistance if measurement is required.

#### Note:

Contact pressure measurement is not a mandatory part of the regular maintenance procedure. If the contact pressure is below 40N, the power contact and the connected cable must be changed.

## 5.6 Greasing of contact areas

### 5.6.1 Greasing of power contacts

Greasing the contacts is a mandatory requirement if the operating cycles for which the unit is certified are to be obtained, as grease reduces the wear on the contact area finish. In addition, less force is required to withdraw the modules.

The contact areas of the power contacts must be **cleaned and greased** whenever the following conditions apply:

- the assembly work and testing routines have been completed in the workshop
- after a revision or after 100 plug-in cycles or after 2 years, whichever is earlier
- immediately before installing the module in the section.

- Grease to be applied:

#### **Klüberlectric KR44-102 contact grease**

- Use a brush to apply the grease.
- Avoid excess grease on the contacts.
- If the modules are supplied as loose parts, they should be greased at the building site.
- See figures 55 and 56 for the contact areas to be greased.

The contacts of the withdrawable module condapter are to be treated similarly.

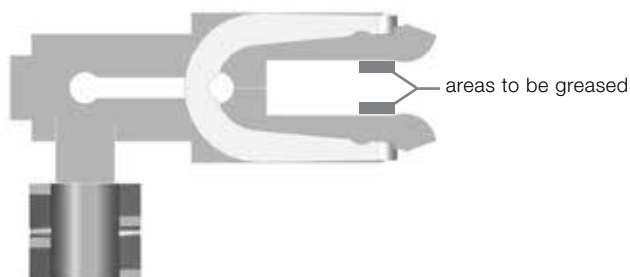


Fig. 55 Power contacts for size 8E/4 and 8E/2 withdrawable modules as well as the outgoing power contacts of 4E-withdrawable modules

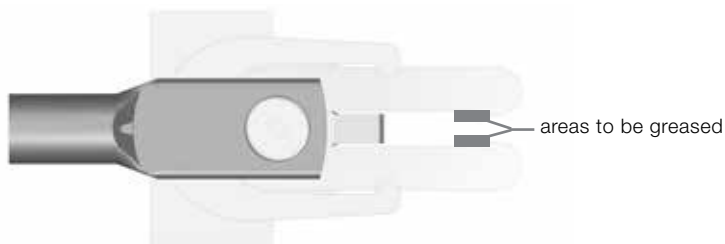


Fig. 56 Power contacts for size 4E to 48E withdrawable modules

The contacts of withdrawable modules supplied separately should only be greased on site. The following numbers of 7 g (8 ml) tubes must be supplied together with the modules for this purpose:

**For 1 to 4 size 8E/4 and 8E/2 modules**

- 1 tube each

**For module sizes 4E to 48E**

- 8 contacts each 0.5 tubes

**For plug-in modules**

- up to 400 A, 8 contacts each 0.25 tubes
- over 400 A, 8 contacts each 1 tube

Prior to packaging for transport, the appropriate number of tubes must be fixed to the modules by the manufacturing department (the tubes should be fixed to the handle of the withdrawable module, at least one tube per packed unit. In the case case of major deliveries to one customer, the grease can also be supplied in tins).

Example:

- 1 size 8E module, 250 A (8 contacts) 1 tube
- 2 size 8E modules, 250 A (8 contacts) 1 tube
- 3 size 8E modules, 250 A (8 contacts) 2 tubes

**Identification numbers of the contact grease**

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

**5.6.2 Greasing the fuse links**

The contact lugs of LV HRC fuses must also be greased each time, before being inserted into the fuse holder of any type of switching device (OS / OESA, SLP / XLP, SR elements, etc.). If the fuses are supplied loose, 0.5 tubes of contact grease are required for each module (1 set = maximum 4 fuses for all sizes).

## 5.7 Lubrication of withdrawable module interlocks

It may be necessary to lubricate the interlocks of size 8E/2 and 8E/4 withdrawable modules when they have been in use for some time (depending on the environmental conditions and tightness). This is done by spraying the movable parts with a lubricant (approx. 1 sec.). A functional test must be performed after this.

**Lubricant required:**

Molycote Omnigloss Spray, Liquid high-pressure lubricant in 300 ml tins

**Manufacturer:**

Dow Corning GmbH  
 D-65201 Wiesbaden/Germany

**Lubrication of withdrawable module interlocks for module sizes 4E to 48E is not necessary during maintenance work.**

## 5.8 Installation of power contacts

### 5.8.1 Installation

Once inserted into the rear wall of the withdrawable module (1TGB120050P0001), or contact housings 1TGB120048P0001 and 1TSA233000P0007, the contact must be properly engaged. Successful engagement is indicated by a **single**, audible click, and can be checked by pulling the cable.

**Please note!** The new contact does not click a second time like the old type once it has passed the engagement hook.

If the contact fails to engage properly, make sure that the engagement hook is the right shape (e.g. free from burrs) and that it is not broken. Parts with a misshapen or broken engagement hook must be replaced.

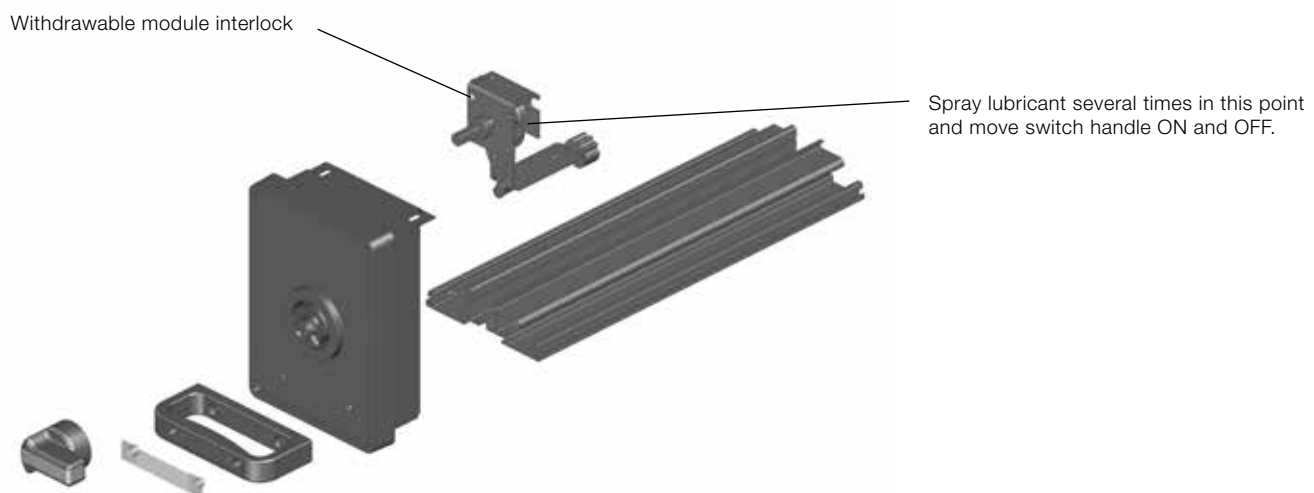


Fig. 57 Lubrication of MNS 8E/4 and 8E/2 withdrawable module interlocks

### 5.8.2 Testing

The withdrawable module assembly must be tested as follows prior to installation in the section (first installation and after revisions):

- Visual inspection (the contacts must be free from visible damage).
- Contact opening size (refer to: Examination of MNS withdrawable module design contact systems within the scope of plant revisions).
- Snapping in (it must not be possible to press the contacts back manually).
- Contact float (the contacts must not sit firmly in the chamber, they must be able to move in all directions in order to ensure tolerance adjustment).

### 5.8.3 Contact plating

#### Contact plating with silver or tin

##### Application of different platings

- Silver (Ag) -> Standard
- Tin (Sn) -> Optional, if requested by the customer.

##### Identification

The type of plating cannot be distinguished visually. This is why the contacts are marked:

- on the contact fingers: impression of “Ag” or “Sn”.

##### Combination of differently plated parts in one switchgear



**Applies in principle to the withdrawable and railable technique:**

**It is not possible to combine busbars and contact systems with different coatings!**

### Exceptions:

A combination of contact material for the following systems, where the contacts are not moved more than 30 times.

- SR- Switch disconnectors
- Plug-in modules (not railable modules)
- RPC modules
- Module condapters 8E/4 and 8E/2 (only the connection between the distribution busbar and condapter)
- tin-plated busbars and contacts **on the incoming side** of a system and **silver-plated** busbars and contacts **on the outgoing side**.

All parts of the MNS busbar system are clearly marked “Ag” or “Sn”.

## 5.9 Paintwork damage

### 5.9.1 Preparation of the damaged area

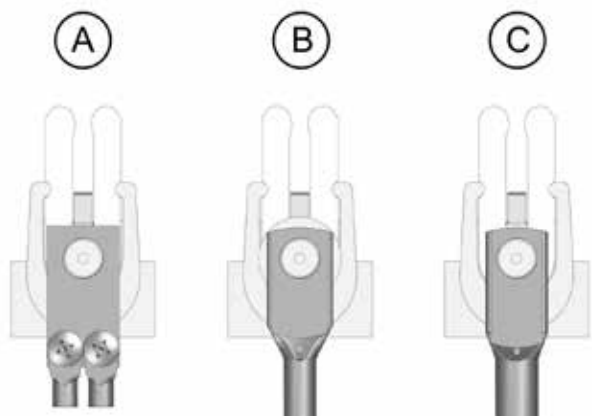
Surfaces or areas soiled by grease/oil must be cleaned with an aliphatic cleaning agent using a linen cloth.

### 5.9.2 Repair

The paintwork repair set whose colour matches that of the installation to which it is attached (if ordered) must be used for paintwork repairs.

All the hardening agent in the small container must be added to the larger container filled with paint. The quantity of hardening agent exactly matches the quantity of paint. After hardening agent and paint have been thoroughly blended together, the mixture must be applied by brush or lambskin paint roller to the surface to be repaired.

Small marks can be touched-up, but the success of the operation depends on surface preparation and/or "handling".



#### Contact forms:

A: up to 2 x 16 mm<sup>2</sup>

B: up to 35 mm<sup>2</sup>

C: up to 70 mm<sup>2</sup>

Fig. 58 Power contacts for 4E ... 48E withdrawable modules



Fig. 59 Contact apparatus housing, cross-section

## 5.10 Mechanical damage

### 5.10.1 Preparation of the damaged area

When major damage to large areas has occurred, the relative surfaces must first be ground with abrasive paper (grade 400). The damaged area must then be wiped with a linen cloth or cleaned with compressed air to remove the dust.

### 5.10.2 Repair

A filler material (alkyd resin basis) must be applied flush with the surface using a scraper. Leave the filler set over night. Lightly grind the filled-in area then apply the paint as described above.

### 5.10.3 Materials

Colour: RAL .... (e.g. 7035, light-grey)  
(2-component synthetic resin varnish)  
Repair paint: RAL .... and hardener (paint repair set)  
Filler: Alkyd resin base  
Cleaning agent: Aliphatic (e.g. white spirit)

### 5.10.4 Tools

For cleaning: Linen cloth (lint-free)  
Abrasive paper (grade 400)  
For painting: Brush or lambskin paint roller  
For repair: Scraper

## 5.11 Tightening torques for screw connections

### 5.11.1 Scope of application

The figures given apply to system screw connections and busbar screw connections on busbars with  $\sigma_{02} \geq 70 \text{ N/mm}^2$  (Cu, Cu/Al, AlMgSi 0,5) in the MNS switchgear system. The values are not applicable to electrical equipment connections and mountings.

#### Exception:

They do however apply to the mountings of equipment with sheet steel bases and the connections of electrical equipment when this is made with flat copper terminals and bolts and nuts in tensile class 8.8.

#### Note:

Consult the manufacturer's technical data sheet for the equipment connections and mountings.

### 5.11.2 Screwing/Bolting accuracy

High-accuracy torque tightening equipment should be used. This must be adjusted so that the maximum torquing value (including tolerance) of each adjustment step does not exceed the given tightening torques in the tables.

### 5.11.3 Testing torque

The testing torque is the preset value of the tightening equipment minus 15%.

### 5.11.4 Tightening torques

– Self-tapping screws in plastic material.

Screw Part Number	Screw type	Dimension mm	Max. tightening torque	
			Thermoplastics Duroplastics Nm	Pur Nm
1TGB 000 116 P... and 1TGB 000 117 P...	TORX pan head tapping screws	4.2 5.5 6.3	2.0 4.5 5.5	- 3.5 3.5

### Bolt and Nuts, and Tightening Torque

– Insulating self-tapping screws.

Screw Part Number	Diameter mm	Max. tightening torque	
		Thermoplastics Duroplastics Nm	Pur Nm
GSIN 100073 P... and GILN 100107 P...	4.2 5.5 6.3	2.0 4.5 5.5	- 3.5 3.5

– Metal self-tapping screws.

Screw Part Number	Diameter mm	Max. tightening torque					
		Steel plate		Aluminium plate		Copper busbar	
		Threading height mm	Nm	Threading height mm	Nm	Threading height mm	Nm
HZN 451307 P...	M3	1.5	1.0	3	1.0	-	-
GILN 100082 P...	M4	1.5	2.0	3	2.0	-	-
	M5	1.5	4.5	3	4.5	-	-
	M6	2.0	5.5	3	5.5	-	-
	M8	3.0	9.5	3	5.5	5.0	9.5

– Busbar (Cu) and system (steel-steel) connecting screws.

Screw type	Diameter mm	Max. tightening torque Nm
DIN 931 hexagonal-head screw DIN 933 hexagonal-head screw DIN 912 cheese-headed screw With or without ESLOK safety, Resistance class 8.8 A2G Hammer-head screw GMN 325 116 P... Screw with SR adapter	M6 M8 M10 M12 M16	8 20 40 70 140

## 5.12 Commissioning and maintenance of MNS reactive power compensation systems

### 5.12.1 Commissioning and maintenance

In the worst case, compensation systems are permanently operated at their maximum power. This means that good ventilation must be ensured in the installation site in order to prevent the ambient temperature from exceeding the max. admissible limit of 35 °C (mean value over 24 hours). Faulty operation or insufficient compensation power can be best determined (although too late) by checking the reactive power demand (electricity bill). If the following points are noted during commissioning and regular maintenance work, a loss in compensation power can be detected at an early stage.

1. Check ventilation in the place of installation.
2. Check the construction:
  - a) Air must be supplied and exhausted above and below each individual module (or modules).
  - b) There must be at least 4 ventilation slots if the bottom plate of the section is closed (no air supply through bottom plate).
  - c) There may be no compartment bottom plates or other installations in the section that could adversely affect ventilation.
  - d) Forced ventilation (or less equipment) is required for protection class > IP 32 or installations which deviate from c) above.
3. Check the settings and operation of the controller (switching outputs).
4. Check contactors for sparking when switching and for faultless making and breaking operations. The maintenance intervals of the contacts of the capacitor contactors, depending on their number of switching operations (can be read off ESTAmat® RPR), are subject to the manufacturer's instructions.



**Do not operate capacitor-contactors by hand!**

5. The current consumption of the system and the modules provides an indication of loss in capacitance if a capacitance test (which requires safety disconnection of the compensation system) is not possible. In this case, the currents and voltages in each phase must be measured simultaneously. (However, current measurement is only a rough criterion, in view of possible current distortions caused by harmonic waves!)
6. Before touching the capacitors:
  - a) Wait for at least one minute until the capacitor is discharged.
  - b) Protect the system against reclosing.
  - c) Verify safe isolation from supply.
  - d) Short-circuit the capacitor terminals among each other and with the housing in order to compensate for differences in potential.
  - e) Protect neighbouring live parts against accidental contact.

7. Perform a visual inspection of the electrical equipment. (Leaks such as oil leakages, bulging of the capacitor lid or housing, condition of terminals, switches, protective devices, reactors, discharge resistors, conductors.)
8. Check protective devices and switches for faultless operation.
9. Clean the modules as well as the air supply and air exhaust regions of each section (ventilation louvers, filter mats).
10. Check bolted connections and clamping units.
11. Measure capacitances and log measured values. (The capacitances of the compensation capacitors may change due to inadmissible heat rise, expiry of useful life, overvoltages, etc. Experience has shown that the inductance values are not subject to major changes).

#### **Please note:**

Before measuring capacities, discharge resistors must be disconnected from capacitors. Setpoint values are given on the module name-plates.

### 5.12.2 Correction of faults

If faulty operation occurs during commissioning, the section wiring (especially in the area of the transport partition) should be checked first.

Other possible faults include the following:

- Controller display remains dark:
  - Check control voltage.
- Controller does not switch in additional steps (although request is available):
  - Measuring voltage or current not, or wrongly, connected.
  - Check fuses.
  - Wrong transformer ratio.
  - Lowest step power too high.
  - Inappropriate C/k value setting / value too low.
- Controller switches very often:
  - Switching time (too) short with quick load changes.
  - Step power too low.
  - Wrong C/k value setting.
- $\cos\phi$  setpoint not reached:
  - Lowest step power too low.
  - Inductive current too low.
- All steps are permanently active:
  - Undercompensation, i.e. installed leading reactive power is not sufficient.
  - Check control voltage.
  - Check LV HRC fuses of the modules.
  - 5 A transformer connected to 1 A controller measuring input.
- Too many steps active (overcompensation):
  - Check transformer installation.
  - Check controller settings.
  - Wrong measuring voltage connection (phase-phase and phase-N exchanged).
- $\cos\phi$  display does not coincide with additional power factor meter reading:
  - wrong voltage measuring connection (phase-phase and phase-N exchanged).
  - slight deviations may be due to inaccurate measuring units and/or different measuring points.

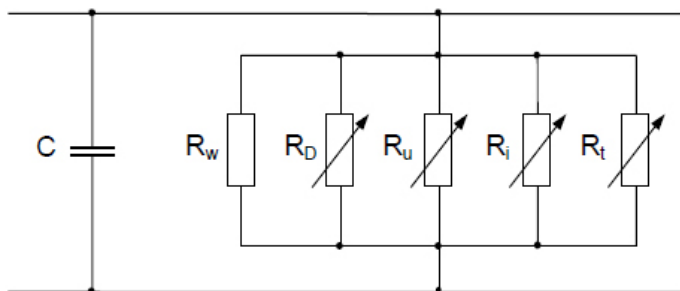


## 5.13 Measuring of the insulation resistance

Insulation measurement is of fundamental importance to an electrical system. Furthermore, it is the only type of measurement that serves for preventive fire protection. The insulation resistance is a complex resistance in the form of a parallel connection of an ohmic resistor  $R_W$  and a capacitance  $C$ .

The equivalent resistance is a variable quantity that is influenced by various parameters.

This is illustrated by the following equivalent circuit diagram:



$R_W$ : constant equivalent resistance

$R_D$ : dielectric resistance

$R_U$ : voltage-dependent resistance

$R_i$ : current-dependent resistance

$R_t$ : time-dependent resistance

For which protective measures do you have to measure the insulation resistance?

**The insulation resistance must be measured for all protective measures! This refers to protective measures without protective conductor and with protective conductor.**

Insulation measurement is required according to DIN VDE 0100, but also to other standards, such as

- IEC 61439-1, Section 11.9,
- EN 60204,
- DIN VDE 0105,
- VDE 0110.

### 5.13.1 Which insulation measurements have to be performed?

DIN VDE 0100 part 610 specifies insulation measurement between the conductors in Section 5.3:



**If the circuits contain electronic components, such as semiconductors, these sensitive components must by no means be damaged by the high measuring voltages.**

Measurement may also be performed with the consumer equipment connected. If the insulation resistance is too low in this case, the consumer equipment must be isolated, and the system and consumer must be measured separately. Prior to commissioning, the following circuits must be measured:

- All line sections between any 2 overcurrent protection devices.
- The section following the last overcurrent protection device without any connected consumer equipment.

Procedure	Required measurement	Remarks
1. Between the outer conductors and the protective conductor		
2. Between the neutral conductor and the protective conductor		Separate the PE and N conductors! This measurement is not required in the TN-C network.
3. Between the outer conductors		This measurement is not required: - if the cable includes an earthed conductor or an earthed sheath; - for switch leads in lighting circuits.
4. Between the outer conductors and the neutral conductor		

### 5.13.2 Which minimum insulation resistance must be available?

In order to exclude the influence of the capacitive reactance, the measurements must be performed with DC voltage. For the values of the measuring voltage and the minimum insulation resistance, please refer to the table below.

Protective measure and rated voltage	Measuring-circuit voltage DC [V]	Minimum insulation voltage value [MΩ]
Extra-low safety voltage, extra-low functional voltage with safe isolation	250	≥ 0.25
Protective separation	500	≥ 1
Rated voltage ≤ 500 V, and extra-low functional voltage without safe isolation	500	≥ 0.5
Rated voltage > 500 V, ≤ 1000 V	1000	≥ 1

## 5.14 Maintenance intervals

### 5.14.1 General

#### 5.14.1.1 Legal conditions

Electrical switchgear and controlgear systems require permanent preventive maintenance not only for technical and economic reasons. In an effort to define due order in the energy sector, the government dictated a number of legal provisions from which the requirements of preventive maintenance can be derived.

#### 5.14.1.2 Preventive maintenance

At the moment, **no technical standard** provides comprehensive guidance on the preventive maintenance of electrical distribution networks and equipment. The principles require electrical systems and equipment to be operated in accordance with the rules of electrotechnology, which include preventive maintenance.

- All defects must be immediately remedied.
- In the event of imminent danger, electrical systems must no longer be operated.

Even the provisions of DIN 57105 part 1/VDE 0105 part 1 do not contain any specific requirements beyond general information about the preventive maintenance of electrical systems. The most important information on preventive maintenance is summarized in item 5, "Preservation of proper condition and repetitive testing". This item stipulates that high-current systems must be kept in proper conditions in accordance with the standards governing their installation.



**Defects in electrical systems must always be remedied immediately, i.e. without any culpable delay. If danger to persons, property or the environment is imminent, defective electrical systems or equipment must be immediately put out of operation. They must not be used in defective conditions.**

A switchgear system is defective if safety is jeopardized by its operation.

In order to be able to promptly recognize any defects that may have occurred after electrical systems have been commissioned, repaired or modified, DIN 57105 part 1 / VDE 0105 part 1 requires the performance of repetitive

tests without, however, detailing concrete terms for the test cycles. Repetitive tests allow the proper condition of electrical systems and equipment to be assessed.

Repetitive tests include:

- a visual inspection
- trial runs
- measurements
- other tests.

### 5.14.2 Maintenance of MNS switchgear systems

#### 5.14.2.1 General safety instructions



**The system or component must be disconnected from the circuit before the switchgear can be cleaned inside. It is inadvisable to use compressed air for cleaning dusty systems.**

#### Safety at work:

The procedure for performing switching operations is prescribed by the implementing instructions in BGV A2, §6. The off-circuit condition must be established prior to commencement of the work and must be ensured at the place of work for the duration of the work itself, in compliance with the following five safety rules, which must be applied as a standard:

#### Five safety rules

##### Before starting to work:

- Safety isolation
- Protection against re-closing
- Verify off-circuit condition
- Earthing and short-circuiting
- Apply a cover or barrier to adjacent live parts.

These five safety rules must be observed as safety measures for work on electrical systems and equipment.

#### 5.14.2.2 Health and safety

Please note the following information:

- In accordance with the regulations in force, installation and maintenance work involving MNS-switchgear systems must only be performed by qualified personnel.
- Before low-voltage switchgear system components can be handled, the component in question must be **isolated!!!** Power supplied to the capacitor by a remote auxiliary power source, if any, must also be isolated.
- When the system has been isolated, wait for one minute to allow the voltage stored in the capacitor to be discharged by the discharging resistors. As an additional safety measure, the outgoing capacitor circuits must be tested for the discharged condition using an insulated cable.
- Make sure that the current transformers were short-circuited before they were isolated or connected.
- Automatic capacitors must be installed in accordance with IEC 60831-1&2 standards and all national regulations.
- A short-circuit may pose dangers to human life and destroy equipment! Therefore, it is of vital importance to use suitable tools and instruments for commissioning or inspecting electrical systems.

### 5.14.3 Maintenance and inspection of MNS switchgear systems

#### 5.14.3.1 General

- To prevent the acceptable risk limit from being exceeded, operation and maintenance must be performed with the utmost care, especially in the case of systems associated with a higher risk (e.g. nuclear power plants).
- Please refer to the relevant product documentation for information about the mechanical and electrical life of electrical equipment.
- All maintenance work and the required tightening torques for the electrical equipment in use must also be carried out in accordance with the manufacturer's mandatory instructions.

#### 5.14.3.2 Maintenance intervals

##### 1. General visual inspection (repetitive tests)

- 1.1 External inspection
- 1.2 Completion of the interior
- 1.3 Switchgear and controlgear assemblies (withdrawable or plug-in modules)

##### 2. Additional inspections

- 2.1 Withdrawable technique
- 2.2 Plug-in, disconnectable, railable technique
- 2.3 Direct connection of incoming and outgoing power feeders to circuit breakers

#### 5.14.3.3 Notes about the inspection lists on the following pages

- The frequency refers to time intervals (monthly, annually, etc.), service hours, starting frequency, etc.  
The following abbreviations are used to denote the frequency:
  - m: monthly
  - a: annually
  - n: insertion cycles of modules
  - x: test in the event of a fault (e.g. after a short-circuit)
- “Installation category” column  
A distinction is made between the following installation categories, since maintenance or inspection frequency depends on the operating conditions:
  - Installation category A: Normal operation
  - Installation category B: Heavy-duty operation, e.g. cement factory
  - Installation category C: Short circuit (fault)

## 5.15 Servicing Tmax XT1 and XT2 mechanisms in MNS R (8E/4 and 8E/2)

The apparatus must be checked (condition, function, damage) and greased after 1000 operation cycles or once a year. ABB recommends Liqui Moly® (TYPE LM 47) with ABB ID 1TGB000235P0001. After greasing, make sure that there is no dust or dirt on the modules as this may impair the switching mechanism.

#### Step 1: Removal of the top cover

Remove module from switchgear and place it on a flat work surface.

Remove the side walls of the module according to the instructions on the back walls and remove the top cover of the Tmax XT mechanism as shown in figure 1 and 2 with a tool.

Note: Please ensure that none of the four location fasteners is damaged when the cover is removed.

#### Step 2: Greasing

As shown in Figure 3, the apparatus must be greased with a brush in the following points: with the MCCB in the “Off” position (see figures 4 and 5) and with the MCCB “On” position (see figures 6 and 7).

Use approximately 0.5 g of grease for each of the four positions.

#### Step 3: Top cover fixing

The top cover must be correctly positioned on the Tmax XT apparatus. Check that all fixing hooks fit into their positions.

#### Step 4: Inspection before putting into service:

- Visually check that the unit is in a good condition
- Check that the unit functions correctly by performing about five operations before switching in the load: opening, closing, relay or MCCB tripped
- Check that the test button of the MCCB is free and accessible. It must be possible to use the test function of the Tmax XT breaker with a tool, e.g. a screwdriver.

#### Part Numbers:

Module side walls	HANL200009P0001 (MNS)
XT top cover	1TGB120132P0001



Figs. 1 and 2: Cover removal



Fig. 3: Grease on the tip of brush

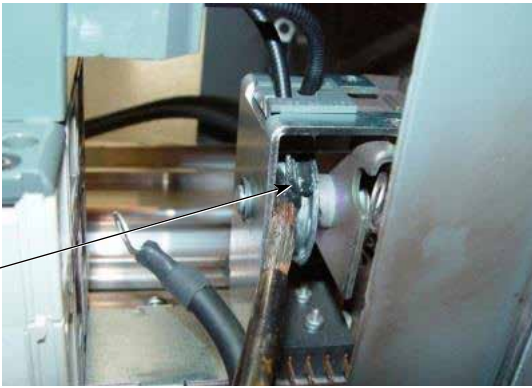


Figs 4 and 5

**MCCB switched to the Off position**

Grease the bowden wire on the cable in the channel on the pull on side

Grease the bowden wire on the right side of the rotary unit

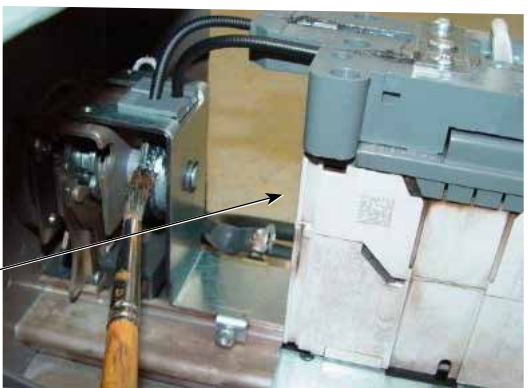


Figs. 6 and 7

**MCCB switched to the On position**

Grease the bowden wire in the channel on the pull off side

Grease the bowden wire on the left side of the rotary unit



test button

Fig. 8: Test button

## 5.16 Maintenance and Inspection List

Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Frequency Install. category			Remarks
			A	B	C	
<b>1.0</b>	<b>General visual inspection (repetitive tests)</b>					
1.1	External inspection					
1.1.1	Check ambient conditions	<ul style="list-style-type: none"> <li>– Room temperature <math>\leq 35\text{ °C}</math></li> <li>– Air, aggressive gases etc.</li> <li>– Relative humidity <math>\leq 50\%</math> at <math>40\text{ °C}</math></li> <li>– Dust</li> </ul>	1y	6m	X	Unpleasant smell Auxiliary heating possibly required
1.1.2	Check ventilation system (efficiency) <ul style="list-style-type: none"> <li>– Operating room</li> <li>– Switchgear system</li> </ul>	<ul style="list-style-type: none"> <li>– Unobstructed air supply to and air exhaust from section</li> <li>– max. temperature inside the section: <math>\leq 60\text{ °C}</math></li> </ul>	1y	6m	X	Touch front surfaces with hand. Check section if hand-warm spots are found
1.1.3	Check condition of enclosure / external paint	<ul style="list-style-type: none"> <li>– Damaged / corroded</li> <li>– Missing parts such as module doors or covers</li> <li>– Ventilation louver dusty / covered</li> <li>– Roof plate dirtied / covered / obstructed / etc.</li> <li>– Fastening of cable compartment doors, side and back panels</li> <li>– Position of withdrawable modules in the section (operating or isolated position)</li> <li>– Cable / equipment compartment doors closed / open</li> </ul>	1y	6m	X	
1.1.4	Accessibility	– Escape route $\geq 650\text{ mm}$	1y	6m	X	
<b>Inspection of insulation resistance</b>						
Measure the insulation resistance in accordance with the procedures indicated for starting. Measured values should not be very different from those detected at the start.						
If the insulation level is notably less, perform voltage tests. It is better to measure the insulation resistance before the voltage tests. If the insulation resistance has decreased, identify the crush point.						

Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Frequency Install. category			Remarks
			A	B	C	
<b>1.2</b>	<b>Completion of the interior</b>					
1.2.1	Equipment compartment – Check filling factor and equipment – Internal conditions  Circuit breakers	– Position of modules in accordance with engineering documents – Contamination, e.g. dust – Blackened contact surface  – Loosened screw  – See the relative installation, operation and maintenance instructions	1y	6m	X	Clean Clean with a cloth and solvent Tightening torque indicated in sect. 5.11 Perform the suggested maintenance procedures
1.2.2	Cable compartment / cable terminal compartment  Personal protection / protective cover	– Incoming feeder in accordance with documents (busbar / cable laterally / top / bottom) – Sufficient room / strain relief – Cable routing; bend radii – Protective cover	1y	6m	X	
1.2.3	Busbar compartment – Check transport connections  – Check busbar supports  – Visual inspection of the condition of the busbar insulation – Insulating busbar holders	– Loosened screw – Color changes at bolted connections – Proper installation of cover in partition wall 3 – Contamination or flashover – Formation of cracks or splits – Shrink-on tube brittle  – Dust – Cracks  – Discharge marks	1y	6m	X	Tighten to indicated tightening torque Check using thermo-vision exposures  Remove the dust Replace the damaged busbar Holders
1.2.4	Earth busbar joints and related connections	– Copper Oxide  – Loosened screw				Remove the oxide by means of file or an emery cloth and clean with cloth and solvent  Tighten according to indicated tightening torque
1.2.5	Main power feeding busbars, distribution busbars, connections between busbars and circuit breakers	– Discharge or smoke marks				Clean with solvent. If necessary replace the damaged part

#### Inspection of insulation resistance

Measure the insulation resistance in accordance with the procedures indicated for starting. Measured values should not be very different from those detected at the start.

If the insulation level is notably less, perform voltage tests. It is better to measure the insulation resistance before the voltage tests. If the insulation resistance has decreased, identify the crush point.



			Frequency Install. category			
Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	A	B	C	Remarks
1.3	General inspection of the switchgear assembly (withdrawable or plug-in, disconnectable, railable technique)					
1.3.1	Design of conductors and conductor installation	Condition of insulation	2y	1y	X	Measure the insulation resistance
1.3.2	Check electrical equipment installed	<ul style="list-style-type: none"> <li>– Bracing</li> <li>– Check contact corrosion, contact gaps, ionization chamber arc splitter, rated currents, settings and tripping</li> <li>– Minimum creepage distance <math>\geq 12.5</math> mm</li> <li>– Check minimum clearance for arcing space</li> </ul>				Comply with the equipment manufacturer's instructions for full maintenance indications  See equipment manufacturer
1.3.5	Required protection class	– EN 60529				
1.3.6	Check efficiency of protective conductor connection	– Check continuity with signal test apparatus	2y	1y	X	
1.3.7	Functional test of the control device	– In accordance with circuit diagram	2y	1y	X	Control connection cable.
1.3.8	Check measuring loops	– In accordance with circuit diagram	2y	1y	X	
2.0	Additional checks					
2.1	Withdrawable technique					
2.1.1	Compact modules (8E/4 + 8E/2) <ul style="list-style-type: none"> <li>– Make sure that module moves easily in compartment</li> <li>– Functional test of mechanical interlock</li> <li>– Check electrical contact-making               <ul style="list-style-type: none"> <li>- Main contacts</li> <li>- Control plugs</li> <li>- Visual inspection of module compartment</li> </ul> </li> <li>– Check efficiency of protective conductor connection</li> </ul> Compact modules (8E/4 + 8E/2 + 6E/4 + 6E/2) with Tmax XT <ul style="list-style-type: none"> <li>– Clean the module</li> <li>– Check the mechanism</li> <li>– Lubricate mechanism</li> </ul>	<ul style="list-style-type: none"> <li>– Remove dust and grease from guide rail if necessary</li> <li>– Lubricate with Omnigloss</li> <li>– Visual inspection</li> <li>– In case of doubt check contact clearance</li> <li>– Remove dust from guide rail with vacuum cleaner</li> <li>– Operate limit switch rocker (if available)</li> <li>– Check condition of mating contacts</li> <li>– Check cam condition at supporting rail</li> <li>– Remove dust</li> <li>– Visual inspection and switching test without load</li> <li>– Greasing</li> </ul>	2-3y 2-3y 2y 1y	1y 1y 1y <sup>(1)</sup>	X X X	Consult Sect. 5.5          Artificial light source          Consult sect. 5.19
2.1.2	4E withdrawable modules <ul style="list-style-type: none"> <li>– Make sure that module moves easily in compartment</li> <li>– Functional test of mechanical interlock</li> <li>– Check electrical contacts               <ul style="list-style-type: none"> <li>- Main contact</li> <li>- Control plug</li> </ul> </li> <li>– Fastening of outgoing cable unit</li> <li>– Protective conductor connection</li> </ul>	<ul style="list-style-type: none"> <li>– Visual inspection</li> <li>– Check contact force</li> <li>– Greasing</li> <li>– Position; the outgoing cable unit could have been pressed out of its normal position by strong cable forces</li> <li>– Condition of the roller in the compartment bottom plate</li> </ul>	2y <sup>(1)</sup>	1y <sup>(1)</sup>	X	Refer to Sect. 5.5 Consult sect. 5.6

<sup>1)</sup> Check the main contact either according to the indicated the mentioned time intervals or after 100 cycles at the latest.



Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Frequency Install. category			Remarks
			A	B	C	
2.2	Plug-in					Also see item No. 1.3: General inspection
2.2.1	MCC's and outgoing energy distribution feeders					
2.2.2	Compensation modules with and without reactor Check electrical equipment in every module  – Visual inspection of main contacts X01 – Condition of short-circuit protection  - LV HRC fuse  - Circuit breaker  – Lubricate contact blades of LV - HRC fuses – Check capacitor contactor - Check for contact corrosion - Switching performance – Visual inspection of filter circuit reactor Connections and windings – Capacitor - Design without reactor: measure all step currents 3-phase or capacitance values - Design with reactor: measure the terminal capacitance – Discharging device - Reactor - Resistor bank – Cable connection – Screwed connection at electrical equipment - Insulation Check controller module – Check controller settings - C/k value - cosφ setpoint - response time – Check step triggering	– Fuse continuity – Fuse tripped  – Contact condition  – Klüberlectric KR44-102  – Contact condition – No humming, bouncing or chattering of reactor  – Condition – See sect. 5.15 for the setpoints – Limit value: $IB \leq 1.3 \times I_n$  – Residual voltage after 1 min $\leq 50$ V – Color change, missing elements – Insulation melted or even corroded – See manufacturer's instructions for tightening torque  – In accordance with manufacturer's operating instructions  – Approximate value 60 s	1y	6m	X	Check contact gaps, contact condition and whether lubrication is necessary  Control connection cable.  Consult sect. 5.6 Signs of overload by mains Resonance in accordance with manufacturer's instructions  Use measuring log according sect. 5.17  Power circuit open, i.e. fused switch disconnecter removed

<sup>1)</sup> Check the main contact to be checked either according to the indicated the time intervals or after 100 cycles at the latest.



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#### Note:

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