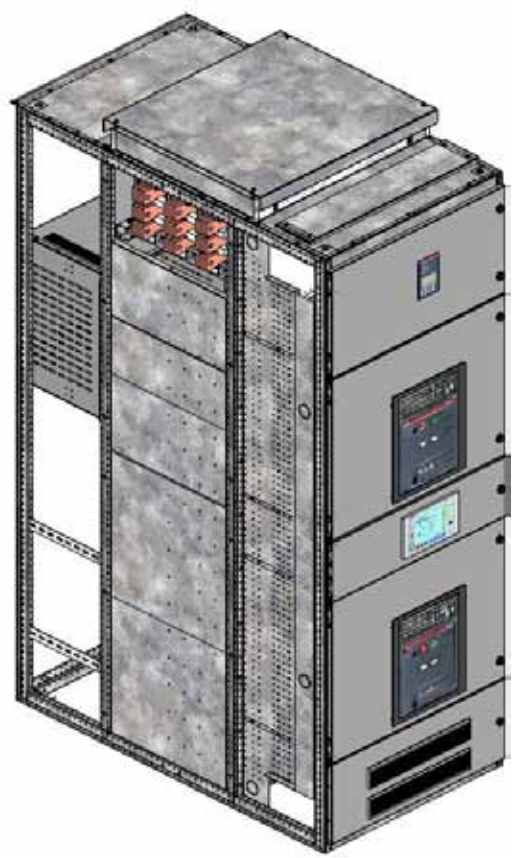
Service Manual

Power – Low Voltage Switchgear MNS-R
Erection, commissioning, operation and maintenance

Indice



Power and productivity
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Consequences in the event of non-compliance

ABB shall not assume any liability for any of the following events:

- Negligent handling of the low-voltage switchgear system and non-compliance with the safety and working regulations as amended from time to time.
- Insufficient maintenance, non-compliance with the recommendations given herein or inappropriate repairs by personnel without the necessary training or adequate equipment.
- Transport damages of any kind.
- Inappropriate use.
- Modification of the low-voltage switchgear systems which were not made by authorized specialized personnel.

Content

1 Technical Description

1.1 Technical data

Standards		Low-voltage switchgear and control gear assemblies Power switchgear and controlgear assemblies	IEC 61439 -1 and -2 EN 61439-1 and -2
Test certificates		ABB SACE ACAE LOVAG CESI	
Electrical data*	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	**Busbars:**	
		Rated current Ie	up to 8000 A
		Rated peak withstand current Ipk	up to 264 kA
		Rated short-time withstand current Icw	up to 120 kA
		MNS-R Distribution bars:	
		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
		MCC-R Distribution bars:	
		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
Mechanical characteristics	Dimensions	Sections and frames	DIN 41488
		Recommended height	2200 mm
		Recommended width	400, 600, 800, 1000, 1200 mm
		Recommended depth	400, 600, 800, 1000, 1200 mm
		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	IP 00 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	
Extras	Paint finish	Enclosure	Special colours (standard RAL 7035)
	Busbar system	Busbars	Sheated
			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, the verification of these requirements need not to be repeated.

** Depending on the electrical equipment.

1.2 Switchboard Basic Structure

1.2.1 Typical Side Section

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

– Equipment compartment.
– Busbar compartment.
– Cable compartment.

The equipment compartment consists of:

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

The busbar compartment consists of:

– Main busbars.
– Distribution bars.
– Vertical busbar for MCC.

The cable compartment consists of:

– Input and output cables.
– Auxiliary accessory (connectors, auxiliary terminal boards, etc.).

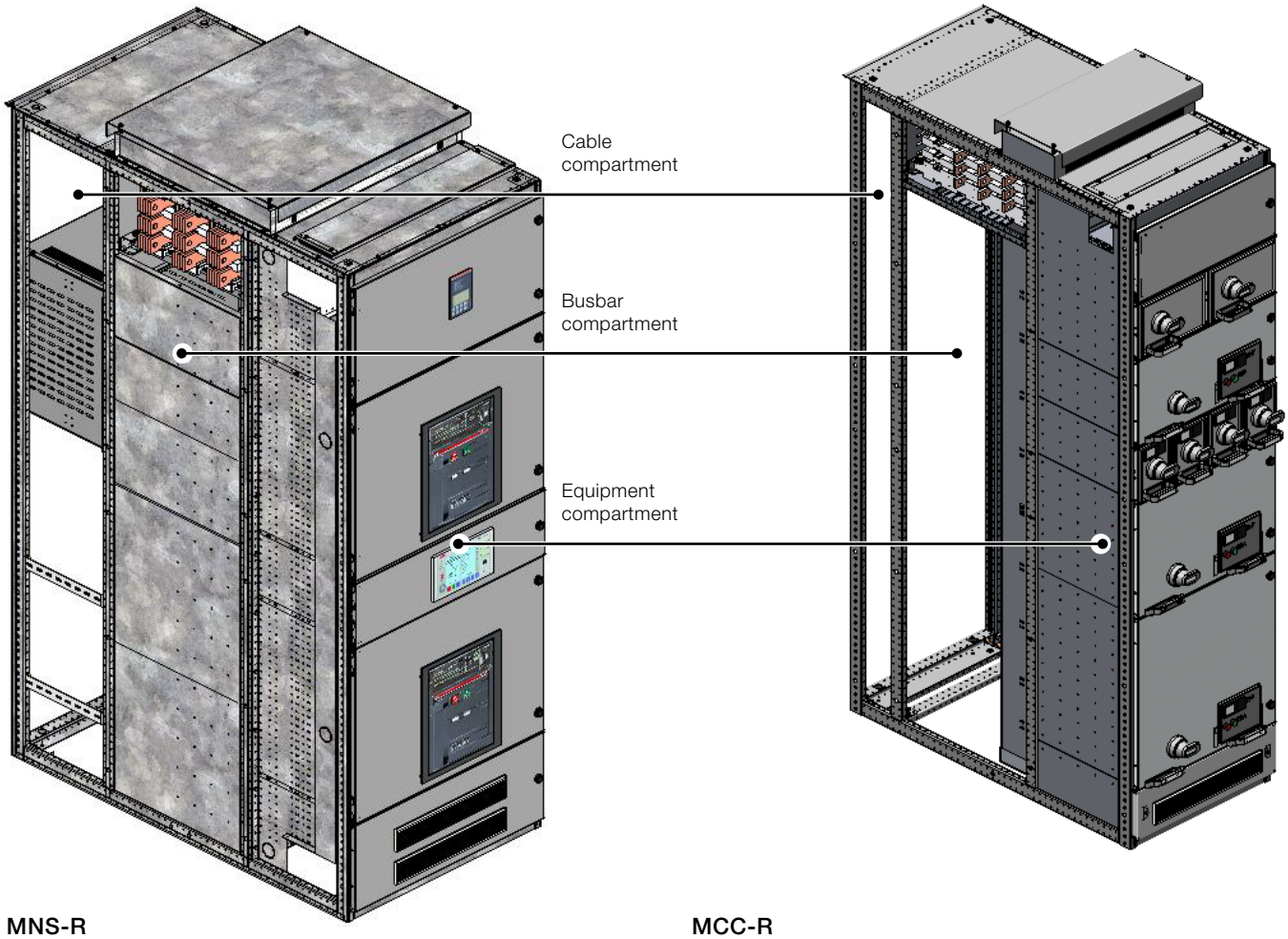


Fig. 1 Typical execution for MNS-R and MCC

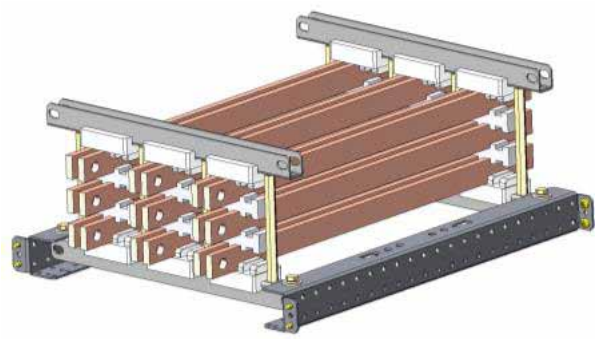
MNS-R uses up to three busbar systems located in the busbar compartment. The location of the main busbar in the cubicle can be Center, Top and Bottom depending upon which types of modules are placed in the cubicle.
There are two types of main busbar system: standard type or multi-level busbar type (see fig. 2).

1.3 Distribution bars

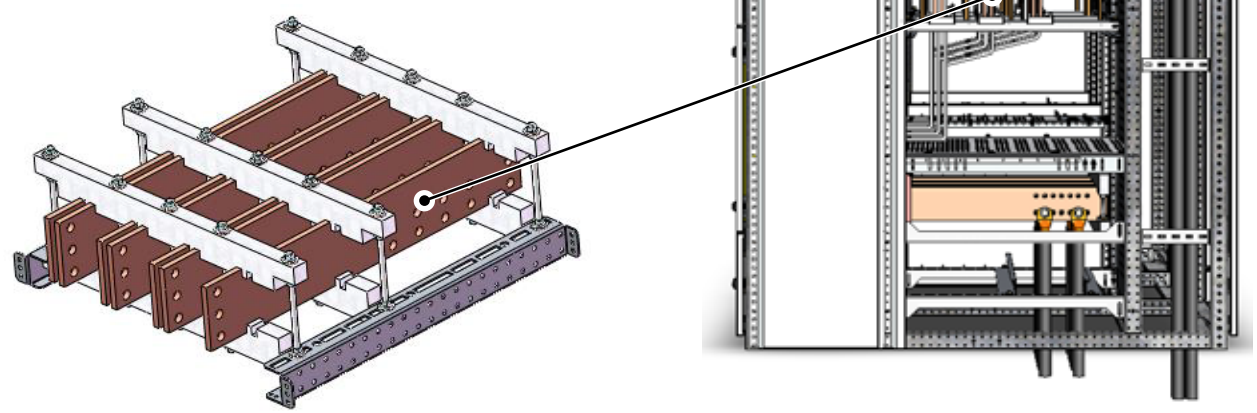
1.3.1 Distribution bars

The distribution bars 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 executions (see fig. 3-4).

– In the fixed, plug-in, module design they are arranged vertically in the busbar compartment.
– In plug-in and withdrable module design bars are embedded into the multifunctional wall made of insulating material (degree of protection IP 20) and held in place and arc prooved covered. The grid for contacting is in this solution 4E.



Multi-level busbar



Standard type busbar

Fig. 2 Typical busbar execution

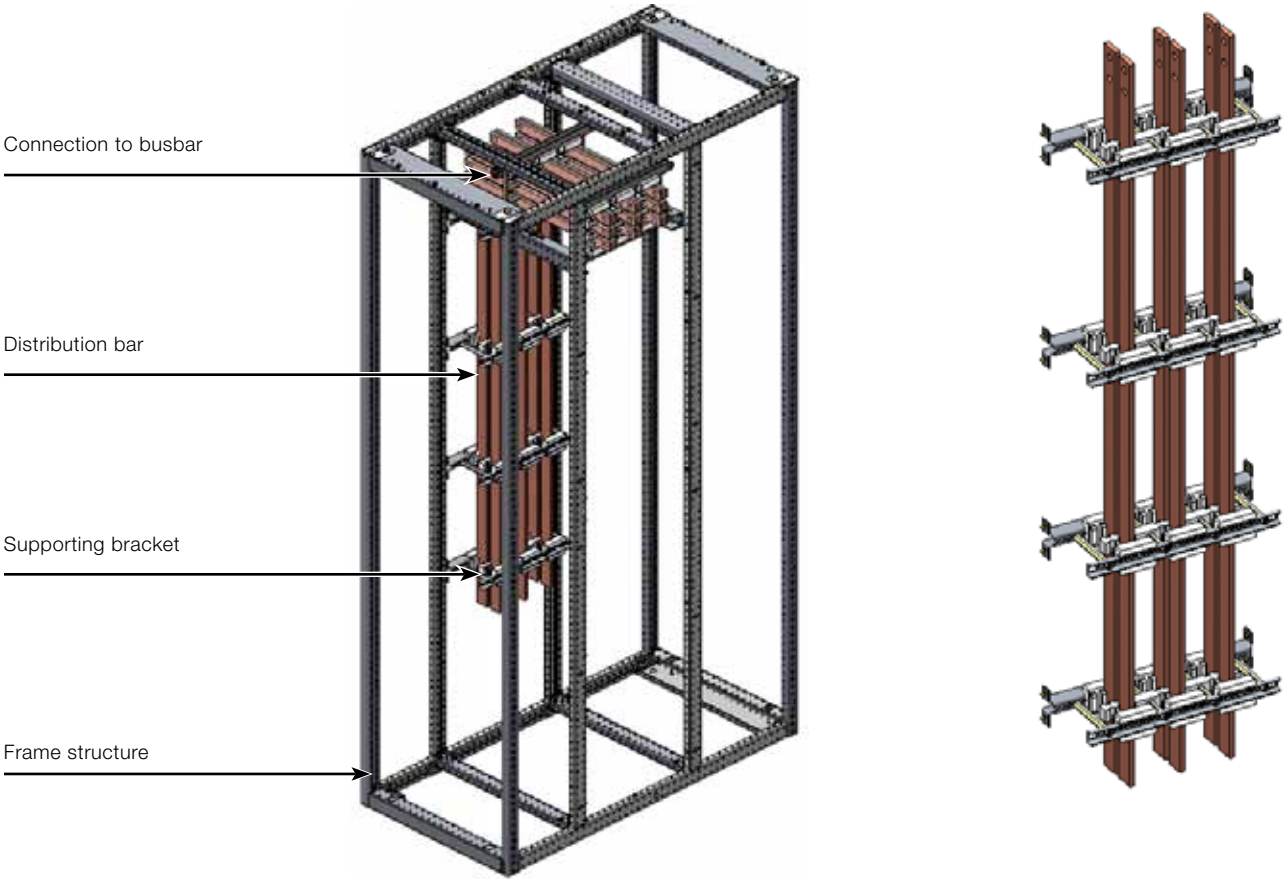


Fig. 3 MNS-R distribution bars

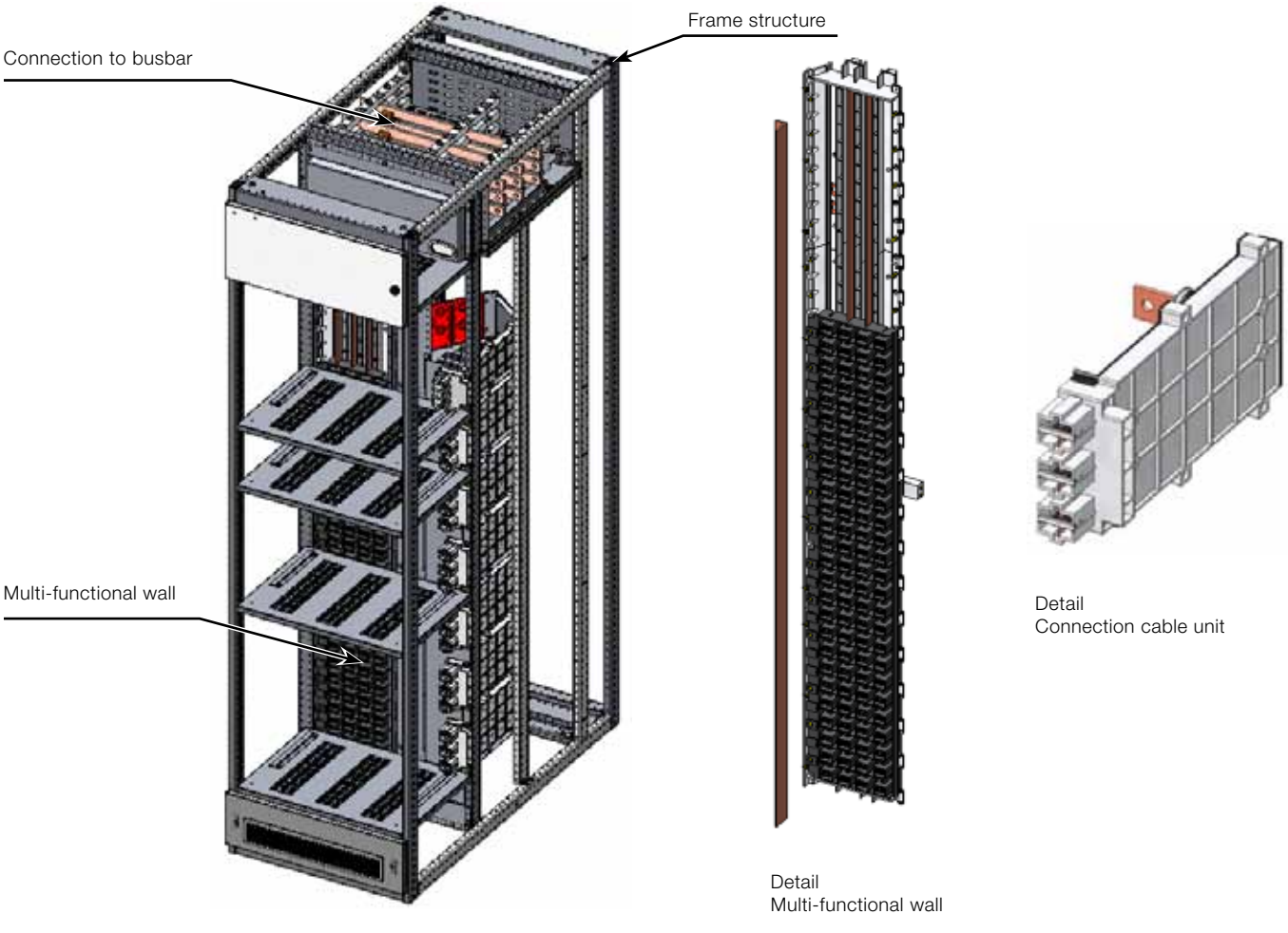


Fig. 4 MCC-R distribution bar

1.3.2 Distribution busbar reinforcement

In case of distribution busbar rated current higher than 750 A, and/or for short circuit rating higher than 65 kA, distribution busbar reinforcement is provided (see fig. 5).

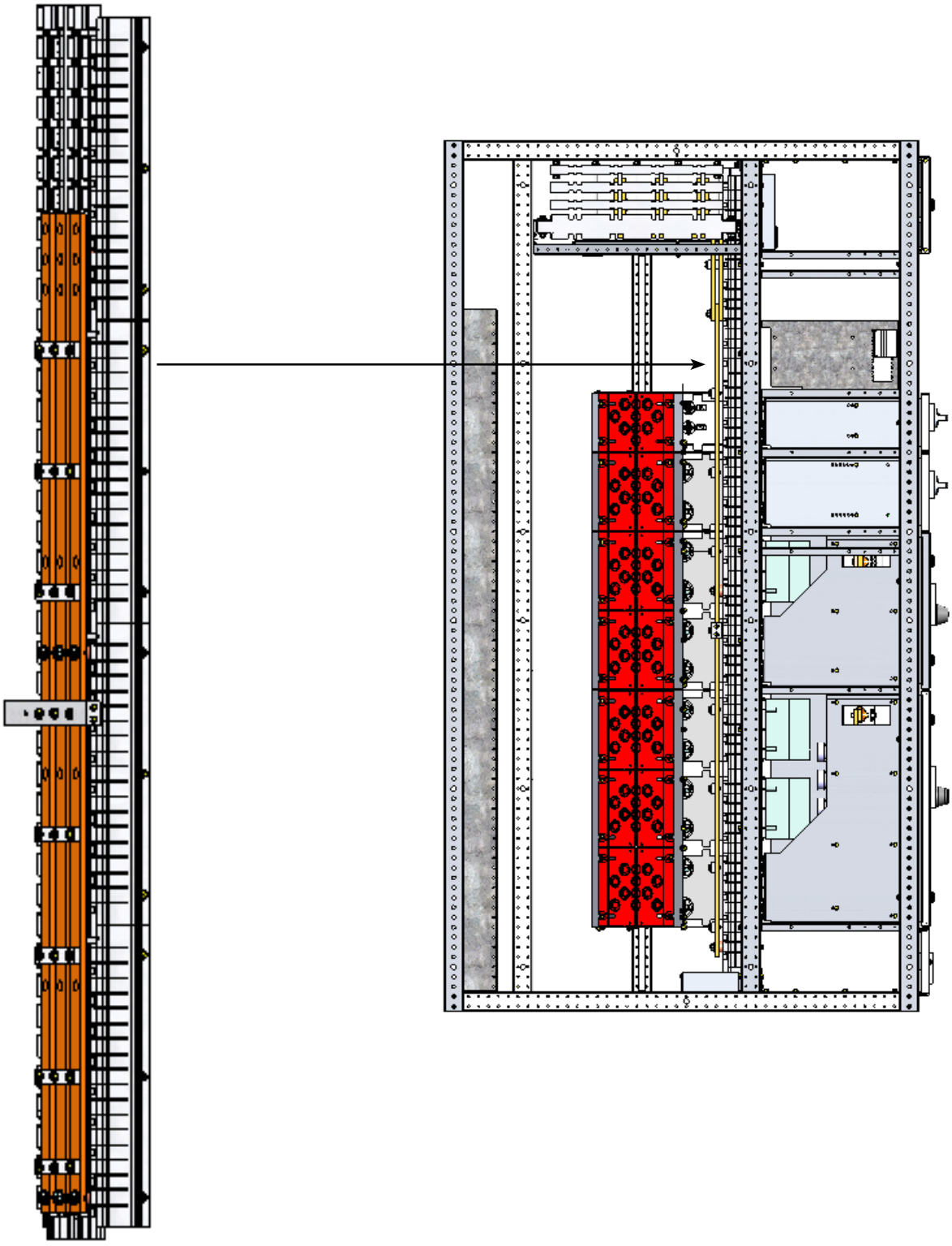


Fig. 5 Distribution bar reinforcement for MCC-R

1.4 Modular add-on parts

The equipment belonging to a functional unit is contained in a single module.
Standard designs are:
– Direct connection to busbar
– Withdrawable technique
– Plug-In technique.

1.4.1 Direct connection to busbar

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

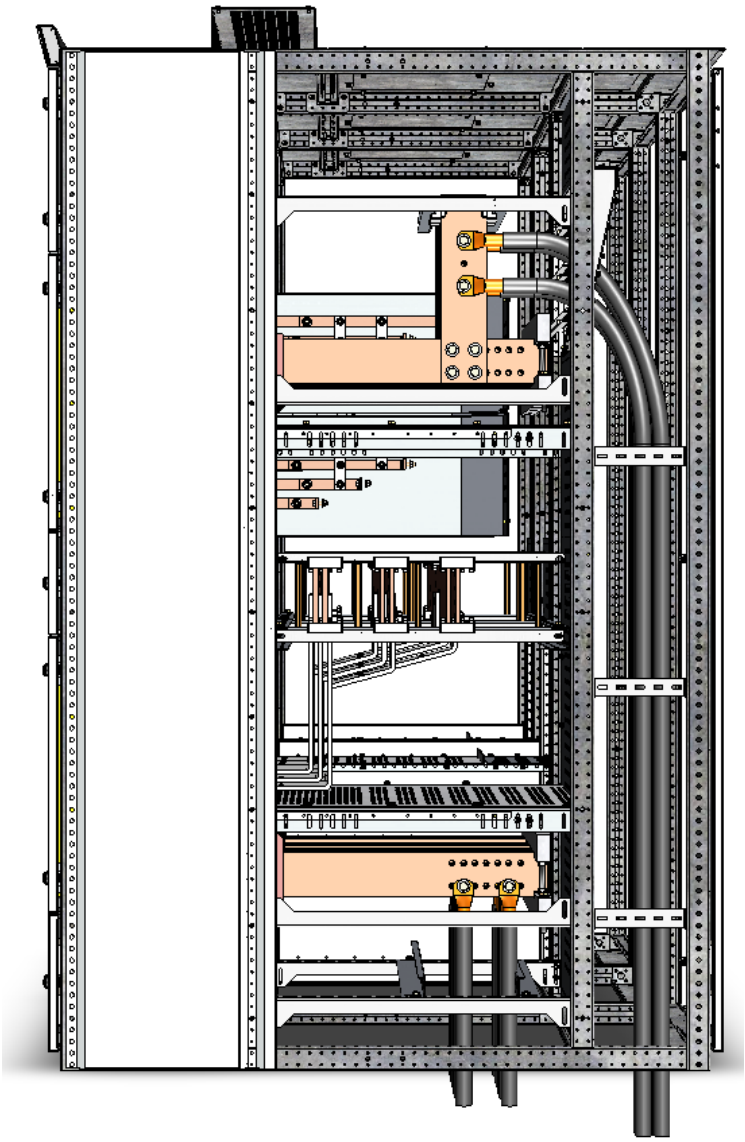


Fig. 6 Typical MNS-R system ACB solution

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

One **600 mm wide** equipment compartment can contain:
– for size 8E/4 4 withdrawable modules
– for size 8E/2 2 withdrawable modules
– for size 6E to 24E one withdrawable module
Empty space are closed off with front covers (see spare parts list).

Withdrawable compartments size 8E/4 and 8E/2 consist of (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 the withdrawable modules size 8E/2 and 8E/4.
The condapter consists of:
– Conductor bars 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 per 8E/4 module: 20 pole.
– Control terminal for each 8E/2 module:
with one control plug: 20, or 40 pole.

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

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

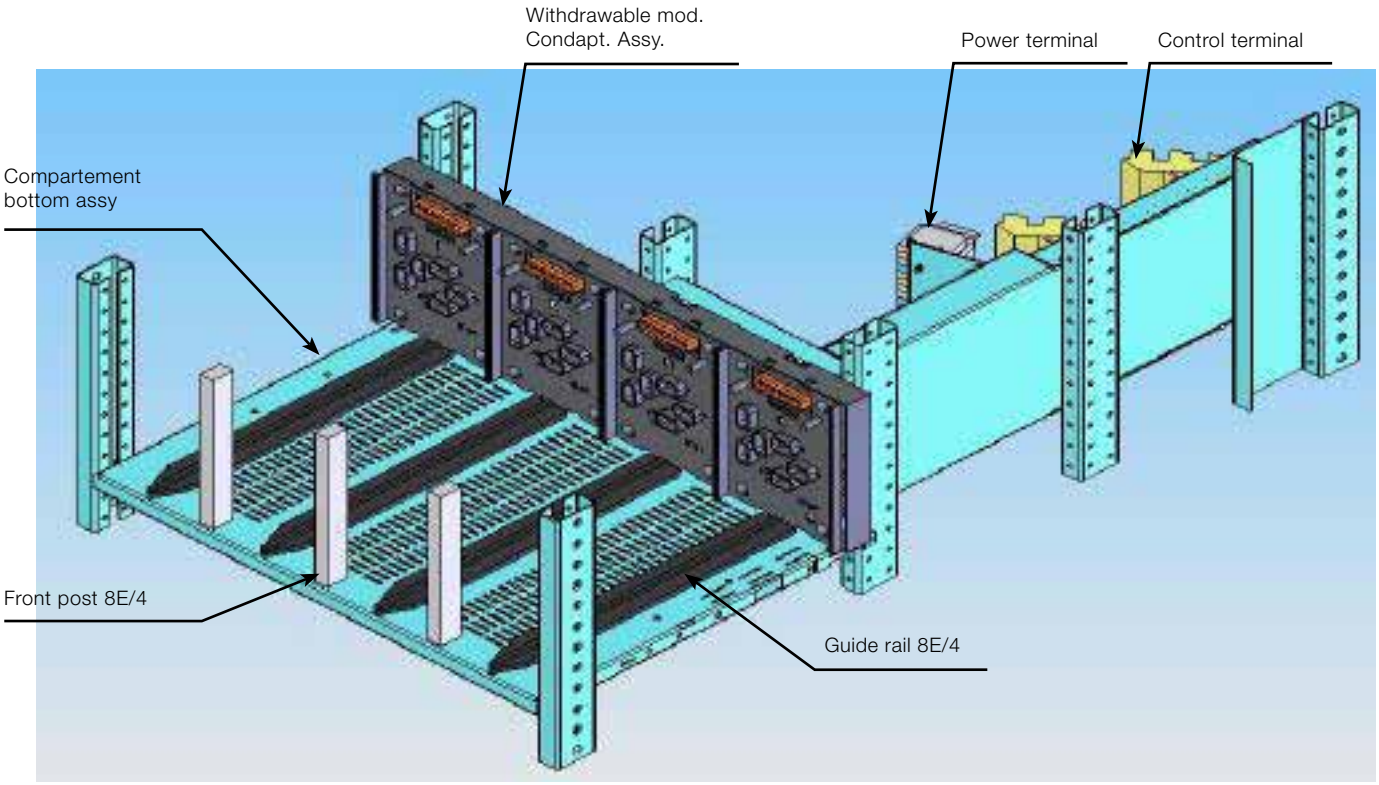


Fig. 7 Withdrawable module compartment for 4 units size 8E/4

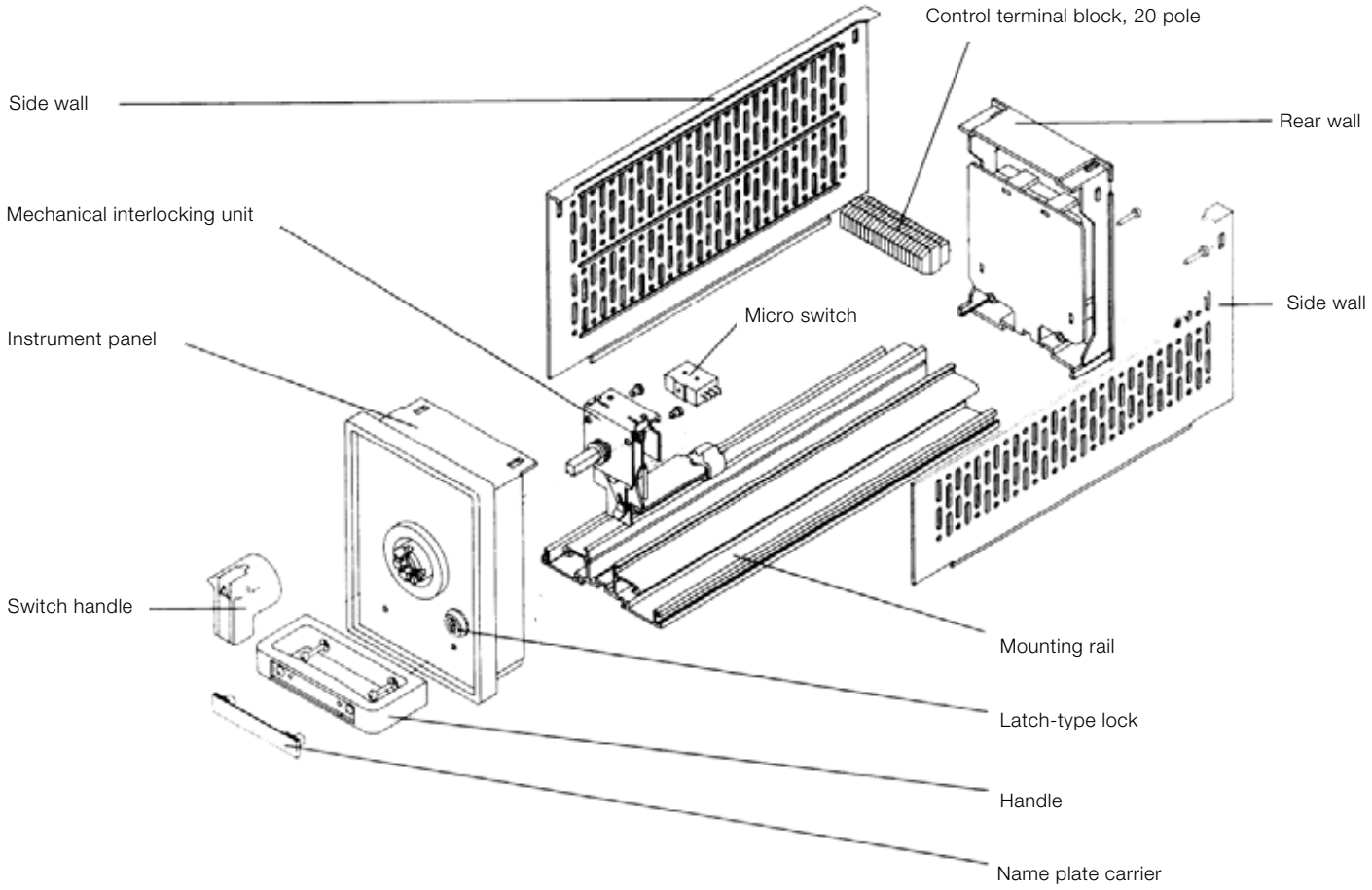


Fig. 8 Empty withdrawable unit size 8E/4 (without electrical equipment)

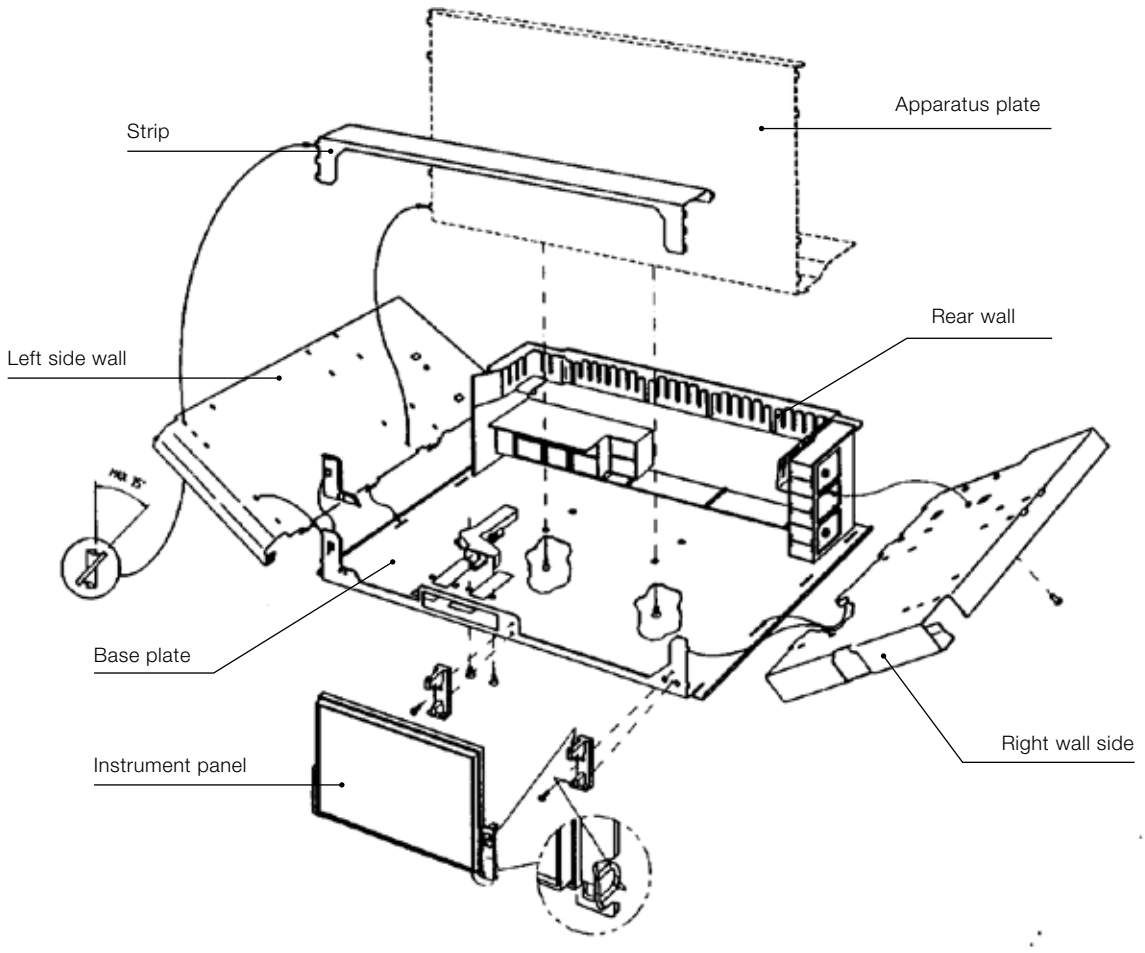


Fig. 9 Empty withdrawable unit > 6E (without electrical equipment)

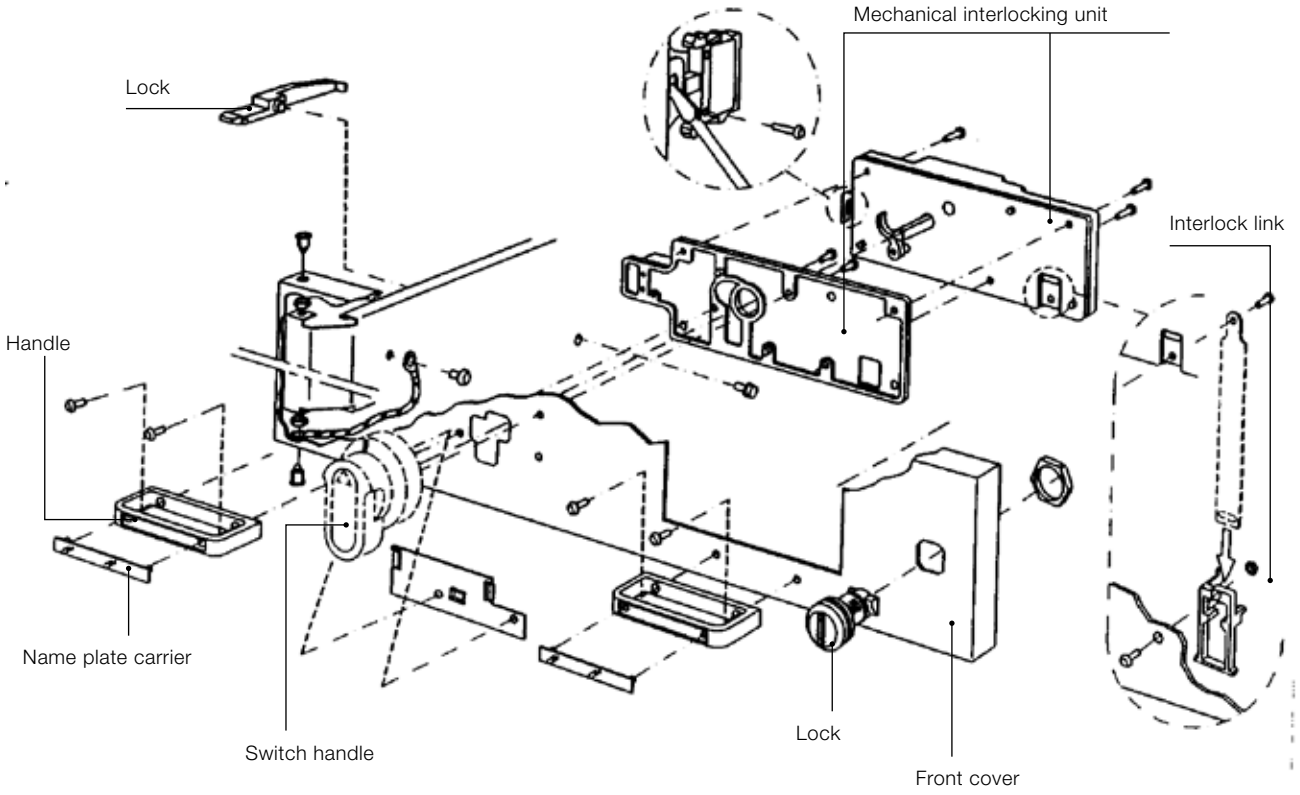


Fig. 10 Withdrawable module door with interlocking for 6E ... 24E

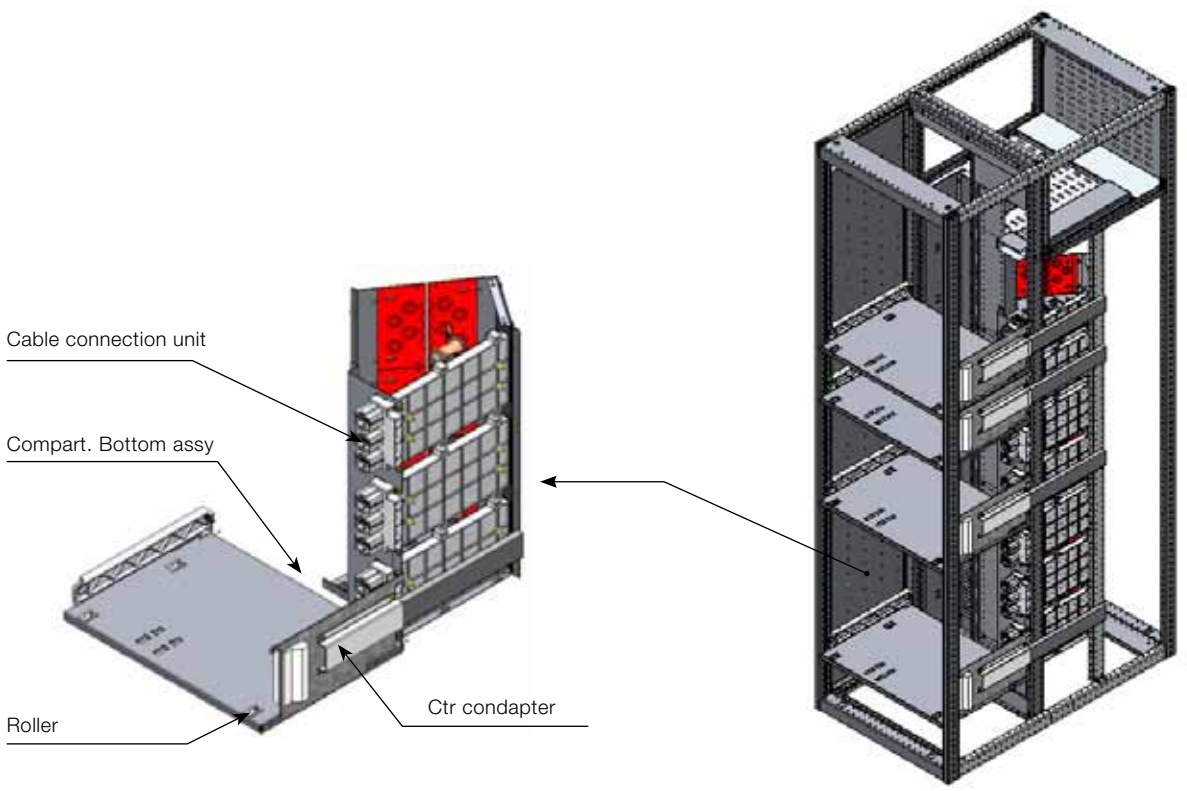


Fig. 11 Withdrawable module compartment for units size 6E ... 24E

Withdrawable module compartments size 6E ... 24E consist of (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 compartment bottom plate. The top cover for the lower compartments is the bottom plate of the compartment above.

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

A hinged instrument panel made of insulating material for measuring, operating and indicating units is also provided for the withdrawable modules size 6E to 24E. It is mounted on the unit itself and protrudes through a cut-out in the hinged front cover of the unit.

For details concerning operating elements see chapter 4.

1.4.3 Plug-IN technique

The Plug-IN units comprise:
– rear plug-in compartment (see fig. 12)
– rear plug-in module (see fig. 13).

Standardized sizes are 6E, 8E, 12E, 16E, 24E, (E = 25 mm). One 600 mm wide equipment compartment can contain:
– for size 6E to 24E one rear plug-in module

Rear plug-in compartments size 6E ... 24E consist of (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 module compartment is covered by a compartment bottom plate. The top cover for the lower compartments is the bottom plate of the compartment above.

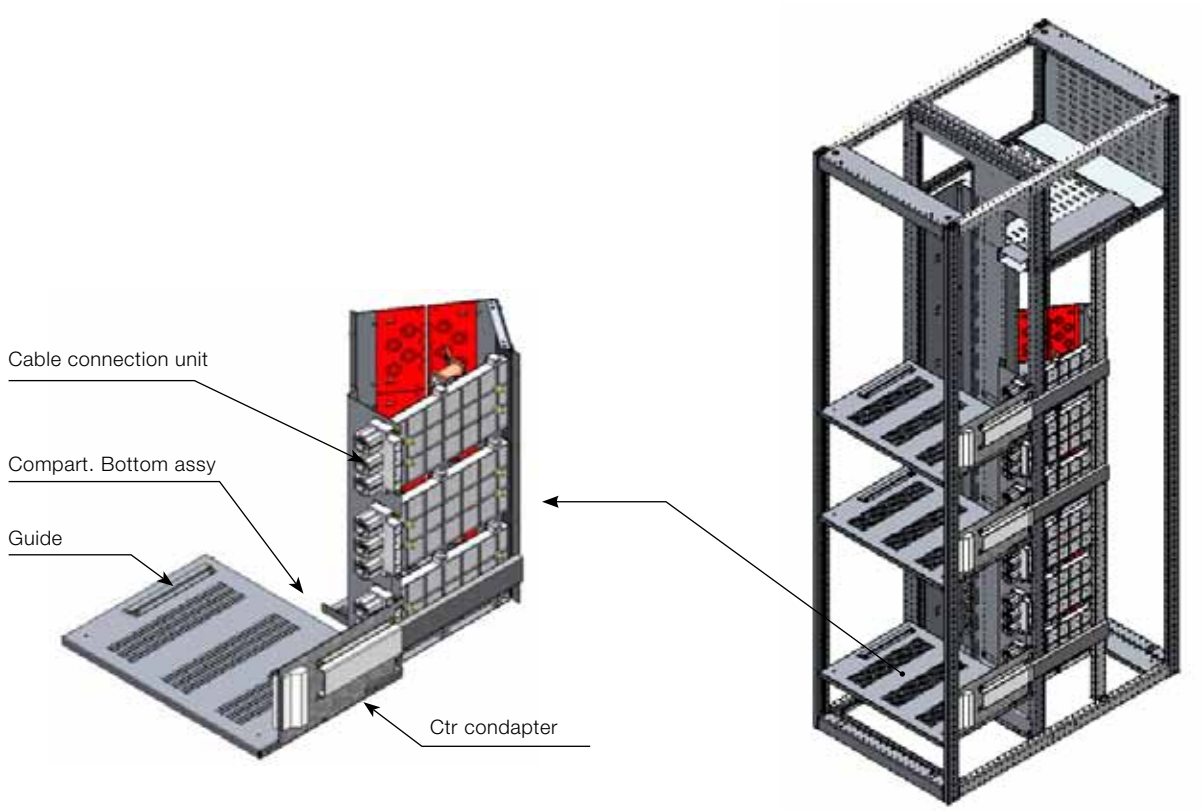


Fig. 12 Plug-In compartment for units size 6E ... 24E

The plug-in modules are fastened directly to the compartment bottom plate using screw.
The plug-in module feeder connection to the distribution busbar system is done directly via the contact device of the plug-in modules. Outgoing cable are connected via plug-in contact to the outgoing connection unit (main circuit) and via terminal blocks (aux circuit). The outgoing cable connection unit are fastened directly to the frame.
Insertion and extraction of the modules is done with special tool.

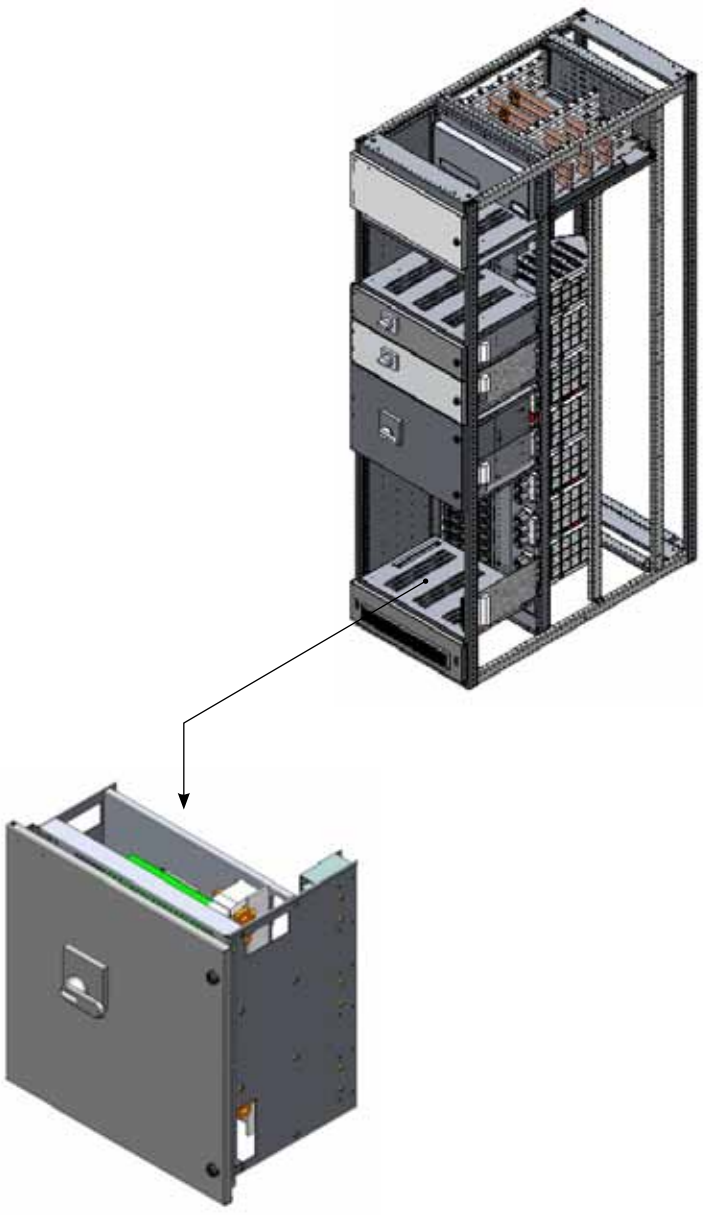


Fig. 13 Plug-In Module (MCCB Fixed)

1.4.4 Capacitor Bank

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

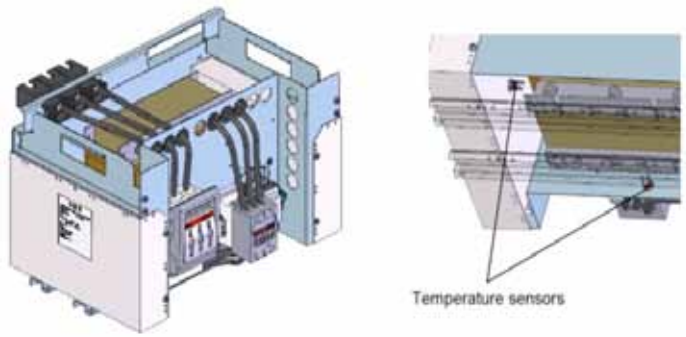


Fig. 14 MNS plug-in-modules with CLMD capacitors

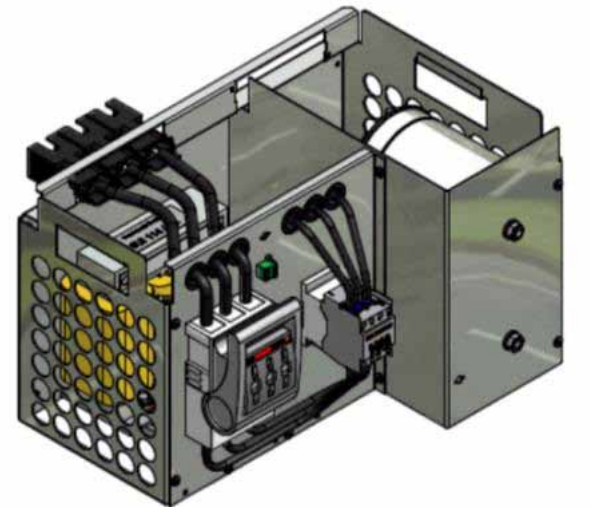


Fig. 15 MNS plug-in-modules with MKPgG capacitors

2. Packing and Transport

2.1 General

The MNS R switchboards are delivered either in single cubicles or in shipping units not exceeding 2,4 meters in lenght, taking also into consideration the type of equipment installed and the available space for handling the switchgear at the erection site.
If no special instruction are given by the customer, the switchboards are delivered with standard packaging, according to ABB internal instructions, and a suitable method of shipping is selected.

2.2 Packing

The cubicles are protected by suitable packaging during transport and possible intermediate storage.
The standard packaging comprise:
– PE-sheeting
– pallet
– plastic strips
– wooden crate (if necessary)

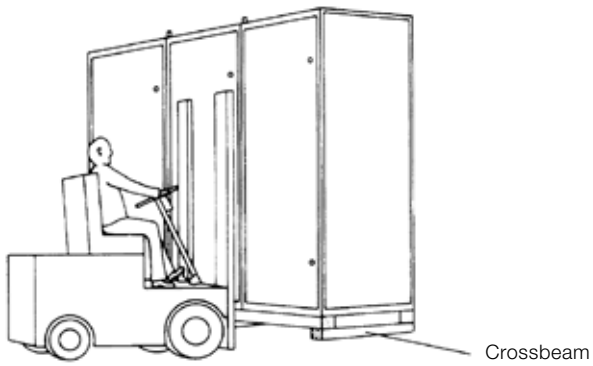


Fig. 16 Fork-lift transport

The transportation on manual lift truck is dangerous, 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

The unloading operation must be carried out by means of cranes or lift trucks. The load must be laid down 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). For roller transport, the wooden crossbeams must be removed (only for cubicles with transverse sections up to 1200 kg) (see fig. 16).
– The compartments for switchboard must be transported only in vertical position.
– Tilting and canting must be avoided.

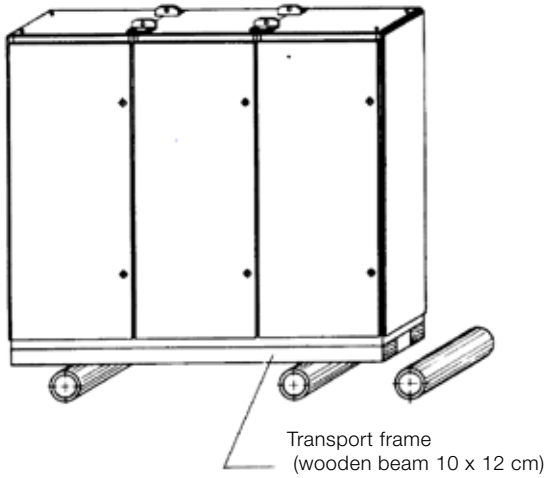


Fig. 17 Roller transport (only for weight of transport unit up to 1200 kg)

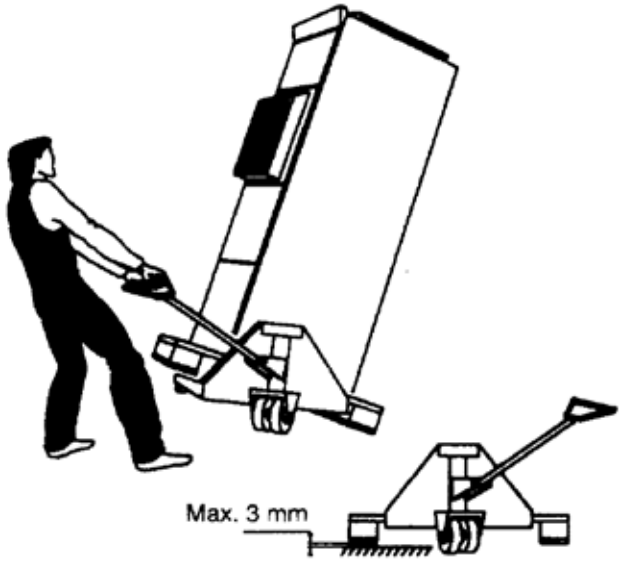


Fig. 18 Transport with hande-pulled truck

2.3.2 Transportation by Means of Crane

– For the transportation by means of a crane, the compartments and the related sending units must be equipped with lifting profiles.
– It is not allowed to fix the lifting devices to the frame sections.
– The angle between the lifting cable and the crane hook must not exceed 120° (see fig. 19-20).
– The lifting can be removed after the apparatus installation has been performed.
– The fastening holes for the lifting angles are to be plugged with plugs GMN 775 502 P18 caps.

Approximate value for acceptable weights lifted by the cable

Cable diameter	**Acceptable load for a 4-cable device, angle between the cable and the crane hook**		
mm	Hemp cable DIN 83325 Kg	Perlon cable DIN 83330 Kg	Steel cable DIN 15060 (160 kg/mm²) 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% greater than the values shown in the table.

2.3.3 Packaging of switchgear components

The following devices and materials have to be delivered separately packed with the switchgear independent from the kind of transport:
– withdrawable air circuit breaker,
– withdrawable moulded case circuit breaker with a nominal current of more than 1,000 A,
– fuses,
– transformers and reactors with a weight of more than 25 kg, in the case of floor mounted units of more than 100 kg,
– precision instruments of high value for measuring and indication,
– fluorescent tubes,
– modules with single phase control power transformers of more than 2 kVA,
– spare withdrawable and P-/R-modules,
– withdrawable modules with weight ≥ 30 kg.

2.4 Storage

The nature and duration of intermediate storage are dependent on the type of packaging.
Standard packaging:
– After the arrival, the goods must be stored in rooms where no condensation can occur.
– Unpack immediately.
– Let the door opened for several hours, to acclimatize the equipment.
– Cover the panels with plastic sheeting in case of any further storage.
– Check for condensation before the installation.

Packaging for marine transportation/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, according to the storage environment condition, if the goods is wrapped in heat sealed protective sheeting and the packaging is undamaged.

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

2.4.1 Spare Module Storage

– In dry rooms.
– Modules must be stored in undamaged original packaging.
– Modules must not suffer sudden changes in temperature.
– Boxes must be stored with the upper side upward.
– Do not store modules with sizes ≥ 16E one on top of the order.

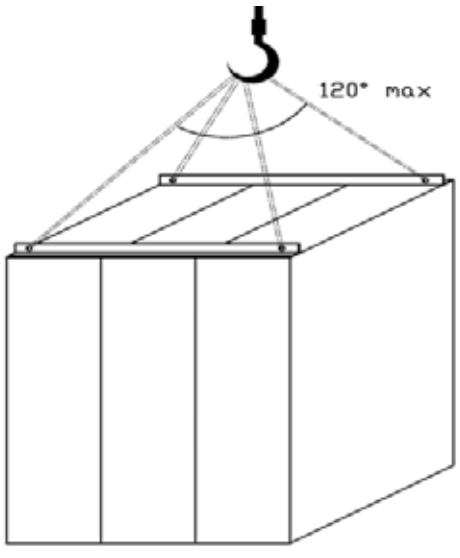


Fig. 19 Crane transport, transport unit unpacked

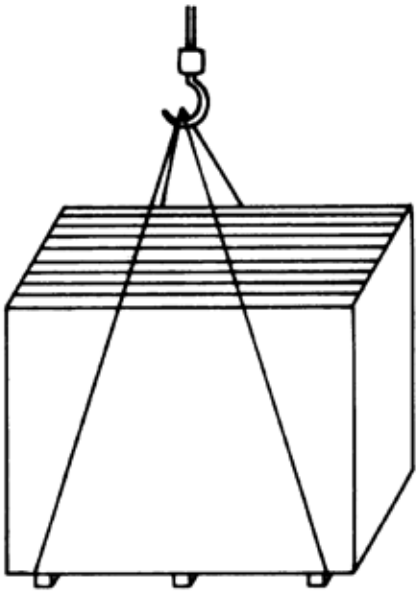


Fig. 20 Crane transport, transport unit in box

3 Erection

3.1 Check on Delivery

After the arrival check that goods is:
– Undamaged in each components.
– Free of damages (otherwise, determine damage entity, cause and possible responsible).

When the damage is detected, proceed as follows:
– Register the visible damage on the delivery note.
– Inform ABB Sace (directly or by means of the supplier or sales representative).
– For non-visible damages, inform, within a week, the forwarding agent by means of a written document.

Complaints for any damage or for other reasons, following the delivery of the goods, must indicate the year of construction of the switchboard and the number of the order confirmation sent by ABB Sace, which are written on the enclosed supply documents.

In case of loss of supply documents, or failure to make a claim, ABB Sace declines any responsibility.

3.2 Installation

It is necessary to keep the best internal conditions, to guarantee an adequate illumination and free access to switchboards. It is recommended to heat the room to avoid sudden changes in temperature, high humidity and condensate.
For a correct installation of the switchboard, it is important to prearrange the frame with care. This must be prepared in advance, with respect to the date of installation, according to the design document indications.

3.2.1 Erection and Connection of the Cubicles

To install the switchgear units, proceed as follows:
– Shipping units to be installed must be aligned with care. Check that they are in vertical position. Doors and panels must not be twisted or stressed. Assembly can start from the right or left.
– Shipping units frames must be screwed together (see fig. 21). Threaded rivets are preinstalled to fix the C-profiles together.

For threaded rivet initial fixing, use an electric or pneumatic screwing device.

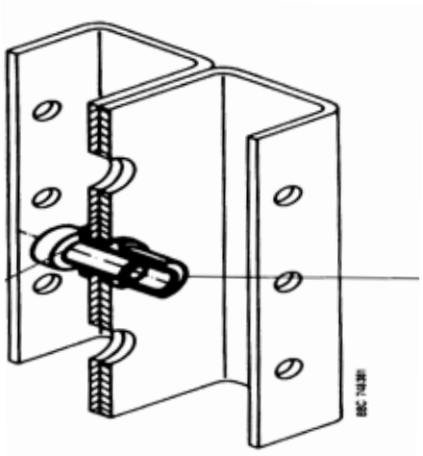


Fig. 21 Frame connection

3.3 Cable and Bar Connection

For any connections and, in particular for those made with standard elements, it is necessary to conform to the tightening torque indicated by the table in Par. 5.11.
Circuit breakers and main switching devices are normally connected with cable or busbar.
– Power and control cables must be fastened to cable mounting rails.
– Power and control cables are connected to:
  - Terminal boards
  - Connection bars or
  - Outgoing cable connection unit.

In case the outgoing bar connections must be disassembled or replaced, before re-installing follow the below instructions:
– Check that the connection contact surface is flat and clean.
– Remove burrs, dents and oxidation by means of a file or a rough cloth. In case of busbars with special protecting treating, after using the above-mentioned tools, restore the protecting treating.
– Remove any grease with a cloth and solvent.

3.3.1 Busbars Connection (see fig. 24a-b)

Before assembling, carefully clean the busbar contact area with a cloth soaked in solvent.
– Verify the busbar correct alignment
– Match the coupling elements
– Lock the joints by means of the coupling elements, bolts and nuts on issue.

Busbars, protective and neutral busbars must be screwed up at transportation subdivisions (connecting elements included). Busbars points of connection are accessible from the rear side. If the installation is carried out correctly, the holes match. Drilling is not permissible, due to the resulting chips. Contact surfaces do not need any particular treating.
For tightening torque, see Par. 5.11.

3.3.2 Protective Conductor Connection (see fig. 25)

All switchboard compartments are normally equipped with an earth busbar whose section is according to the switchboard short circuit level.
The earth busbar is located in the rear side of the switchboard (at the bottom). The earthing busbar joint of each shipping unit must be done according to the following procedures:
– Remove any traces of oxidation from the contact surfaces of the busbars, by means of a file or emery cloth.
– Remove any grease with a cloth and solvent.
– Perform the earth busbar joints by means of screws, washers and nuts supplied.

Switchboard earthing must be performed by means of copper conductor whose cross-sectional area is not lower to that of the earth busbar.
The doors are earthed by means of yellow-green copper conductors (minimum cross-sectional area 2,5 mm^2).
No connection is necessary, if no energized element is connected to the door (≤ 50 V AC or ≤ 120 V DC).
In all cases, protective conductor connections screwed on to painted surfaces should be secured with serrated contact washers. Any means of locking the screws for galvanized surfaces 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

According with the required protection degree, it is necessary to seal the sections in the place of installation.
– For degrees of protection IP X2 or IP 5X the bottom plate covers (flanges) have to be sealed, if not already done at the manufacturer‘s site. To seal the bottom plate covers the self adhesive sealing 15 x 2 mm (GSIN100021P0010) has to be used which has to be applied after cleaning (see below) on the inside bending of the flanges with an overlapping distance of 3 mm to the bending (see fig. 22).
– For degrees of protection IP X1 or IP 4X a sealing of the frames between the sections (section/ section) at the transport division is necessary, if not already done at the manufacturer‘s site.

Therefore the following measures have to be taken:
– The connection sides of the affected frame sections have to be cleaned with cleaner using an oil- and grease-free piece of cloth.
– After drying of the cleaner the self-adhesive sealing tape 15 x 2 mm (GSIN100021P0010) has to be applied to the C-sections at distance of 3 mm from outer edge (see fig. 23).

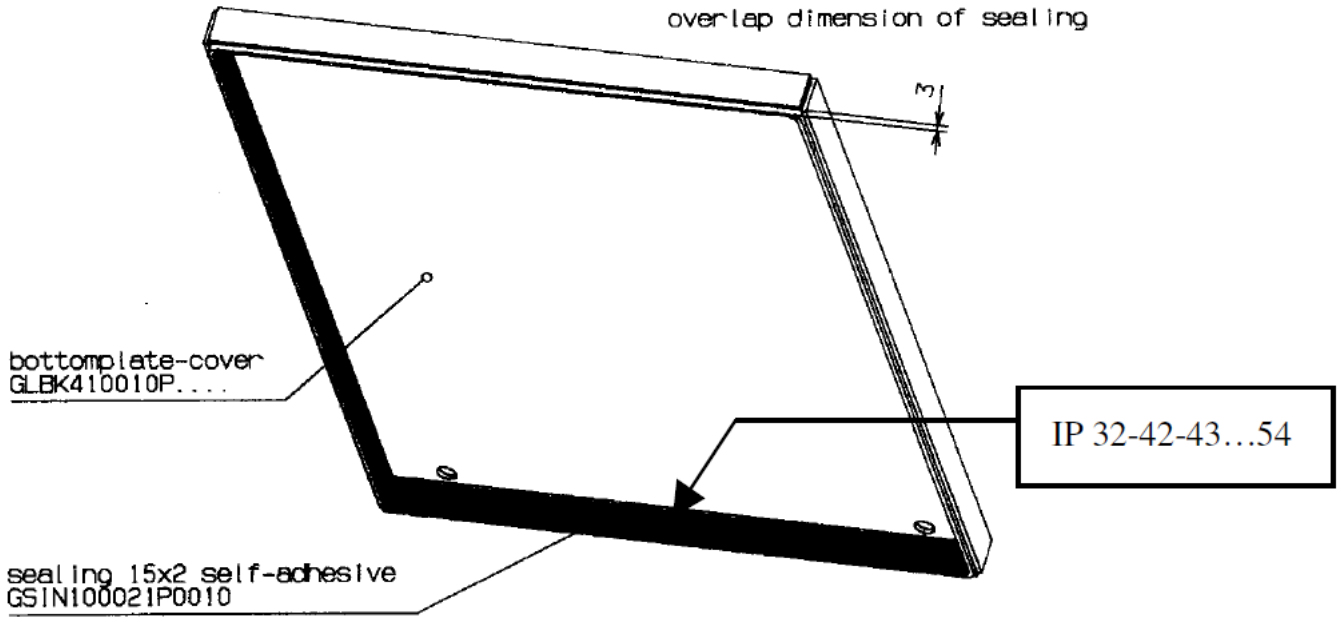


Fig. 22 Gaskets on bottom plate cover

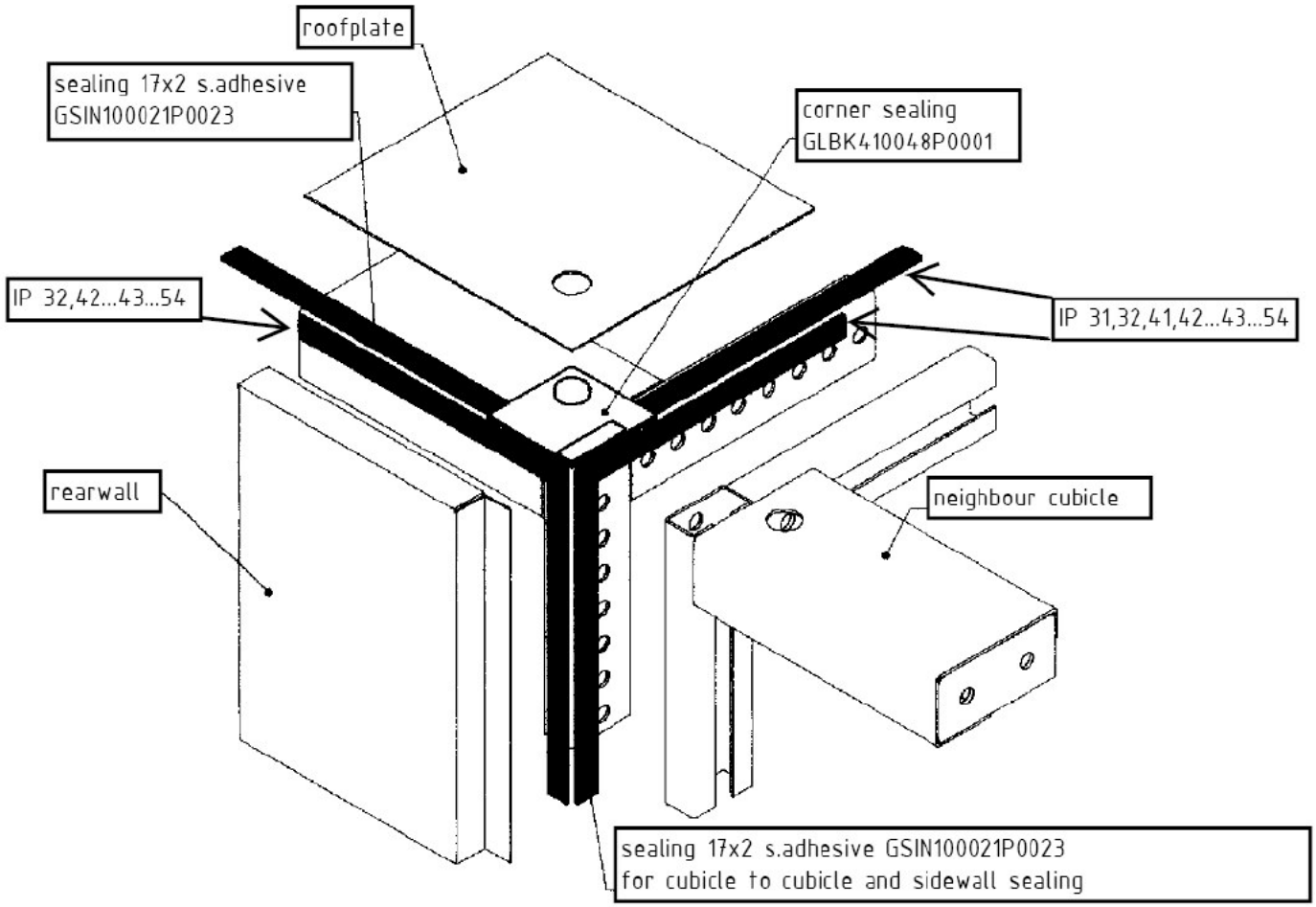
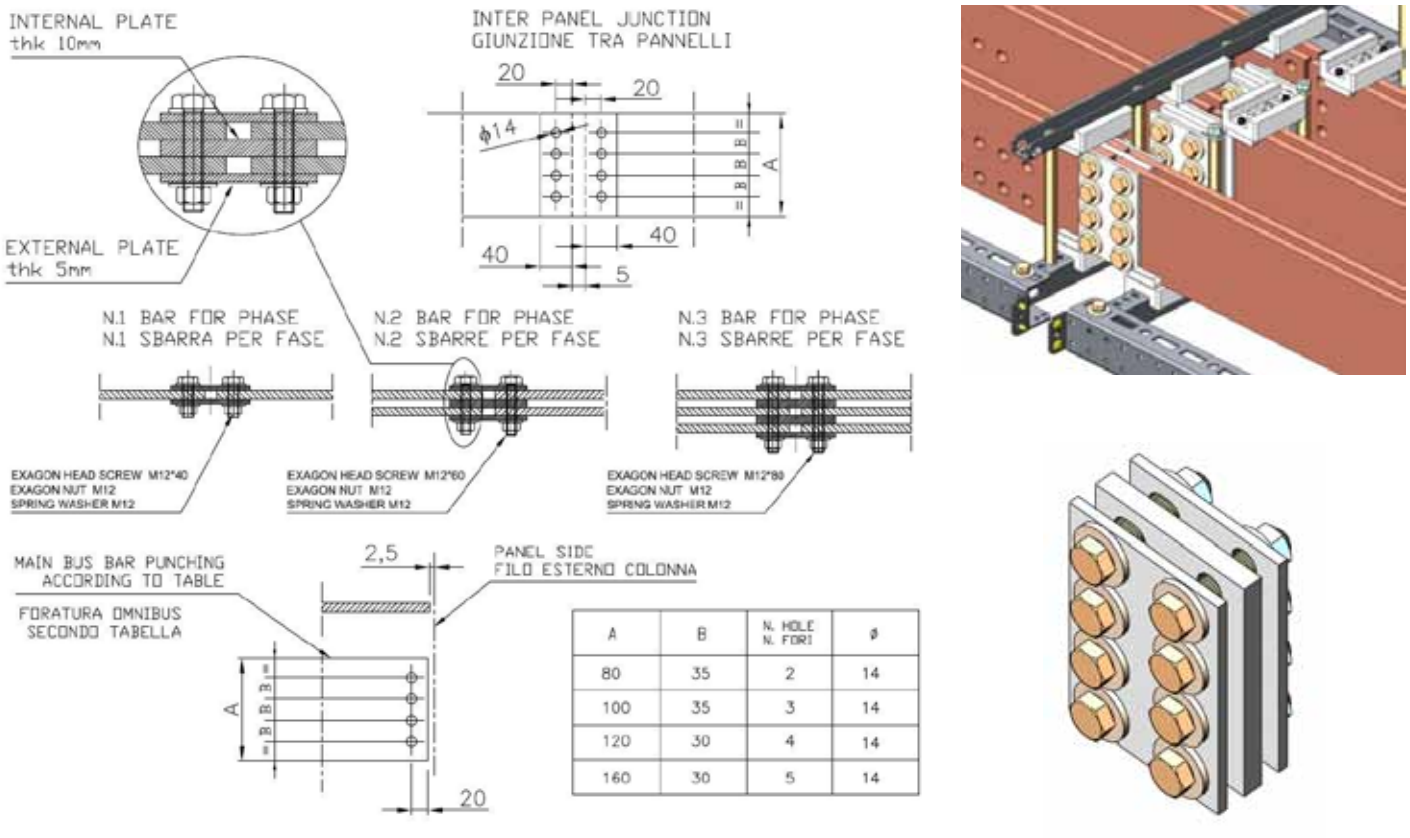
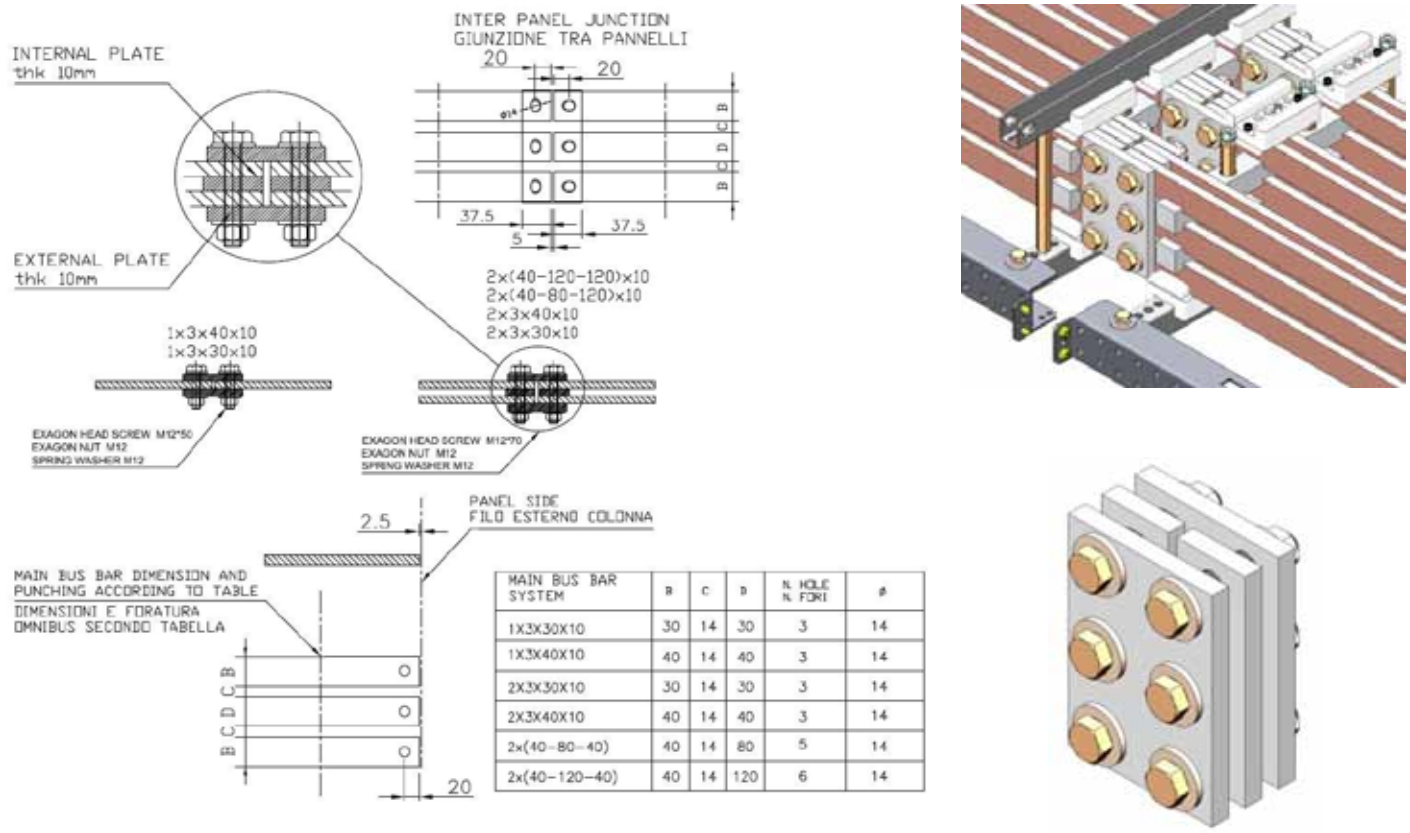


Fig. 23 Gaskets between adjacent compartments and roof



A	B	N. HOLE N. FORI	ø
80	35	2	14
100	35	3	14
120	30	4	14
160	30	5	14

Fig. 24a Standard busbar connections



MAIN BUS BAR SYSTEM	B	C	D	N. HOLE N. FORI	ø
1X3X30X10	30	14	30	3	14
1X3X40X10	40	14	40	3	14
2X3X30X10	30	14	30	3	14
2X3X40X10	40	14	40	3	14
2x(40-80-40)	40	14	80	5	14
2x(40-120-40)	40	14	120	6	14

Fig. 24b Multi-level busbar connections

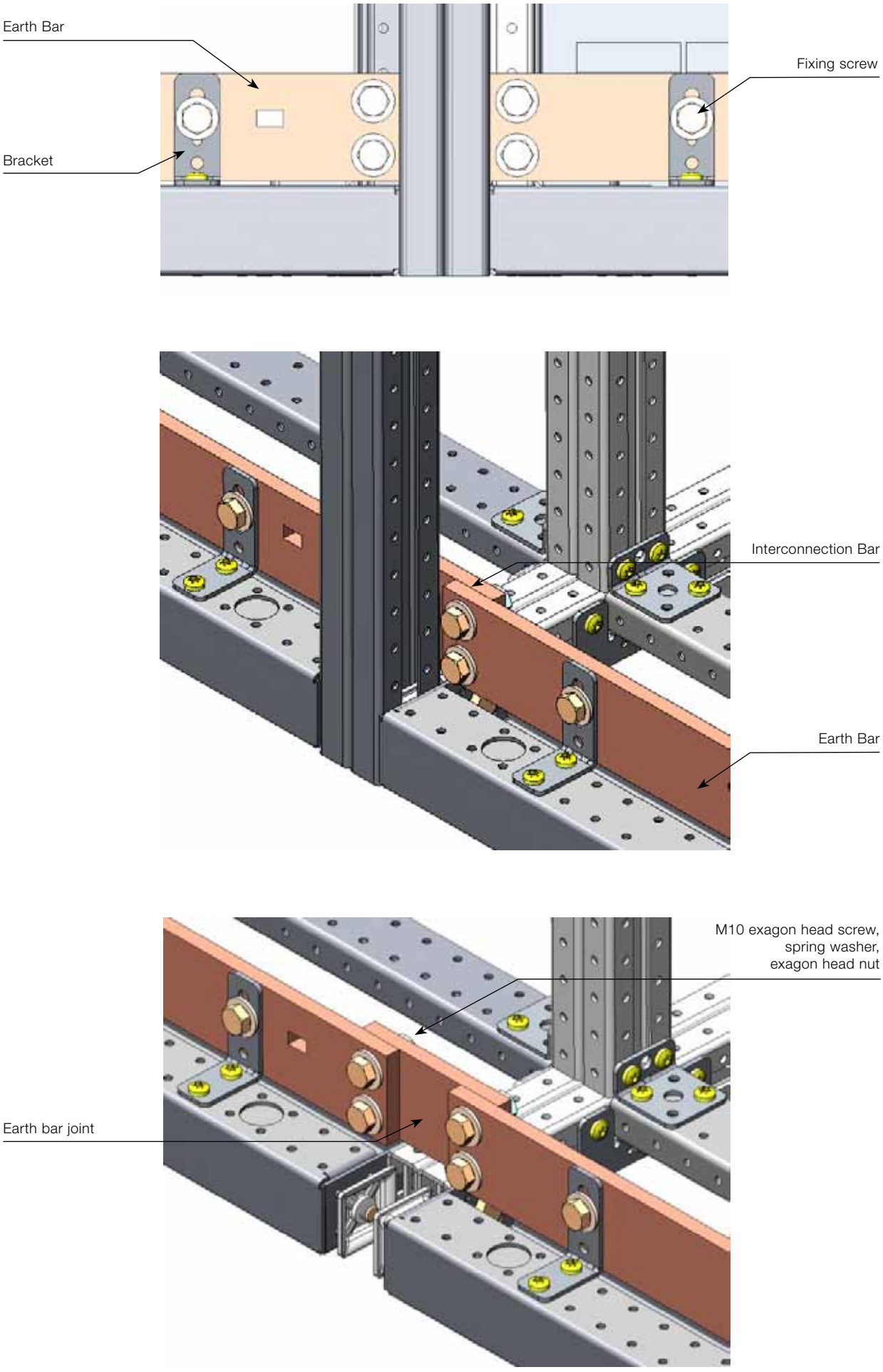
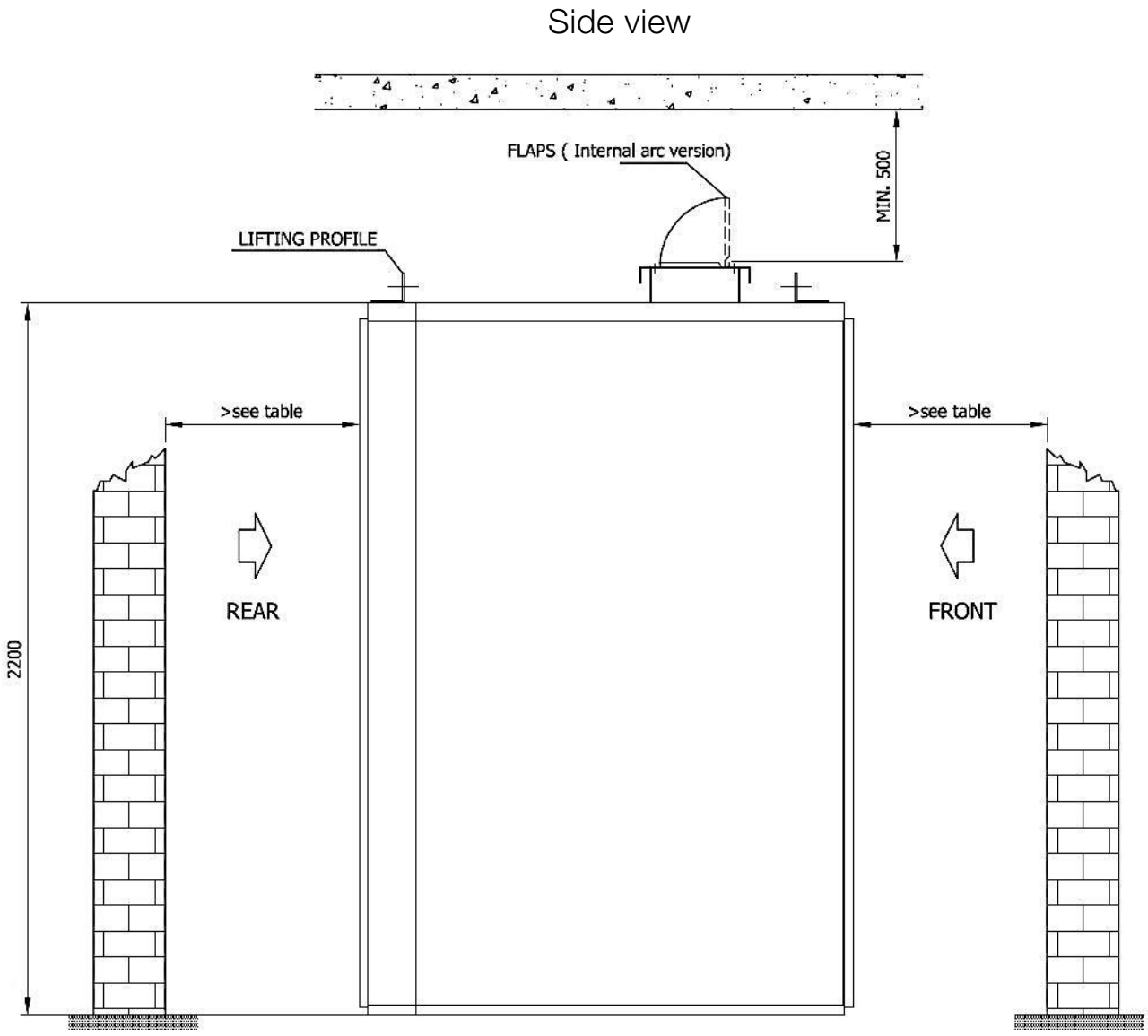


Fig. 25 Earth Bar Connection detail

3.4 Additional Information Switchgear Positioning

The distance from the wall (front and rear) should be according to the following rules:
– bigger than the width of the largest panel
– at least 800 mm to allow normal operations
– according to safety rules, for emergency/evacuation plans (see fig. 26-27).

To install the last compartment (right), the distance between the last compartment and the wall (right) must be 150 mm. The minimum distance between the left wall and the last left compartment must be 150 mm, so the doors can be opened in an angle of more than 90°.
The distance between the upper edge of the highest cubicle end and the ceiling must be min. 500 mm for cubicles which are internal arc proof (see fig. 26).



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

* In case of ACB withdrawable version, the use of lifting trolley may be required to remove and insert the breaker.
In this case evaluate also the space requirement for the lifter movement.
** For panel width 1000mm, 2 x 500 width rear door are provided
For panel width 1200mm, 2 x 600 width rear door are provided

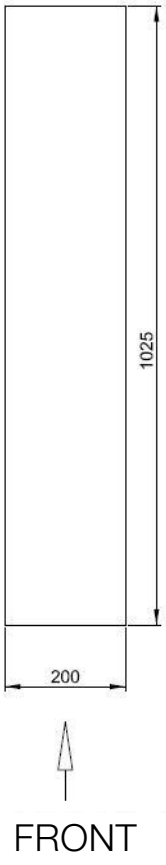
Fig. 26 Free space around the frame

3.5 Floor cut-outs

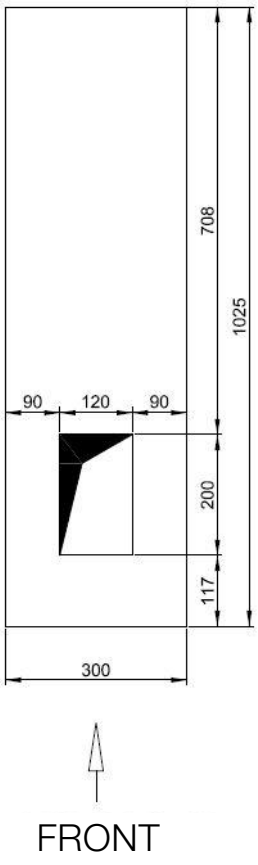
If floor cut-outs are required at site to supply cables and wires the measurements must be taken according to the following sketches (all measurements in mm).

Depht 1025 mm
Busbar compartment 525 mm

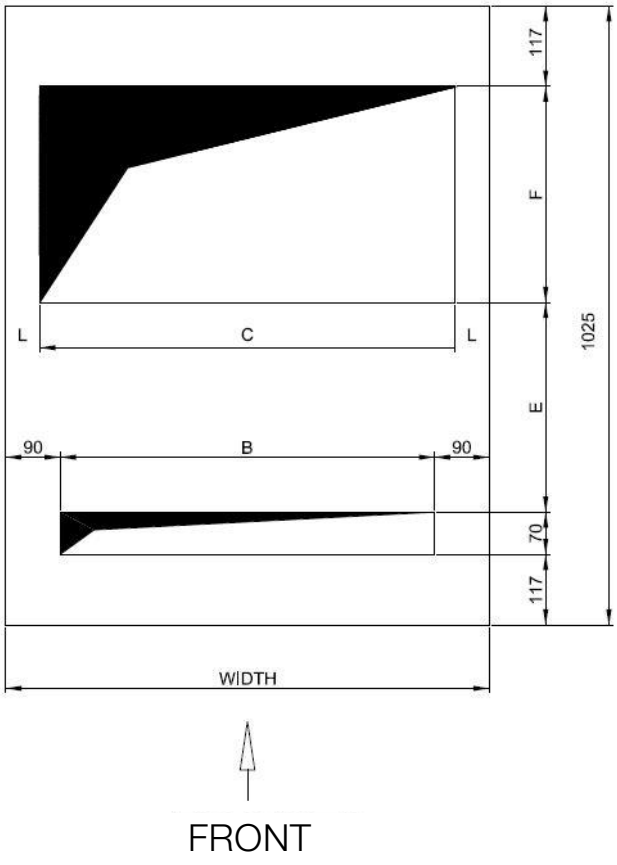
Panel width 200 mm



Panel width 300 mm



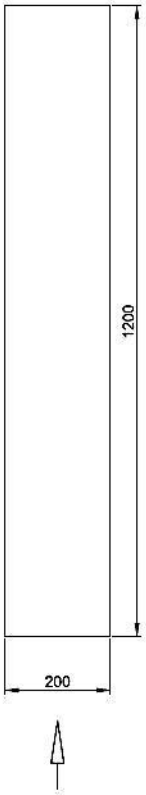
Panel width ≥ 400 mm



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

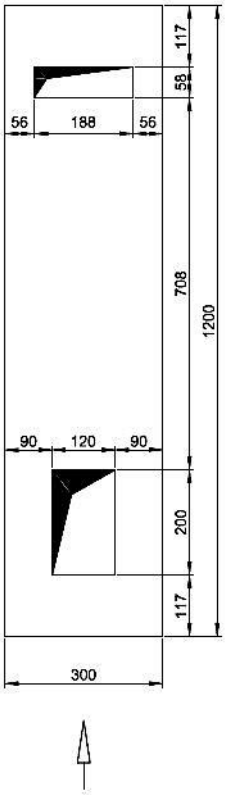
Depht 1200 mm
Busbar compartment 525 mm

Panel width 200 mm



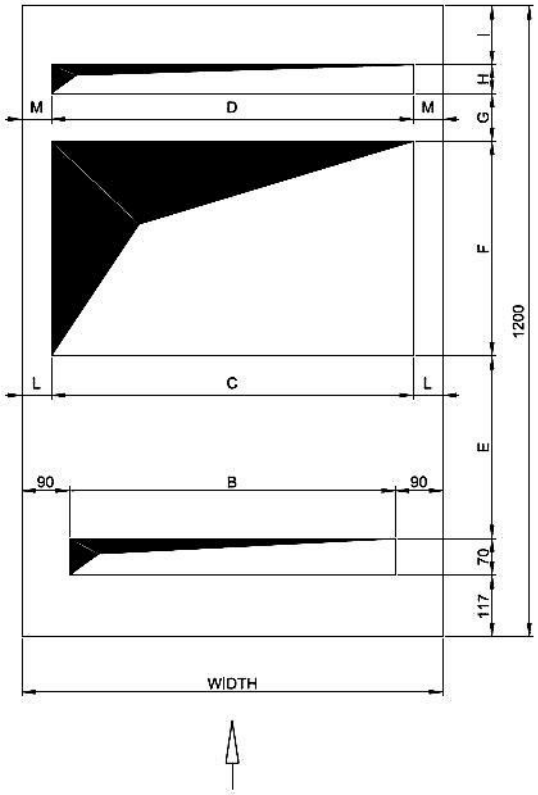
FRONT

Panel width 300 mm



FRONT

Panel width ≥ 400 mm



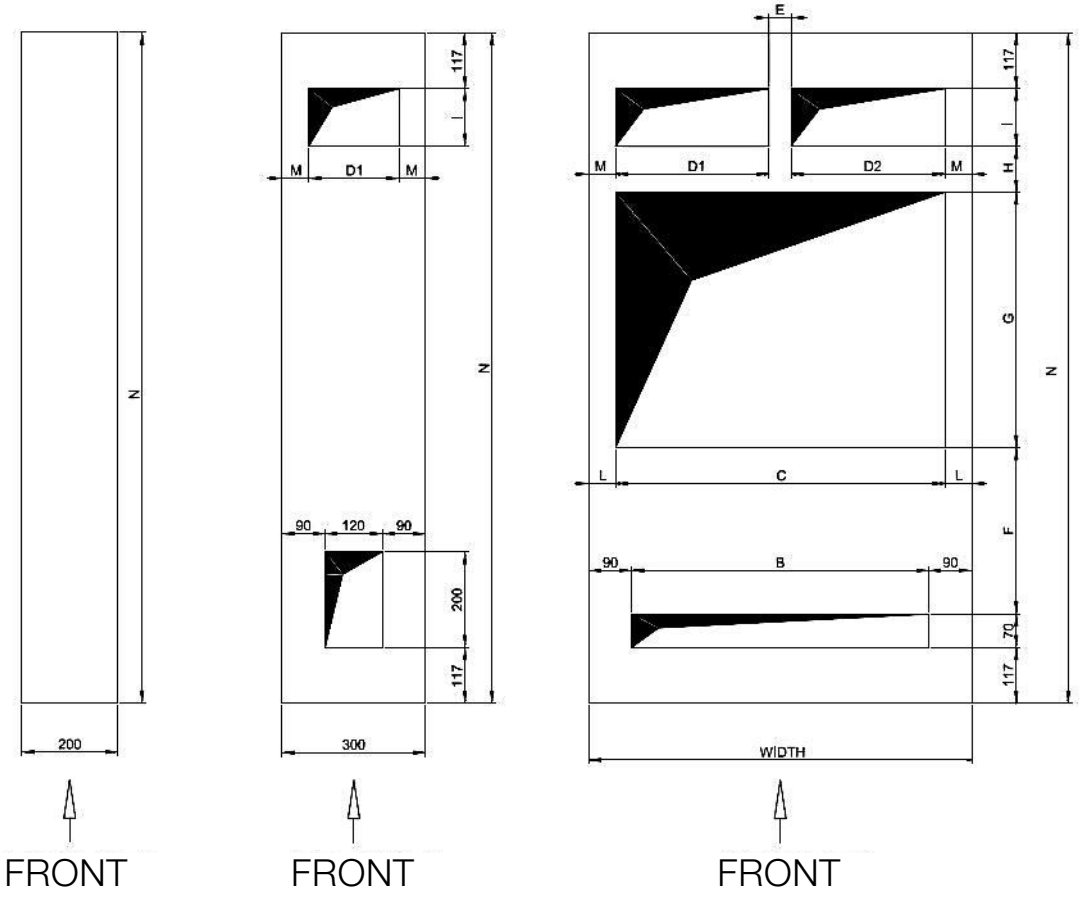
FRONT

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

Depht 1400-1600 mm
Busbar compartment 525-650 mm

Panel width 200 mm **Panel width 300 mm** **Panel width ≥ 400 mm**



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 Fastening methods to Foundation

The installation of switchboards equipped with cables entering form the bottom, requires a foundation with an opening or a cable duct.
Compartments can be installed directly to the floor or preferably on a base frame which is:
– Embedded in the concrete floor
– Fixed on supports on a false floor.

When erecting the base frame the following must be observed:
– The base frame should be aligned and checked by an ABB SACE qualified operator (on customer's request).
– The frame must not exceed a horizontal tolerance of ±1 mm on a length of 1 m.
– The frame must not ondulate (▱ | 2 / 1000 according to DIN ISO 1101).

During the installation, the switchboard 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 welding should be protected against corrosion by means of an adequate treating (a coat of paint).

If the switchboard is installed on false floors, notice that:
– Tolerance is the same as in the case of a base frame.
– The subsoil must be solid, so that the tolerances are not exceeded by settling of the soil (especially when using insulation layers and adhesives).
– The false floor must have a carrying capacity of p=20 kN/m^2 (compression load from the top to the bottom).

During the installation, the switchboard is welded or screwed to the false floor.
– The welded joint length, on the front and rear sides of each cubicle, should not be less than 20 mm. Each welding should be protected against corrosion by means of an adequate treating (a coat of paint).

The switchboard has three anchor points available, see fig. 28.
The base frame could be a standard UPN profile or a HALFEN profile.
If the switchboard shall be anchor either to the floor or UPN profile, the fixing point A and B may be used; in case of HALFEN profile only fixing point C shall be used.
Installation drawing according to the selected anchor point are shown in fig. 29-30-31.

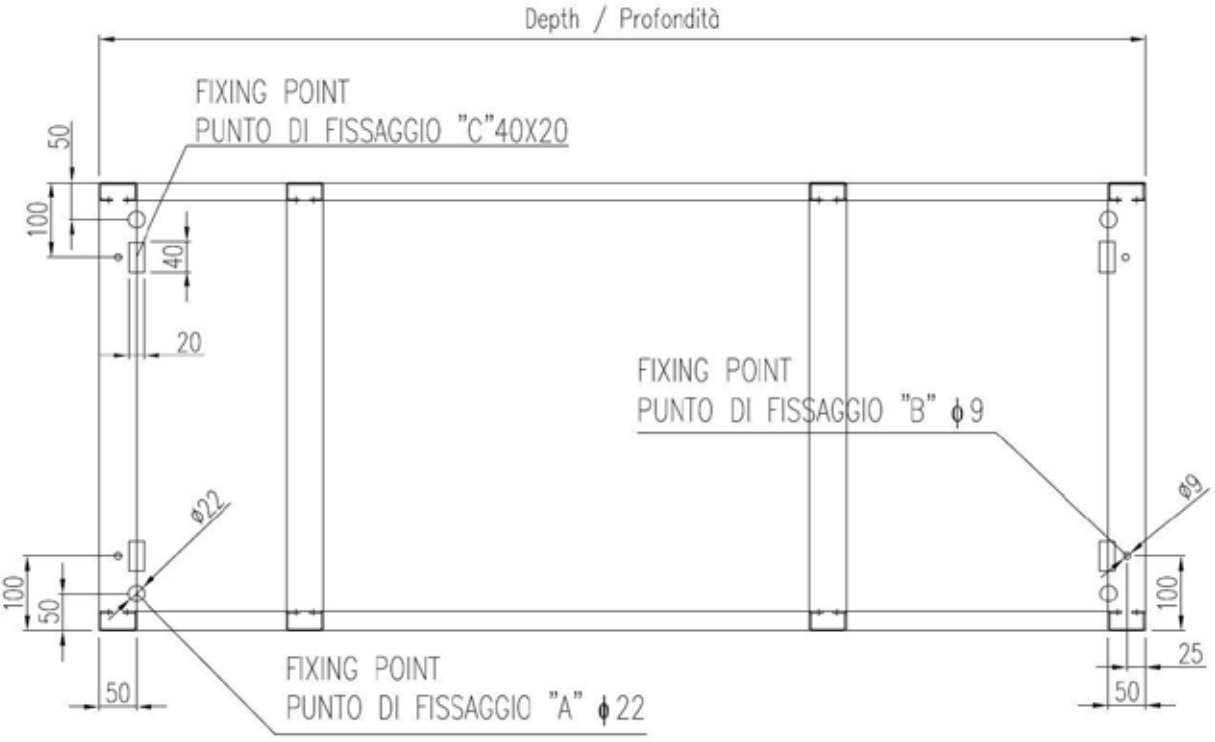


Fig. 28 Switchboard three anchor points

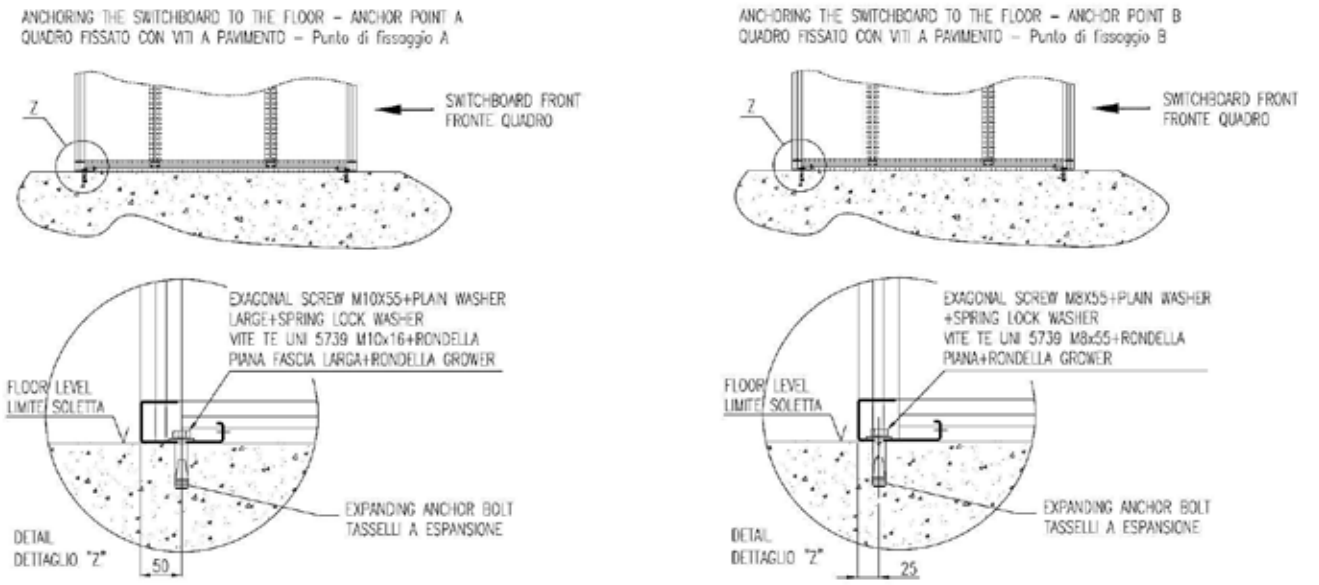


Fig. 29 Anchoring the switchboard to the floor

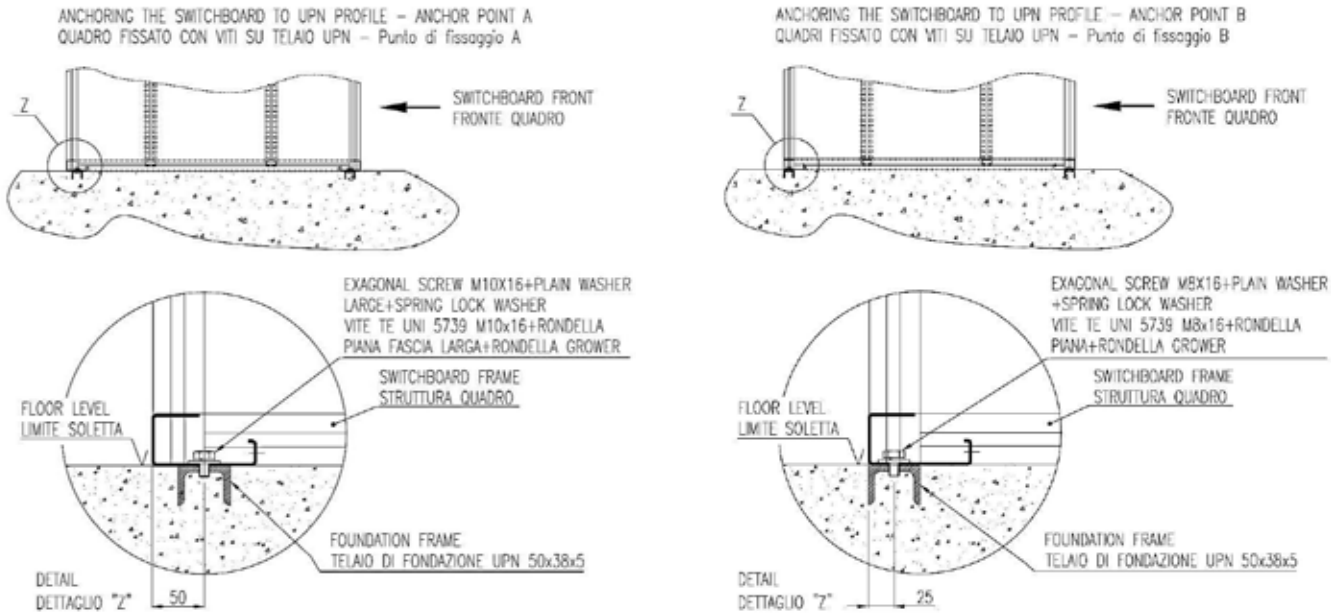


Fig. 30 Anchoring the switchboard to the UPN profile

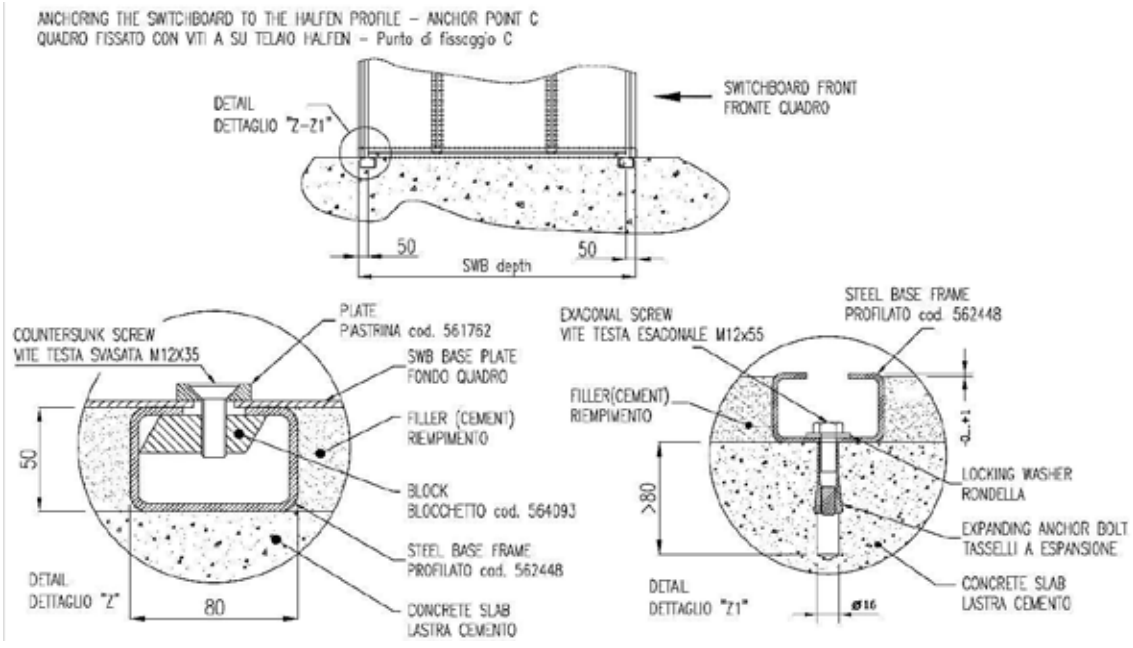


Fig. 31 Anchoring the switchboard to the halfen profile

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 fig. 32, 33, 34).
The outgoing cable must be fastened to the cable support with plastic seal.

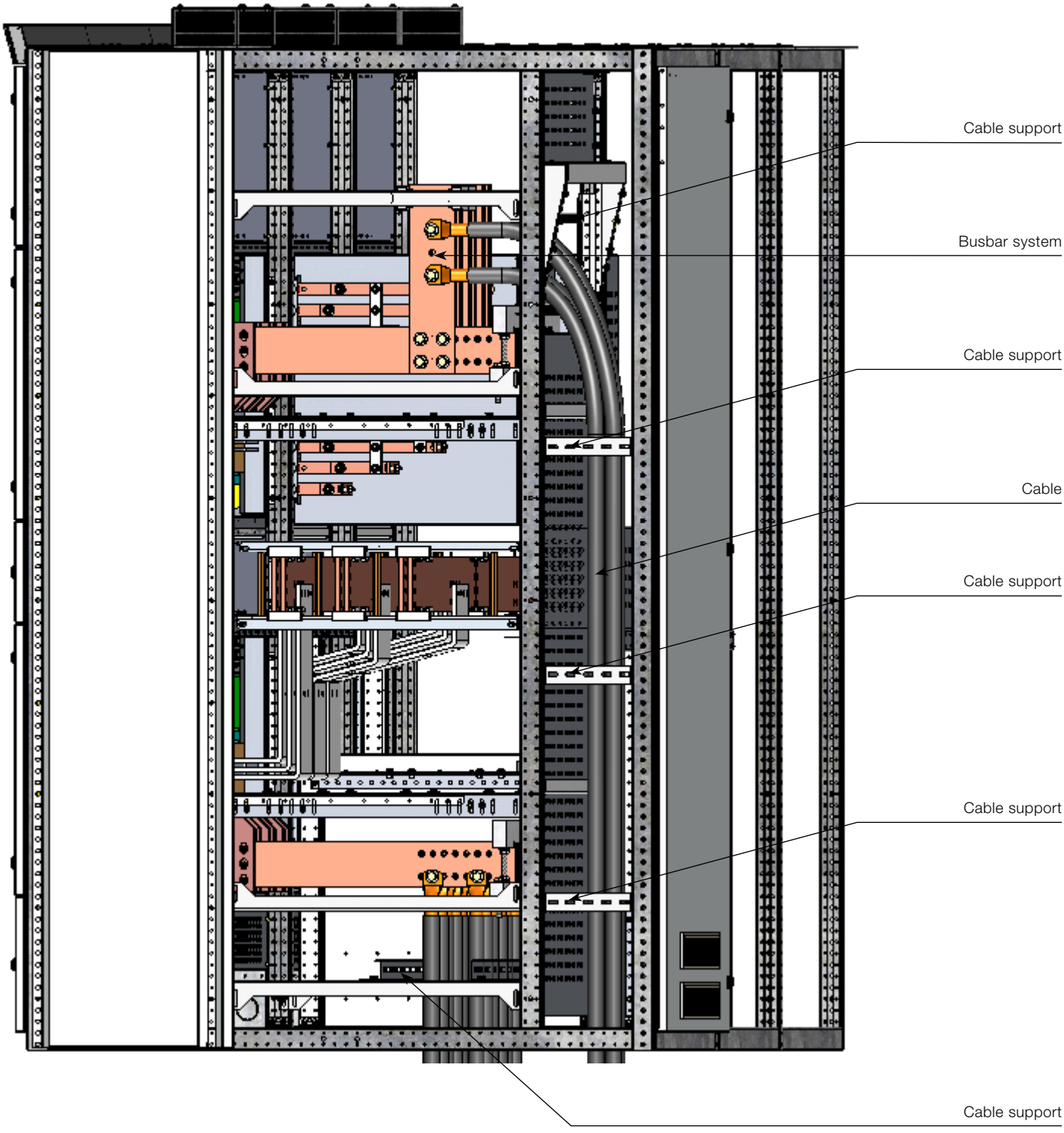
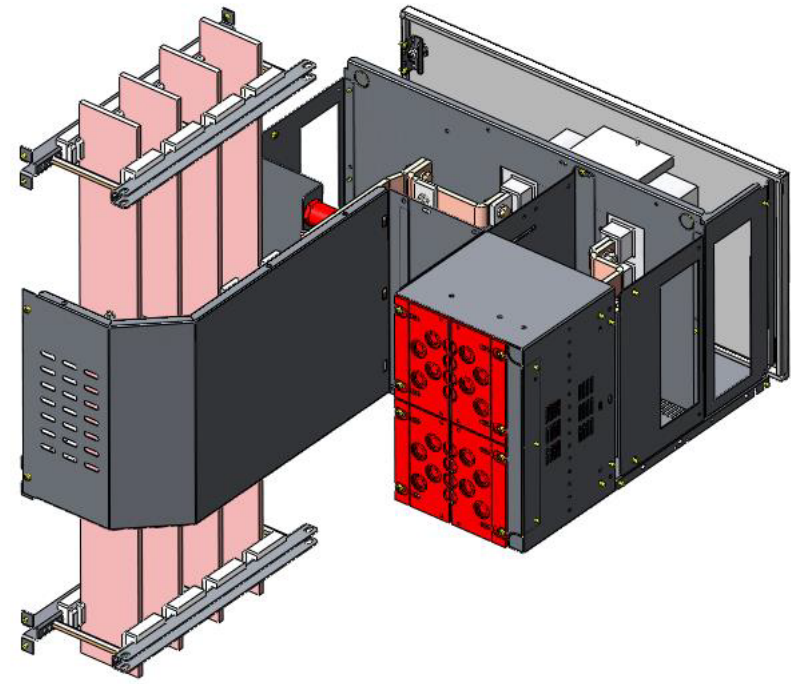


Fig. 32 Typical Cable connection from Emax to busbar and cable



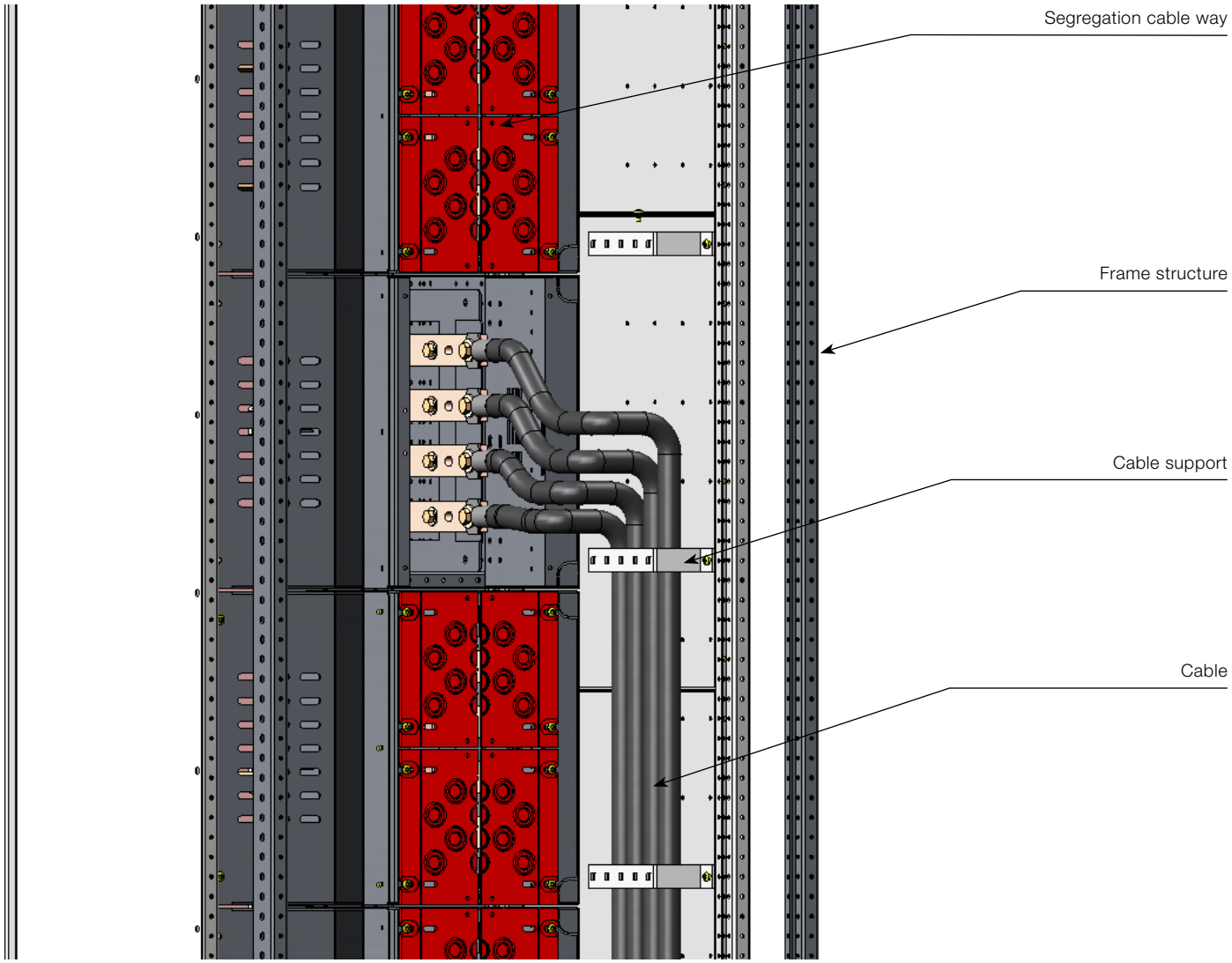
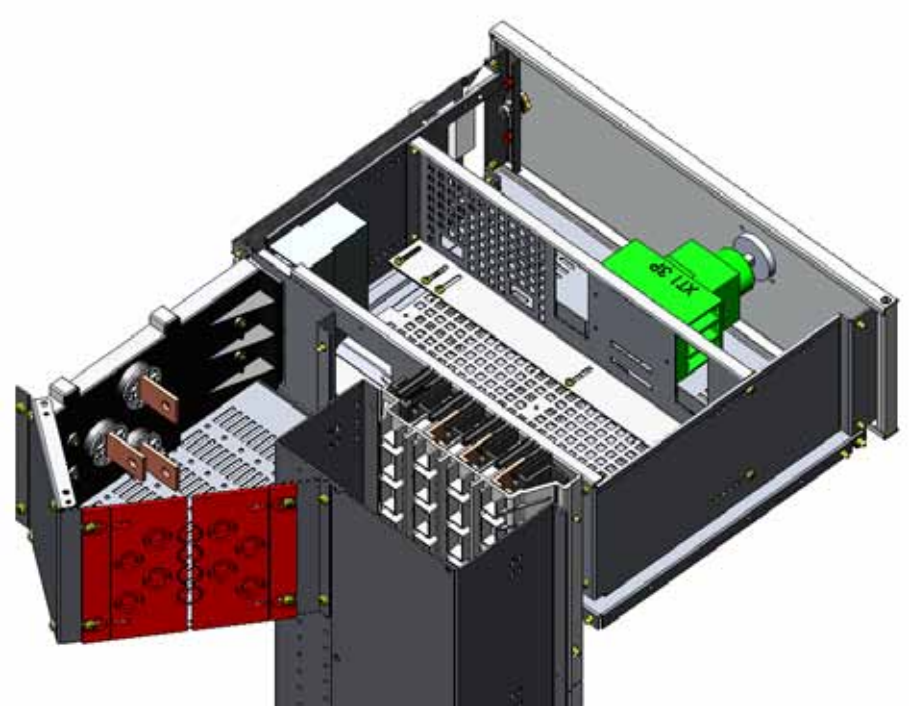


Fig. 33 Typical Cable connection from Fixed module



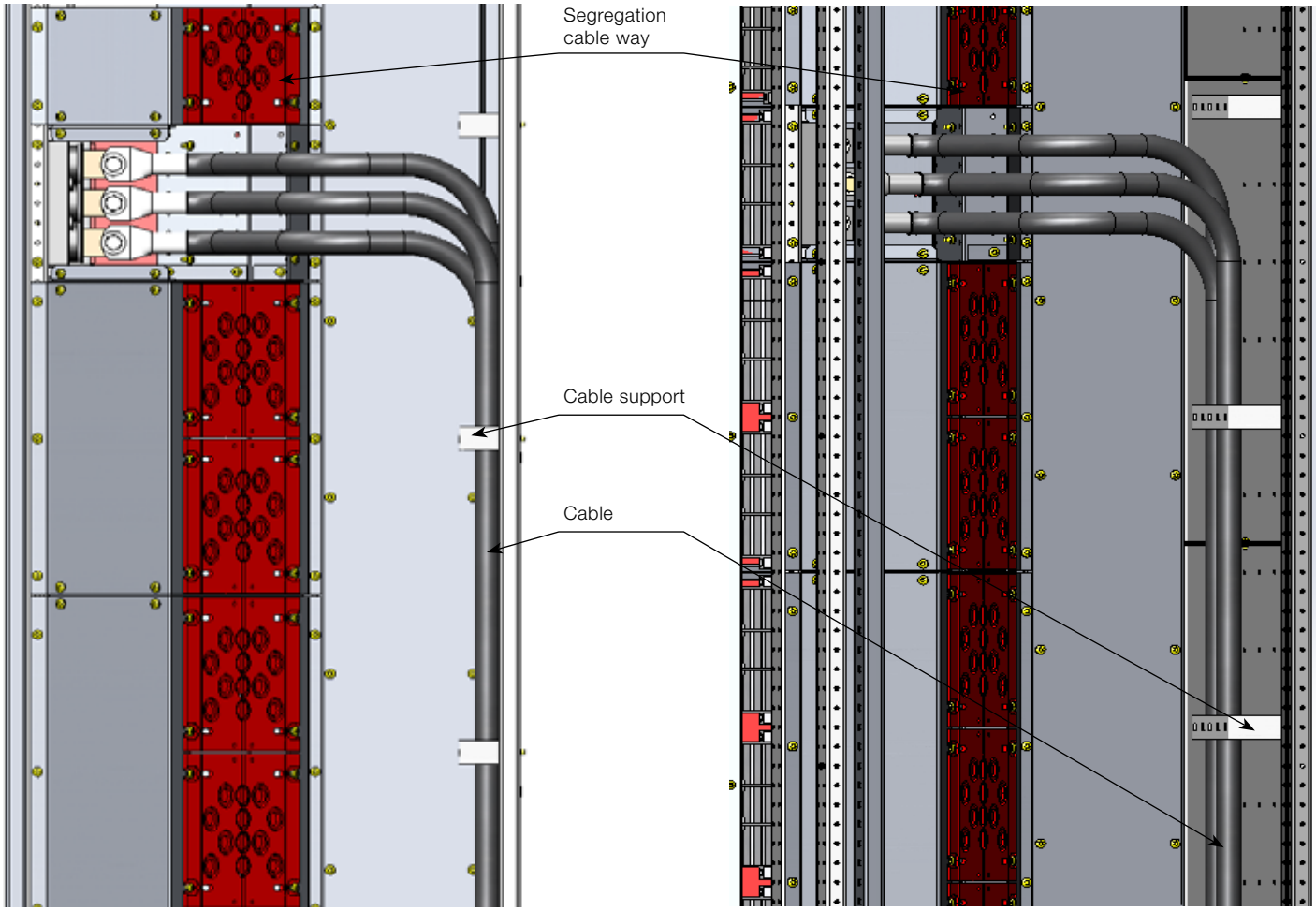


Fig. 34 Typical Cable connection from MCC-R

3.7.2 Cable connection, wiring

Cable lugs type

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 bar in standard configuration are according the following tables; special cable connection can be design to fulfill specific customer requirement.

Up to 400 mm² cable cross section, the connection between the cable unit and cable lug must be done with M12 Screw, spring washer and nut. For cable section bigger then 400 mm², the connection between the cable unit and cable lug must be done with M16 Screw, spring washer and nut; in this case, the standard bus bar hole diameter must be increased from 13 mm to 17 mm.

Cable section [mm²]	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 [mm²]	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 [mm²]	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 [mm²]	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 [mm²]	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	Arrangement	Cable lugs type	Max number of cables and cross section for phase [mm²]
T2	Horizontal	Normal	2x25(M8)
		Contanied palm	2x50(M8)
T3	Horizontal	Normal	2x70(M8)
		Contanied palm	2x150(M8)
T4	Horizontal	Normal	2x70(M8)
		Contanied palm	2x150(M8)
T4 320	Horizontal	Normal	1x95(M8) / 2x70(M8)
		Contanied palm	2x150(M8)
T5 400	Horizontal	Normal	1x185(M10) / 2X150(M10)
		Contanied palm	1x240(M10) / 2X185(M10)
T5 630	Horizontal	Normal	1x240(M12) / 2X185(M12)
		Contanied palm	1x240(M12) / 2X185(M12)
T6 630 / 800	Horizontal	Normal	2x240(M12)
		Contanied palm	2x240(M12)
T7 / X1	Horizontal	Normal	2x240(M12) / 4*240**(M12)
		Contanied 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 n.1 50x10
(*) T7-X1 1250/1600A Copper section n.2x50x10 ph/ 50x10 N
(**) Only for T7-X1 1250/1600A (to be verify case by case depending on depth/width)
(***) For vertical arrangement bottom

Withdrawable modules cable connection

Module size	Poles	Inc [A]	Max number of cables and cross section for phase [mm²]
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 [mm²]
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)

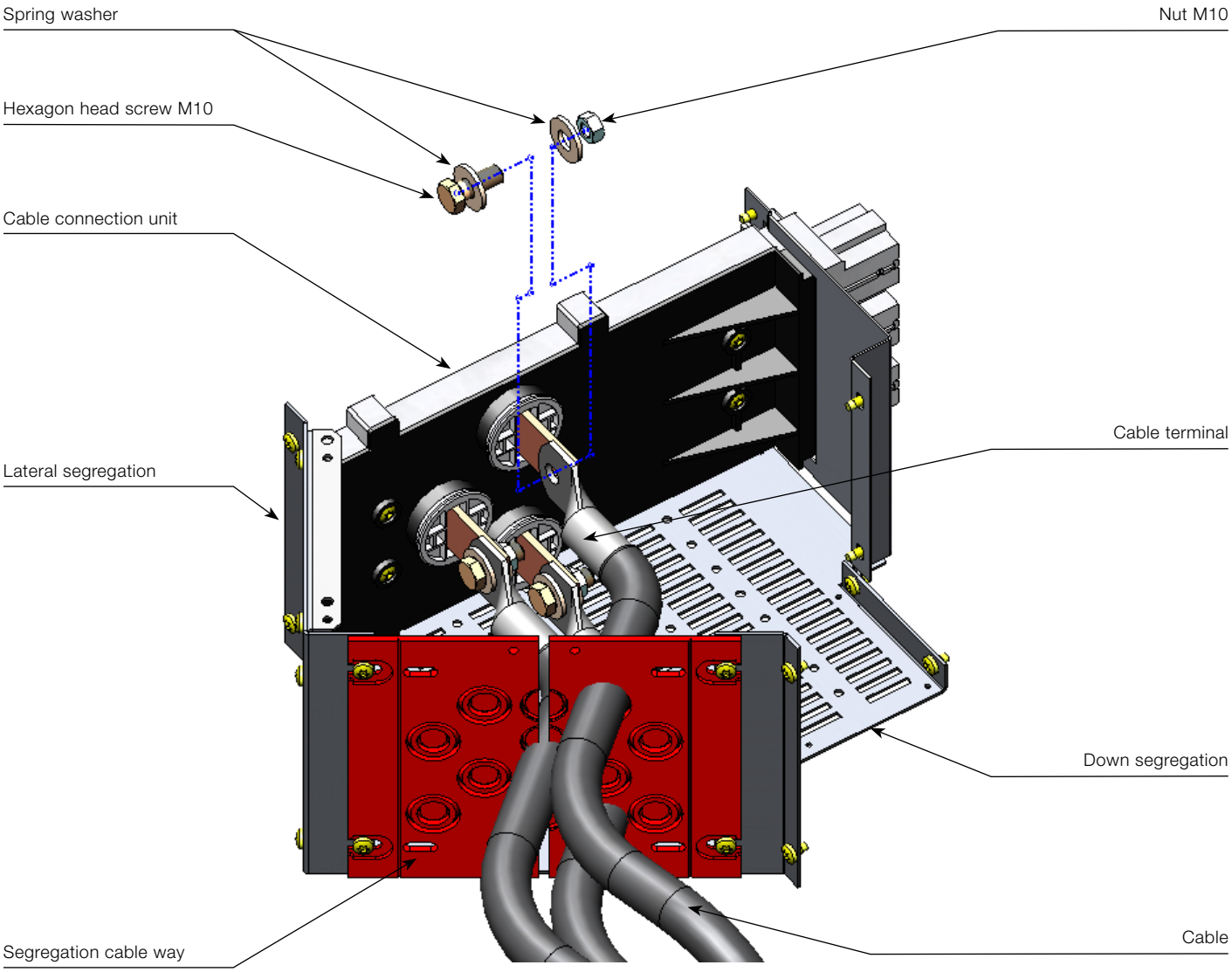


Fig. 35 Typical Cable connection

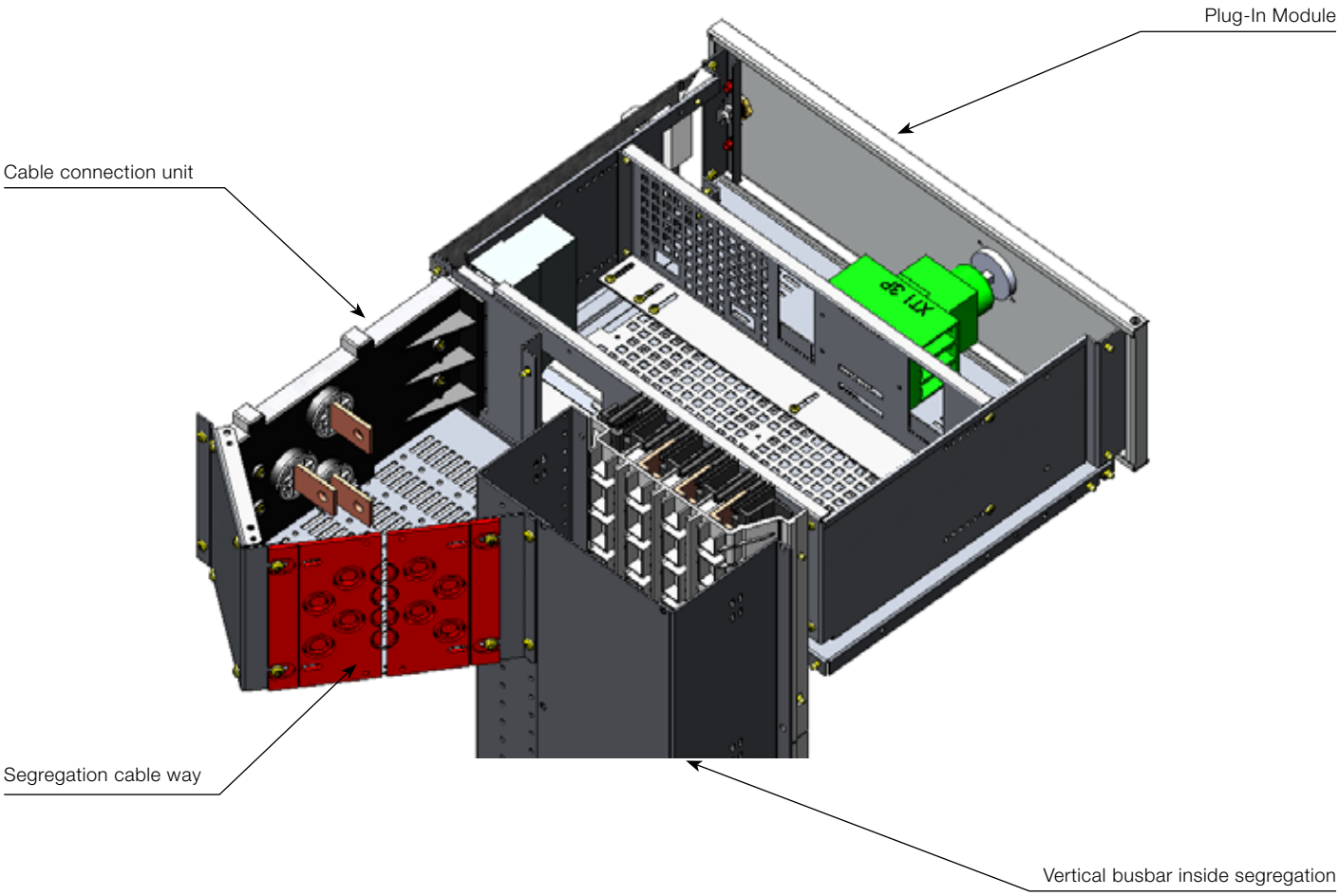


Fig. 36 Typical Cable connection for Plug-In module and Mcc module

3.8 Protective conductor connection

The protective conductors have to 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) with a screw M6.
– Over 100 A:
  - To the vertical PE connection bar, arranged front right in the cable compartment as screw connection or using a bar mounting terminal.

The green and yellow conductor (colour marking over the entire length) may only be used as protective (PE) or PEN conductor. It must not be used as a voltage carrying conductor by altering the colours at the ends or employed as regulator earth or as a connector for the shield earth.
In all cases, protective conductor connections screwed on to painted surfaces should be secured with serrated contact washers. Any means of locking the screws is permissible for fastening screwed connections to galvanised surfaces.
No lock-washers are required for roundhead screws (so-called Taptite screws) when screwed into galvanised parts for the first time.

The protective conductors are connected to the doors by flexible green and yellow copper conductors (cross-section 2.5 mm^2).
The connections are not necessary if no live (≤ 50 V AC or ≤ 120 V DC) equipment is mounted to the doors.
The continuous connection of the protective conductor circuits to inactive metal parts of the building (in accordance with IEC 60439 or DIN VDE 0100 Part 540) is to be carried out according to the conditions at the erection site.

3.9 Neutral conductor connection

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

Key to abbreviations

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

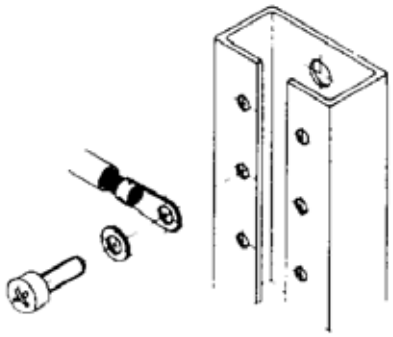


Fig. 37 Protective conductor connection at a vertical structural C-section

3.10 Final Preparations

– Remove the safety devices for the transportation of the heavy components of the apparatus.
– Assemble the equipment, as circuit breakers, fuses, lamps, meters. The various components are opportunely labelled. Follow the enclosed assembly instructions.
– Remove foreign materials, as tools, packaging material and residuals.
– Clean the insulating parts by means of an antistatic cloth. Do not use carbon tetrachloride, trichlorethylene or hydrocarbon solvents.
– Close the doors.

3.11 Check Operations

– Check the busbar connection to the transportation units. Tight-ening torque, Par. 5.11.
– Check base frame fastening.
– Check that the required protection degree is achieved, especially concerning the bottom closing.
– General visual inspection: appearance, completeness, labels, foreign materials in the switchboard, and dirt.
– Check that cables connection and wiring connection has been carried out completely and correctly.

4. Start up and Operation

4.1 Start up

Follow the detailed inspection before to switch ON the switchboard.

Item	Operation	Note
1. Compartment	– Visually inspect internal and external parts for any possible evident damage; remove any foreign material (i.e. test tools left after the – assembly) Carefully clean the insulating parts, remove any – trace of damp Remove dust or dirt from the air-intake grilles	
2. Power circuit connections	Check the tightening and the continuity	
3. Earth busbar and related connections	Check the tightening and the continuity	
4. Insulation	Measure the insulation resistance of the power circuit (phase-phase and phase-earth), auxiliary circuit and of the anticondensate heater The measured value must be at least > 100 Mohm	– The insulation resistance value is strongly influenced by environmental conditions – The switchboard must NOT be put in service if the insulation resistance is too low, for example lower than 1 Mohm – If the insulation resistance low value is due to humidity, activate the anticondensate heater (after having performed the inspections described in step 8, and possibly taking the thermostat to the higher value); if necessary use also provisional heaters
5. Circuit breakers	– Before putting in service, carry out all necessary operation described in the instructions related to each circuit breaker – Check the necessary devices and the accessories for the operation; in case of key-locked circuit breaker (open or closed), each circuit breaker must be equipped with only one key – Put the circuit breakers into the service position	
6. Protective release device	Check the correct calibration according to the selective diagrams of the plant	
7. Auxiliary circuits	According to the diagram, check the functionality and the operation logic sequences of the auxiliary circuits	Before performing this inspection, check the calibration of each relay of the switchboard
8. Anticondensate heater	– Feed the circuit – Adjust the thermostat to the higher temperature allowed – Check that the heater temperature raises – Adjust the thermostat so that the temperature inside the switchboard is always higher than the outside ambient temperature (approximately 35° C)	

– In case of particular apparatus configuration, it is possible that the previous inspections must be integrated with others suggested by the technician responsible for the apparatus.
– Check that the current transformer secondary winding is connected to the related protective and/or measuring amperometric circuit, then remove any possible short-circuit connections.
– In case the voltage transformer secondary winding must be connected to switchboard external equipment, check for the following conditions, to avoid overloads or short-circuits in the voltage transformers:
  - Check that the total comsumption of the equipment is not higher than the transformer capacities.
  - Check for incorrect connections (also provisional) in the measuring circuit or connections not in accordance with the switchboard connection and other units (supply switchboard, subswitchboards, control or operating desks, etc.).
  - Check that only one phase of the voltage transformer secondary winding is earthed.
– At the end of the preliminary test, carry out 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 design constructive separation form) of the external closing panels
  - Check that the different mechanical and electrical interlocks (possibly deactivated to carry out start test with switchboard not powered) have been restored.
– Feed the control circuit
– Close the circuit breakers (according to system), and ensure that any related function operates regularly
– Check the correct operation of the auxiliary instruments

Respect the general safety rules

4.2 Operation

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

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

If using certain standard load-break switches and circuit breakers the handle for operating those devices also activates the electrical and mechanical interlocking. A micro switch 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- und control-circuits are closed
	OFF Can be locked with 3 padlocks	in section	All main- und 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- und control-circuits are disconnected
	ISOLATED Position Can be locked with 3 padlocks	The module is 30 mm drawn out of the section	All main- und control-circuits are disconnected and the isolating distance is fulfilled

Fig. 38

Description of operating handle positions 8E/4 and 8E/2 modules
The switch handle can be moved from position “OFF” to position “ON” only after the handle has been depressed (push-to-turn feature).
The switch handle can be locked in the positions “OFF” and “TEST” and the isolated position with up to three padlocks (see 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 in position “OFF” or “ISOLATED”.

Resetting circuit breakers in withdrawable modules

When moulded-case circuit breakers are tripped on faults, the switch handle might jump into 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.

Then, the circuit breaker can be switched on again.

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

Note:

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

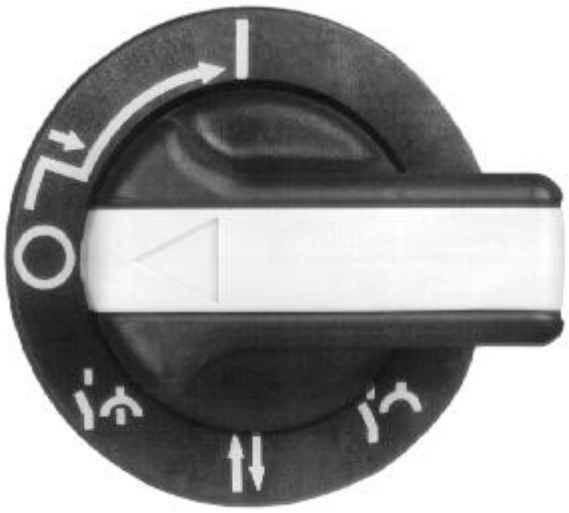


Fig. 39 Switch operating handle for withdrawable modules size 8E/4 and 8E/2 with position markers

Fig. 40 Withdrawable module size 8E/4 with 3 padlocks

4.2.2 Withdrawable units size 6E up to 24E

Withdrawable units size 6E up to 24E are built-up of sheet steel components which constitute the supporting frame for the electrical components and the contact elements. The hinged front cover offers the advantage of easy accessibility to the built in components from the front side. Opening the front cover with a key is only possible in isolated, test or OFF-position of the withdrawable unit. If a parallel coupling is installed, opening of one lock is sufficient. Opening of the front cover while the operating handle is in “ON”-position is only possible with a screw driver.

If opening the front cover while the operating handle is in “ON”-position it is possible to touch live parts.

The withdrawable unit can be equipped with an instrument panel made of insulating material for the installation of measuring, operating and indicating instruments. The hinged instrument panel is mounted to the withdrawable unit and sticks out 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. After tilting down the instrument panel a better access to the equipment both in the withdrawable unit and the instrument panel is provided.

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

	Position of switch	Position of module	Main and control circuits
	ON	in section	All main- und control-circuits are closed
	OFF Can be locked with 3 padlocks	in section	All main- und 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- und control-circuits are disconnected
	ISOLATED Position Can be locked with 3 padlocks	The module is 30 mm drawn out of the section	All main- und control-circuits are disconnected and the isolating distance is fulfilled

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

A test function of the control circuit for moulded case circuit breakers with motor operating is not possible in the test position.
A secure breaking of the maincircuit is achieved in the OFF-position due to the isolating characteristics of the used main switching devices. In addition it is necessary for working at the consumer to achieve a secure isolation of the main- and control-circuits by moving the withdrawable module to the isolated position.

Resetting circuit breakers in withdrawable modules
When moulded-case circuit breakers are tripped on faults, the switch handle might jump into 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.
Then, the circuit breaker can be switched on again.

1. Turn switch handle from “ON” position to “OFF” position and further to the stop.
2. When released, the switch handle swings back to “OFF” position.
3. The circuit breaker is ready to be switched on.

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

Fig. 42 Withdrawable module size 8E

Fig. 43 Withdrawable module size 16E

Moving of the withdrawable module
The withdrawable unit can only be moved, if the operating handle is in position “MOVE”. This ensures that it is not possible to move a withdrawable module under load.
For moving a withdrawable unit the operating handle has to be brought to the position “MOVE” and the withdrawable module has to be pulled out with the use of the two handles. When the unit starts moving the operating handle immediatly moves back to the position “OFF” and the withdrawable unit interlocks after 30 mm in the isolated position. In this position the main and control contacts are disconnected.

For further moving of the withdrawable unit the operating handle has to be switched to the position “MOVE” again. Afterwards the withdrawable module has to be pulled out further.
Before removing the withdrawable unit from the section completely the withdrawable unit interlocks again to avoid being pulled out from the section uncontrolled. To release this safety stop it is necessary to press down the lever on the left side of the withdrawable unit (see fig. 46). If the withdrawable unit which should be moved is installed in a high position in the section the safety stop can be released by supporting the withdrawable unit with the right hand from below and releasing the lever with the left hand.

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

Afterwards the withdrawable unit can be removed completely from the section.

Depending on their size withdrawable units have a high weight. Therefore the following safe ty measures have to be obeyed by all means:

- After moving out the withdrawable unit halfway from the withdrawable module compartment the operator has to grasp the withdrawable unit from below under the sides (for withdrawable units size 4E and 8E).
- For withdrawable units size 12E and bigger the withdrawable unit should only be withdrawn by two persons. For this the operators should be located at one side of the withdrawable unit each and grasp the withdrawable unit from bellow (12E) or at the provided hand grips located at the side walls (> 12E).
- The withdrawable unit should not be left longer than necessary in the position of the safety stop, because the centre of gravity is already outside the section in this position. Disregarding of this regulation can lead to mechanical damage at the withdrawable unit.

Withdrawable units in isolated position or in the position of the safety stop are not to be used as help for climbing because persons can be endangered and/or the switchgear can be damaged.

The test position can be achieved without moving the withdrawable unit by turning the operating handle to the position “TEST”.
The operating handle can be locked in the positions “OFF” and “TEST” by using up to three padlocks. Removing of the unit can be prevented by an additional mechanical lock (protection against theft) which additionally can be installed in the front cover.
For withdrawable units that are not being used the operating handle must be in the position “OFF”.

4.2.3 Plug-IN units 8E up to 24E

The plug in modules are fastened directly to the compartment bottom plate using screw.
The plug in module feeder connection to the distribution bus bar system is done directly via the contact device of the plug in modules. Outgoing cable are connected via plug in contact to the out-going connection unit (main circuit) and via terminal blocks (aux circuit). The outgoing cable connection unit are fastened directly to the frame.
Insertion and extraction of the modules is done with special tool (see fig. A)

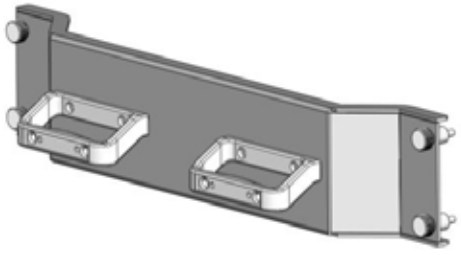
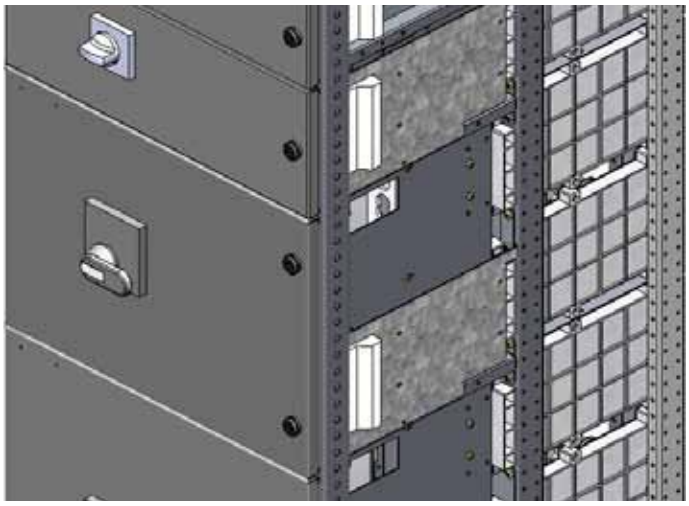


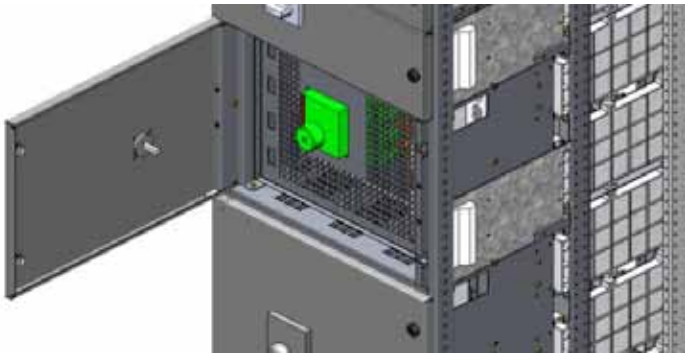
Fig. A Special tool for extraction module

For the use of special tool and the extraction procedures of the module plug-in, please refer to the label instruction installed on special tool and step shown in this table:

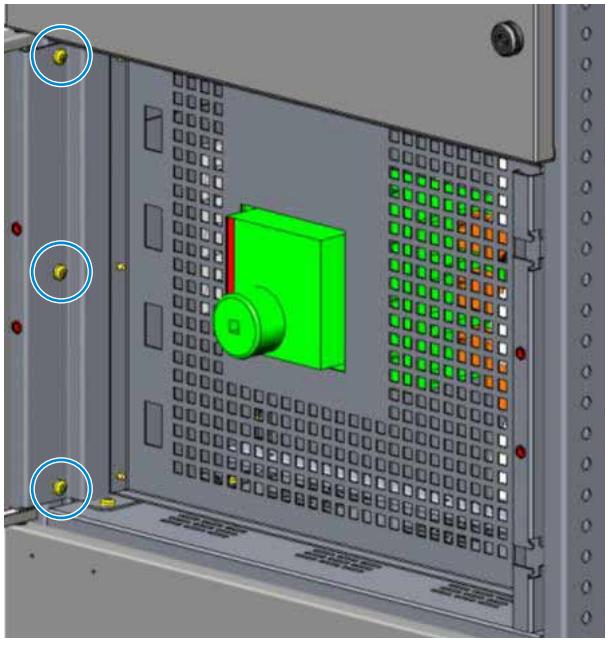
STEP 1
Switch off the breaker



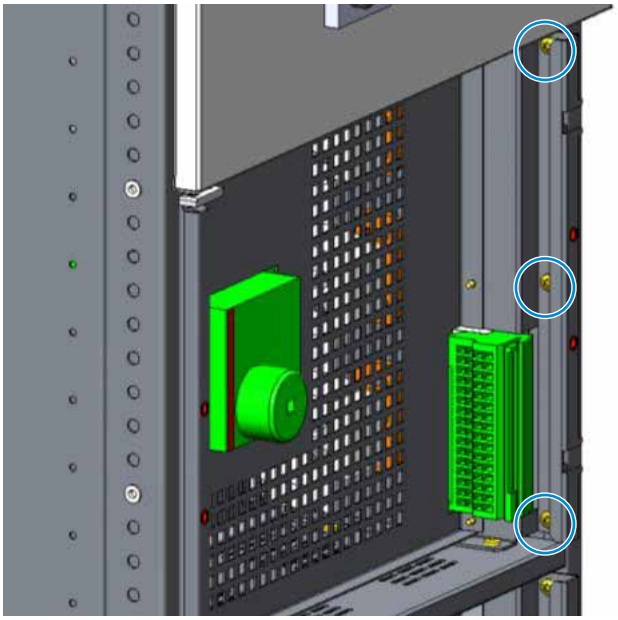
STEP 2
Open Door



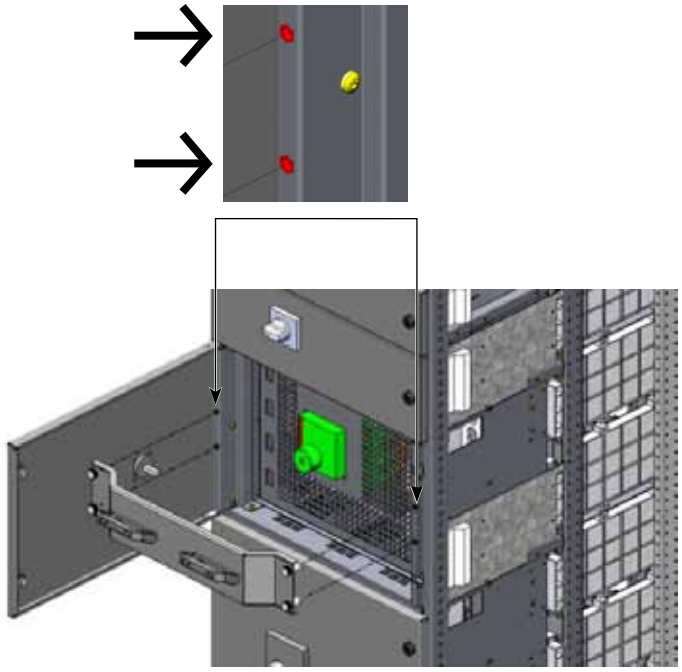
STEP 3
Unscrew highlighted screws



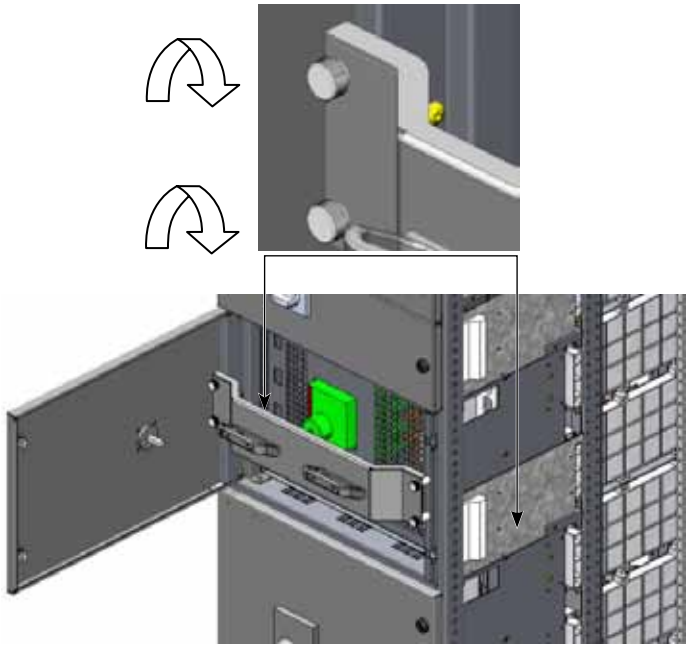
STEP 4
Unscrew highlighted screws and unplug the terminal block



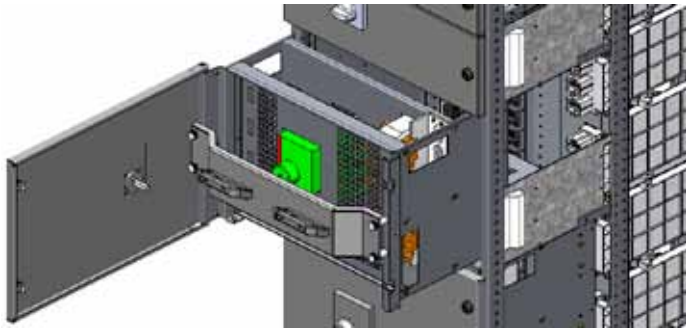
STEP 5
Position the removal tool near the fixing points highlighted



STEP 6
Screw the knobs in to the fixing points specified in step 5



STEP 7
Extract the plug-in module



4.3 Special information

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

5. Maintenance and Spare Parts

5.1 General

Maintenance work, such as replacing fuses etc., must only be carried out by suitable instructed personnel observing the safety rules.

When working on switchgear sections the following regulations must be observed:
– The national and international safety rules (e.g. VDE 0105, regulations for the operation of power installations). The 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. For modifications inside the sections it is necessary to reconsider the changed heat balance. The allowed limit of temperature-rise inside the switchpanel must not be exceeded. In case of doubt please contact your appropriate ABB branch.

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

5.2 Withdrawable technique

The following description refers to the standard modules. For modules differing from the standard version separate descriptions should be applied for.

The multi-functional wall is arranged between the busbar and the equipment compartment. It covers the complete height and width of the equipment compartment and fullfils the following functions:
– Holding of distribution bars.
– Fastening and covering of distribution bars by means of the distribution bar cover.
– Protection against formation and propagation of arc faults.

The contact openings of the distribution bar covers fulfill IP 20 and therefore conversion is made possible without the need of interruption of operation for the section (see fig. 52).
The withdrawable module can be exchanged or removed and replaced in the compartment during maintenance without isolation.
With the interlocking switch handle in the move position, withdrawable modules size 8E/4 and 8E/2 can be withdrawn without stop. The modules size 6E up to 24E have to 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 screw driver

If opening the front cover while the operating handle is in “ON” -position it is possible to touch live parts.

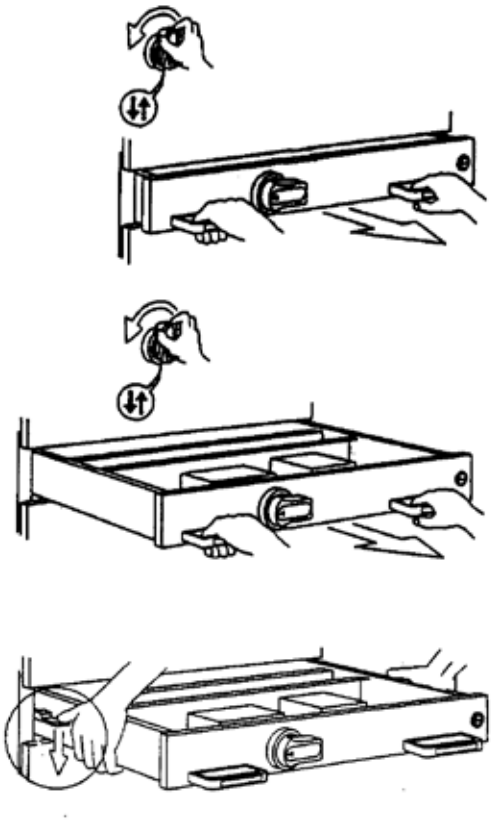


Fig. 46 Draw out of a withdrawable module

Main fuses in withdrawable modules with hinged front cover are accessible after the main switching device has been turned OFF and after the front cover has been unlatched. Unlocking the front cover with the module in the operating position can only be achieved by means of a tool, e.g. a screw driver (see fig. 45).
The interlocking mechanism can be found at the side of the switch handle.
For conversion or modification of complete withdrawable module units, e.g. replacement of one large unit through several smaller units or vice versa, the frame-mounted compartment has to be exchanged, too (see fig. 52/53).

5.3 Plug-in technique

In case of modifications of switchgear sections a possible change of the heat balance inside the sections has to taken into account. The allowed limit of temperature-rise inside the switchgear section may not be exceeded (contact ABB).

Plug-in modules
The plug-in module can be exchanged or removed and replaced in the compartment during maintenance without isolation (see fig. 47-48-49-50-51)

Proceed as follows to remove a module:

- **Isolating the modules**
- **Opening the breaker**
- **Protecting against reclosing**
- **Verify isolation from supply**
- **Earthing and short-circuiting**
- **Barriering adjacent live parts**
- **Detach outgoing cable and 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).**

The modules are installed in reverse order.
If the plug-in module need to be extract, before to insert it again, grease the guide to facilitate the insertion.

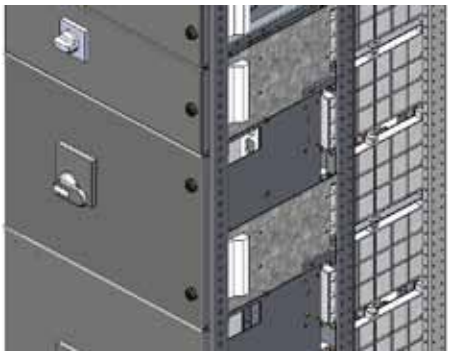


Fig. 47 Switch off the breaker

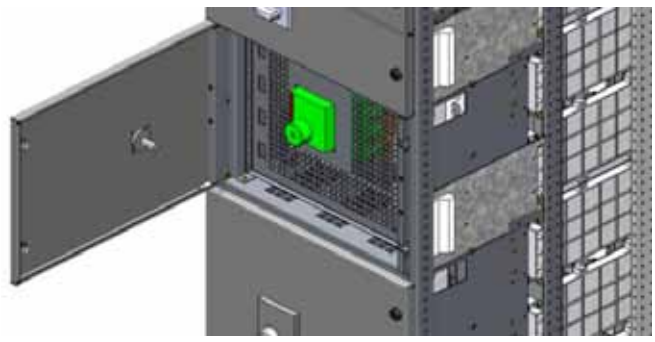
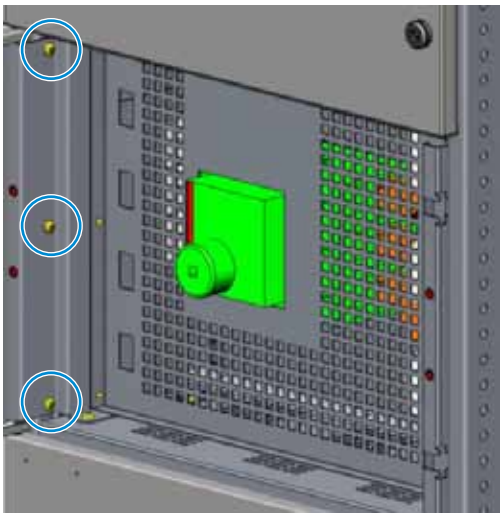


Fig. 48 Open Door



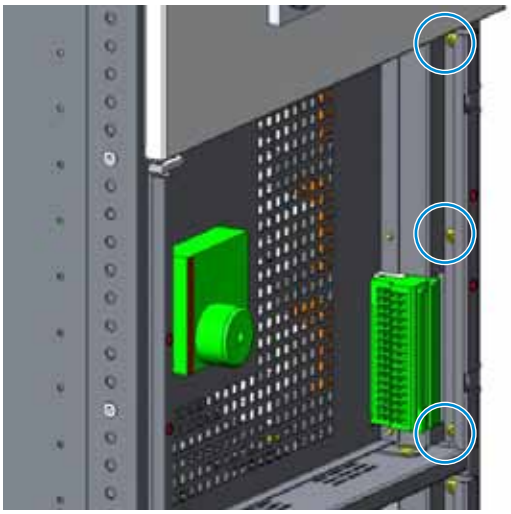


Fig. 49 Unscrew highlighted screws and unhook terminal block

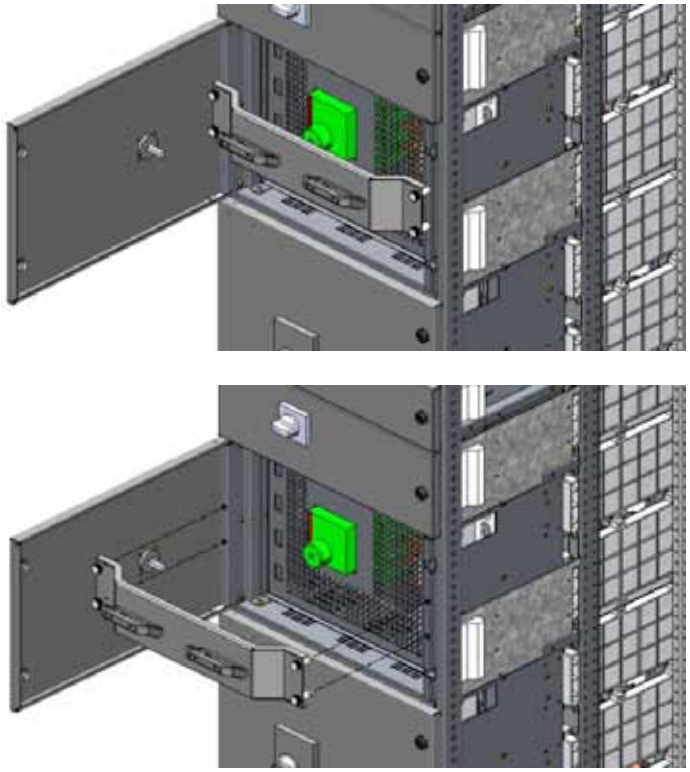


Fig. 50 Screw the knobs of tool

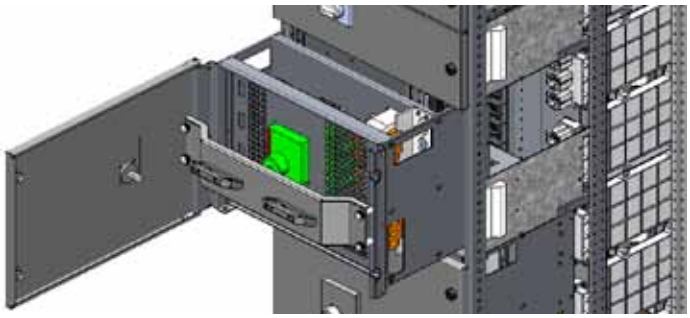


Fig. 51 Extract the plug-in module

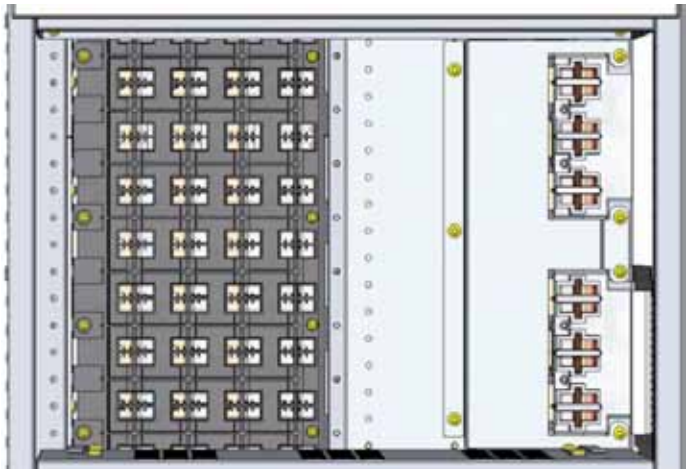


Fig. 52 Withdrawable module compartment size 8E with outgoing cable connection unit, 2E-distribution bar cover

5.4 Conversion and change of withdrawable module compartments

Before the conversion and/or change of withdrawable module compartments the withdrawable module below the affected withdrawable module compartments has to be removed from the section. By using a appropriate cover for the compartment bottom plate of the withdrawable module compartment below small parts have to be prevented from falling through.

In case of modifications of switchgear sections a possible change of the heat balance inside the sections has to be taken into account. The allowed limit of temperature-rise inside the switchgear section may not be exceeded (contact ABB).

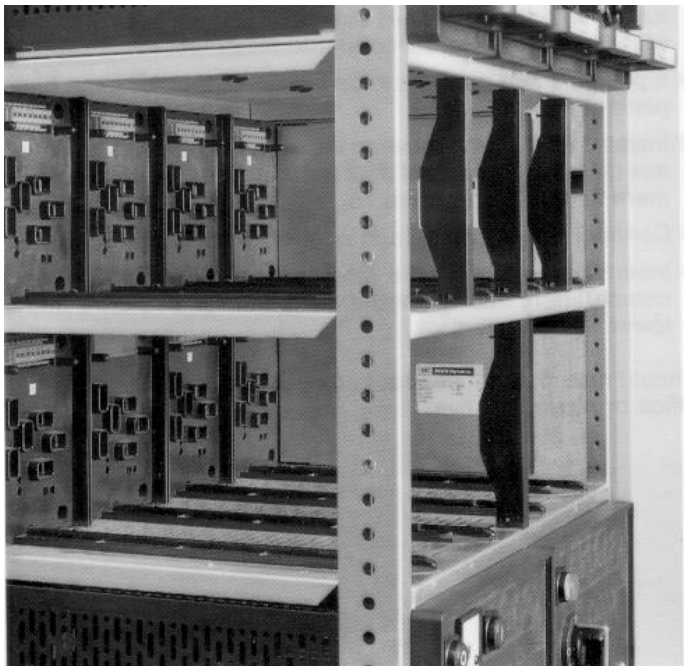


Fig. 53 Conversion to withdrawable module compartments size 8E/4 and 8E/2

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

The conversion has to take place in the following sequence:

Disassembly (see fig. 52)

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

Reassembly (see fig. 7 and 53)

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

During mounting of a withdrawable unit condapter it has to be made sure that a earthing connection is established at the lower right screw connection using a bushing (GLBL210021P0001) and a washer A 6,4 (9ADA312-6) (see fig. 7).

– 8 plastic guide rails have to be mounted, 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 power cables and control wiring.
– Insert four withdrawable modules size 8E/4 into the upper compartment and two withdrawable units size 8E/2 into the lower compartment.

Should new material be required contact the nearest ABB-sales office or representative.

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

The conversion has to take place in the following sequence:

Disassembly

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

Reassembly

– Install 2 outgoing cable connection units (details see fig. 35).
– 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 the rollers and covers have to be mounted.
– Between the newly installed compartment bottom plates one control terminal block support per withdrawable module compartment with one or two 16-/20-pole terminal blocks must be mounted on the right hand side (in the cable compartment). If only one terminal block per support is required it must be mounted in the upper part of the cut-out of the support. The lower part has to be covered with a cover plate.
– Connect power cables with their protective covers (bellows) and also the control wiring.
– Insert three new withdrawable units size 8E.

Should new material be required contact the nearest ABB sales office or representative.

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

The conversion has to take place in the following sequence:

Disassembly

– Pull out the 6 withdrawable units.
– Disconnect power and control cables and wiring.
– Disassemble the two middle compartment bottom plates with front posts and guide rails (see fig. 7).
– Remove 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).

Reassembly

– Install one outgoing cable connection unit depending on the module design. Depending on the current or whether a star-delta unit is used two outgoing cable connection units can be mounted.
– Install guide rail left on the lower compartment bottom plate (see fig. 9).
– Mount roller and cover in the compartment bottom plate (see fig. 9).
– Install control terminal block support with one or two 16-/20-pole control terminal blocks. When only one 16-/20-pole control terminal block is required mount it in the upper part of the support and use a cover for the lower part of the support.
– Connect power cable including protective cover (bellows, see fig. 35) and control wiring. For parallel connection of two out-going cable connection units an additional bellow is required.
– Insert new withdrawable unit size 24E.

5.4.4 Example 4: Conversion of 3 units size 8E (height 200 mm) into one unit size 24E (height 600 mm)

The conversion has to take place in the following sequence:

Disassembly

– Pull out the 3 withdrawable units.
– Disconnect power cables after protective cover (bellows) has been removed (see fig. 35). Due to the protective covers on the adjacent outgoing cable connection units working 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 to one or two 16-/ 32-pole control terminal blocks. When converting from two to one control terminal block the remaining one must be at the top of the support while the space below has to be covered with a cover.
– Dismantle the two middle compartment bottom plates with their guide rails The lower bottom plate remains unchanged (see fig. 9).
– Depending upon module design remove one or two outgoing cable connection units. When necessary exchange outgoing cable connection unit. Depending upon current or whether a star-delta unit is required two outgoing cable connection units have to remain or must be exchanged.

Reassembly

– Connect power cable including protective cover (bellows) and control wiring (see fig. 35).
– Insert new withdrawable unit size 24E.

Should new material be required contact the nearest ABB sales office or representative.

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.
For all works in connection with the activities required for this purpose, all relevant determinations of the MNS manufacturing instructions and MNS product information sheets must be observed and complied with in addition to the valid safety regulations and all relevant provisions.
The former include the following:
– "Installation of power contacts"
– "Greasing of power contacts"
– "Tightening torques of bolted connections"
which you will find in this chapter, too.

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).
The visual inspection of the contact system should include the following items resp. their observation is strongly recommended:
– Damages (e.g. worn silver resp. tin layer, signs of inadmissible heating, etc.) at the contacting surfaces of the MNS contacts and their counterparts (distribution bars, withdrawable module condapter, outgoing cable connection unit).
– Contacts movable and properly snaped into position in the withdrawable module rear wall or contact apparatus housing.
– Deformation of contacts (bent), mechanical damages.
– Medium-force fit of the contact spring (withdrawable modules 8E/4 and 8E/2) in its specified position.
– Insulation behind crimping swollen.
– Contacts greased.

In cases of doubt, the contact force may be measured using a special testing device.
In the event of doubts additionally measure the contact clearance with a slide gauge or standard gauge. The specified values of 4.7 $^{+0,05}_{-0,2}$ mm must not be exceeded or left short.

If irregularities are detected, we recommend replacing contacts, complete withdrawable module rear wall for 8E/2 and 8E/4 modules or the entire contacting system and/or informing the respective ABB Service department in order to determine and coordinate further measures.

Please note:
The **size of the contact opening** need not be checked for the contact ≥ 4E (e.g. using a gauge block), because this check does not make sense due to construction.

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

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 exchanged if contact force is below the given value

Fig. 54 Check of contact force and contact opening

5.5.1 Maintenance procedure

5.5.1.1 Regular visual check:

Recommendation is to perform the visual check of the MNS power contacts after every 100 mechanical movements of the withdrawable modules or every 2 years, whatever is present earlier.

If any of below detections is made, we recommend exchanging the power contacts including the connected cables. Counter parts need only to be changed if specific damages are visible as below.

5.5.1.2 Checking procedure:

– Before the visual check
  - Check colour of contact grease as a first and sensitive hint on overheating damage is a discoloured contact grease (red-brown to black).
  - Clean the power contacts from grease.
– Check for visible damages at the power contact system, its contact surface or their counter parts. Damages are:
  - 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 inadmissible heating, like 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 snapped into position in the contact housing.
– Check that the contacts are not mechanically deformed, bent or damaged.
– Check that the power contact spring is still in original position, properly fixed and not loose.
– Check that connected cables are smoothly routed and proper bending radii are kept.

After visual check or replacement is finalized, power contacts shall be properly greased according to chapter 5.6.

5.5.1.3 Additional verification in case of doubt:

In case of absence of visible damages and if one of the following situations is found:

– Power contact has been in use for more than 1000 operating cycles or more than 10 years.
– No grease at the power contacts Dark-discoloured, burnt or visible (red-brown to black).melted contact grease
– It can be recommended to measure the contact pressure according to ABB guidelines. Please contact ABB Service for assistance to perform the measurement.

Note:

The measurement of the contact pressure is not a compulsory part of the regular maintenance procedure. If the contact pressure is below 40N the power contact and the connected cable must be exchanged.

5.6 Greasing of contact areas

5.6.1 Greasing of power contacts

Greasing the contacts is a mandatory prerequisite for reaching the operating cycles to which the unit is certified through type test as the grease reduces the wear of the contact area finish. Furthermore, the force needed for withdrawing the modules is reduced.

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

– the assembly works 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:
  Contact grease **Klüberlectric KR44-102**
– Use a brush to apply the grease.
– Avoid excess grease on the contacts.
– If modules are supplied as loose parts, they should be greased at the building site.
– For contact areas to be greased, see figures 55 and 56.

Contacts of the withdrawable module condapter are to be treated similarily.

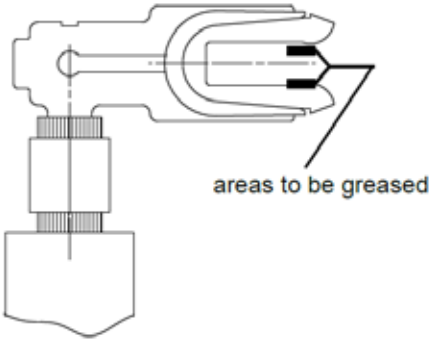


Fig. 55 Power contacts for withdrawable modules size 8E/4 and 8E/2 as well as the outgoing power contacts of the 4E-withdrawable modules

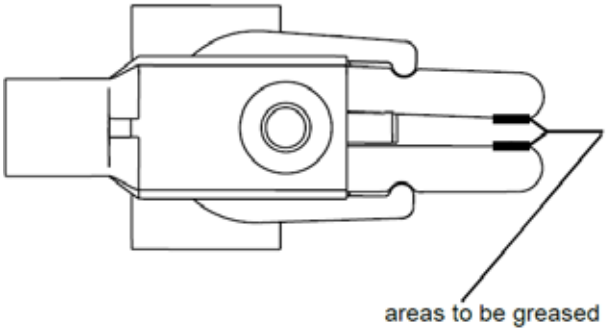


Fig. 56 Power contacts for withdrawable modules size 4E to 48E

Withdrawable modules which are to be supplied separately, the contacts should only be greased on site. The following quantities of 7 g (8 ml) tubes are to be supplied together with the modules for this purpose:

For 1 up to 4 modules of size 8E/4 and 8E/2

– 1 tube each

For module sizes 4E up 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 transport packaging the appropriate number of tubes has to be fixed to the modules by the manufacturing department (tubes are fixed to the withdrawable module handle, at least one tube per packaging unit, in case of major deliveries to one customer the grease can also be supplied in tins).

Example:

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

Ident 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 the LV HRC fuses must also be greased every 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 loosely, 0.5 tubes of contact grease are required for each module (1 set = maximally 4 fuses for all sizes).

5.7 Lubrication of withdrawable module interlocks

When the withdrawable modules have been in use for some time, it may be necessary to lubricate the interlocks of the withdrawable modules size 8E/2 and 8E/4 (dependent on the environmental conditions and the tightness). For this purpose the mobile parts must be sprayed with a lubricant (approx. 1 sec.). Thereafter a functional test must be carried out.

Lubricant to be used:

Molycote Omnigliss 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 up to 48E is not necessary during maintenance works.

5.8 Installation of power contacts

5.8.1 Installation

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

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

In case the contact does not properly engage, it has to be checked whether the engagement hook has the proper shape (and does not, e.g., have any extrusion edges), or whether the engagement hook is broken. Parts whose engagement hook is not properly shaped, or broken, have to be replaced.

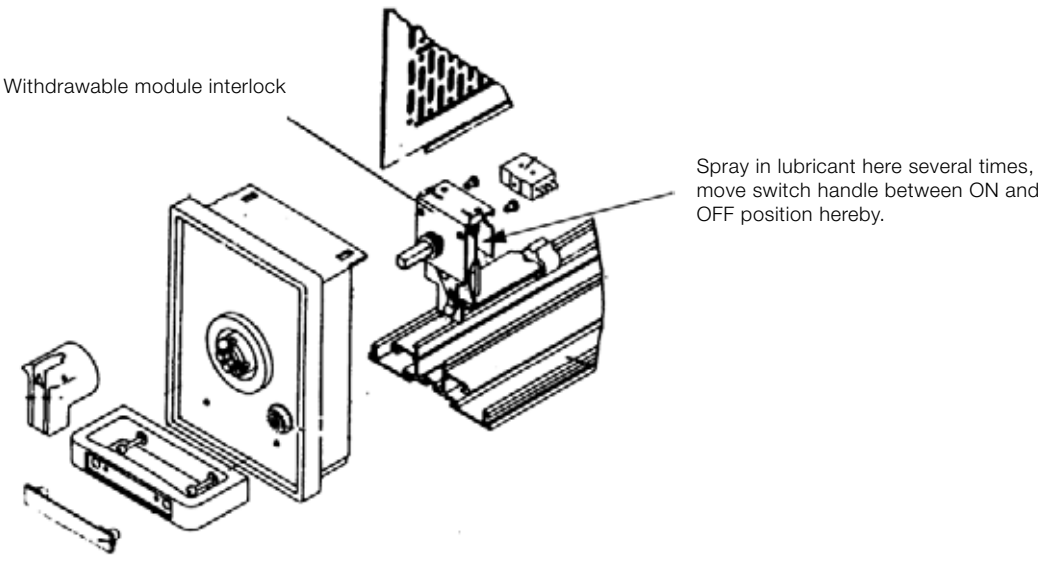


Fig. 57 Lubrication of MNS-withdrawable module interlocks 8E/4 and 8E/2

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 not have any visible damages).
– 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 mobile in all directions in order to ensure a tolerance adjustment).

5.8.3 Contact plating

Contact plating with silver or tin

Application of different platings

– Silver (Ag) -> Standard
– Tin (Sn) -> Option on customer request.

Identification

The type of plating is visually not distinguishable. That is why contacts are marked:

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

Combination of differently plated parts in one switchgear

It applies in principle for the withdrawable and railable technique:

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

Exceptions:

The mix 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 distribution bar and condapter)
– tin-plated busbars and contacts **at the incoming side** of a system and **silver-plated** busbars and contacts **at the outgoing side**.

For clear verification also all parts of the MNS busbar system are marked with “Ag” or “Sn”.

5.9 Paintwork damage

5.9.1 Preparation of the damaged location

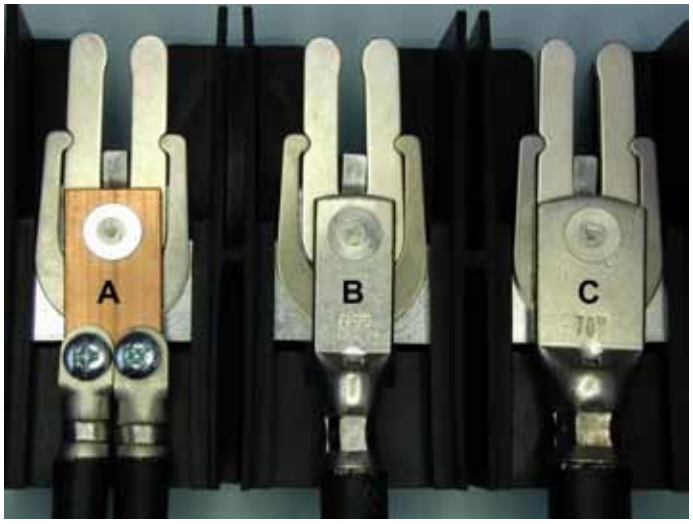
Surfaces or locations soiled by grease/oil shall be cleaned with an aliphatic cleaning agent using a linen cloth.

5.9.2 Execution

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

The hardening agent in the small container shall be completely added to the larger container filled with paint. The quantity of hardening agent exactly matches the quantity of the paint. After hardening agent and paint have been thoroughly mixed the mixture shall be applied using a brush or a lambskin paint roller to the surface to be repaired.

Small marks may be repaired isolated; but the success depends on the surface preparation and/or the "handling".



Contact forms:
A: up to 2 x 16 mm²
B: up to 35 mm²
C: up to 70 mm²

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

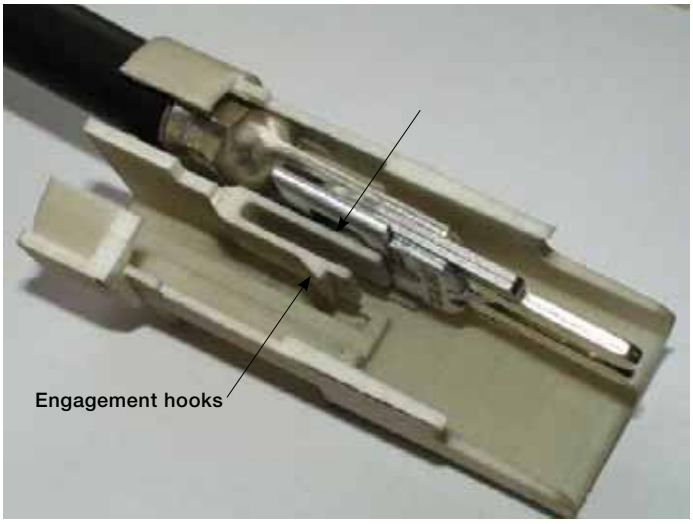


Fig. 59 Contact apparatus housing, cross-section

5.10 Mechanical damage

5.10.1 Preparation of the damaged location

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

5.10.2 Execution

A filler material (alkyd resin basis) shall be applied flush with the surface using a drawing scraper. The filler shall be left to set over night. The filled-in location has again to be slightly ground. Thereafter the paint has to be applied as described above.

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 quoted apply to system screw connections and busbar screw connections on busbars with $\sigma_{02} \geq 70$ N/mm^2 (Cu, Cu/Al, AlMgSi 0,5) in the switchgear system MNS. 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 of tensile class 8.8.

Note:

For equipment connections and mountings see the technical data sheets of the manufacturers.

5.11.2 Accurancy of Screwing/Bolting

High-accuracy torque tightening equipments should be used. These are 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.

			Max. tightening torque	
Ident.-no of the screw	**Screw type**	**Dimension** mm	**Thermoplastics Duroplastics** Nm	**Pur** Nm
1TGB 000 116 P.... and 1TGB 000 117 P....	TORX pan head tapping screws	4.2	2.0	-
		5.5	4.5	3.5
		6.3	5.5	3.5

Bolt and Nuts, and Tightening Torque

– Insulating self-tapping screws.

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

– Metal self-tapping screws.

		Max. tightening torque					
Screw Part Number	**Diameter**	**Steel plate**		**Aluminium plate**		**Copper busbar**	
	mm	**Thre-ading height** mm	Nm	**Thre-ading height** mm	Nm	**Thre-ading height** mm	Nm
HZN 451307 P... GILN 100082 P...	M3	1.5	1.0	3	1.0	-	-
	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	M3 M4 M5 M6 M8	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 with their maximum power. Therefore, good ventilation is to be ensured in the place of installation in order to prevent the ambient temperature from exceeding the max. admissible limit of 35 °C (mean value over 24 hours). Malfunctions or an 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 the regular maintenance works, 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) Above and below each individual module (or the modules), an air supply and air discharge must be available.
   b) If the section bottom plate is closed (no air supply through bottom plate), there must be at least 4 ventilation slots.
   c) No compartment bottom plates or other installations may be present in the section which might adversely affect ventilation.
   d) For protection class > IP 32 or installations which deviate from c) above, forced ventilation (or a reduced amount of equipment) is required.
3. Check the settings and the functioning 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 serves as an indication for a 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 discharge 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 the 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. Setpopint values are given on the module name-plates.

5.12.2 Correction of faults

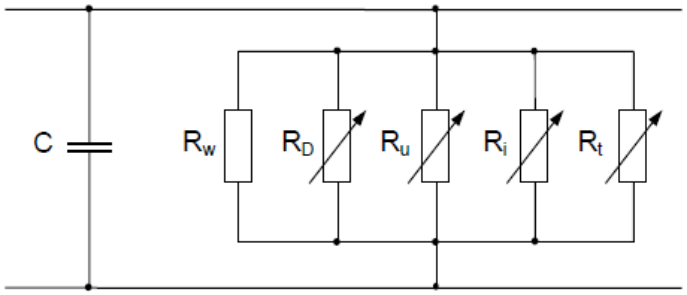
In the event of malfunctions during commissioning, the section wiring (especially in the area of the transport partition) should be checked first.

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 improperly connected.
  - Check fuses.
  - Wrong transformer ratio.
  - Lowest step power is 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.
– cosφ setpoint is not reached:
  - Lowest step power is 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).
– cosφ 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 RW 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.

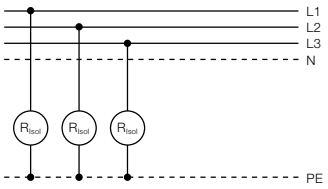
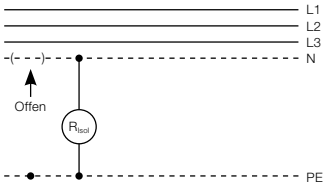
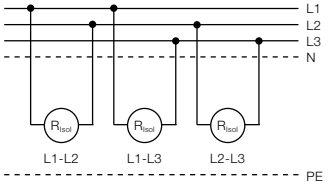
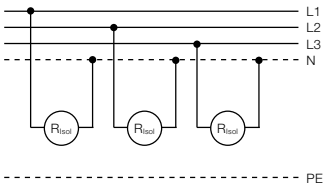
Insulation measurement is required according to DIN VDE 0100, but also to other standards, such as
– IEC 61439-1, Section 11.9,
– EN 60204,
– DIN VDE 0105,
– VDE 0110.

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 consuming equipment connected. If the insulation resistance is too low in this case, the consuming 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 a grounded conductor or a grounded 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]
Safety extra-low voltage, functional extra-low voltage with safe isolation	250	≥ 0.25
Protective separation	500	≥ 1
Rated voltage ≤ 500 V, and functional extra-low 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 the 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, i.a., that the electrical systems and equipment must be operated in accordance with the rules of electrotechnology, which includes 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 on 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, i.a., that high-current systems must be kept in proper conditions in accordance with the standards governing their installation.

Defects of 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 condition.

A switchgear system is defective if safety is jeopardized by its operation.
In order to be able to timely recognize any defects that might have occurred after commissioning of the electrical systems or after a repair or modification thereof, DIN 57105 part 1 / VDE 0105 part 1 demands the performance of repetitive tests, however, without detailing concrete terms for the test cycles. Repetitive tests serve for the evaluation of the proper condition of electrical systems and equipment.
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

For cleaning the switchgear system inside, the system or component must be off circuit. It is not recommended to use compressed air for purging dusty systems.

Safety at work:
The procedure for performing switching operations is prescribed by the implementing instructions on 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 in compliance with the following five safety rules which must be applied as a standard:

Five safety rules

Before to start the work:
– Safety isolation
– Protection against re-closing
– Verify off-circuit condition
– Earthing and short-circuiting
– Cover or barrier adjacent live parts.

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

5.14.2.2 Health and safety

Please note the following information:
– In accordance with the valid regulations all installation and maintenance work involving MNS-switchgear systems may only be performed by qualified personnel.
– For manipulations at low-voltage switchgear system compo-nents, the component to be manipulated must be **isolated!!!** The power supply to the capacitor by a remote auxiliary power source, if any, must also be isolated.
– When the system has been isolated, allow the voltage stored in the capacitor to be discharged by the discharging resistors **by waiting for one minute**. As an additional safety measure, the outgoing capacitor circuits must be tested for discharged condition using an insulated cable.
– Check whether the current transformers have been short-circuited before they are isolated or connected.
– The automatic capacitor must be installed in accordance with the standards IEC 60831-1&2 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 inspection of electrical systems.

5.14.3 Maintenance and inspection of MNS switchgear systems

5.14.3.1 General

– Especially in the case of systems associated with a higher risk (e.g. nuclear power plants) the operation and maintenance must be handled extremely carefully in order not to exceed the acceptable limit risk.
– For information on the mechanical and electrical life of electrical equipment, please refer to the relevant product documentation.
– All maintenance work and the required tightening torques relating to the electrical equipment in use must also be carried out in accordance with the binding manufacturer´s instructions.

5.14.3.2 Maintenance intervals (incl. item no. acc. to 5.14.4)

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 with circuit breakers

5.14.3.3 Notes on 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, because the frequency of maintenance or inspection 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 Service on Tmax XT1 and XT2 mechanisms in MNS-R (8E/2 and 8E/2)

After 1000 operation cycles or once a year the mechanism has to be checked (condition, function, damages, etc.) and greased. ABB prescribes Liqui Moly® (TYPE LM 47) with ABB ID 1TGB000235P0001. After greasing, please ensure the modules are not contaminated with dust or dirt, 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 module 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 all four fixing location fastener are not damaged during removal of the cover.

Step 2: Greasing
The mechanism has to be greased with a brush as it can be seen in Figure 3 at the following positions. With the MCCB in the “Off” position see figure 4 and 5. With the MCCB “On” position see figure 6 and 7.
For each of the four positions use approximately 0.5 g of grease.

Step 3: Fixing of top cover
The top cover has to be correctly located on the Tmax XT mechanism. It shall be checked that all fixing hooks locate in their positions.

Step 4: Inspection before putting into service:
– Carry out a visual check that the unit is in good condition
– Check that the unit is working 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. With a tool, e.g. screwdriver, is must be possible to use the test function of the Tmax XT breaker.

Part Numbers:

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

Fig. 1 and 2: Cover removal

Fig. 3: Grease on the tip of brush

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

Fig. 4 and 5

MCCB switched to the On position

Grease the bowden wire in the channel on the pull off

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

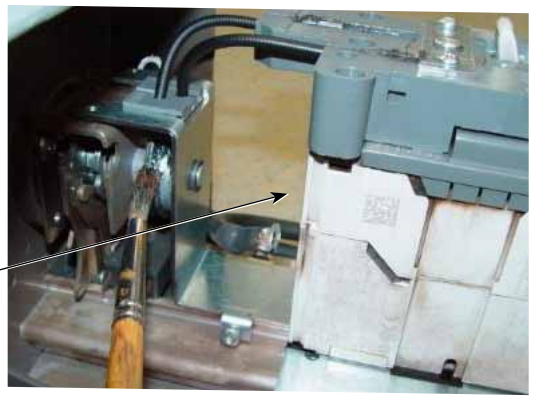


Fig. 6 and 7

test button

Fig. 8: Test button

5.16.4 Maintenance and Inspection List

			Frequency Install. category			
Item no.	**Work to be performed**	**Measured, test and limit values, operating and auxiliary materials**	**A**	**B**	**C**	**Remarks**
1.0	**General visual inspection (repetitive tests)**					
1.1	External inspection					
1.1.1	Verify ambient conditions	– Room temperature ≤ 35 °C – Air, aggressive gases etc. – Relative humidity ≤ 50% at 40 °C – Dust	1a	6m	X	Unpleasant smell Auxiliary heating possibly required
1.1.2	Check ventilation system (efficiency) – Operating room – Switchgear system	 – Air supply to and air discharge from section not obstructed – max. temperature inside the section: ≤ 60 °C	1a	6m	X	 Touch fronts with hand surface, check section if hand-warm spots are found
1.1.3	Check condition of enclosure / outside paint	– Damaged / corroded – Missing parts such as module doors or covers – Ventilation louver dusty / covered – Roof plate contaminated / covered / obstructed / etc. – Fastening of cable compartment doors, side and back panels – Position of withdrawable modules in the section (operating or isolated position) – Cable / equipment compartment doors closed / open	1a	6m	X	
1.1.4	Accessibility	– Escape route ≥ 650 mm	1a	6m	X	

Insulation resistance inspection

Measure the insulation resistance in accordance with the same procedures indicated for the start. Measured values should not be very different from those detected during the start.
If the insulation level is notably less, carry out voltage tests. It is better to perform the insulation resistance measurement before the voltage tests, and in case of insulation resistance decrease it is necessary to search the crush point.

Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Frequency Install. category A	B	C	Remarks
1.2	**Completion of the interior**					
1.2.1	Equipment compartment					
	– Check filling factor and equipment	– Arrangement of modules in accordance with engineering documents	1a	6m	X	
	– Internal conditions	– Contamination, e.g. dust				Clean
		– Contact surface blackening				Clean with cloth and solvent
		– Loosened screw				Tightening torque indicated in par. 5.11
	Circuit breakers	– See the related installation, operation and maintance instructions				Carry out the suggested maintenance procedures
1.2.2	Cable compartment / cable terminal compartment	– Incoming feeder in accordance with documents (busbar / cable laterally / top / bottom)	1a	6m	X	
		– Sufficient room / strain relief				
		– Cable routing; bending radii				
	Personal protection / protective bellows	– Protective bellows				
1.2.3	Busbar compartment					
	– Check transport connections	– Loosened screw				Tighten according to tightening torque
		– Color changes at bolted connections	1a	6m	X	Check using thermo-vision exposures
		– Proper installation of cover in partition wall 3				
	– Check busbar supports	– Contamination or flashover				
		– Formation of cracks or creeping paths				
	– Visual inspection of the condition of the busbar insulation	– Shrink-on tube brittle				
	– Insulating busbar keepers	– Dust				Remove the dust
		– Crack				Replace the demaged busbar
		– Discharge marks				Keepers
1.2.4	Earth busbar joints and relalated connections	– Copper Oxide				Remove the oxide by means of file or a emery cloth and clean with cloth and solvent
		– Loosened screw				Tighten according to 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

Insulation resistance inspection

Measure the insulation resistance in accordance with the same procedures indicated for the start. Measured values should not be very different from those detected during the start.
If the insulation level is notably less, carry out voltage tests. It is better to perform the insulation resistance measurement before the voltage tests, and in case of insulation resistance decrease it is necessary to search the crush point.

Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Frequency Install. category 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	2a	1a	X	Measure the insulation resistance
1.3.2	Check electrical equipment installed	– Bracing – Check contact corrosion, contact gaps, ionization chamber arc splitter, rated currents, settings and tripping – Minimum creepage distance ≥12,5 mm – Check minimum clearance for arcing space				For the complete maintenance work, observe the instructions of the equipment manufacturer Cf. 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	**2a**	**1a**	**X**	
1.3.7	Function test of the control device	– In accordance with circuit diagram	**2a**	**1a**	**X**	Control connection cable.
1.3.8	Check measuring loops	– In accordance with circuit diagram	**2a**	**1a**	**X**	
2.0	**Additional checks**					
2.1	**Withdrawable technique**					
2.1.1	Compact modules (8E/4 + 8E/2)					
	– Check easy movement of module in compart-ment	– Remove dust and grease from guide rail if necessary	2-3a	1a	X	
	– Function test of mechanical interlock	– Lubricate with Omnigliss	2-3a	1a	X	
	– Check electrical contact-making		2a	1a[1]	X	
	- Main contacts	– Visual inspection – In case of doubt check contact clearance				Refer to Chapter 5.5
	- Control plugs					
	- Visual inspection of module compartment	– Remove dust from guide rail with vacuum cleaner – Actuate limit switch rocker (if available) – Check condition of mating contacts				Artificial light source
	– Check efficiency of protective conductor con-nection	– Check cam condition at supporting rail				
	Compact modules (8E/4 + 8E/2 + 6E/4 + 6E/2) with Tmax XT					
	– Clean the module	– Remove dust				
	– Check the mechanism	– Visual inspection and switching test without load				
	– Lubricate mechanism	– Greasing	1a	6m	X	Refer to chapter 5.19
2.1.2	Withdrawable modules 4E					
	– Check easy movement of module in compart-ment					
	– Function test of mechanical interlock					
	– Check electrical contacts					
	- Main contact	– Visual inspection – Check of contact force – Greasing	2a[1]	1a[1]	X	Refer to Chapter 5.5 Refer to chapter 5.6
	- Control plug					
	– Fastening of outgoing cable unit	– Position; the outgoing cable unit might be pressed out of its normal position by strong cable forces				
	– Protective conductor connection	– Condition of the roller in the compartment bottom plate				

[1] Main contact to be checked either according the mentioned time intervals or latest after 100 cycles.

Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Frequency Install. category A	B	C	Remarks
2.2	**Plug-in**					**Cf. also 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		1a	6m	X	Check of contact gaps, contact condition and lubrication not neces-sary
	– Visual inspection of main contacts X01					
	– Condition of short-circuit protection					Control connection cable.
	- LV HRC fuse	– Fuse continuity				Refer to chapter 5.6
		– Fuse tripped				Signs of overload by mains
	- Circuit breaker	– Contact condition				resonance in accordance
	– Lubricate contact blades of LV - HRC fuses	– Klüberlectric KR44-102				with manufacturer´s
	– Check capacitor contactor					instructions
	- Check for contact corrosion	– Contact condition				
	- Switching performance	– No humming, bouncing or chattering of reactor				
	– Visual inspection of filter circuit reactor					
	Connections and windings	– Condition				
	– Capacitor	– Setpoints see chapter 5.15				Use measuring log
	- Design without reactor: measure all step currents 3-phase or capacitance values	– Limit value: IB ≤ 1,3 x In				according chapter 5.17
	- Design with reactor: measure the terminal capacitance					
	– Discharging device					
	- Reactor	– Residual voltage after 1 min ≤ 50 V				
	- Resistor bank	– Color change, missing elements				
	– Cable connection	– Insulation molten or even corroded				
	– Screwed connection at electrical equipment	– For tightening torque, cf. manufacturer´s instructions				
	- Insulation					
	Check controller module					
	– Check controller settings					
	- C/k value	– In accordance with manufacturer´s operating instructions				
	- cosφ setpoint					Power circuit open, i.e.
	- response time	– Approximate value 60 s				fused switch discon
	– Check step triggering					nector removed

[1] Main contact to be checked either according mentioned the time intervals or latest after 100 cycles.

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