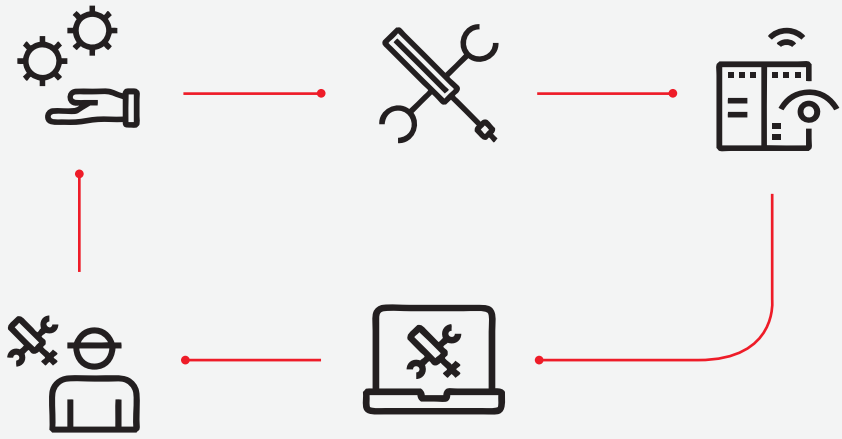
LOW VOLTAGE SYSTEM

MNS® low voltage switchgear
Service manual



- Fast and professional
- Reliable and safe
- Life cycle management for an improved performance

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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 noncompliance 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**

Technical reservations

- **The data and figures of this publication are subject to change as required by technical progress**
- **Disconnectable and railable technique mentioned in this brochure are not applicable to China market.**

Table of contents

Safety first

Safety requirements when working on electrical systems.

Safety relevance

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

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

Understanding and managing the risk

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

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

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

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

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

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

- Intact Insulation. Under these conditions the circuit fulfils its designed function and the flow of energy can be predicted.
- Breached Insulation. Under these conditions a short circuit may occur. This could prove hazardous to life and property.

The flow of energy is random and may not be predictable. Damaged insulation must always be reported. There are two reasons for accidental contact with live parts:

- Apparatus being made live whilst others are working on it,
- Unsafe working practices .

The highest danger to human life and property is the situation with the occurrence of an electrical arc. An electric arc is a dangerous release of energy created by an electrical fault or short circuit. It contains thermal energy, pressure waves, acoustic energy and debris. The intense energy and very short duration of an electric arc flash represents a very unique event.

The temperature of an electric arc can reach up to 20 000 °C (35 000 °F), or two to three times the surface temperature of the sun! Exposure to these extreme temperatures both burns the skin directly and causes ignition of clothing, which adds to the burn injuries.

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

Warning signs and labels

‘No Overlapping, No Stepping’ on the Pressure relief roof plates & the Bulged roof plates & the expanded metal mesh roof plates.

Electrical systems shall be labeled according to the hazard risk level. ISO 3864 and its ANSI equivalent Z535.4 prescribe the layout and application of signs. Following sings are typically applied:

Typical warning signs and labels

High Voltage ISO 3864	Arc Flash Hazard ISO 3864	Warning Sign ANSI Z535.4	Danger Sign ANSI Z535.4
			

Basic principles and precautions to be observed

In accordance with the valid local regulations, all installation and maintenance work involving MNS low voltage switchgear systems may only be performed by skilled and qualified personnel. For work at low voltage electrical system and components, the component to be modified or worked on must be isolated and confirmed dead.

If in doubt of the task to be carried out, ABB Service technicians should be utilized for the work. Never utilize untrained personnel who are not certified with the system.

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

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

Areas of work

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

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

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

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

Five safety rules

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

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

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

Permit to work

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

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

Personal Protection Equipment (PPE)

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

When working on or near live parts the minimum standard for clothing is that products shall be capable of withstanding e.g. electrical arc with an incident energy of 8 cal/cm^2.

For the majority of work on or near energized systems, this means that the clothing provided must be manufactured and tested to the following standards:

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

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

Special considerations when working on electrical equipment

Capacitors

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

CT's

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

Auxiliary or temporary supply

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

Technical description

1.1 Technical data

MNS3.0 front access switchgear

Standards	**Type-tested switchgear assembly**			**GB/T 7251.1/12-2013, IEC 61439-1/2, EN 61439-1/2, DIN_VDE 0660, Patr 500 of BS 5486, UTE63-412**
Test certificates	China compulsory product certification			China quality certification centre
	Type test			ASTA, Shanghai testing & inspection for electrical equipment
	Short-circuit withstand strength test			ASTA, Shanghai testing & inspection for electrical equipment
	Resist to accidental arcs acc. to IEC 61641 and part 508 of VDE0660			ASTA, great-Britain
	Classification society certification (shipping)			Gemanischer lloyd
	Earthquake test for security areas in nuclear power stations			DRL german research institute
Electrical data	Rated voltages	Rated insulation voltage Ui		up to 1000 V AC , 3P, 1500 V DC**
		Rated operating voltage Ue		up to 690 V AC, 3P, 750 V DC
		Rated impulse withstand voltage Uimp		6/8/12 kV
		Overvoltage category		II/III/IV
		Degree of pollution		3
		Rated frequency		up to 60 Hz
	Rated currents	Busbars	Rated current Ie	up to 6300 A
			Rated peak withstand current Ipk	up to 220 kA
			Rated short-time withstand current Icw	up to 100 kA
		Distribution bars	Rated current Ie	up to 2000 A
			Rated peak withstand current Ipk	up to 220 kA
			Rated short-time withstand current Icw	up to 100 kA
		Arc proof	Rated operating current	690 V
			Expected short-circuit current	100 kA
			Duration of short-circuit	300 ms
			Criterion	1 to 7
Mechanical characteristics	Dimensions	Sections and frames		DIN41488
		Standard height		2200 mm
		Standard width		400, 600, 800, 1000, 1200 mm
		Standard depth		800, 1000, 1200 mm
		Basic grid size		E=25 mm acc. to DIN 43660
	Surface protection	Frame		Alu-zinc coated
		Internal partitions and mounting plate		Alu-zinc coated or zinc coated or non-metal
		Transverse section		Alu-zinc coated or zinc coated
		Enclosure		Alu-zinc coated and powder coated RAL 7035, light grey
	Degrees of protection	IEC 529		up to IP54
	Plastic components	Halogen-free, self-extinguishing		DIN VDE0304 part 3
		flame retardant, CFC-free		IEC 707
		Internal subdivision		up to Form 4

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MNS rear access switchgear

Standards	**Type-tested switchgear assembly**			**GB/T 7251.1/12-2013, IEC 61439-1/2, EN 61439-1/2**
Test certificates	China compulsory product certification			China quality certification centre
	Type test			Shanghai Testing & Inspection Institute for Electrical Equipment Co., Ltd.
	Short-circuit withstand strength test			
	Resist to accidental arcs			
	EEMC (electro magnetic compatibility)			
	Salt spray test			
	Seismic test			China national center for quality supervision and test of electrical apparatus products
Electrical data	Rated voltages	Rated insulation voltage Ui		up to 1000 V AC, 3P, 1500 V DC*
		Rated operating voltage Ue		up to 690 V AC, 3P, 750 V DC
		Rated impulse withstand voltage Uimp		6/8/12 kV
		Overvoltage category		II/III/IV
		Degree of pollution		3
		Rated frequency		up to 60 Hz
	Rated currents	Busbars	Rated current Ie	up to 6300 A
			Rated peak withstand current Ipk	up to 220 kA
			Rated short-time withstand current Icw	up to 100 kA
		Distribution bars	Rated current Ie	up to 2000 A
			Rated peak withstand current Ipk	up to 176 kA
			Rated short-time withstand current Icw	up to 80 kA
		Arc proof	Rated operating current	415 V / 690 V
			Expected short-circuit current	100 kA / 65 kA
			Duration of short-circuit	300 ms
			Criterion	1 to 7
Mechanical characteristics	Dimensions	Sections and frames		DIN 41488
		Standard height		2200 mm
		Standard width		400, 600, 800, 1000, 1200 mm
		Standard depth		1000, 1200 mm
		Basic grid size		E=25mm acc. to DIN43660
	Surface protection	Frame		Alu-zinc coated
		Internal partitions and mounting plate		Alu-zinc coated or zinc coated or non-metal
		Transverse section		Alu-zinc coated or zinc coated
		Enclosure		Alu-zinc coated and powder coated RAL 7035, light grey
	Degrees of protection	IEC 529		up to IP54
		Halogen-free, self-extinguishing		DIN VDE0304 part 3
	Plastic components	flame retardant, CFC-free		IEC 707
		Internal subdivision		up to Form 4
Extras	Busbar system	Busbars		Sheathed
				Silver galvanized
				Tin galvanized
	Special qualification	Test certificates		See test certificates listed above
				Special colours (standard RAL 7035)
	Paint finish	Enclosure		

1.2 Mechanical design

The basic mechanical design comprises:

- The frame
- The enclosure
- The internal constructions

The basic elements of the frames are C-sections of 2 mm thick sheet steel with holes at 25 mm intervals. The parts of the frame are secured with thread-forming screws and required no maintenance.

The corner joints are carried out by means of:

- Pressure plates
- ESLOK-secured hex head screws M10 x 18

Depending on the different type of construction, the cubicle may be enclosed partially or on all sides. Doors, front covers and rear walls can be provided with ventilation louvers. Windows in the doors are made of multilayer safety glass or polycarbonate (See Figure. 3 and 4).

Depending on the requirements or the design the cubicles are divided into functional compartments.

MNS 3.0 front access switchgears are designed in terms of single face and double face respectively. The single face MNS 3.0 front access switchgear is configured with 3 chambers, and the main busbar is located in the busbar chamber at the rear part of the switchgear. The device chamber for the installation of function unit is at the front left part of the switchgear, while the cable chamber at the front right of the switcher equipped with an openable door is used to facilitate wiring for the customer. A device chamber and a cable chamber are located on the rear and front part of the MNS side outgoing double face switchgear respectively which shares a common busbar chamber and both faced openable doors for operations are available for both faces of the swtichgear.

The equipment modules are situated in the equipment compartment.

The busbar compartment contains:

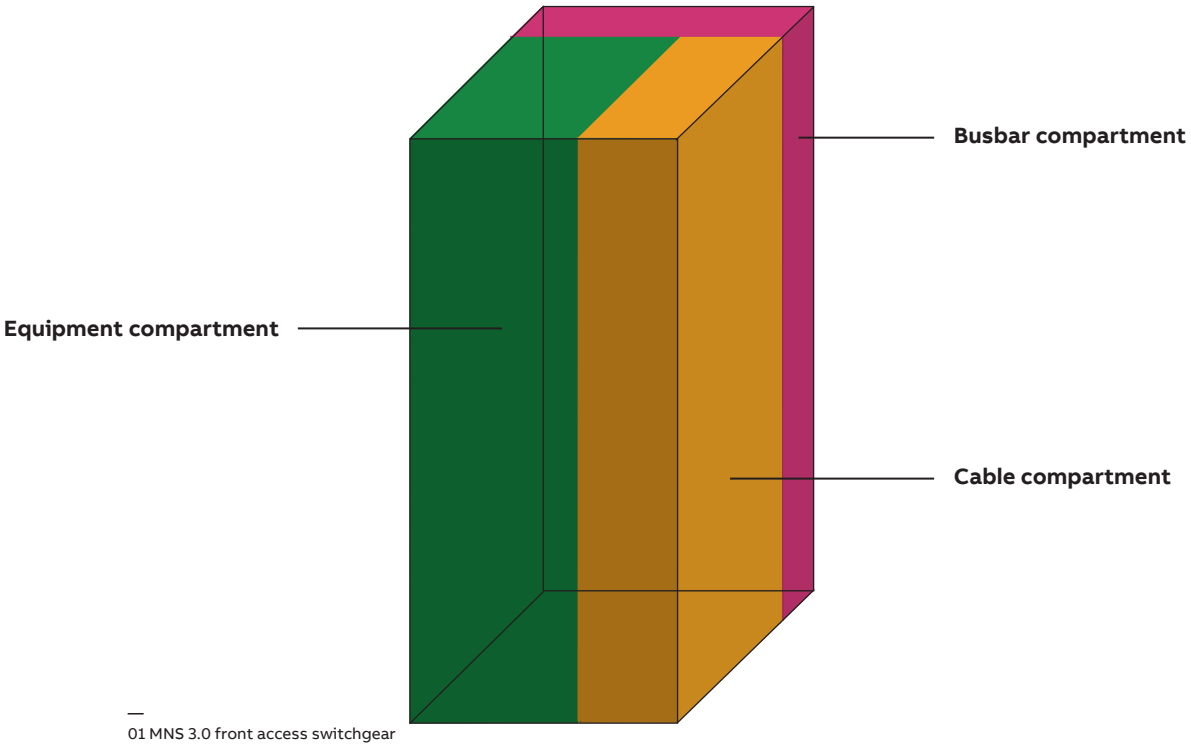
- Busbars
- Distribution bars

The cable compartment contains:

- Incoming and outgoing cables
- Cables for interconnecting the modules
- Auxiliary accessories (cable clamps, outgoing cable connection units, wiring ducts, etc.)

The equipment modules, functional compartments and cubicles are separate d by separation walls if required. Cubicles can be arranged for front operation or front and rear operation.

Three chambers are designed in the MNS rear outgoing cabinet. The main busbar is located in the busbar chamber on the top chamber of the cabinet. Device chamber of the functional unit is located in the front chamber of the cabinet. The rear door of the cabinet can be opened to reach the cable chamber which is available for the cabling by the client.



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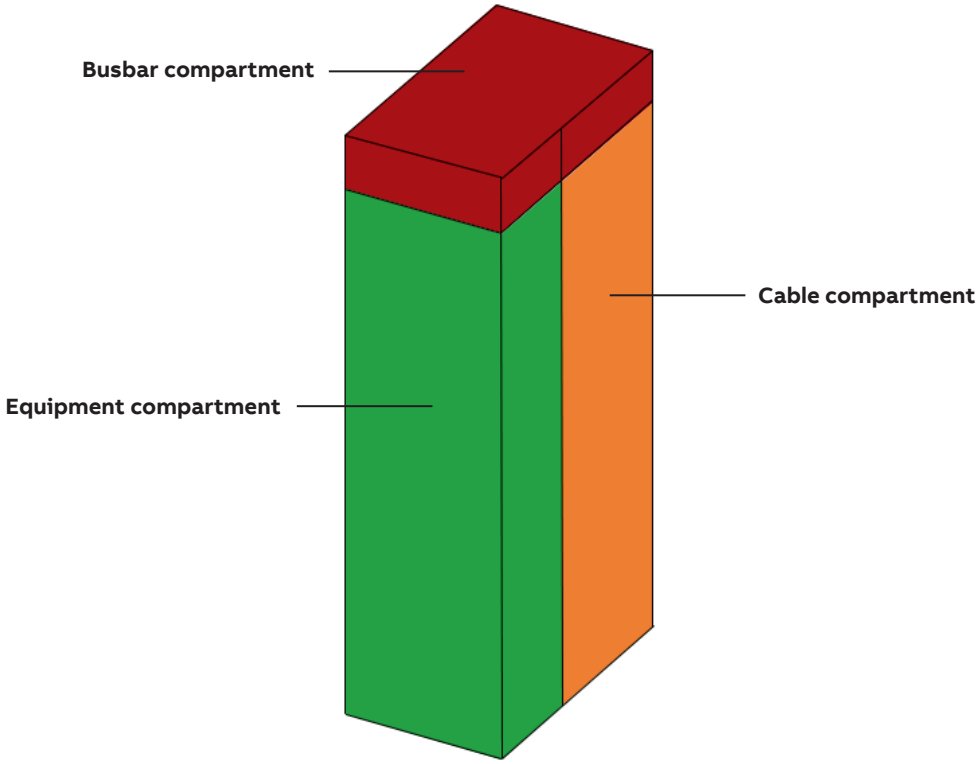
01 MNS 3.0 front access switchgear



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02 MNS Rear access switchgear

1.3 Busbar system

The following busbar systems can be installed:

- Busbars (see fig. 5, 6 and 11)
- Distribution bars (see fig. 7)
- Protective and neutral conductor bars (PE+N/PEN) (see fig. 6)

1.3.1 Busbars

The busbars are arranged in the rear section (busbar compartment) of the cubicle horizontally in two selectable levels:

- Double busbar systems are located at the upper and lower level
- Single busbar systems are located at the upper or lower level, as required
- The cross-section of the busbars in both levels can be different
- For double busbar systems separate, parallel or coupled operation is possible
- Depending on the current 2, 4 or 8 (2x4) conductors per phase are used
- Cubicles for front and rear operation have a common busbar system

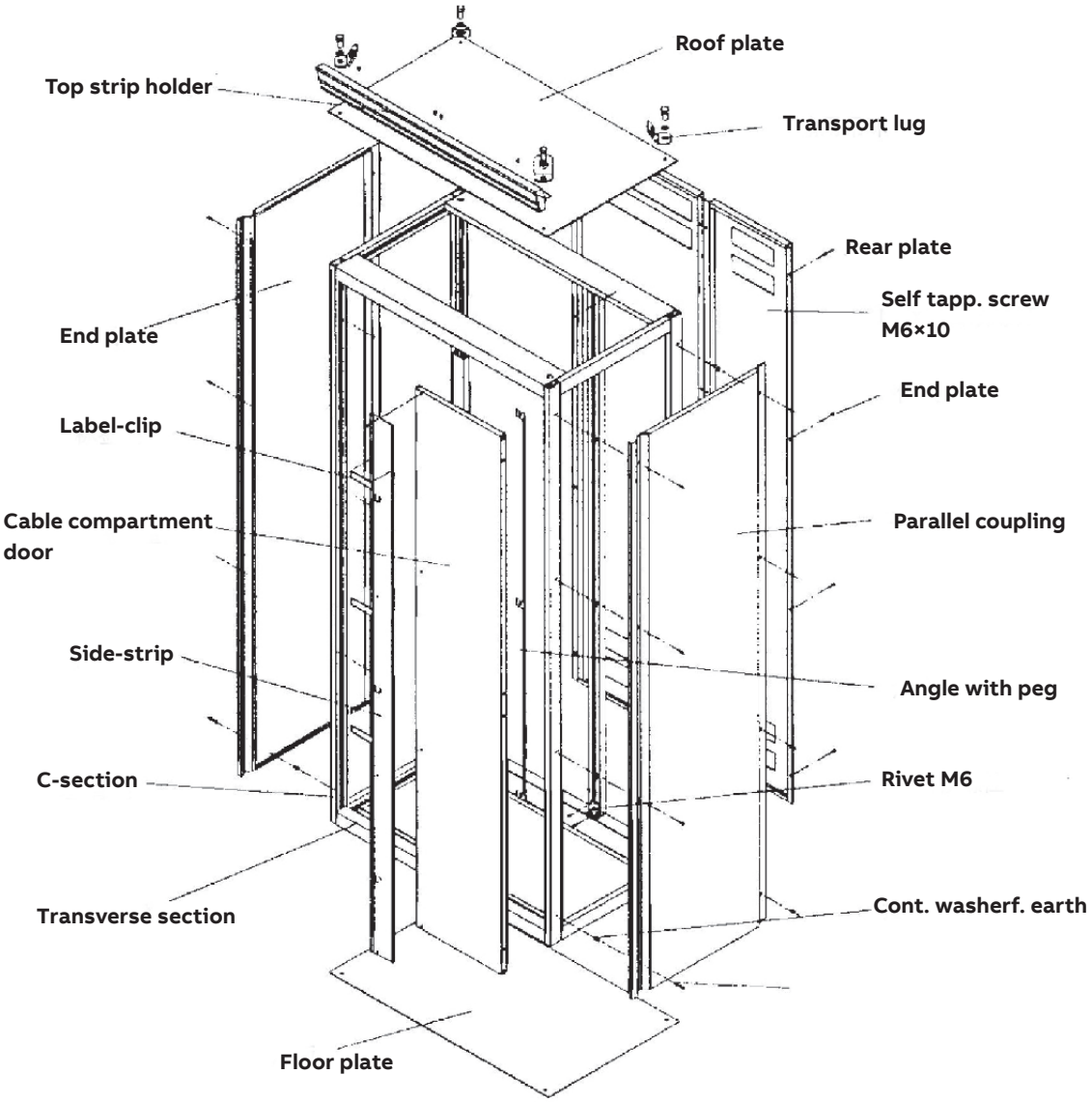
1.3.2 MNS rear outgoing main busbar

The main busbar is located on the top of switchgear (in the busbar chamber) divided in two groups i.e. front group and rear group:

- Double group main busbar system is arranged in the front and rear groups respectively
- Single group of main busbar system can be arranged in the front or the rear group
- Sectional areas of the two groups of main busbars could be different
- The main busbar is available in single, series connection and parallel
- Each phase could be consisted of either 2 or 4 main busbars depending on the current of the main busbar

1.3.3 Distribution busbar

- Distribution busbar is used for the connection between the components of functional unit and main busbar
- In the fixed design, the distribution busbar is located in the busbar chamber (See Figure. 7)
- In the draw-out design, the distribution busbars are embedded into the corresponding positions of the multi-function board (portection level IP20) and its flash guard function is realized by the cover plate of the distribution busbar. The multi-function board is made of insulation material



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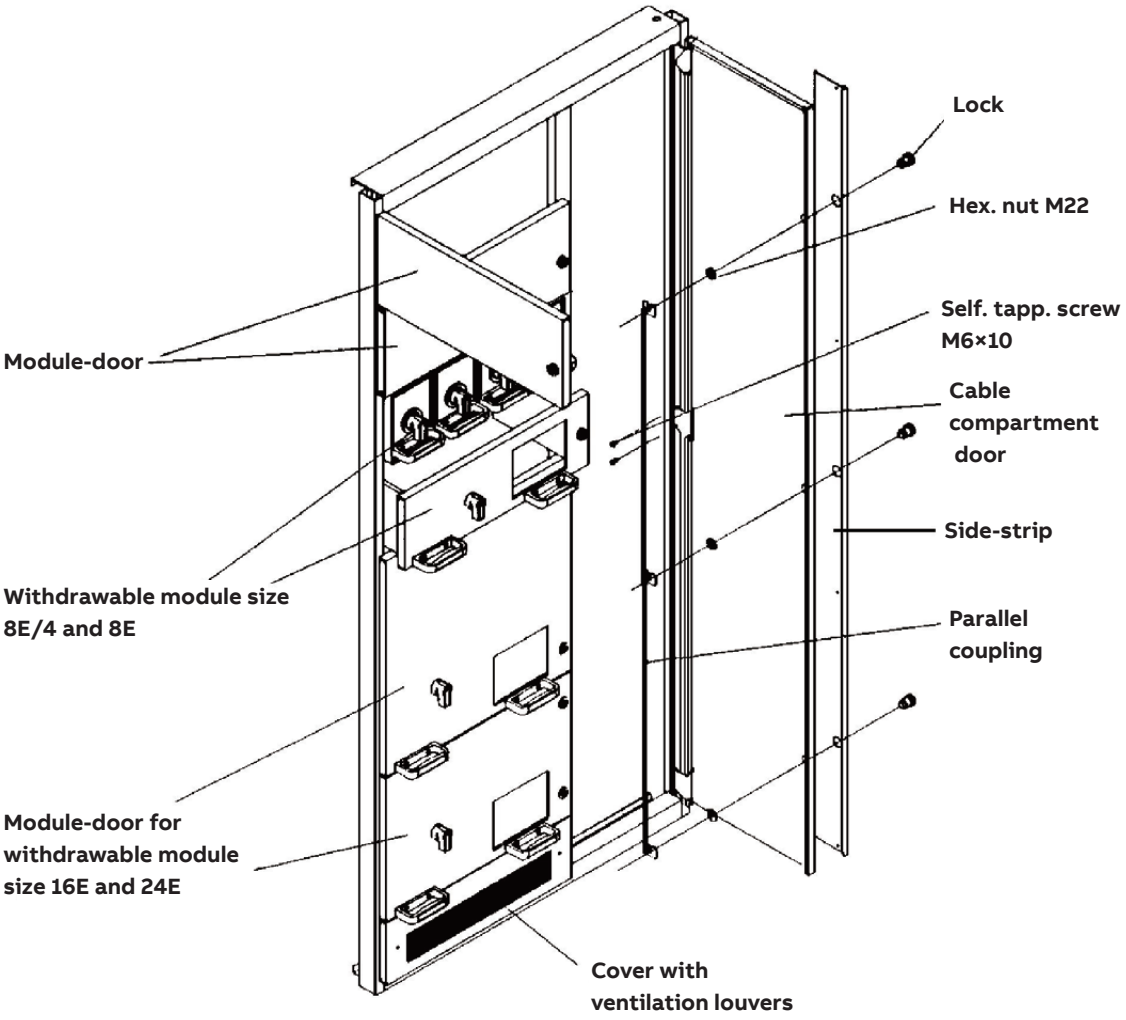
03 Frame with enclosure



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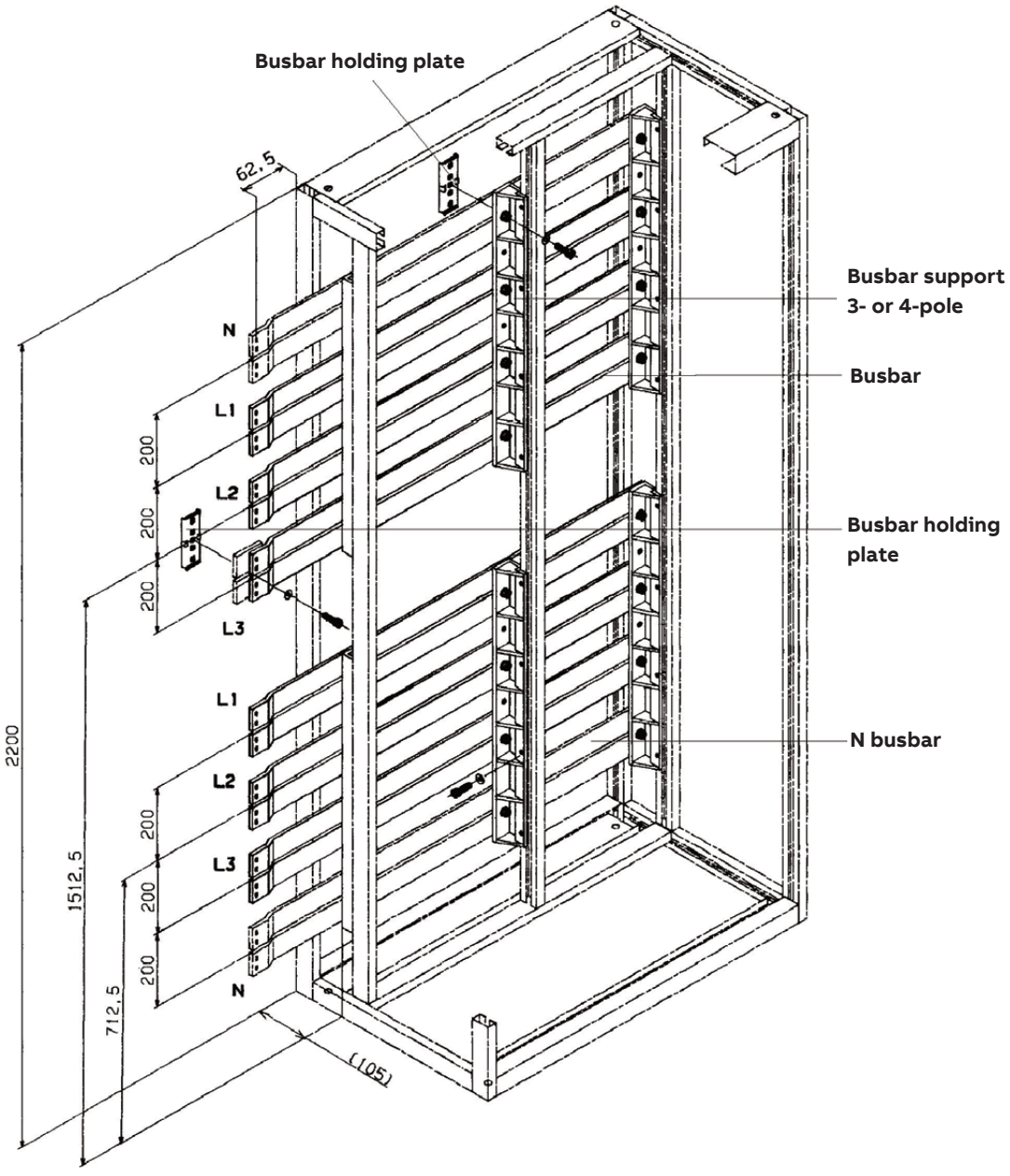
04 Front mounted equipment (example)



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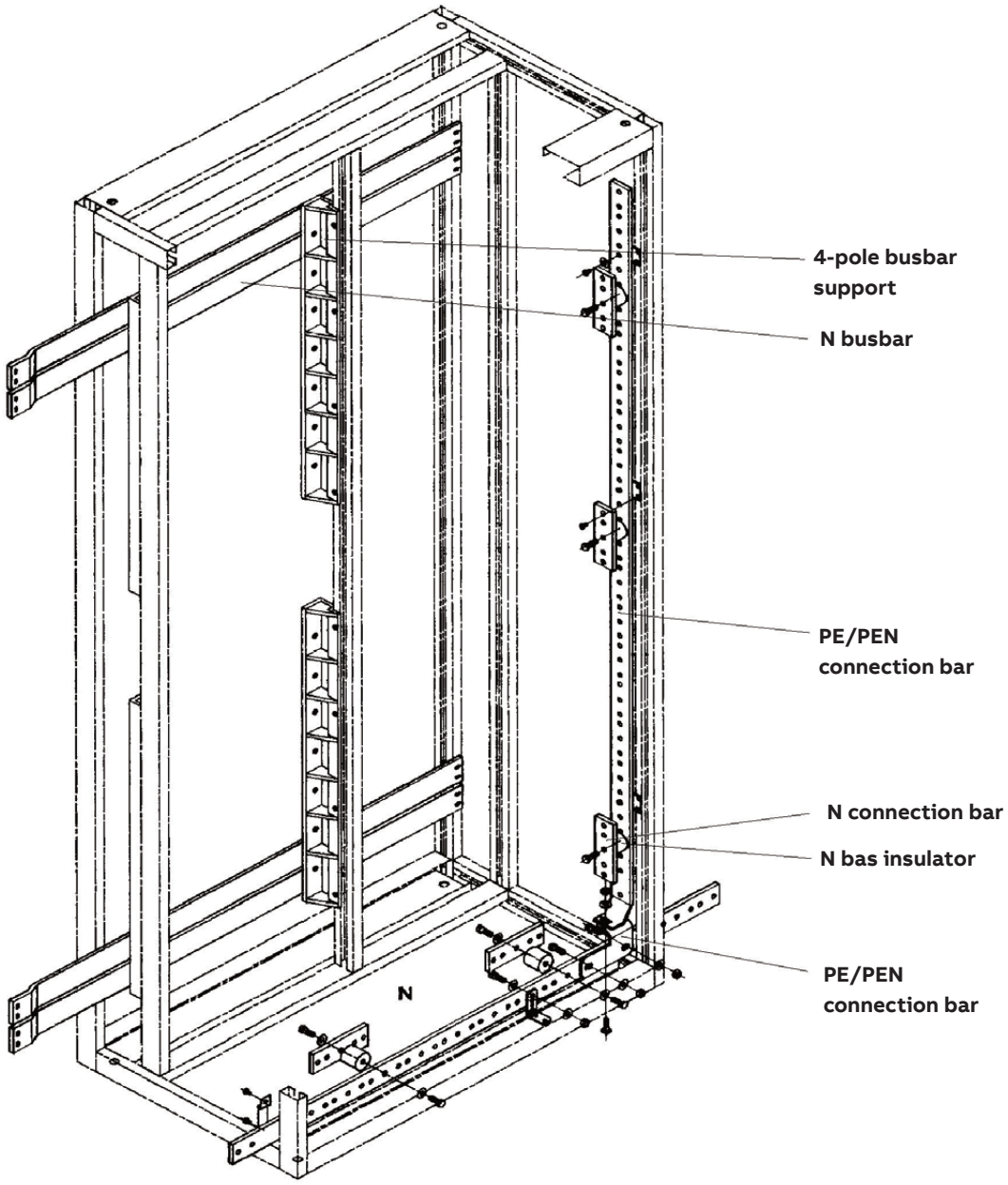
05 Busbar system with outlined 4th pole



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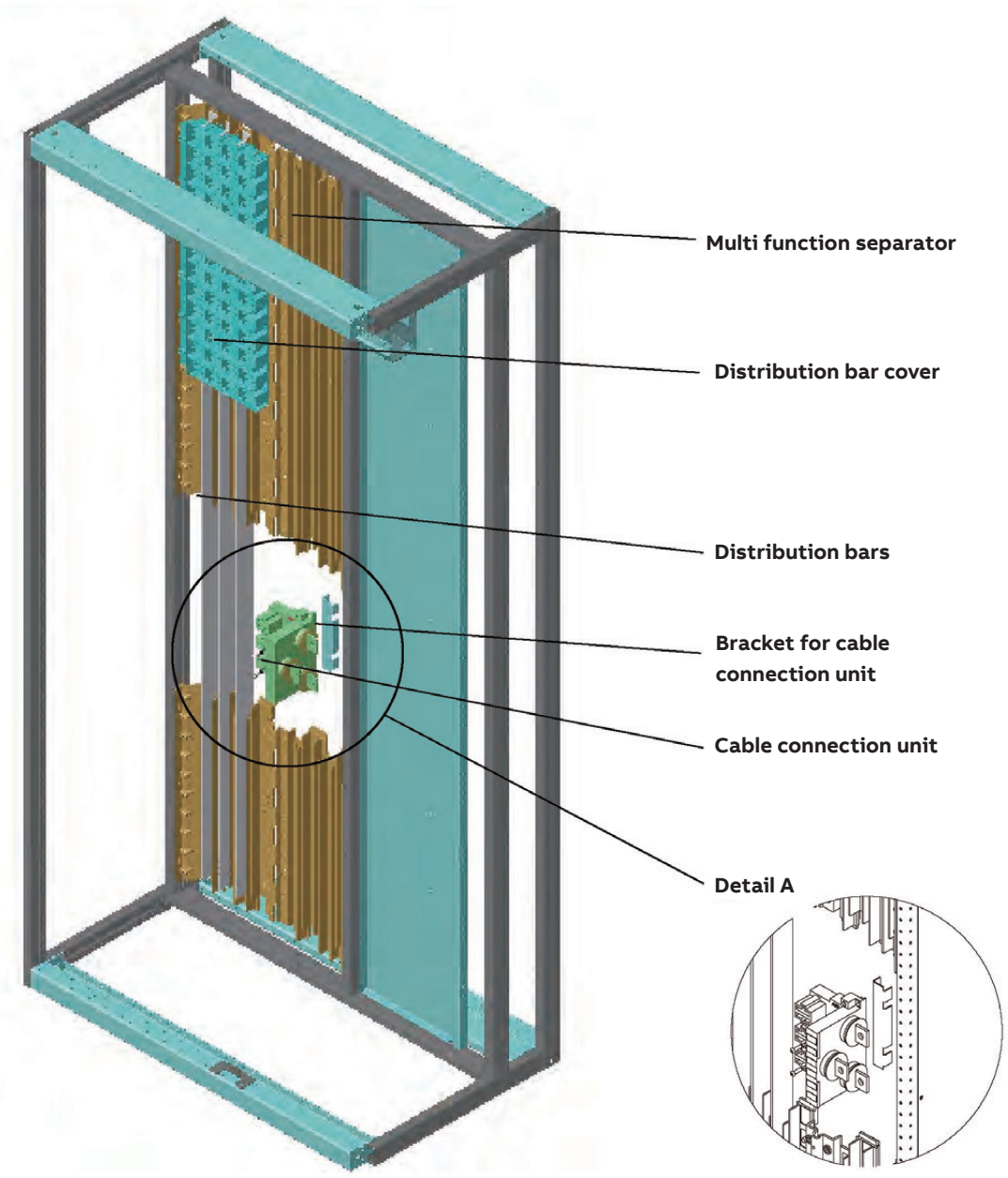
06 N-busbars, protective bars (PE) and neutral bars (N)



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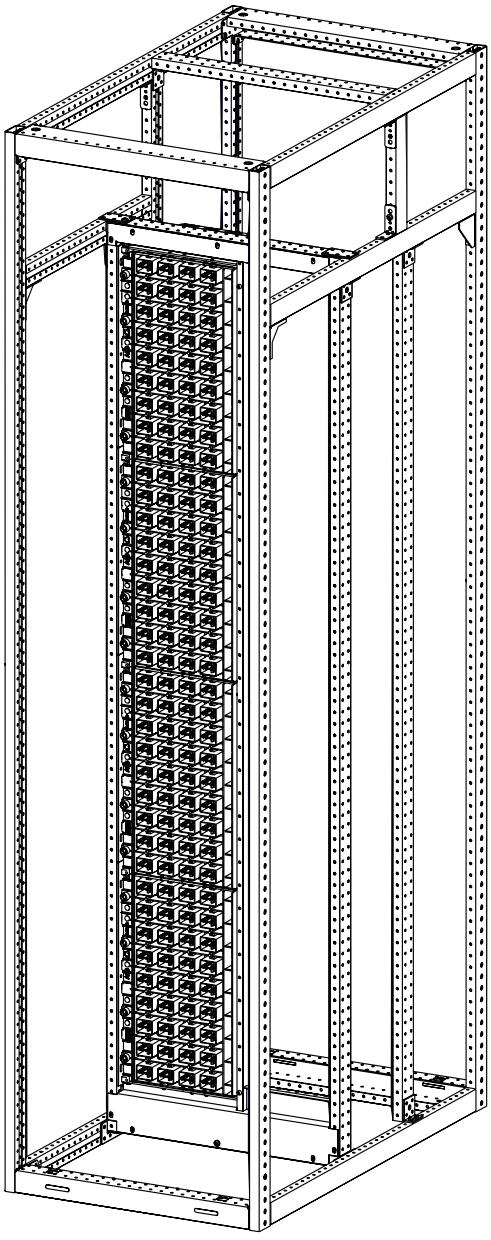
07 Cubicle distribution bar embedded in multi-function separator with outgoing cable connection unit and 2E distribution bar covers



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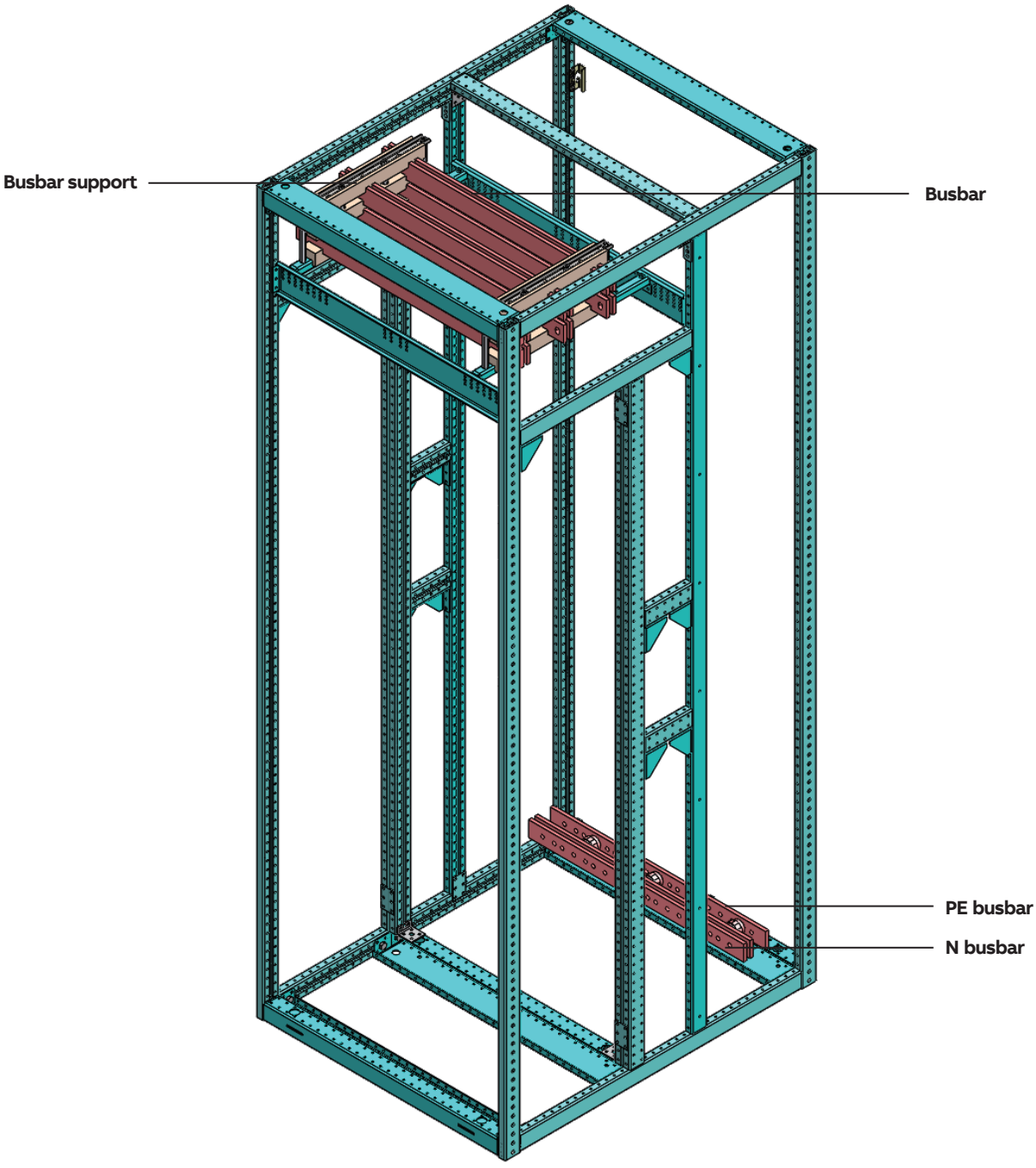
08 Multi-function separator located in rear access section



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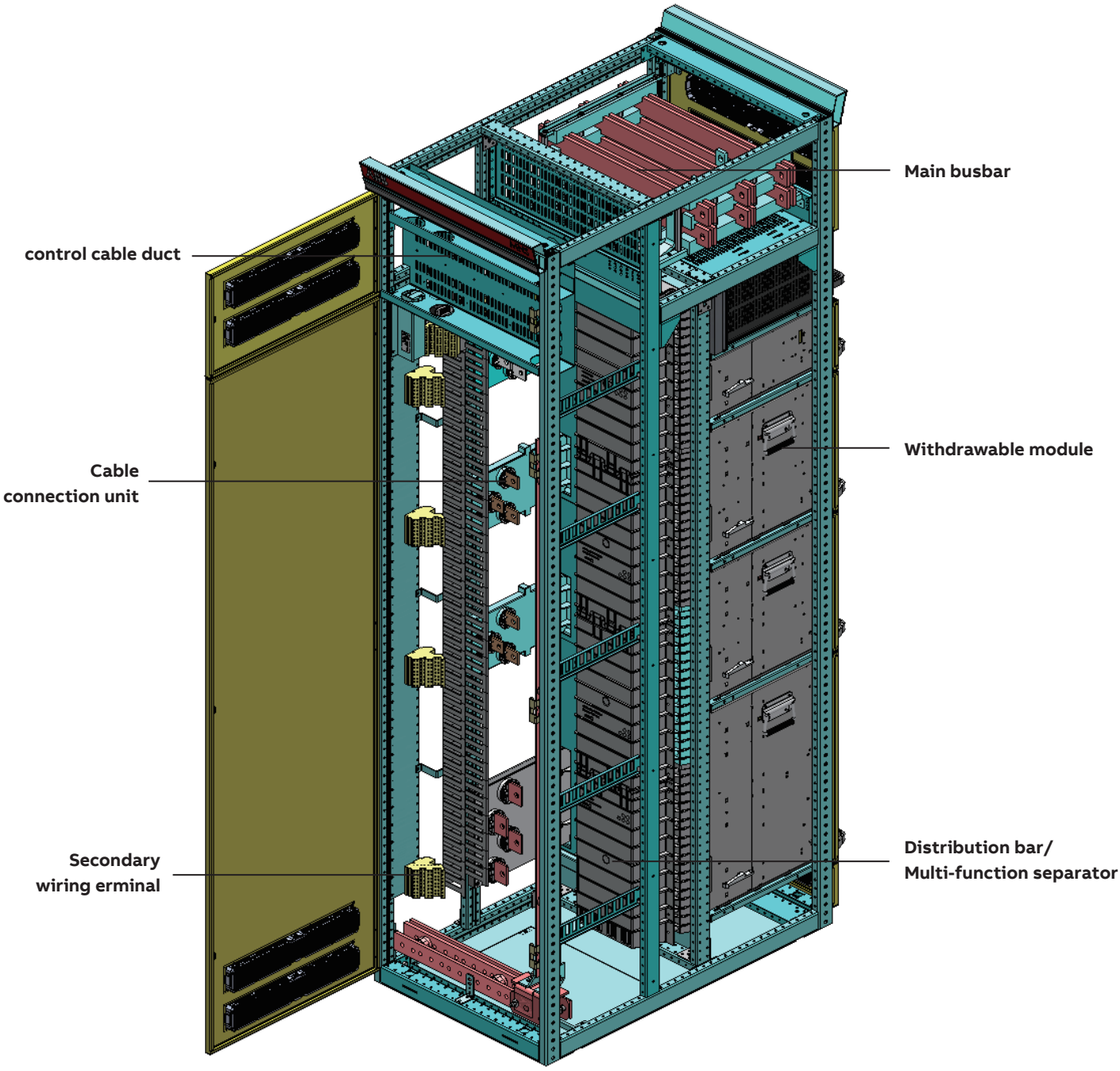
09 4P Busbar System



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10 A standard MNS feeder cubicle features width of 600 mm, depth of 1000 and height of 2300 mm. The primary outgoing line goes through CCU, and the user can conduct connection in the cable compartment. The secondary line is connected to the cable compartment via secondary components for user's connection. The function unit can be withdrawable or fixed style.

1.3.4 Protective conductor + neutral conductor/PEN conductor

Guard wire (PE) for the system connection is installed in the anterior inferior part of the cabinet rack unit and fixed directly onto the frame in parallel with the neutral line "N" strip which is fixed with insulator. The length of the strips depends on the length of the cabinet of the transportation unit.

The PEN strip is designed based on 50% or 100% size of the N strip and phase strip.

The guard wire for the connection of the cabinet is installed in the cable chamber vertically in parallel with the netural wire connection strip which is fixed with the insulator.

Modular holes are opened in all the PE+N and PEN strips for the connection of cables.

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11 With Emax withdrawable modular switchgear

1.4 Modular add-on parts

Standard designs are:

- Direct connection to the busbar
- Fixed technique
- Withdrawable technique
- Control modules or control cubicles
- Front modules (indicating, measuring, annunciating, operating and control units mounted on the instrument panel of the front cover or the measuring recess)

1.4.1 Direct connection to the busbar

Air circuit breaker and moulded-case circuit breaker.

1.4.2 Withdrawable technique

Withdrawable units comprise:

- The withdrawable module
- The frame-mounted module compartment

Standardized sizes are 8E/4, 8E/2, 4E, 6E, 8E, 12E, 16E, 20E,24E, 36E, 40E, 44E .

Modules ≥ 36E consist of 2 withdrawable modules interlocked with each other, whereby only the upper module is withdrawable. The lower module is bolted with the frame.

One 600 mm wide equipment compartment can contain:

- For size 8E/4 4 withdrawable modules
- For size 8E/2 2 withdrawable modules
- For size 4E to 48E 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:

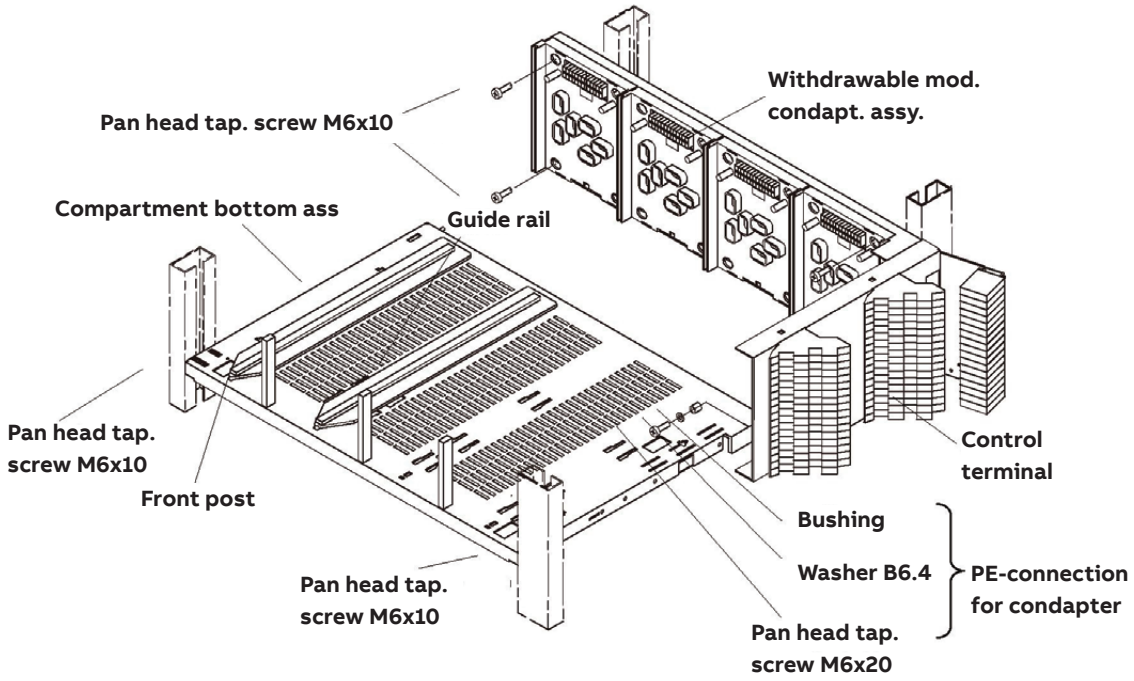
- Compartment bottom plate
- Withdrawable module condapter
- Guide rails
- Front posts

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: 16, 20 or 38 pole
- Control terminal for each 8E/2 module:
  with one control plug: 16, 20 or 38 pole
  with two control plugs: 32, 40 or 76 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 with drawable modules is made of insulating material and serves as instrument panel for measuring, operating and indicating units.



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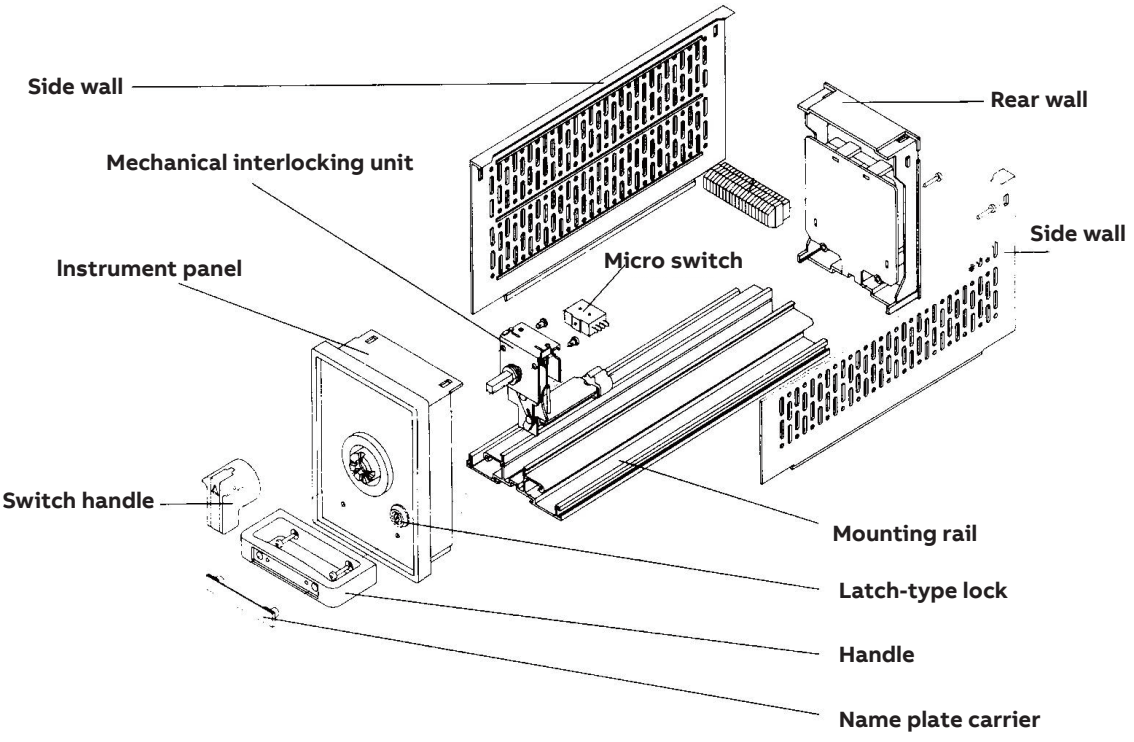
12 Withdrawable module compartment for 4 units size 8E/4 or 2 units size 8E/2



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

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

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

The uppermost withdrawable module compartment is covered by a compartment bottom plate.

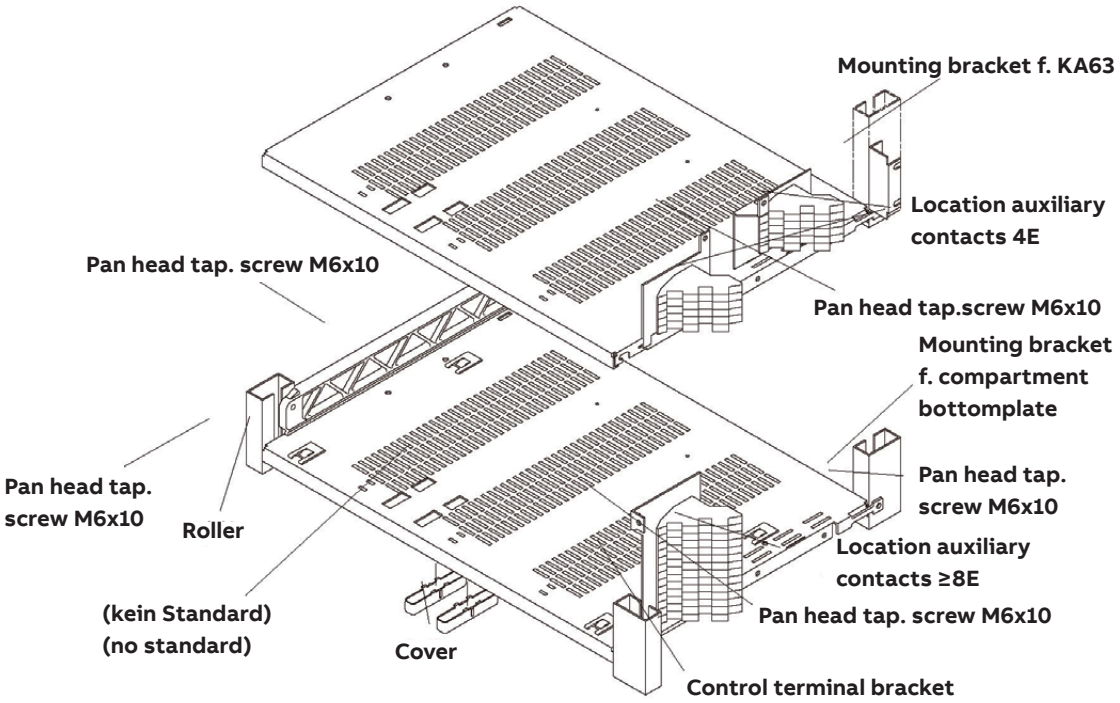
The top cover for the lower compartments is the bottom plate of the compartment above.

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 4E 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.



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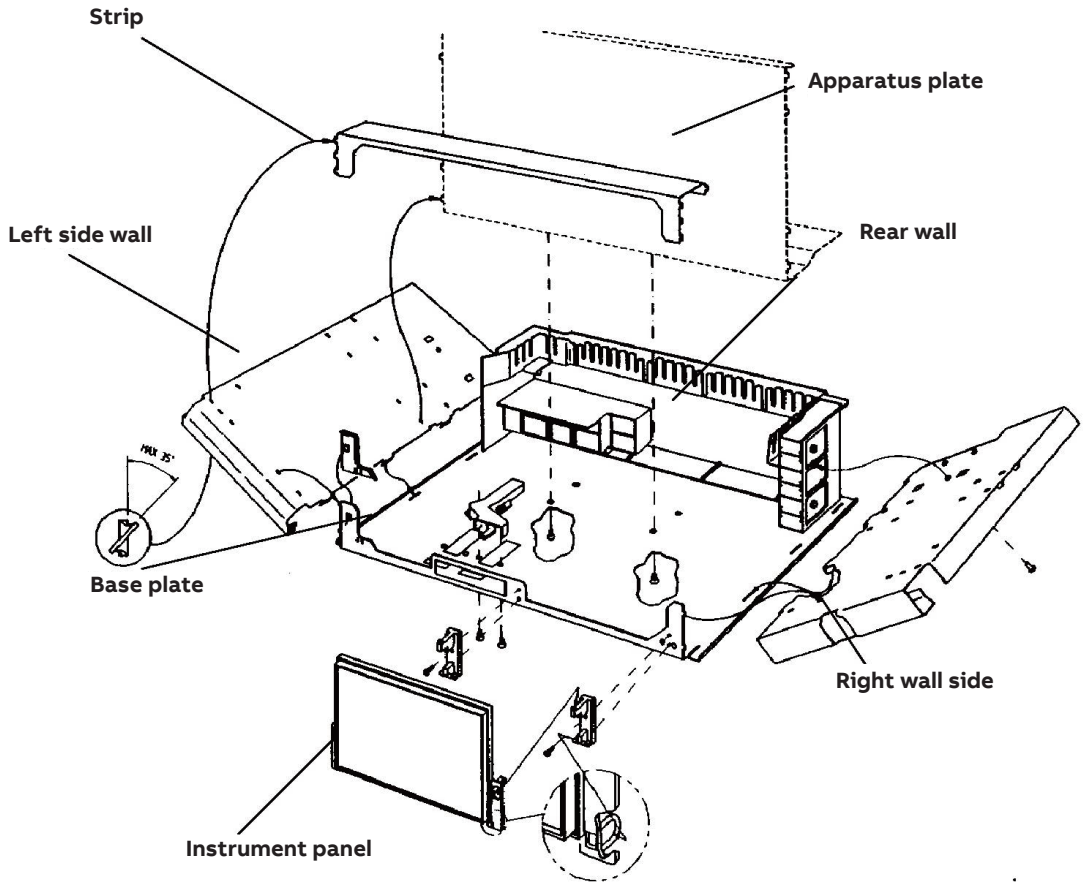
14 Withdrawable module compartment for units size 4E ...24E



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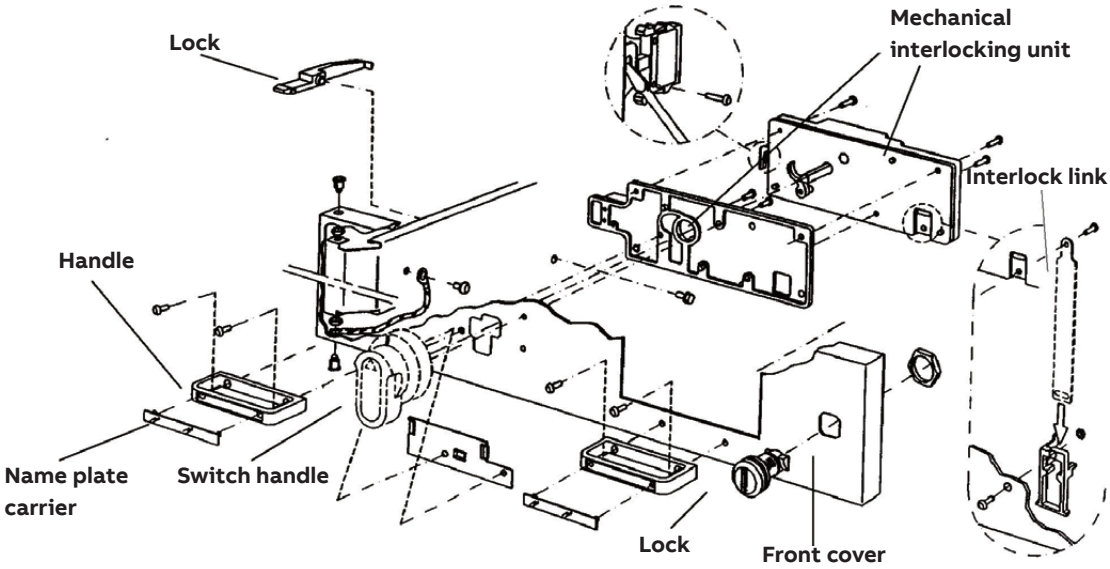
15 Empty withdrawable unit >4E (without electrical equipment)



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16 Withdrawable module door with interlocking for 4E ... 24E

Packing and transport

2.1 General

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

If no special instructions are given by the customer, packing is carried out based on ABB shipping guidelines and a suitable method of shipping is selected.

Maximum size of a shipping unit (length x width x height) in mm:

Unpacked	3100x1300x2200
Packed in crate	3300x1500x2540

Approximate values for weights per cubicle in kg:

	Operation from one side	Operation from both sides
Incoming feeder 1600 A	500	#
Incoming feeder 2500 A	700	#
Incoming feeder 4000 A	1000	#
Incoming feeder 6300 A	1800	#
Withdrawable module cub	500	900
Plug-in/disconn. mod. cub.	400	700
Control cubicle	300	500

2.2 Packing

2.2.1 Cubicles

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

The standard packaging comprises:

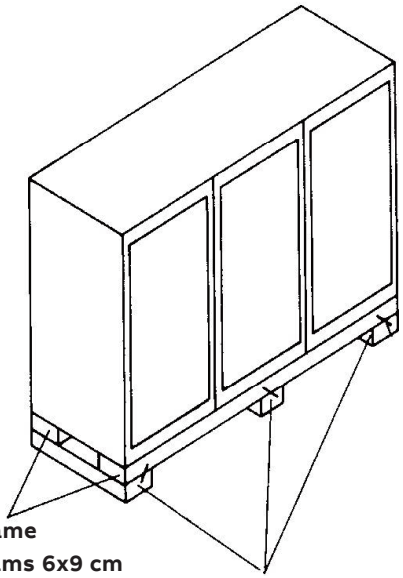
- PE-sheeting,
- Transport frame consisting of wooden beams (9x6 cm) with wooden fixing ledges and wooden cross beams (6x9 cm) for fork-lift transport (see fig. 17) or: euro pallet
- Plastic strips
- Wooden crate (if necessary)

Each unit is furnished with a tray.

- Is to prevent the cubicle steel sections from bending
- Consists of wooden beams 6x9 cm
- Has to be fixed in such a way that the front and rear transverse sections and the module supporting frame rest on the transport frame
- Has to be fastened to the cubicle by means of plastic strips and wooden fixing ledges. The plastic strips have to be bolstered by foam plastic foil

Unpacked shipping units have to be provided directly with wooden cross beams (see fig. 17) for handling by fork-lift trucks. For packed shipping units the wooden cross beams are located underneath the packing material.

To protect them against moisture, the switchgear installations have to be encased in a foil. A protective drying agent (such as silicagel) has to be provided between the foil and the switchgear.



—
17 Shipping unit with transport frame or euro pallet

The export/seaworthy packaging comprises:
- Closed wooden box
- Heat-sealed foil
- Drying agent (acc. DIN 55474)
- Wooden cross beams (8x10 cm) for fork-lift transport
- Elastic packing means as pads

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

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

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

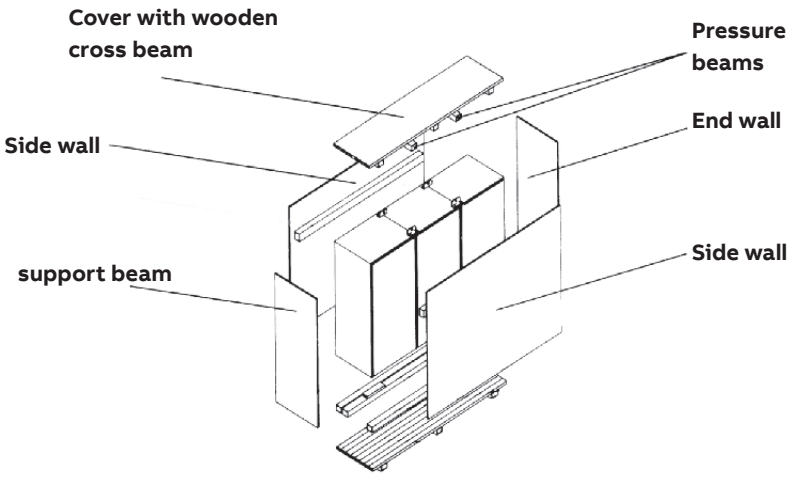
2.2.2 Packaging of switchgear components

The following devices and materials have to be delivered separately packed with the switchgear independent from the kind of transport:
- Draw out type air circuit breaker above E4
- Precision instruments of high value for measuring and indication
- Fluorescent tubes

With exception of the LV HRC fuses the above mentioned parts have to be marked (label, tag) by the work shop including the statement of the module location.

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

18 Crating



19 Box packing

2.3 Handling of switchgear components

2.3.1 Circuit breaker

Circuit breaker have to be treated the following way:

- Fixed circuit breaker have to be braced additionally
- Withdrawable air circuit breaker and withdrawable moulded case circuit breaker with a rated current of more than 1000 A have to be dismounted and packed separately
- Heavy busbar constructions have to be supported during transport in an adequate way. It is urgently necessary to attach a caution label demanding the removal of the used transport fixing material during switchgear erection.

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

The bracing has to be removed prior to commissioning. Separately shipped circuit breakers are to be mounted in accordance with the mounting instructions enclosed.

2.3.2 Withdrawable modules

Withdrawable modules have to be secured for shipping by their own mechanical interlock operated by the switch handle (OFF position).

Necessary switch positions prior to commissioning:

- Switch handle must be in position “OFF”

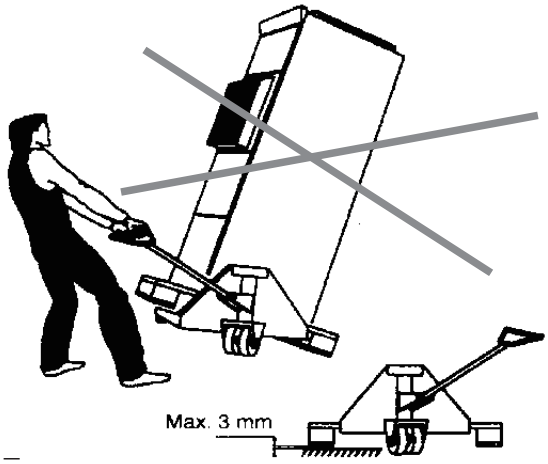
2.4 Unloading and transport at site

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

2.4.1 Ground transport

- By fork-lift truck (fig. 20)
- By lifting and conveying devices
- In an emergency, with rollers (min. 3 pieces) For roller transport the wooden cross-beams must be removed (see fig. 20)
- Switchgear cubicles have to be transported only in the vertical position
- Tilting and canting must be avoided (see fig. 20)
- Single cubicles (cubicles without withdrawable modules, circuit breaker cubicles without circuit breakers) may be briefly tilted into the horizontal position if the height of the doorway to the place of erection does not permit vertical transport. In this case the cubicle sections must be supported over a widearea

Cubicles may easily tip over when transported with a hand-pulled truck. Therefore the distance between he wooden cross beam or the pallet and the underground should not be more than 3 mm (see fig. 20).



—
20 Transport with a hand-pulled truck

2.4.2 Transport by crane

- For the transport by crane the cubicles resp. the shipping units are equipped with lifting angles (see fig. 25)
- Fastening of any lifting device directly to the frame sections is not permitted
- The lifting rope angle at the crane hook must not be larger than 120° (see fig. 23)

—
Guide values for permissible rope loading

Rope diam	Permissible load for a four-rope arrangement, rope angle at crane hook 120°		
	Hamp ropes DIN 83325	Perlon ropes DIN 83330	Steel ropes DIN 15060 (160 kg/mm²)
mm	kg	kg	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 rope angle of 90° the permissible load is appro-ximately 40% larger than the values given in the table.

The arrangements of the lifting angles are shown in fig. 25.Shipping units with one or two cubicles are equipped with singleangles.

Shipping units consisting of three or four cubicles areequipped with dual angles.

The sign advertising the tilting danger must not be removed before all cubicles have been secured to the foundation. Don´t put the switchgear down on one edge,because of the danger of a considerable mechanicaldamage.

2.5 Intermediate storage

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

Cubicles in standard packaging:

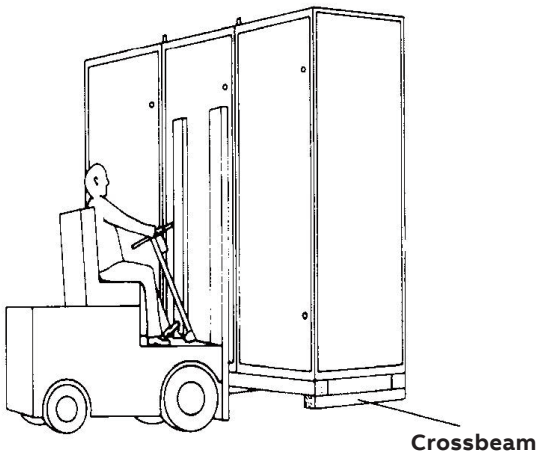
- Store indoors after arrival where no condensation can occur. Should be furnished with doors and windows which could be opened and closed as well as the controllable ventilation equipment. The relative humidity shall not exceed 65~70% and the temperature shall be kept between - 5°C to 38°C with an average temperature wthin a cycle i.e. 24 h not exceeding 35°C
- Unpack immediately
- Open the doors for several hours to acclimatize the equipment
- Cover the cubicles with plastic sheeting for any subse quent storage periods
- Check regularly for condensation forming under the sheeting until the start of installation

Cubicles with export/seaworthy packaging:

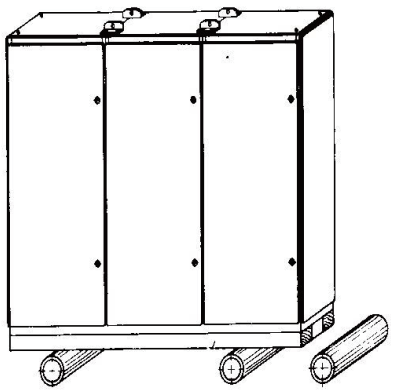
- Moisture protection is only guaranteed if the packaging is undamaged
- Storage period of maximum 12 months if wrapped in heat sealed PE sheeting and the packaging is undamaged
- A notification in advance is needed in case storage of 12 months is foreseen

2.6 Storage of drawers modules

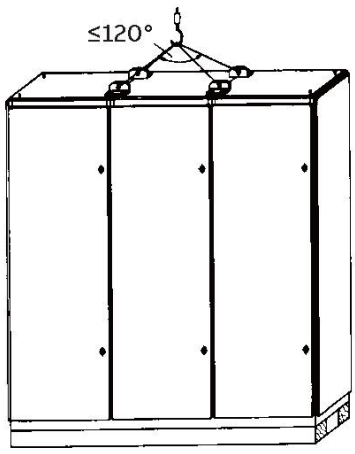
- Storage is only allowed in dry rooms
- The modules have to be stored in undamaged original packing
- Do not expose the modules to bigger temperature variations
- Store the boxes with the top side to the top
- Do not store modules with sizes ≥16E one on top of the other



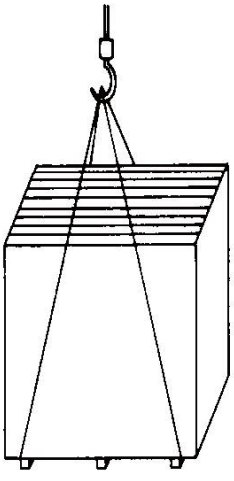
21 Fork-lift transport



22 Roller transport (only for weight of transport units up to 1200 kg)



23 Crane transport, transport unit unpacked



24 Crane transport, transport unit in box

2.7 Checks on delivery

Check the consignment on arrival at site for:

- Completeness
- Transport damage (if found, determine the extent, cause and originator)

When damage is detected it must be proceeded as follows:

- Immediately write down visible damage in the consignment note
- Report hidden damage in writing to the relevant forwarding agent within one week

When certification is missing or a claim has not been made, the manufacturer can disclaim all liability.

2.8 Constructional requirements

To prevent damage being caused by moisture and dirt the following tasks (only examples) must be carried out before erection of the switchgear:

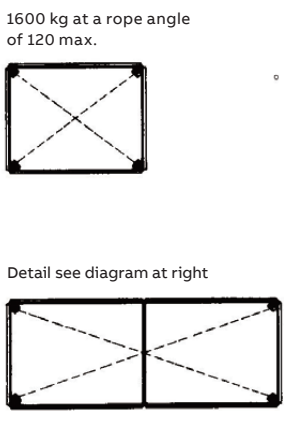
- Walls and ceilings plastered, painting completed
- Doors and windows installed
- Openings in the floor, wall and ceiling for cables, conductors pipes, bars and ventilation in accordance with the construction drawings provided
- Supporting brackets, beams, enclosures and foundation frames assembled and painted
- If necessary, assemble braces appropriate to the basic dimensions of the switchgear installation with cross struts corresponding to the cubicle divisions

Suitable indoor conditions must be maintained. Adequate lighting as well as free access to the switchgear rooms must be provided. Excessive temperature fluctuations together with high humidity should be prevented by heating the room. Condensation should also be prevented.

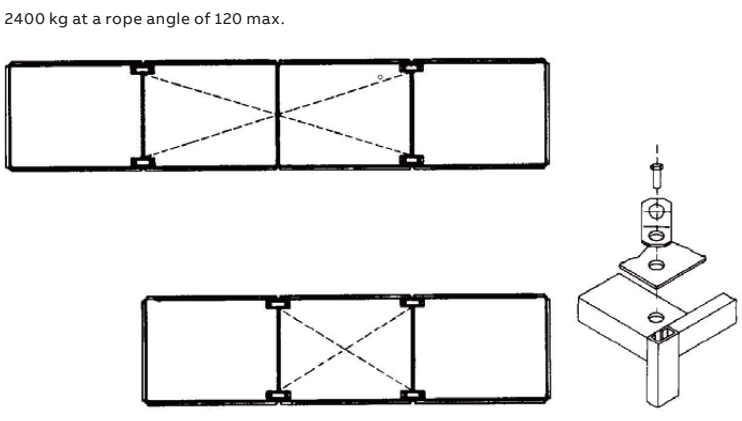
2.9 Removal of the transport frame

The transport frame has to be removed at site as described in the following before installing and connecting the switchgear:

- Release the rear parts of the transport frame. For this purpose it may be necessary to unscrew the rea walls
- Afterwards refit the rear walls correctly



25 Arrangement of lifting angles (plan view of MNS-cubicles)



26 Frame corner joint with lifting angle

Erection and commissioning

3.1 Erection

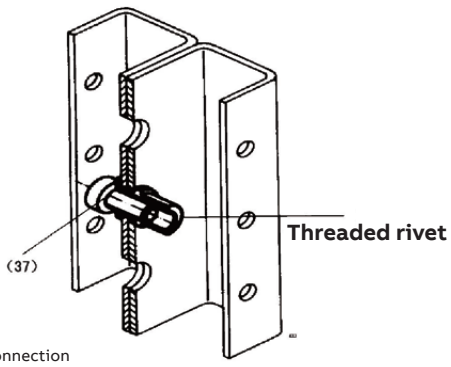
3.1.1 Erection and connection of the cubicles

The erection of the cubicles should be carried out, as described in the following:

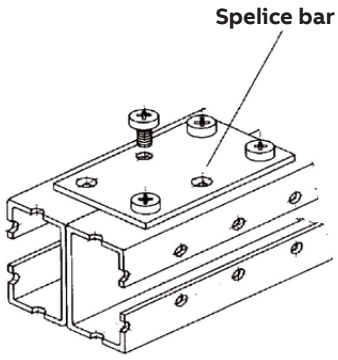
- The shipping units which are to be erected in one row have to be aligned accurately and checked that they are vertical. Doors and panels must not be twisted or stressed
- The frames of the shipping units have to be screwed together (see fig. 27). The vertica sections for front operated units are already fitted on the left front and rear with 4 special nuts. For front and rear operated cubicles, the vertical sections at front left and rear right are fitted with the special nuts
- The side walls for the end cubicles have to be fastened. For this purpose, taptite or torx screws M6x10 (see fig. 29) have to be used. During fastening the side walls it has to be made sure that at least at one bolted connection a protective conductor connection is realised by placing a contact washer underneath
- Additionally to the vertical sections or if the access to the screw joints in the vertical sections is obstructed by installed equipment, the bottom sections can be screwed together using the frame connectors which are enclosed (see fig. 28)

For the initial tightening of the thread-forming screws an electric or compressed-air operated screw-driver should be used.

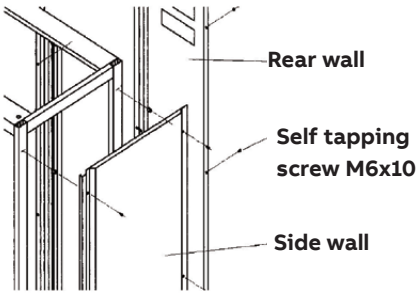
For tightening torques for bolted frame connections refer to chapter 5.10.



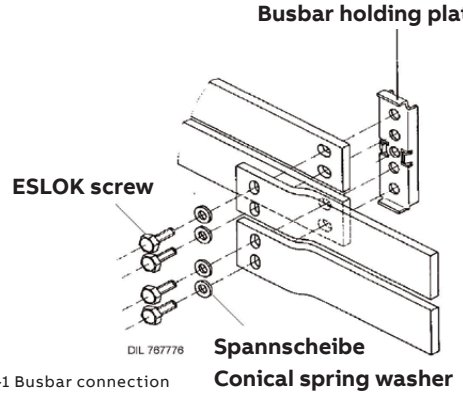
27 Frame connection



28 Additional frame connection

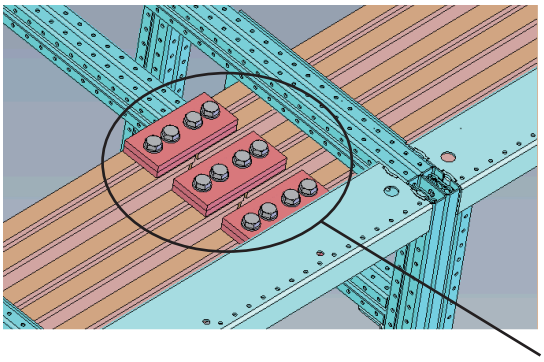


29 Mounting of rear and side wallt



30-1 Busbar connection

- The busbars as well as the protective (PE bars)and neutral conductor bars(N bars) have to be bolted at the transport divisions using the connections provided (see fig. 31). Only ESLOK sealed screws together with one conical spring washer each are to be used. The connecting points for the busbars are accessible through partition wall between the cable and busbar compartments. This partition wall must be closed after the bars have been secured. Elongated holes at the ends of the bars ensure adequate adjustment within the tolerances set. If the erection is properly carried out the holes will match up as required (see fig.30-1/-2/-3). Drilling is not permissible, due to the resulting chips. Contact surfaces do not need a special pretreatment. In case of dirt, the contact surfaces should be cleaned with a soft cloth. Do not use a metal brush or chemical liquids. In case of double busbar systems, the bars should be deburred or slightly phased (on both sides 45° +0 -15 with 1+1-0,5 mm). Refer to chapter 5.10 for tightening torques for bolted connections of bus bars, protective and neutral conductor bars
- The protective conductor (PE or PEN) is to be con-nected to the PE/PEN bar. Additional connections to the central earthing system can be made at any point of the perforated PE/PEN bar. Local regulations must be complied with
- The lifting angles may be removed, for details (see chapter 2.4.2)



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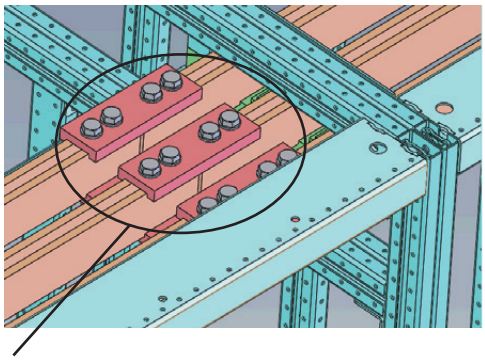
30-2 MNS Rear busbar connection (bus type “工”)



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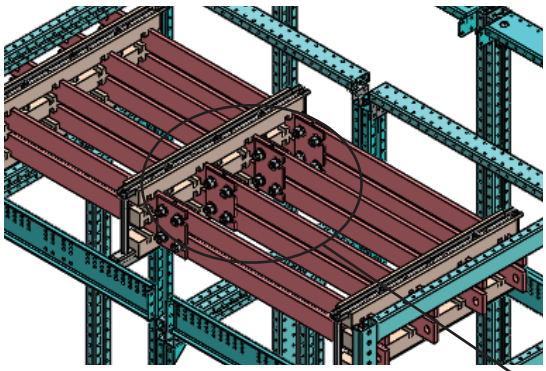
30-3 MNS Rear busbar connection (bus type60×10)



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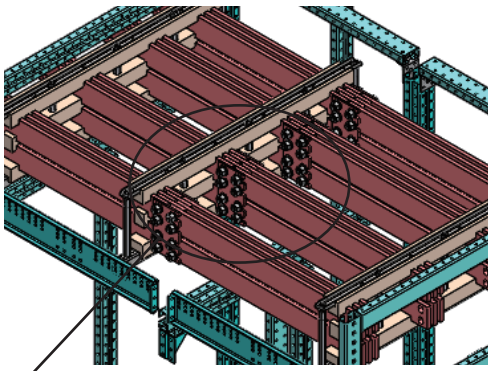
30-4 2000A MNS Rear main busbar connection



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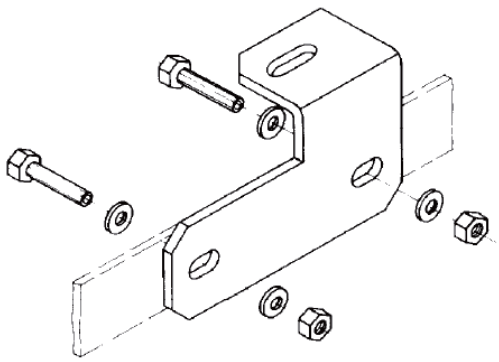
30-5 5000A MNS Rear main busbar connection



—
31 PE/N-connection

3.1.2 Additional information for switchgear positioning

The area around the cubicles to be left clear should be at least 80 mm (see fig. 33).

To be able to mount the last (right) cubicle, the distance between the end cubicle and the (right) wall must be at least 150 mm (see fig. 33).

In case of left-mounted doors, the minimal distance between the (left) wall and the (left) end cubicle should be also 150 mm, such that the doors can be openend in an angle of more than 90° (see fig 33).

The distance from the upper edge of the (highest) cubicle to the ceiling should be at least 500 mm for cubicles which are resistant to accidental arcs (see fig. 32).

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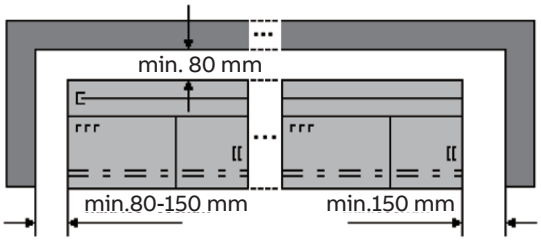
32 Free space above cubicle

3.1.3 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).



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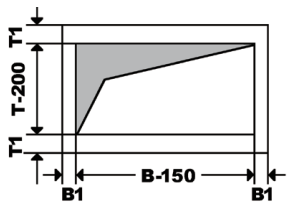
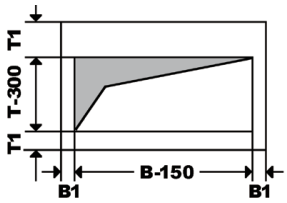
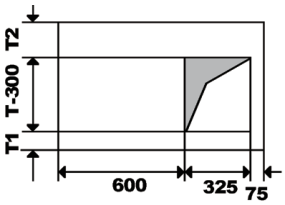
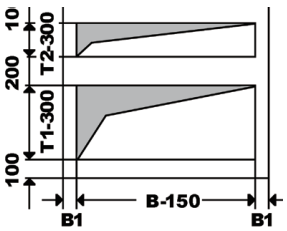
33 Walldistances

Cubicles without busbar compartment	Cubicles with busbar compartment	Cubicles with cable and busbar compartment; cable entry only to the cable compartment	Cubicles with busbar compartment and two-sided operation
			
B: total width T: total depth T1=100 B1=75	B: total width T: total depth T1=100 T2=200 B1=75	T: total depth T1=100 T2=200	B: total width T1: depth of equipment compartment T2: depth of equipment compartment B1=75 mm

—
34 Floor cutouts

3.2 Fastening methods to foundation

The switchgears should preferably be erected on a base frame which is either

- Embedded in the concrete floor or
- Rests as false floor on supports

Remarks: the erection of switchgears having the cable entries at the bottom requires a foundation with an opening or a cable duct.

When erecting the base frame the following must be observed:

- The base frame should be aligned and checked under the supervision of an ABB fitter
- The horizontal tolerance of the entire switchboard must not exceed ±3 mm
- The frame must not ondulate (according to DIN ISO1101)

During erection the switchgear is welded or screwed to the base frame, screwed is only for underfloor raceuay (see fig. 36).

- The length of the weld seams at the front and rear of each cubicle should not be less than 20 mm. All weldings must be protected against corrosion by a coat of paint (e.g. zinc paint)
- The screwed connection is carried out through the transverse section. The mounting holes required for metal straddling dowels M 8 must be drilled during erection (see fig. 37)

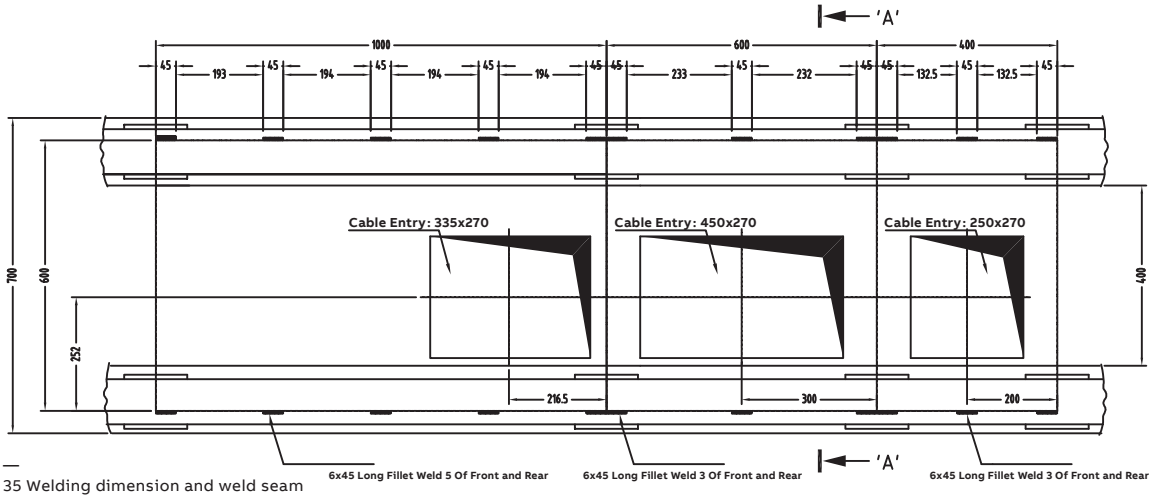
When false floors are used, notice that:

- Tolerances are the same as for the base frame
- The subsoil must be firm, so that the tolerances are not exceeded by settling of the soil (especially when using insulation layers and adhesives)
- The false floor has to have a carrying capacity of p=20 kN/m^2 (compression load from top to bottom)

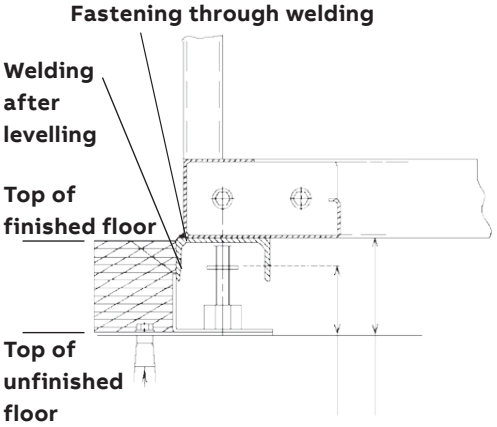
During erection the switchgear is welded or screwed to the false floor.

- The length of the weld seams at the front and rear of each cubicle should not be less than 20 mm. Then a reliable earth connection is provided. All weldings must be protected against corrosion by a coat of paint (e.g. zinc paint)
- If welding is not possible, the switchgear can be bolted to the false floor. The necessary mounting holes should be drilled on site

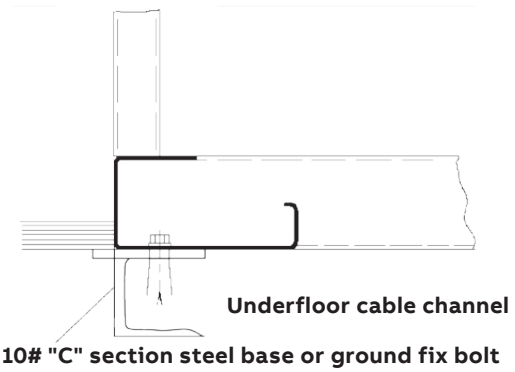
Care should be taken to ensure that the base sections of each cubicle rests evenly on the supports. Taking into account the bending radius of the cables and adequate accessibility, a minimum floor height of 500 mm is recommended.



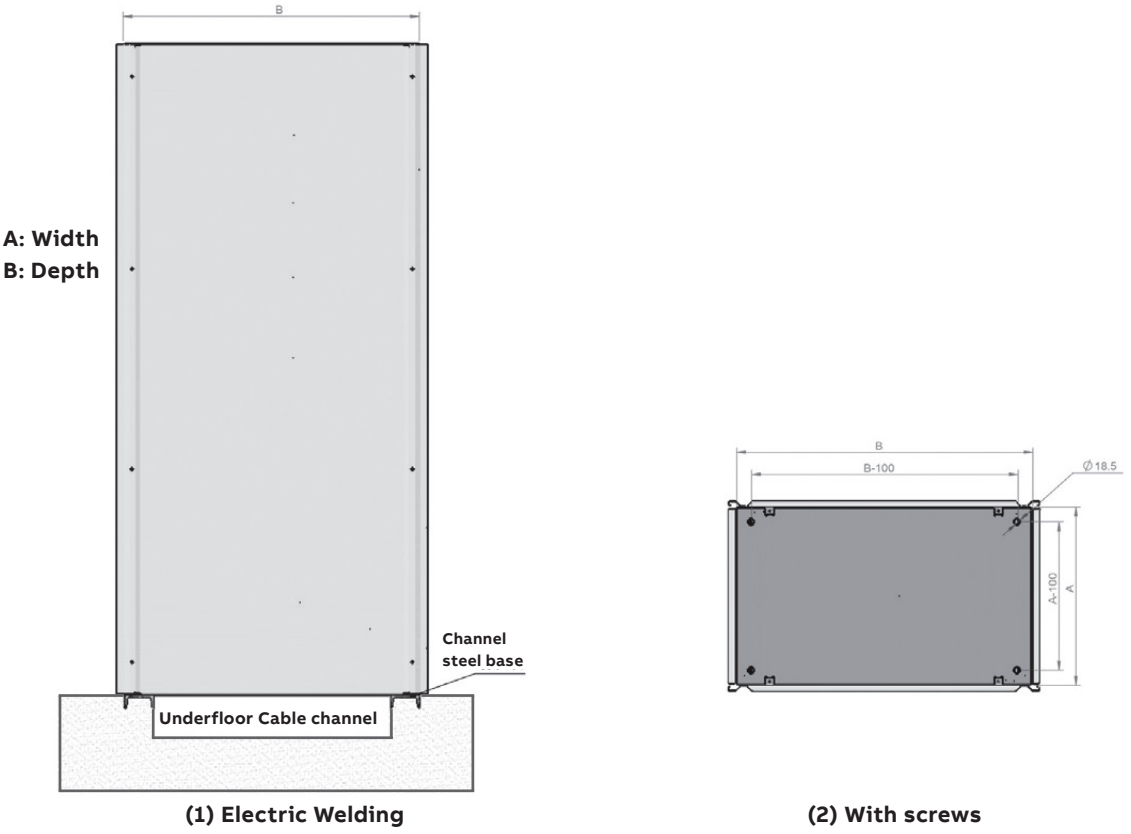
35 Welding dimension and weld seam



36 Fastening methods to foundation (examples)



37 Fastening methods to foundation (examples)



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38 Installation foundation drawing

3.3 Cable connections, wiring

Switch type	Rated current up to		
	≤1500 A	2500 A	3150 A
	Max. numbers of cables and cross-section per phase		
OT	4x300 mm²	8（12）x300 mm²	12（16）x300 mm²
	(with supplementary cable connector)		

Switch type	Rated current up to
	≤1600 A
	Max. numbers of cables and cross-section per phase
Moulded case	3（6）x240 mm²
circuit breaker	(with supplementary cable connector)

The control cables are led vertically at the side of the cubicles and are connected directly to the control terminals of the circuit breaker modules or if necessary, to the terminal strips in the control equipment recess.

3.3.1 Cable connection in cubicles with cable compartment

Power and control cables are to be attached to the cable mounting rails in the cable compartment (see fig. 39).

Power and control cables are to be stripped off their jacket below the connections of each module. Power and control cables are connected to:

- Terminals (see fig. 42)
- Connection bars
- Outgoing cable connection units (see fig. 42)

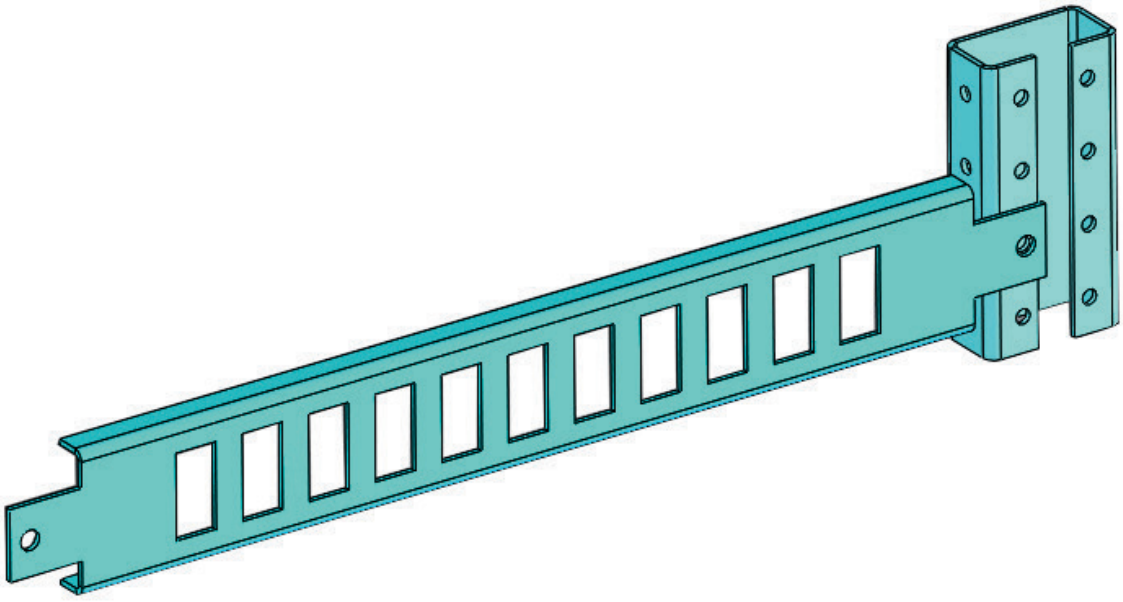
Bellows providing protection against electrical shock are to be used for:

- Cable connections to outgoing cable connection units for withdrawable modules (see fig. 41)

3.3.2 Cable connections in control cubicles and wiring between shipping units

The control cables are installed at the side in the lower part of the cubicle and led to the control modules through the vertical wiring duct. Before positioning the cables it is advisable to secure them with cable straps.

Control cables and conductors for the cubicle to cubicle wiring are led through the control wiring duct situated in the upper part of the equipment compartment. At the transport divisions the separated cables have to be connected. For this the cables have to be connected to the terminals of the control wiring duct in accordance with the markings.



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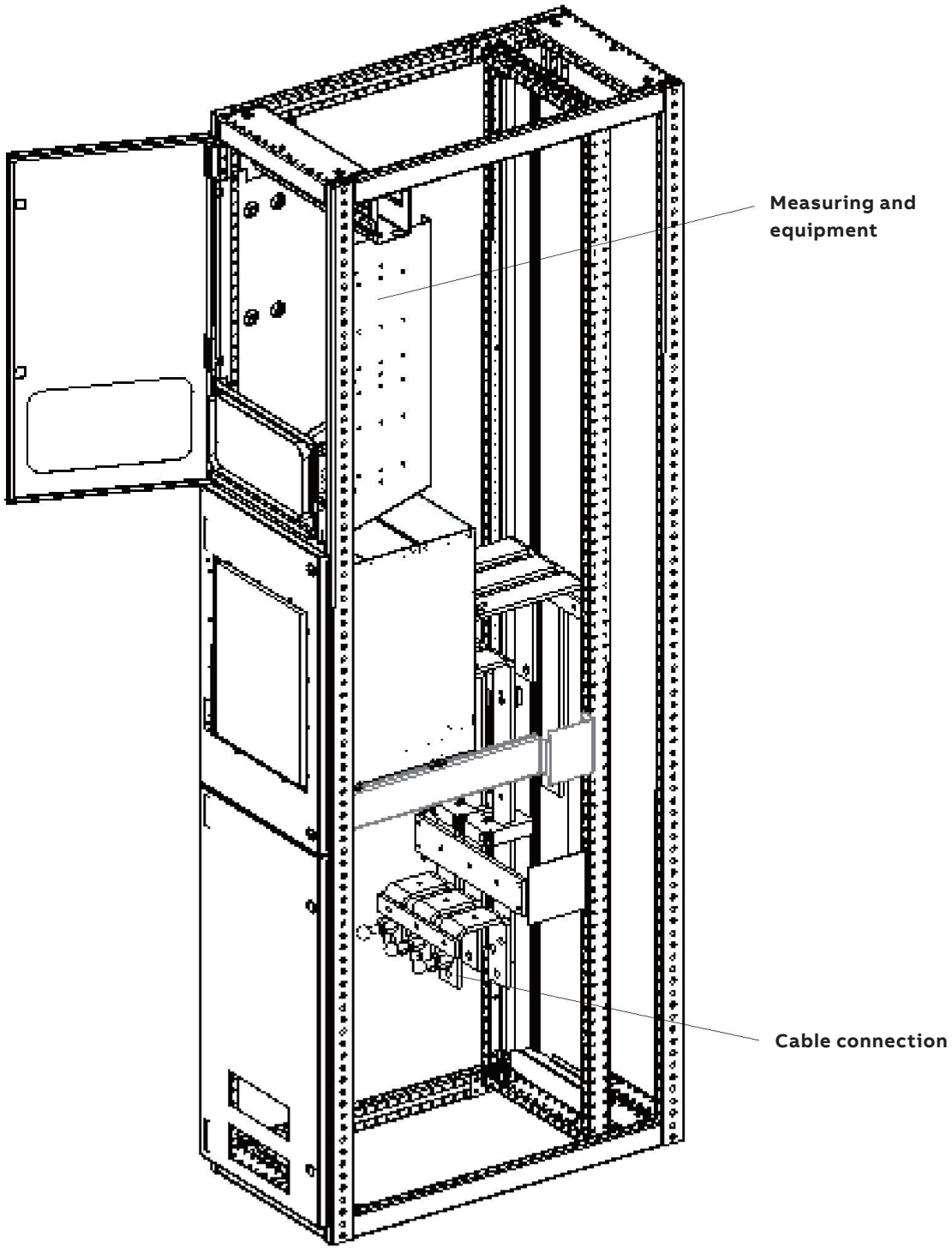
39 Fixed cable crossbar



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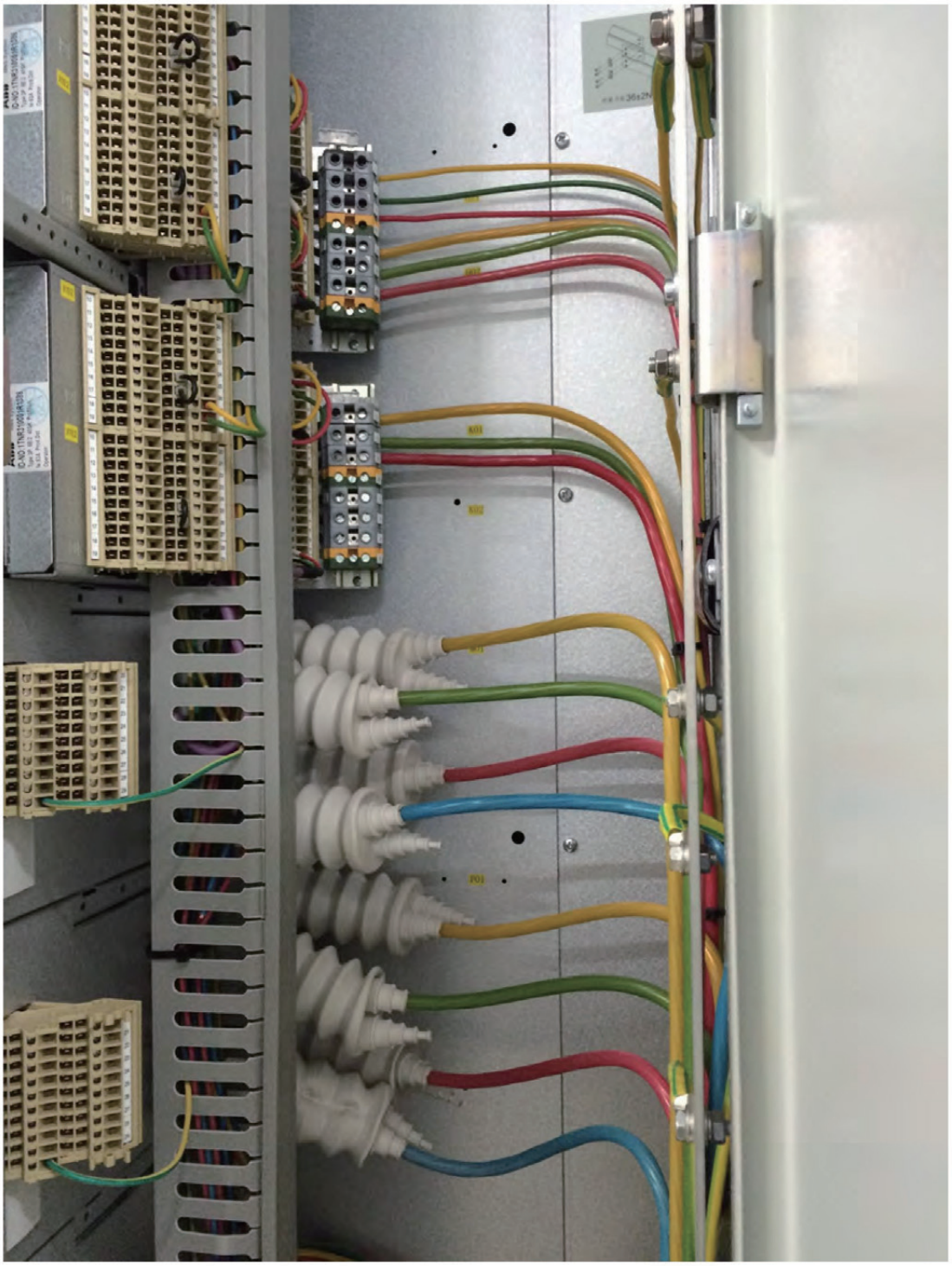
40 Direct connection at a circuit breaker



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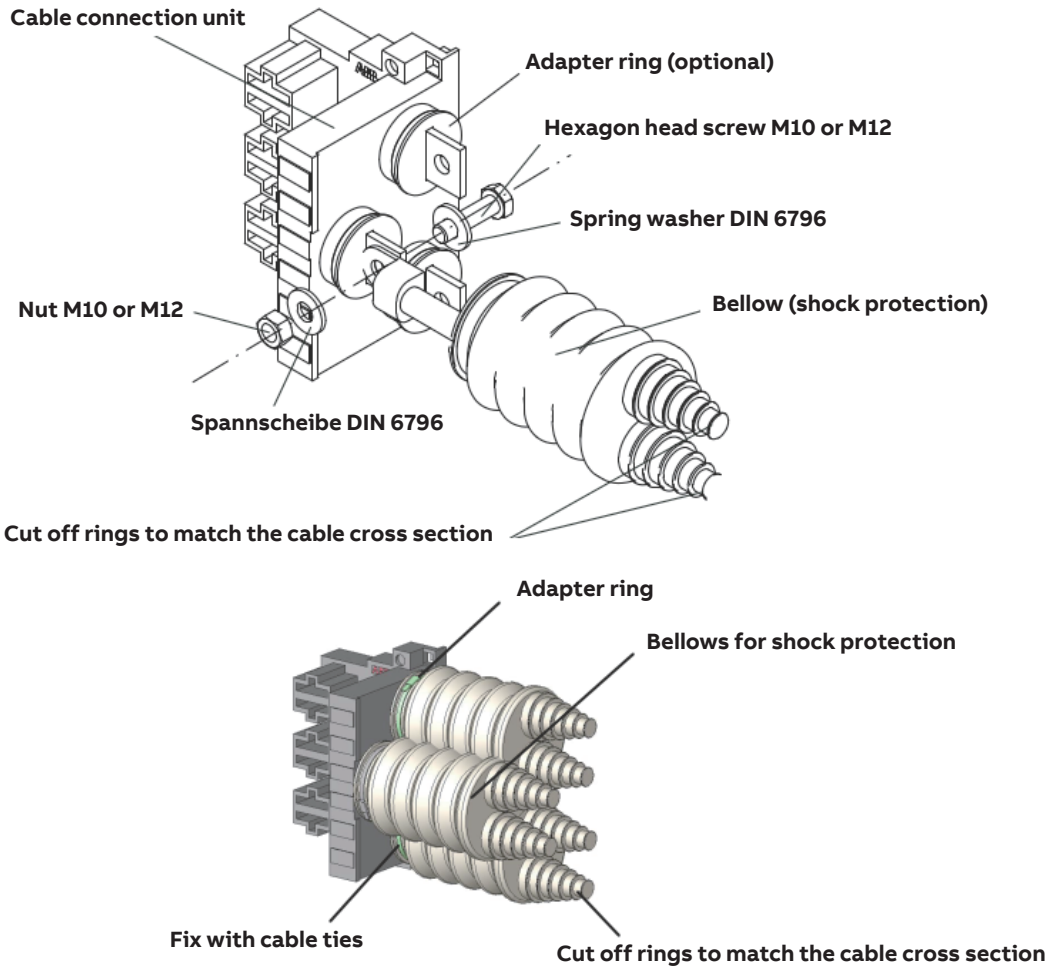
41 Connection of drawer circuit outgoing cables



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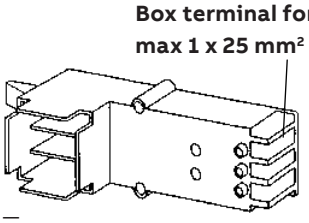
42 Cable connection for withdrawable modules from 6E

Rated current	Number of poles	Cable connection	Withdrawable module size	Max. tightening torque
160 A	3		8E upto 24E	
	6		8E upto 24E	
250 A	3	M10x30	6E	50 Nm
	4		6E	
	4		8E upto 24E	
400 A	3	M12x35	8E upto 24E	80 Nm
630 A	3		16E upto 24E	

—
Cable connection device can be used in the drawer loop about 4E regardless whether there is branch busbar no not. (see Figure 42)

Cable connection device CCU	Number of poles	Rated current	Rated conductor wire diameter (copper)
8E/4 drawer	3/4	45^)	10 mm²
8E/2 drawer	3/4/6	63	35 mm³
4E drawer junction device	3	63	35 mm³
6E / 8E drawer junction device	3/6	160	2X120 mm⁵
6E drawer junction device	4	250	2X120 mm⁶
8E drawer junction device	3	400	2X240 mm⁷
12E drawer junction device	3/4	630	2X240 mm⁸
16E drawer junction device	3	630	2X240 mm²



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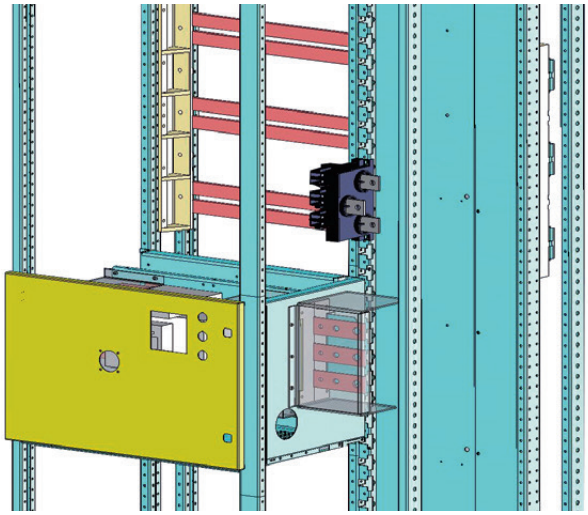
43 Cable connection unit for 4E-modules (max. 63 A)



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44 Installation of drawer CCU

3.4 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 rail-able module
- Up to 100 A: To the railable section located at front right (see fig. 45) with a screw M6
- Over 100 A: To the vertical PE connection bar, arranged front right in the cable compartment (see fig. 6) 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.

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 (ELV) equipment is mounted to the doors.

The continuous connection of the protective conductor circuits to inactive metal parts of the building (in accordance with IEC 61439 or DIN VDE 0100 Part 540) is to be carried out according to the conditions at the erection site.

3.5 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 abbreviation

Object	IEC 60439-1 / VDE 0660 Teil 500
Protective earthconductor	PE
Neutral conductor	N
Neutral conductor with protective function	PEN

3.6 Special information

3.6.1 Interruption of work

If work is interrupted during erection or connection, measures should be taken to ensure that maximum protection is provided against outside interference like dust, moisture and foreign objects, like:

- Close the switchgear doors
- If necessary, cover the switchgear with foil
- If necessary, the place of erection must be heated

3.6.2 Degree of protection

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

- For degrees of protection ≥IPX2 or ≥IP5X the bottom plate covers (flanges) have to be sealed at the site, if not already done at the manufacturers. To seal the bottom plate covers the self adhesive sealing 15x2 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
- For degrees of protection ≥IP X1 sealing of the frames between the cubicles (cubicle/ cubicle) at the transport division is necessary. Therefore the following measures have to be taken:
  - The connection sides of the affected frame sections have to be cleaned with Terokal R(GSIN100298P0001) cleaner using an oil- and grease-free piece of cloth
  - After drying of the cleaner the self-adhesive sealing tape 15x2 mm (GSIN100021P0010) has to be applied to the C-sections at a distance of 3 mm from the outer edge
  - In view of dampproof and ratproff, the part of outgoing feeder cable crossing the baseplate of the cabinet bottom shall be sealed. Normally we will use stepped sheath, MCT and flanges and we are open to the requirements of the client

3.6.3 Damage to paintwork

Refer to chapter 5.8 "Damage to paintwork"

3.6.4 Supply of material

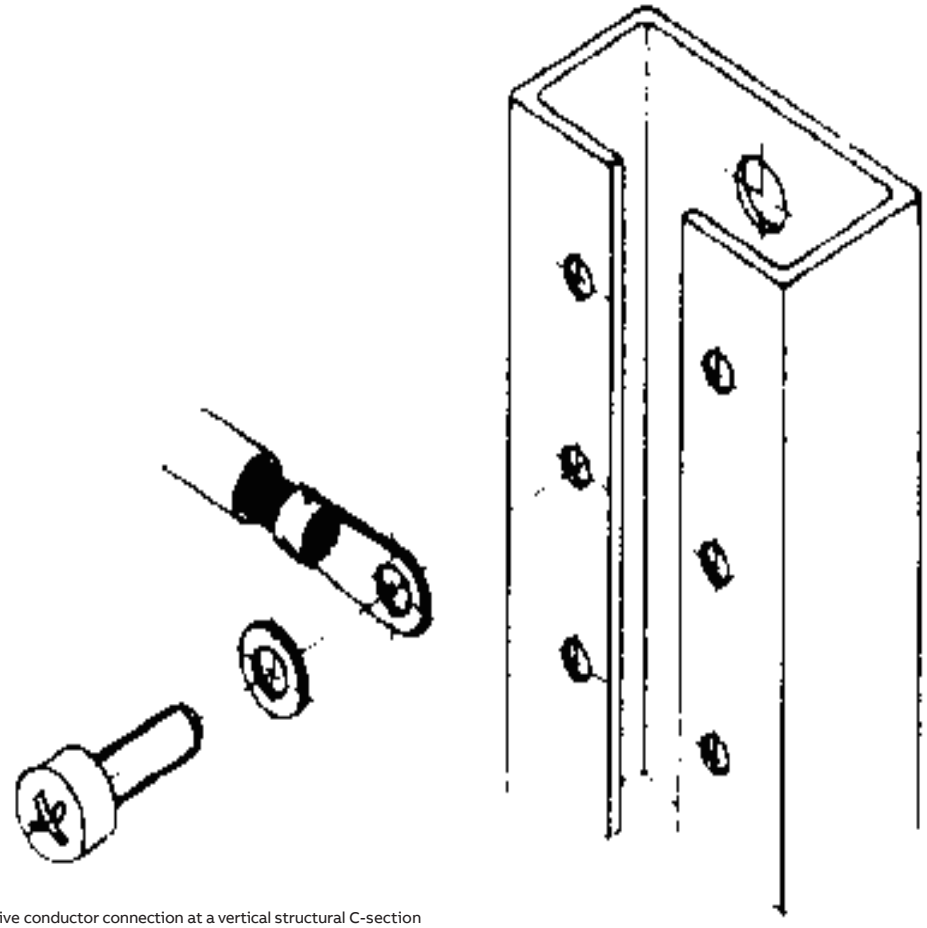
Spare parts and accessories are contained in the relevant lists or are obtainable through the responsible project or sales department of ABB.

3.7 Final preparations

- Remove transport safety devices (wooden bracing) from heavy components
- Mount separately shipped equipment, such as withdrawable circuit breaker, fuses, fluorescent tubes, measuring instruments. The equipment is appropriately marked. Enclosed mounting instructions have to be obeyed
- Remove any foreign parts, such as tools, packing material or conductor scraps from the switchgear
- Clean insulating parts with an anti-static cloth. Do not use any solvents as for example carbon tetrachloride, trichlorethylene or hydrocarbons
- Close the doors
- Slide the withdrawable modules into testing position (see chapter 4, operation)

3.8 Checks

- Clean the site, especially to check whether there is dust or other particle impurities in the busbar clamp. Make sure that the busbar is clean especially for the rear outgoing switchgear
- Check the busbar connections at the shipping unit divi-sions. (refer to chapter 5.10 for tightening torques)
- Check the frame connections at the transport divsions
- Check the floor fastening (to foundation or false floor)
- Check the realization of the required degree of protection, particulary with regard to the bottom plates
- General visual check; appearance, completeness, markings, foreign parts in the switchgear, dirt
- Check for correct and complete cable connections and wiring as far as installed on site
- Barriers in place
- Check for correct and complete protective conductor connetions
- Earthing system Whether it is connected with earthing system correctly or not
- Check the insulation resistance, the minimum value is 0.5 megohm (disconnect all secondary loops and arresters)



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45 Protective conductor connection at a vertical structural C-section

3.9 Commissioning

- Switch on control voltage
- Test the control, protection and monitoring equipment and the mechanical and electrical interlocking devices
- Apply voltage to the busbars (insulation test!)
- Switch on the main circuits individually
- Check the indication and measuring equipment for correct readings

Observe the general precautionary rules and regulations.

Operation

4.1 Electrical equipment
Separate provided operating instructions have to be obeyed for the electrical equipment.

4.2 Fixed technique
No separate operating instructions are necessary for fixed modules.

4.3 Withdrawable units size 8E/4 and 8E/2
A micro switch with 2 NO and 2 NC contacts is provided for electrical interlocking.

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

The switch handle can be locked in the positions "OFF" and "TEST" and the isolated position with up to three padlocks(see fig. 49).

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".

4.3.1 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.

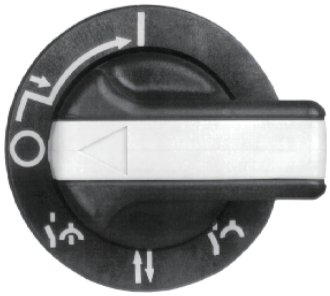
	Position of switch	Position of module	Main and control circuits
	ON	in cubicle	All main- and control-circuits are closed
	OFF Can be locked with 3 padlocks	in cubicle	All main- and control-circuits are disconnected
	TEST can be locked with 3 padlocks	in cubicle	All main-circuits are disconnected, the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

—
46 Description of operating handle positions 8E/4 and 8E/2 modules

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).

47 Withdrawable module size 8E/2 with INSUM



48 Switch operating handle for withdrawable modulessize 8E/4 and 8E/2 with position markers

49 Withdrawable module size 8E/4 with 3 padlocks

4.4 Withdrawable units size 4E up to 24E

Withdrawable units size 4E up to 24E are built-up of sheet steel components which constitute the supporting frame for the electrical components and the contact elements. The hinged front cover offers the advantage of easy accessibility to the built in components from the front side. Opening the front cover with a key is only possible in isolated, test or OFF-position of the withdrawable unit. 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 (see chapter 5, fig. 56).

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

—
50 Description of operating handle positions 4E to 48E modules

—
51 Withdrawable module size 8E

—
52 Withdrawable module size 16E

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 controlcircuits by moving the withdrawable module to the isolated position.

4.4.1 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 reestablished 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.

- Turn switch handle from "ON" position to "OFF" position and further to the stop
- When released, the switch handle swings back to “OFF“ position
- 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).

4.4.2 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 cubicle completely the withdrawable unit interlocks again to avoid being pulled out from the cubicle uncontrolled. To release this safety stop it is necessary to press down the lever on the left side of the withdrawable unit (see fig. 57).

If the withdrawable unit which should be moved is installed in a high position in the cubicle 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. Afterwards the withdrawable unit can be removed completely from the cubicle.

Depending on their size withdrawable units have a high weight. Therefore the following safety 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 cubicle 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".

4.5 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

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53 Switch operating handle for withdrawable modules size 4E up to 24E with position markers

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 cubicles 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 cubicles 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 cubicles it is necessary to reconsider the changed heat balance. The allowed imit of temperature-rise inside the switch-panel must not be exceeded. In case of doubt please contact your appropriate ABB branch.

The use of ESLOK-secured screws renders maintenance of the bar connections unnecessary. After fault situations the checks are to be carried out just as before commissioning.

5.1.1 Maximum admittable effective power loss Pveff

The following preconditions are valid for the standard values given under 5.1.1.1 and 5.1.1.2:

- Cubicle distance from wall at least 40 cm
- Middle cubicle in multi cubicle arrangement

5.1.1.1 Standard values of maximum admittable effective power loss Pveff for degrees of protection up to IP31 and IP41, natural air circulation

Roof-plate:	stretch lattice
Front:	1 ventilation louvre IP 30/IP 40
Back:	1 ventilation louvre IP 30/IP 40

For small cubicles (W=400, 600 mm) 2 ventilation louvres must be used. In case of ventilation from bottom (without bottom plate) i.e. because of cable pits or false floors, there are no ventilation louvres necessary for cubicles, as long as an equivalent air circulation is possible.

5.1.1.2 Standard values of maximum admittable effective power loss Pveff for protection classes IP32/IP42 (non-ventilated) and IP54

Cubicle:	H=2200 mm
	W=1000 mm
	D=600 mm
Equipment compartment:	W1=600 mm

Decrease resp. increase of standard values:

- For cubicles <1000 mm curve 3 must be lowered in percentage terms, i.e. for W=800 mm, lower curve 3 to 80%
- For end cubicles of a switchgear, an increase of the curves by 20% can be taken into account, due to an additional emmission area of one side wall (Cubicle distance to wall at least 8 cm)

5.1.1.3 Pv Reduction factors for use of withdrawable modules size 8E/4 and 8E/2

See fig.54, the table gives reduction factors to be multiplied with the permissible power loss for withdrawable modules size 8E/4 and 8E/2 due to additional barriers confining ventilation.

Rows 3 and 5 relate to the examples given in the table head.

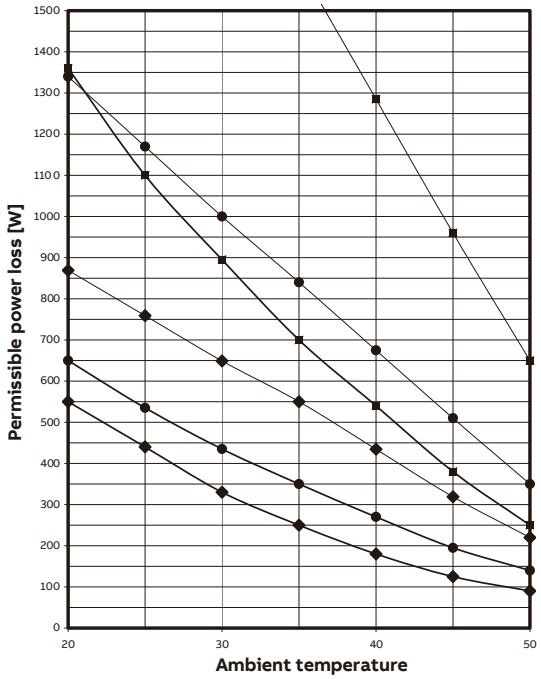
Given data are valid for an ambient temperature of 35°C.

5.1.2 Possibilities for testing the control circuits of withdrawable modules

Prior to commissioning of a motor or energy outgoing unit the function of the control circuits must be tested according to the interlocking conditions.

This can be done as follows:

- When the withdrawable modules are in test position
- For withdrawable modules 8E to 24E by means of a test adapter
- With the help of a test cable



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54 Standard values of maximum admittable effective power loss Pveff

5.1.3 Test position of the withdrawable module
This corresponds to the standard design.

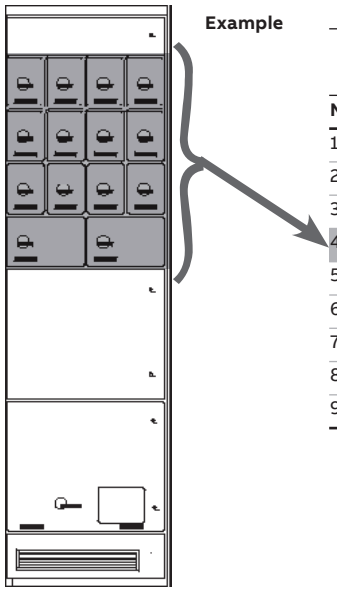
- The main switch (fused motor switch, circuit breaker) is switched off. The power and control circuits are disconnected
- The switch handle is turned to ”TEST” position. The withdraw able module remains in the contact position. The power circuit is disconnected, the control circuit is operational
- In this position, the internal and externalswitching conditions can be tested without power

Explanation of diagram curves:
The curves correspond to an air temperature of 60°C below the roof plate of the switchgear cubicle.

Reduction factors for withdrawable modules size 8E/4 and 8E/2 see next page.

——IP30 – IP42, ventilated
——IP32 – IP54, non-ventilated

◆ Withdrawable technique
● Plug-in, disconnectable and railable technique
■ Cubicles without subdivisions, energy distribution, electronics



	IP30 – IP42, ventilated		IP32 – IP54, non-ventilated	
		Example max. Pv = 550 W per cubicle		Example max. Pv = 250 W per cubicle
No. of occupied rows	Reduction factor	Resulting power loss	Reduction factor	Resulting power loss
1	0.77	424 W	0.91	228 W
2	0.69	380 W	0.87	218 W
3	0.66	363 W	0.85	213 W
4	0.63	347 W	0.83	208 W
5	0.61	336 W	0.81	203 W
6	0.60	330 W	0.80	200 W
7	0.59	325 W	0.80	200 W
8	0.59	325 W	0.79	198 W
9	0.59	325 W	0.79	198 W

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55 Reduction factors, applicable to the permissible power loss for withdrawable modules size 8E/4 and 8E/2

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56 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 touchlive parts.

For the safety of personnel and equipment, it is suggested that the operation shall be implemented only by the customer staff who are trained for operation by ABB.

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-function separator 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 cubicle (see fig. 58).

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 4E up to 24E have to be withdrawn up to the stop position, released and then removed completely (see fig. 57).

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. 56).

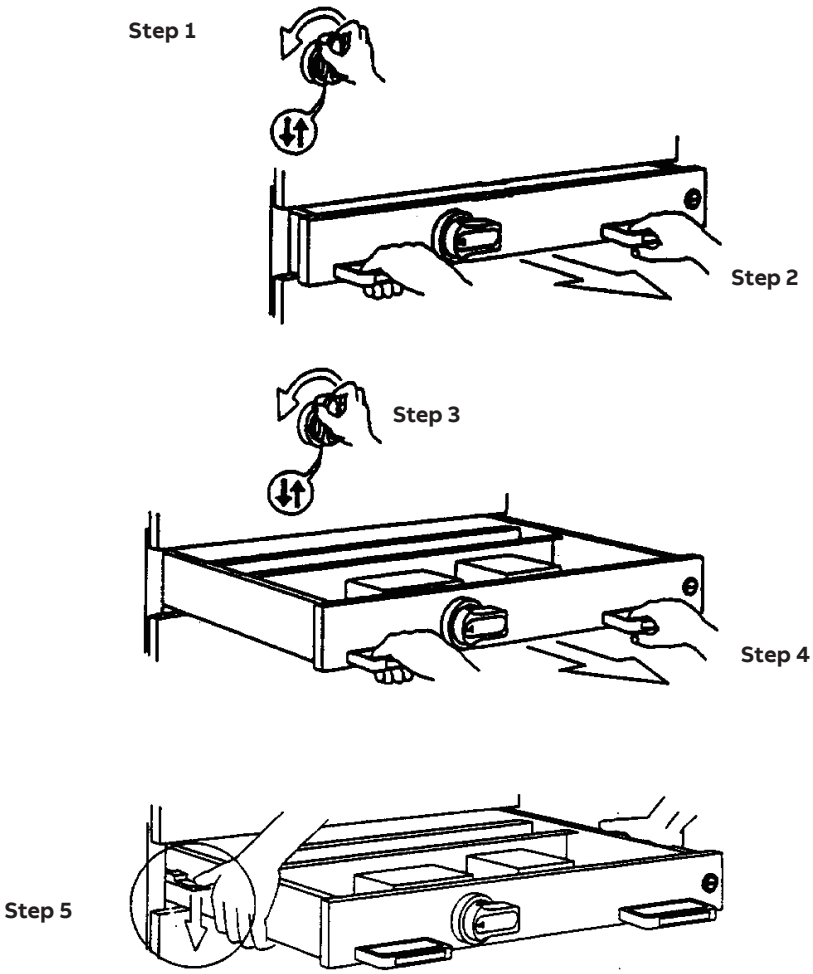
The interlocking mechanism can be found at the side of the switch handle.

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. 58/59).

5.3 Conversion and change of withdraw able 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 cubicle. By using a appropriate cover for the compartment bottom plate of the withdrawable module com-partment below small parts have to be prevented from falling through.

In case of modifications of switchgear cubicles a possible change of the heat balance inside the cubicles has to be taken into account. The allowed limit of temperature-rise inside the switchgear cubicle may not be exceeded (see fig. 54/55).



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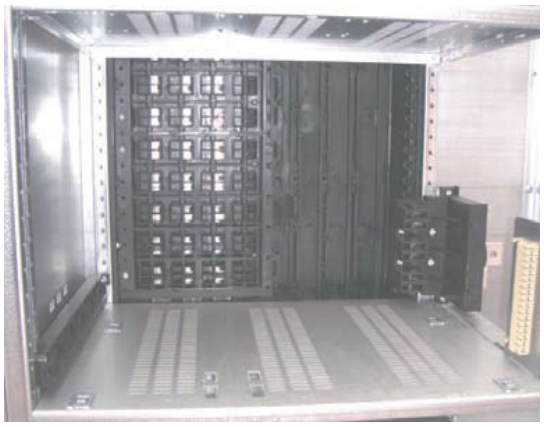
57 Draw out of a withdrawable module



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

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59 Conversion to withdrawable module compartments size 8E/4 and 8E/2

5.3.1 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. 58)
- 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 cabl com-partment can be performed without danger (see fig.42)
- 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. 42)

Reassembly (see fig. 12 and 59)
- 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. 13), 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. 12).

- 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

5.3.2 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. 42)
- Insert two new compartment bottom plates with a dis-tance 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 withdraw-able 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) (see fig. 44) 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.

5.3.3 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. 12)
- Remove guide rail and front post from the lower com-partment bottom plate (see fig. 12)
- Take out the 2 withdrawable module condapters with their terminal blocks (see fig. 12)

Reassembly
- Install one outgoing cable connection unit (details see fig. 44) 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. 14)
- Mount roller and cover in the compartment bottom plate
- 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 (bel-lows, see fig. 42) and control wiring. For parallel con-nection of two outgoing cable connection units an addi-tional bellow is required
- Insert new withdrawable unit size 24E

5.3.4 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. 42). 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-/20-pole control terminal blocks. When converting from two to one control terminal block the remaining one must be at the top of the support while the space below has to be covered with a cover
- Dismantle the two middle compartment bottom plates with their guide rails The lower bottom plate remains unchanged (see fig. 14)
- Depending upon module design remove one or two outgoing cable connection units. When necessary exchange outgoing cable connection unit (details see fig. 44). 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
- Insert new withdrawable unit size 24E

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

5.4 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; BGVA2), electrical plants must be maintained in an orderly conditionby 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
- Contact torque measurement and reference value

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 cubicle (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.

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.

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.

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

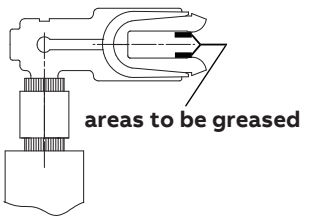
5.5 Greasing of contact areas

5.5.1 Greasing of power contacts
Greasing the contacts is a mandatory prerequisite for reaching theoperating 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.

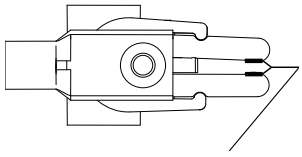
Contact areas of the power contacts are to be cleaned and greased whenever the following.

Conditions apply:
- The assembly works and testing routines have been completed in the workshop
- After a revision or after 100 plug-in cycles or normal operation after 5 years or heavy duty operation after 2 years, whichever is earlier immediately before installing the module in the cubicle

Grease to be applied:
- Use a brush to apply the grease
- Avoid excess grease on the contacts
- If modules are supplied as loose parts, they should be greasedat the building site
- For contact areas to be greased, see figures 60 and 61



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



61 Power contacts for withdrawable modules size 4E to 48E

5.6 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 afunctional test must be carried out.

Lubrication of withdrawable module interlocks for module sizes 4E up to 24E is not necessary during maintenance.

5.7 Installation of power contacts

5.7.1 Installation
5.7.1.1 Once inserted in the withdrawable module rear wall the contact must be properly engaged. Successful engagement is indicated by a single, audible click, an dcan be verified by pulling the cable.

Please note!
The new contact type does not click a second timeonce 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.

5.7.1.2 SOTAX
Check the Sotax before installation:
The spring strip on each contact shall be installed in place; the contact shall be aligned on the vertical surface and in the middle of the Sotax housing.

5.7.2 Testing
The withdrawable module assembly must be tested as follows prior to installation in the cubicle (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 Paintwork damage

5.8.1 Preparation of the damaged location
Surfaces or locations soiled by grease/oil shall be cleaned with an aliphatic cleaning agent using a linen cloth.

5.8.2 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".

5.9 Mechanical damage

5.9.1 Preparation of the damaged location
When major damage to large areas has occurred the resp-ective 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.

5.9.2 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.

5.9.3 Tools

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

5.10 Tightening torques for screw connections

5.10.1 Scope of application
The figures quoted apply to system screw connections and busbar screw connections on busbars with σ02≥70 N/mm2 (Cu, Cu/Al, AlMgSi 0,5) in the switchgear system MNS.

The values are not applicable to electrical equipment connections and mountings.

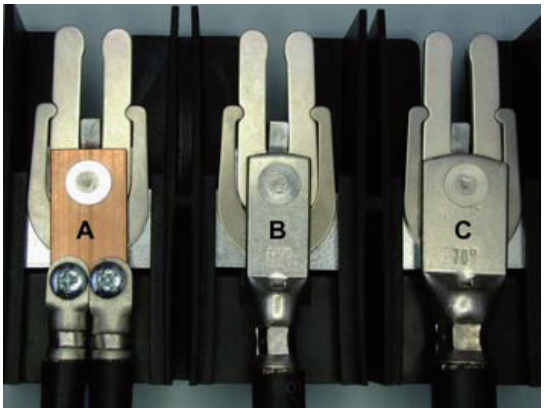
Exception:
They do however apply to the mountings of equipment with sheet steel bases and the connections of electrical equipment when this is made with flat copper terminals and bolts and nuts of tensile class 8.8.

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

5.10.2 Exactness 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.

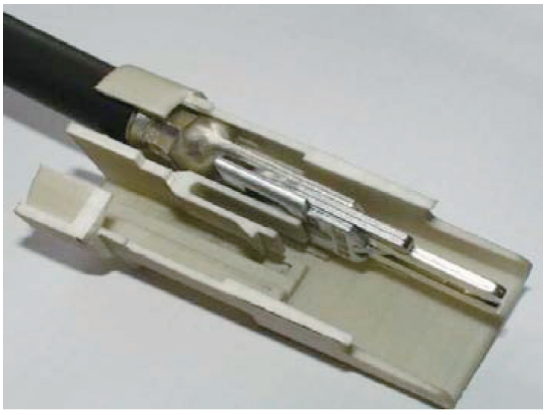
5.10.3 Testing torque
The testing torque is the preset value of the tightening equipment minus 15%.

5.10.4 Tightening torques
•Self-tapping screws in plastic material



62 Power contacts for withdrawable modules 4E ... 48E

Contact forms:
A: bis/up to 2x16 mm²
B: bis/up to 35 mm²
C: bis/up to 70 mm²



63 Contact apparatus housing, cross-section

In case the self-drilling bolt and screw bolt are loose, only manual screw driver could be used instead of any machine.

Screw type	Dimension	Tightening torque
Hex socket head cap screws DIN 912, with ESLOK	M6	8
Hex head bolts DIN 931, with ESLOK	M8	20
Hex head screws DIN 933, with ESLOK	M10	40
Hex socket head cap screws ISO 4762 (DIN 912)	M12	70
Hex head bolts ISO 4014 (DIN 931)	M16	140
Hex head screws ISO 4017 (DIN 933)		

5.11 Commissioning and maintenance of MNS reactive power compensation systems

5.11.1 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.

- Check ventilation in the place of installation
- Screws for busbar connections (Cu) and system connections (steel/steel)
- Check the construction:
  a) Above and below each individual module (or the modules), an air supply and air discharge must be available.
  b) No compartment bottom plates or other installations may be present in the cubicle which might adversely affect ventilation.
  c) For protection class >IP32 or installations which deviate from b) above, forced ventilation (or a reduced amount of equipment) is required.
  d) A transverse partitioning must be installed between the cable compartment and the equipment compartment.
- Check the settings and the functioning of the controller (switching outputs)
- 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!

- 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!)
- 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.
- Perform a visual inspection of the electrical equipment. (leakssuch as oil leakages, bulging of the capacitor lid or housing, condition of terminals,switches, protective devices, reactors, discharge resistors, conductors)
- Check protective devices and switches for faultless operation
- Clean the modules as well as the air supply and air dis-charge regions of each cubicle (ventilation louvers, filter mats)
- Check bolted connections and clamping units
- 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.)

Please note:
Before measuring capacities discharge resistors must be disconnected from capacitors. Setpopint values are given on the module nameplates.

5.11.2 Correction of faults

In the event of malfunctions during commissioning, the cubicle 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

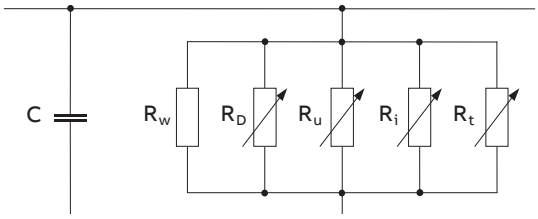
- Controller does not switch in additional steps (although request is available):
  - Measuring voltage or current not or improperly connected. Check fuses
  - Wrong transformer ratio
  - Lowest step power is too high
  - Inappropriate C/k value setting/value too low
- Controller switches very often:
  - 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)
- Cosϕdisplay 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

5.12 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:



RW: constant equivalent resistance
RD: dielectric resistance
RU: voltage-dependent resistance
Ri: current-dependent resistance
Rt 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.

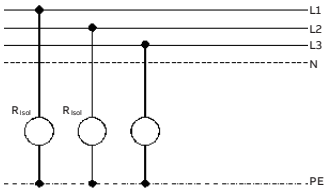
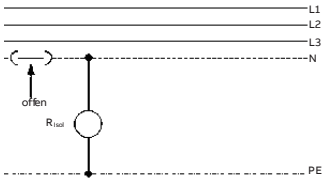
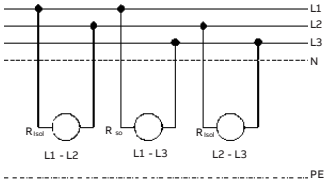
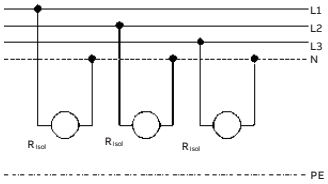
Insulation measurement is required according to DIN VDE 0100,but also to other standards, such as

- IEC 60439-1, Section 8.3.4
- EN 60204
- DIN VDE 0105
- VDE 0110

5.12.1 Which insulation measurements have to be peformed?

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 mea-suring voltages.

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 measure is not required in the TN-C network
3. Between the outer conductors		• 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		

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

5.12.2 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 extralow voltage without safe isolation	500	≥0.5
Rated voltage >500 V, ≤1000 V	1000	≥1

5.12.3 Required measuring accuracy

The operating error within the marked measuring range must not exceed ±30% with respect to the value reading. This error range permitted by DIN VDE 0413 part 1 initially seems to be very high. From the equivalent circuit diagram above, however, it becomes obvious that the insulation resistance is composed of a fixed component and four other components which may vary according to different parameters. This results in the large variation range.

5.12.4 Minimum readings (Note recommended operating error of -30%!)

Protective measure or rated voltage	Reading [MΩt]
Extra-low voltage	0.36
Rated voltage ≤500 V	0.7
Rated voltage ≥500 V, ≤1000 V	1.4

Remark: The assessment of the measured values has to take into account the overall condition of the system!

5.12.5 Capacitive charges

For longer leads and cables, first allow the capacitive charging process to be completed and the indicator of the measuring device to come to a standstill before performing the reading.

If a capacitive charging process was observed, the leads must be discharged after measurement in order to prevent electric shock.

5.13 Maintenance intervals

5.13.1 General

5.13.1.1 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.

5.13.1.2 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

5.13.2 Maintenance of MNS switchgear systems

5.13.2.1 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

Prior to commencement of 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.

5.13.2.2 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 components, 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 discharg-ing 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 regula tions
- 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

5.13.3 Maintenance and inspection of MNS switchgear systems

5.13.3.1 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

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

- General visual inspection (repetitive tests)
  a) External inspection
  b) Completion of the interior
  c) Switchgear and controlgear assemblies (withdrawable or plug-in modules)
- Additional inspections
  a) Withdrawable technique
  b) Plug-in, disconnectable, railable technique
  c) Direct connection of incoming and outgoing power feeders with circuit breakers, e.g. Emax, ISOMAX or Tmax

5.13.3.3 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 maintenanceor 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)

—

5.13.4 Maintenance and inspection list

Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Frequency Install. category 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 such as SO2 , H2S etc. • Relative humidity ≤50% at 40°C • Dust	1a	6 m	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 cubicle not obstructed • max. temperature inside the cubicle: ≤60°C	1a	6 m	X	Touch fronts with hand surface, check cubicle 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 cubicle (operating or isolated positvon)	1a	6 m	X	
1.1.4	Accessibility	• Escape route ≥650 mm	1a	6 m	X	
1.2	Completion of the interior					
1.2.1	Equipment compartment • Check filling factor and equipment • Internal conditions	• Arrangement of modules in accordance with engineering documents • Contamination, e.g. dust	1a	6 m	x	
1.2.2	Cable compartment/cable terminal compartment Personal protection/protective bellows	• Incoming feeder in accordance with documents (busbar/cablelaterally/top/bottom) • Sufficient room/strain relief • Cable routing; bending radii • Protective bellows	1a	6 m	X	
1.2.3	Busbar compartment • Check transport connec-tions • Check busbar supports • Visual inspection of the con-dition of the busbar insulation	• Color changes at bolted connections • Proper installation of cover in partition wall 3 • Contamination or flashover • Formation of cracks or creeping paths • Shrink-on tube brittle	1a	6 m	X	Check using thermo-vision exposures
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, rated currents, settings and tripping • Minimum creepage distance ≥12,5 mm • Check minimum clearance for arcing space				For the complete main-tenance work, observe the instructions of the equipment manufacturer Cf. equipment manufacturer

Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Frequency Install. category A	B	C	Remarks
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)		2 -3a	1a	X	
	• Check easy movement of module in compartment	• Remove dust and grease from guide rail if necessary	2 -3a	1a	X	Refer to
		• Lubricate with Omnigliss	2a1	1a1	X	Chapter 5.5
	• Function test of mechanical interlock					Refer to chapter 5.6
		• Visual inspection				
	• Check electrical contact-making	• In case of doubt check contact clearance				
	- Main contacts	• Greasing				Artificial light source
		• Remove dust from guide rail with vacuum cleaner				
	- Control plugs	• Actuate limit switch rocker (if available)				
	- Visual inspection of module com partment	• Check condition of mating contacts				
		• Check cam condition at supporting rail				
	• Check efficiency of protective con ductor connection					
2.1.2	Withdrawable modules ≥4E		2a1		X	Refer to
	• Check easy movement of module in compartment	• Visual inspection				Chapter 5.5
		• Check of contact force Greasing				
	• Function test of mechanical interlock	• Position; the outgoing cable unit might be pressed out of its normal position by strong cable forces				
	• Check electrical contacts Main contact	• Condition of the roller in the compartment bottom plate				
	- Control plug					
	• Fastening of outgoing cable unit					
	• Protective conductor connection					
2.2	Plug-in, disconnectable, railable technique					Cf. also item no. 1.3: General inspection
2.3	Direct connection (incoming and outgoing feeders with circuit breaker)	• Visual inspection of main connections	1a	6 m	X	Analogous to item 1.3
		• Color change at switch main connections	1a	6 m	X	"Gen. inspection of
		• Condition of main and eroded contacts	1a	6 m	X	switchgear assembly"
		• Function test				
	Additional checks:	• Fastening of transformers				Procedure in
	• Check main switching device	• Secondary cable routing				accordance with
		• Condition of transformer housings				manufacturer´s
	• Check current transformer arrangement	• Check screwed connections				instructions
		• Mechanical condition of supporting plate				
		• Formation of creepage paths				
	• Check supports at angle and connection sets	• Check screwed connections				
		• Check cable strain relief				
	• Condition of partitioning (if available)	• Cable routing, min. bending radii, edge protection, etc.				
	• Check external connections					
3.0	Reactive power compensation system		1a	6 m	X	In case of any abnormality, please contact ABB service engineers
	• Master switch					
	- Circuit breaker					

Item no.	Work to be performed	Measured, test and limit values, operating and auxiliary materials	Frequency Install. category A	B	C	Remarks
		• Visual inspection • On-off condition				
	- XLP					
		• Closed properly • Fuse continuity • Contact lubrication • Clamp spring examination, discoloration or exception				
	• Contactor					
		• Visual inspection • Abnormal sound				
	• Reactor					
		• Whether insulation paper turns yellow or not • Noise • Temperature. For the limit, refer to manufacturer's instructions • Whether components, such as temperature control switches, are normal or not				
	• Capacitors					
		• Whether the appearance is subject to bulging or oil seepage • Capacitance measurement. If the capacitance drops by 10%, the capacitor must be replaced. • Operating current. If the current unbalance is over 5%, the capacitor should be replaced. • Discharge resistor inspection				
	• Control module					
		• Basic parameter re-check • C/K value • Cos setting • Step size control. Its suggested value is greater than 40 s				
	• Cables and bolts					
		• Discoloration or aging • Bolt tightening. For tightening force, refer to manufacturer's instructions				
	• Ventilation device					
		• Ventilation window shall be intact and unblocked • Fans shall run properly				
	• Capacitance drawer					
		• Primary contact pressure, refer to manufacturer's instructions				
	• Harmonic inspection					
		• Refer to the national standard. The suggested value of harmonic voltage content is less than 5% and that of the harmonic current content is less than 10%. • Whether harmonic distribution matches with reactance rate				

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

Trouble and treatment

Trouble and treatment

Typical problems are listed in the following table, please refer to it in case help and solution are needed.

Note:

1. Try to find out what is happening before checking the following list.
2. In case no solution applicable in the list, please contact the service engineer or call customer service hotline: 0592-5719201 for help.

NO	Status	Possible reasons	Recommendations
1	Switching room door is too small to let the switchgear in	Transportation unit of the switchgear is too long	Contact the service engineer
		Switching room door is not wide enough	Contact the service engineer
2	Cable connection unit burnt	Clamp force of the primary contact is not enough	Replace the primary contact and cable
		Long-term overload	Adjust the load or circuit capacity
		No regular maintenance	Regular inspection and maintenance
3	Too high temperature in cabinet	Poor cooling	Improve the cooling condition
		Overload or poor contact	Check the circuit working condition
		Harmonic	Harmonic suppression
4	Indicator doesn't light	Fusible core burn out	Replace the fusible core
		Loose line or terminal fall off or disconnected	Tighten the line or re-access
		Indicator is burnt	Replace the Indicator
5	No response of the button	Button contact damage	Replace the button contact or button
		The line is loose or disconnected	Tighten the line or re-access
		Actuators (e.g., contactor,etc.) are damaged	Check the circuit components
6	Drawer circuit breaker can't be closed	Undervoltage coil is disconnected with power supply or damaged	Electrify the under-voltage coil or Replace it
		Drawer interlocking mechanism is damaged	Replace the drawer interlocking mechanism
		The problem of the circuit lies in the breaker itself	Check the circuit breaker and replacement the damaged parts
		Circuit breaker is not reset after tripping	Reset the circuit breaker after trouble clearing
7	Serious accidents happened in the swicthgear	Short-circuit in the cabinet or dowmstream equipment	Leave the field unchanged and contact the service engineer. Must not recover the power supply before finding out the problem

ABB Xiamen Low Voltage Equipment Co., Ltd.
361101
No.881, FangShanXiEr Road, Xiang'an District,
Xiamen, Fujian
Tel: +86 592 6038118

ABB China Contact Center
Hotline (China): 400-820 9696
800-820 9696 (fix line only)
Hotline (Overseas): +86-21-3318 4688
E-mail: contact.center@cn.abb.com

www.abb.com

Official website of ABB MNS Solutions

ABB China Customer Contact Center

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