DISTRIBUTION SOLUTIONS

MNS® low voltage switchgear
Service manual

- Fast and professional
- Reliable and safe
- Life cycle management for an improved performance
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 02
01. Technical description 04
02. Packing and transport 21
03. Erection and commissioning 26
04. Operation 38
05. Maintenance and spare parts 42
06. Trouble and treatment 58
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 classed 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

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

- Permission to work
- Special considerations when working on
Typical warning signs and labels

<table>
<thead>
<tr>
<th>High Voltage ISO 3864</th>
<th>Arc Flash Hazard ISO 3864</th>
<th>Warning Sign ANSI Z535.4</th>
<th>Danger Sign ANSI Z535.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Warning Sign]</td>
<td>![Danger Sign]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>![Arc Flash Hazard]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
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/cm².

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 Assessment 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

<table>
<thead>
<tr>
<th>Standards</th>
<th>Type-tested switchgear assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test certificates</td>
<td>China compulsory product certification</td>
</tr>
<tr>
<td>Type test</td>
<td>ASTA, Shanghai testing &amp; inspection for electrical equipment</td>
</tr>
<tr>
<td>Short-circuit withstand strength test</td>
<td>ASTA, Shanghai testing &amp; inspection for electrical equipment</td>
</tr>
<tr>
<td>Resist to accidental arcs acc. to IEC 61641 and part 508 of VDE0660</td>
<td>ASTA, great-Britain</td>
</tr>
<tr>
<td>Classification society certification (shipping)</td>
<td>Gemanischer Lloyd</td>
</tr>
<tr>
<td>Earthquake test for security areas in nuclear power stations</td>
<td>DRL german research institute</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical data</th>
<th>Rated voltages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated insulation voltage Ui</td>
<td>up to 1000 V AC , 3P, 1500 V DC**</td>
</tr>
<tr>
<td>Rated operating voltage Ue</td>
<td>up to 690 V AC , 3P, 750 V DC</td>
</tr>
<tr>
<td>Rated impulse withstand voltage Uimp</td>
<td>6/8/12 kV</td>
</tr>
<tr>
<td>Overvoltage category</td>
<td>II/III/IV</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>up to 60 Hz</td>
</tr>
<tr>
<td>Rated currents</td>
<td>Rated current Ie</td>
</tr>
<tr>
<td>Distribution bars</td>
<td>up to 6300 A</td>
</tr>
<tr>
<td>Rated peak withstand current Ipk</td>
<td>up to 220 kA</td>
</tr>
<tr>
<td>Rated short-time withstand current Icw</td>
<td>up to 100 kA</td>
</tr>
<tr>
<td>Arc proof</td>
<td>Rated operating current</td>
</tr>
<tr>
<td>Expected short-circuit current</td>
<td>690 V</td>
</tr>
<tr>
<td>Duration of short-circuit</td>
<td>300 ms</td>
</tr>
<tr>
<td>Criterion</td>
<td>1 to 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical characteristics</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sections and frames</td>
<td>DIN41488</td>
</tr>
<tr>
<td>Standard height</td>
<td>2200 mm</td>
</tr>
<tr>
<td>Standard width</td>
<td>400, 600, 800, 1000, 1200 mm</td>
</tr>
<tr>
<td>Standard depth</td>
<td>800, 1000, 1200 mm</td>
</tr>
<tr>
<td>Basic grid size</td>
<td>E=25 mm acc. to DIN 43660</td>
</tr>
<tr>
<td>Surface protection</td>
<td>Frame</td>
</tr>
<tr>
<td>Internal partitions and mounting plate</td>
<td>Alu-zinc coated or zinc coated or non-metal</td>
</tr>
<tr>
<td>Transverse section</td>
<td>Alu-zinc coated or zinc coated</td>
</tr>
<tr>
<td>Enclosure</td>
<td>Alu-zinc coated and powder coated RAL 7035, light grey</td>
</tr>
<tr>
<td>Degrees of protection</td>
<td>IEC 529</td>
</tr>
<tr>
<td>Plastic components</td>
<td>Halogen-free, self-extinguishing</td>
</tr>
<tr>
<td></td>
<td>Alu-zinc coated or zinc coated</td>
</tr>
<tr>
<td></td>
<td>DIN VDE0304 part 3</td>
</tr>
<tr>
<td></td>
<td>Flame retardant, CFC-free</td>
</tr>
<tr>
<td></td>
<td>IEC 707</td>
</tr>
<tr>
<td></td>
<td>Internal subdivision</td>
</tr>
<tr>
<td></td>
<td>up to Form 4</td>
</tr>
</tbody>
</table>
## MNS rear access switchgear

### Standards

<table>
<thead>
<tr>
<th>Type-tested switchgear assembly</th>
<th>GB/T 7251.1/12-2013, IEC 61439-1/2, EN 61439-1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test certificates</td>
<td>China compulsory product certification</td>
</tr>
<tr>
<td>Type</td>
<td>China quality certification centre</td>
</tr>
<tr>
<td>Short-circuit withstand strength test</td>
<td>Shanghai Testing &amp; Inspection Institute for Electrical Equipment Co., Ltd.</td>
</tr>
<tr>
<td>Resist to accidental arcs</td>
<td></td>
</tr>
<tr>
<td>EEMC (electromagnetic compatibility)</td>
<td></td>
</tr>
<tr>
<td>Salt spray test</td>
<td></td>
</tr>
<tr>
<td>Seismic test</td>
<td>China national center for quality supervision and test of electrical apparatus products</td>
</tr>
</tbody>
</table>

### Electrical data

<table>
<thead>
<tr>
<th>Rated voltages</th>
<th>Rated current Ie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated insulation voltage Ui</td>
<td>up to 1000 V AC, 3P, 1500 V DC*</td>
</tr>
<tr>
<td>Rated operating voltage Ue</td>
<td>up to 690 V AC, 3P, 750 V DC</td>
</tr>
<tr>
<td>Rated impulse withstand voltage Uimp</td>
<td>6/8/12 kV</td>
</tr>
<tr>
<td>Overvoltage category</td>
<td>II/III/IV</td>
</tr>
<tr>
<td>Degree of pollution</td>
<td>3</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>up to 60 Hz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rated currents</th>
<th>Rated peak withstand current Ipk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Busbars</td>
<td>up to 6300 A</td>
</tr>
<tr>
<td>Rated current Ie</td>
<td>up to 220 kA</td>
</tr>
<tr>
<td>Rated short-time withstand current Icw</td>
<td>up to 100 kA</td>
</tr>
<tr>
<td>Distribution bars</td>
<td></td>
</tr>
<tr>
<td>Rated current Ie</td>
<td>up to 2000 A</td>
</tr>
<tr>
<td>Rated peak withstand current Ipk</td>
<td>up to 176 kA</td>
</tr>
<tr>
<td>Rated short-time withstand current Icw</td>
<td>up to 80 kA</td>
</tr>
<tr>
<td>Arc proof</td>
<td></td>
</tr>
<tr>
<td>Rated operating current</td>
<td>415 V / 690 V</td>
</tr>
<tr>
<td>Expected short-circuit current</td>
<td>100 kA / 65 kA</td>
</tr>
<tr>
<td>Duration of short-circuit</td>
<td>300 ms</td>
</tr>
<tr>
<td>Criterion</td>
<td>1 to 7</td>
</tr>
</tbody>
</table>

### Mechanical characteristics

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Sections and frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sections and frames</td>
<td>DIN 41488</td>
</tr>
<tr>
<td>Standard height</td>
<td>2200 mm</td>
</tr>
<tr>
<td>Standard width</td>
<td>400, 600, 800, 1000, 1200 mm</td>
</tr>
<tr>
<td>Standard depth</td>
<td>1000, 1200 mm</td>
</tr>
<tr>
<td>Basic grid size</td>
<td>E=25mm acc. to DIN43660</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surface protection</th>
<th>Alu-zinc coated or zinc coated or non-metal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>Alu-zinc coated</td>
</tr>
<tr>
<td>Internal partitions and mounting plate</td>
<td>Alu-zinc coated or non-metal</td>
</tr>
<tr>
<td>Alu-zinc coated or zinc coated</td>
<td></td>
</tr>
<tr>
<td>Transverse section</td>
<td>Alu-zinc coated or zinc coated</td>
</tr>
<tr>
<td>Enclosure</td>
<td>Alu-zinc coated and powder coated RAL 7035, light grey</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degrees of protection</th>
<th>IEC 529</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic components</td>
<td>Halogen-free, self-extinguishing</td>
</tr>
<tr>
<td></td>
<td>DIN VDE0304 part 3</td>
</tr>
<tr>
<td></td>
<td>flame retardant, CFC-free</td>
</tr>
<tr>
<td></td>
<td>IEC 707</td>
</tr>
<tr>
<td>Internal subdivision</td>
<td>up to Form 4</td>
</tr>
</tbody>
</table>

### Extras

<table>
<thead>
<tr>
<th>Busbar system</th>
<th>Busbars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sheathed</td>
</tr>
<tr>
<td>Special qualification</td>
<td>Test certificates</td>
</tr>
<tr>
<td></td>
<td>See test certificates listed above</td>
</tr>
<tr>
<td></td>
<td>Special colours (standard RAL 7035)</td>
</tr>
<tr>
<td>Paint finish</td>
<td>Enclosure</td>
</tr>
<tr>
<td></td>
<td>Silver galvanized</td>
</tr>
<tr>
<td></td>
<td>Tin galvanized</td>
</tr>
</tbody>
</table>
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 switchgear.

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.

![Diagram of MNS 3.0 front access switchgear]

- Equipment compartment
- Busbar compartment
- Cable compartment

01 MNS 3.0 front 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 (protection 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
03 Frame with enclosure
04 Front mounted equipment (example)
Busbar holding plate

Busbar support
3- or 4-pole

Busbar holding plate

N busbar

05 Busbar system with outlined 4th pole
06 N-busbars, protective bars (PE) and neutral bars (N)
07 Cubicle distribution bar embedded in multi-function separator with outgoing cable connection unit and 2E distribution bar covers
08 Multi-function separator located in rear access section
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 neutral 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.

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 withdrawable modules is made of insulating material and serves as instrument panel for measuring, operating and indicating units.
12 Withdrawable module compartment for 4 units size 8E/4 or 2 units size 8E/2

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.

---

14 Withdrawable module compartment for units size 4E ... 24E
15 Empty withdrawable unit >4E (without electrical equipment)

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

<table>
<thead>
<tr>
<th>Operation from one side</th>
<th>Operation from both sides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incoming feeder 1600 A</td>
<td>500</td>
</tr>
<tr>
<td>Incoming feeder 2500 A</td>
<td>700</td>
</tr>
<tr>
<td>Incoming feeder 4000 A</td>
<td>1000</td>
</tr>
<tr>
<td>Incoming feeder 6300 A</td>
<td>1800</td>
</tr>
<tr>
<td>Withdrawable module cub</td>
<td>500</td>
</tr>
<tr>
<td>Plug-in/disconn. mod. cub.</td>
<td>400</td>
</tr>
<tr>
<td>Control cubicle</td>
<td>300</td>
</tr>
</tbody>
</table>

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.
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.
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 wide area

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

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

<table>
<thead>
<tr>
<th>Rope diam</th>
<th>Permissible load for a four-rope arrangement, rope angle at crane hook 120°</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hamp ropes</td>
</tr>
<tr>
<td></td>
<td>DIN 8325</td>
</tr>
<tr>
<td>mm</td>
<td>kg</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>180</td>
</tr>
<tr>
<td>12</td>
<td>280</td>
</tr>
<tr>
<td>14</td>
<td>350</td>
</tr>
<tr>
<td>16</td>
<td>470</td>
</tr>
<tr>
<td>18</td>
<td>580</td>
</tr>
<tr>
<td>20</td>
<td>720</td>
</tr>
<tr>
<td>24</td>
<td>1000</td>
</tr>
<tr>
<td>30</td>
<td>1600</td>
</tr>
<tr>
<td>36</td>
<td>2400</td>
</tr>
</tbody>
</table>

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

The arrangements of the lifting angles are shown in fig. 25. Shipping units with one or two cubicles are equipped with singleangles.
Shipping units consisting of three or four cubicles are equipped 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 considerable mechanical damage.

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 within 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 subsequent 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
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 rear walls
- Afterwards refit the rear walls correctly

---

1600 kg at a rope angle of 120 max.

2400 kg at a rope angle of 120 max.

Detail see diagram at right

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 vertical 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.
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 connected to the PE/PEN bar. Additional connections to the central earthing system can be made at any point of the perforated PE/PEN bar. Local regulations must be complied with.
- The lifting angles may be removed, for details (see chapter 2.4.2)
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 opened 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).

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).

<table>
<thead>
<tr>
<th>Cubicles without busbar compartment</th>
<th>Cubicles with busbar compartment</th>
<th>Cubicles with cable and busbar compartment; cable entry only to the cable compartment</th>
<th>Cubicles with busbar compartment and two-sided operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="32-Free-space-above-cubicle" alt="Diagram" /></td>
<td><img src="33-Wall-distances" alt="Diagram" /></td>
<td><img src="34-Floor-cutouts" alt="Diagram" /></td>
<td><img src="34-Floor-cutouts" alt="Diagram" /></td>
</tr>
<tr>
<td><img src="34-Floor-cutouts" alt="Diagram" /></td>
<td><img src="34-Floor-cutouts" alt="Diagram" /></td>
<td><img src="34-Floor-cutouts" alt="Diagram" /></td>
<td><img src="34-Floor-cutouts" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- **B**: total width
- **T**: total depth
- **T1**: 100
- **B1**: 75
- **T**: total depth
- **T1**: 100
- **T2**: 200
- **B1**: 75
- **B**: total width
- **T**: total depth
- **T1**: depth of equipment compartment
- **T2**: depth of equipment compartment
- **B1**: 75 mm
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 false floor. The screw 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 $p=20 \text{kN/m}^2$ (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.

---

**Fastening through welding**

*Welding after levelling*

*Top of finished floor*

*Top of unfinished floor*

**Underfloor cable channel**

10# "C" section steel base or ground fix bolt
### 3.3 Cable connections, wiring

<table>
<thead>
<tr>
<th>Switch type</th>
<th>Rated current up to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤1500 A</td>
</tr>
<tr>
<td></td>
<td>Max. numbers of cables and cross-section per phase</td>
</tr>
<tr>
<td>OT</td>
<td>4x300 mm²</td>
</tr>
<tr>
<td></td>
<td>(with supplementary cable connector)</td>
</tr>
</tbody>
</table>

38 Installation foundation drawing
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.
40 Direct connection at a circuit breaker
41 Connection of drawer circuit outgoing cables
Cable connection unit

Hexagon head screw M10 or M12

Nut M10 or M12

Spring ock washer DIN 7980

Plain washer ISO 7098

Adapter ring

Bellows for shock protection

Fix with cable ties

Cut off rings to match the cable cross section

---

42 Cable connection for withdrawable modules from 6E

---

<table>
<thead>
<tr>
<th>Rated current</th>
<th>Number of poles</th>
<th>Cable connection</th>
<th>Withdrawable module size</th>
<th>Max. tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>160 A</td>
<td>3</td>
<td>-</td>
<td>8E upto 24E</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>M10x30</td>
<td>8E upto 24E</td>
<td>50 Nm</td>
</tr>
<tr>
<td>250 A</td>
<td>3</td>
<td>M10x30</td>
<td>6E</td>
<td>50 Nm</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td>6E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td>8E upto 24E</td>
<td></td>
</tr>
<tr>
<td>400 A</td>
<td>3</td>
<td>M12x35</td>
<td>8E upto 24E</td>
<td>80 Nm</td>
</tr>
<tr>
<td>630 A</td>
<td>3</td>
<td></td>
<td>16E upto 24E</td>
<td></td>
</tr>
</tbody>
</table>

---

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

<table>
<thead>
<tr>
<th>Cable connection device CCU</th>
<th>Number of poles</th>
<th>Rated current</th>
<th>Rated conductor wire diameter (copper)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8E/4 drawer</td>
<td>3/4</td>
<td>45^\text{a)}</td>
<td>10 mm\text{\textsuperscript{2}}</td>
</tr>
<tr>
<td>8E/2 drawer</td>
<td>3/4/6</td>
<td>63</td>
<td>35 mm\text{\textsuperscript{2}}</td>
</tr>
<tr>
<td>4E drawer junction device</td>
<td>3</td>
<td>63</td>
<td>35 mm\text{\textsuperscript{2}}</td>
</tr>
<tr>
<td>6E / 8E drawer junction device</td>
<td>3/6</td>
<td>160</td>
<td>2X120 mm\text{\textsuperscript{2}}</td>
</tr>
<tr>
<td>8E drawer junction device</td>
<td>4</td>
<td>250</td>
<td>2X120 mm\text{\textsuperscript{2}}</td>
</tr>
<tr>
<td>8E drawer junction device</td>
<td>3</td>
<td>400</td>
<td>2X240 mm\text{\textsuperscript{2}}</td>
</tr>
<tr>
<td>12E drawer junction device</td>
<td>3/4</td>
<td>630</td>
<td>2X240 mm\text{\textsuperscript{2}}</td>
</tr>
<tr>
<td>16E drawer junction device</td>
<td>3</td>
<td>630</td>
<td>2X240 mm\text{\textsuperscript{2}}</td>
</tr>
</tbody>
</table>

---

43 Cable connection unit for 4E-modules (max. 63 A)
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 conadapter 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 mm²). 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

<table>
<thead>
<tr>
<th>Object</th>
<th>IEC 60439-1 / VDE 0660 Teil 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protective earthconductor</td>
<td>PE</td>
</tr>
<tr>
<td>Neutral conductor</td>
<td>N</td>
</tr>
<tr>
<td>Neutral conductor with PEN</td>
<td>PEN</td>
</tr>
</tbody>
</table>

---
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 ≥IPX1 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 ratproof, the part of outgoing feeder cable crossing the baseplate of the cabinet bottom shall be sealed. Normally we will use steped 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, trichlorethyIene 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 divisions. (refer to chapter 5.10 for tightening torques)
- Check the frame connections at the transport divisions
- 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 connections
- 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)
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.

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

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).
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 screwdriver (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.
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 immediately 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 below (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 abstracted or clogged

---

53 Switch operating handle for withdrawable modules size 4E up to 24E with position markers
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 admissible effective power loss \( P_{veff} \)

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 admissible effective power loss \( P_{veff} \) 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 admissible effective power loss \( P_{veff} \) 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 emission area of one side wall (Cubicle distance to wall at least 8 cm)

5.1.1.3 \( P_v \) 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
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 withdrawable module remains in the contact position. The power circuit is disconnected, the control circuit is operational
• In this position, the internal and external switching 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

<table>
<thead>
<tr>
<th>IP30 – IP42, ventilated</th>
<th>IP32 – IP54, non-ventilated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example max. ( P_V = 550 \text{ W per cubicle} )</td>
<td>Example max. ( P_V = 250 \text{ W per cubicle} )</td>
</tr>
<tr>
<td>No. of occupied rows</td>
<td>Reduction factor</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>1</td>
<td>0.77</td>
</tr>
<tr>
<td>2</td>
<td>0.69</td>
</tr>
<tr>
<td>3</td>
<td>0.66</td>
</tr>
<tr>
<td>4</td>
<td>0.63</td>
</tr>
<tr>
<td>5</td>
<td>0.61</td>
</tr>
<tr>
<td>6</td>
<td>0.60</td>
</tr>
<tr>
<td>7</td>
<td>0.59</td>
</tr>
<tr>
<td>8</td>
<td>0.59</td>
</tr>
<tr>
<td>9</td>
<td>0.59</td>
</tr>
</tbody>
</table>

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

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

In case of modifications of switchgear 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).
57 Draw out of a withdrawable module

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

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 cable compartment 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
- Install two outgoing cable connection units (details see fig. 42)
- Insert two outgoing cable connection units 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

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 outgoing cable connection units 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 withdrawal 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 compartment 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
5.3.2 Example 2: Conversion of one unit size

- 8 plastic guide rails have to be mounted,
- The left guide rail on the lower compartment
- Remove control terminal block and its support

5.3.1 Example 1: Conversion of one unit size

- Remove cable connection unit (see fig. 42)
- Withdrawable units size 8E/2 into the lower compartment and two post for 8E/2 modules in the other compartment
- Four for each compartment bottom plate
- Each module (withdrawable / plug-in module, distribution bars, or the withdrawable module connector, outgoing cable connection units) an additional bellows 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 condition by their operator.

For all works in connection with the activities required for this purpose, all relevant determinations of the MNS manufacturing instructions and MNS product information sheets must be observed and complied with in addition to the valid safety regulations and all relevant provisions.

The former include the following:
- Installation of power contacts
- Greasing of power contacts
- Tightening torques of bolted connections
- 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 connector) 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 connector, outgoing cable connection unit)
- Contacts movable and properly snapped 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.

![Warning: 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 operating cycles to which the unit is certified through type test as the grease reduces the wear of the contact area finish. Furthermore, the force needed for withdrawing the modules is reduced.

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

Conditions apply:
- The assembly works and testing routines have been completed in the workshop
- After a revision or after 100 plug-in cycles or after 2 years, whichever is earlier immediately before installing the module in the 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 greased at the building site
- For contact areas to be greased, see figures 60 and 61

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 a functional test must be carried out.

Lubrication of withdrawable module interlocks for modules 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 d can be verified by pulling the cable.

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

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

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

5.9.2 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 $\sigma_{02}\geq 70$ 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

---

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

In case the self-drilling bolt and screw bolt are loose, only manual screw driver could be used instead of any machine.
### Table: Screw type and dimensions

<table>
<thead>
<tr>
<th>Screw type</th>
<th>Dimension</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hex socket head cap screws DIN 912, with ESLOK</td>
<td>M6</td>
<td>8</td>
</tr>
<tr>
<td>Hex head bolts DIN 931, with ESLOK</td>
<td>M8</td>
<td>20</td>
</tr>
<tr>
<td>Hex head screws DIN 933, with ESLOK</td>
<td>M10</td>
<td>40</td>
</tr>
<tr>
<td>Hex socket head cap screws ISO 4762 (DIN 912)</td>
<td>M12</td>
<td>70</td>
</tr>
<tr>
<td>Hex head bolts ISO 4014 (DIN 931)</td>
<td>M16</td>
<td>140</td>
</tr>
<tr>
<td>Hex head screws ISO 4017 (DIN 933)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

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. Setpoint 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
- Cosф 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)
- Cosф display does not coincide with additional power factor meter reading:
  - Wrong voltage measuring connection (phase-phase and phase-N exchanged)
  - Slight deviations may be due to inaccurate measuring units and/or different measuring points

5.12 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:

```
\[
\begin{align*}
C & \quad R_d & \quad R_w & \quad R_f \\
\end{align*}
\]
```

** 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 performed?
DIN VDE 0100 part 610 specifies insulation measurement between the conductors in Section 5.3.

If the circuits contain electronic components, such as semiconductors, these sensitive components must by no means be damaged by the high measuring voltages.
Measurement may also be performed with the consuming equipment connected. If the insulation resistance is too low in this case, the consuming equipment must be isolated, and the system and consumer must be measured separately.

Prior to commissioning, the following circuits must be measured:
- All line sections between any 2 overcurrent protection devices
- The section following the last overcurrent protection device without any connected consumer equipment

### 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.

<table>
<thead>
<tr>
<th>Protected measure</th>
<th>Measuring-circuit voltage DC [V]</th>
<th>Minimum insulation voltage value [MΩ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety extra-low voltage, functional extra-low voltage with safe isolation</td>
<td>250</td>
<td>≥0.25</td>
</tr>
<tr>
<td>Protective separation</td>
<td>500</td>
<td>≥1</td>
</tr>
<tr>
<td>Rated voltage ≤500V, and functional extralow voltage without safe isolation</td>
<td>500</td>
<td>≥0.5</td>
</tr>
<tr>
<td>Rated voltage &gt;500 V, ≤1000 V</td>
<td>1000</td>
<td>≥1</td>
</tr>
</tbody>
</table>

### 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%)!

<table>
<thead>
<tr>
<th>Protective measure or rated voltage</th>
<th>Reading [MDt]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra-low voltage</td>
<td>0.36</td>
</tr>
<tr>
<td>Rated voltage ≤500 V</td>
<td>0.7</td>
</tr>
<tr>
<td>Rated voltage ≥500 V, ≤1000 V</td>
<td>1.4</td>
</tr>
</tbody>
</table>

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 then obtain the reading of the measuring device in order to prevent electric shock.

If a capacitive charging process was observed, the leads must be discharged 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 discharging resistors by waiting for one minute. As an additional safety measure, the outgoing capacitor circuits must be tested for discharged condition using an insulated cable
- Check whether the current transformers have been short-circuited before they are isolated or connected
- The automatic capacitor must be installed in accordance with the standards IEC 60831-1&2 and all national regulations
- A short-circuit may pose dangers to human life and destroy equipment! Therefore, it is of vital importance to use suitable tools and instruments for commissioning or inspection of electrical systems

5.13.3 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) Withdrawal technique
  b) Plug-in, disconnectable, railed 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 maintenance inspection depends on the operating conditions:
  Installations category A: Normal operation
  Installations category B: Heavy-duty operation, e.g. cement factory
  Installations category C: Short circuit (fault)
### 5.13.4 Maintenance and inspection list

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Work to be performed</th>
<th>Measured, test and limit values, operating and auxiliary materials</th>
<th>Frequency Install. category</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>General visual inspection (repetitive tests)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>External inspection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.1</td>
<td>Verify ambient conditions</td>
<td>• Room temperature ≤35°C&lt;br&gt;• Air, aggressive gases such as SO2, H2S etc.&lt;br&gt;• Relative humidity ≤50% at 40°C&lt;br&gt;• Dust</td>
<td>1a 6m X</td>
<td>Unpleasant smell&lt;br&gt;Auxiliary heating possibly required</td>
</tr>
<tr>
<td>1.1.2</td>
<td>Check ventilation system (efficiency)</td>
<td>• Air supply to and air discharge from cubicle not obstructed&lt;br&gt;• max. temperature inside the cubicle: ≤60°C</td>
<td>1a 6m X</td>
<td>Touch fronts with hand surface, check cubicle if hand-warm spots are found</td>
</tr>
<tr>
<td>1.1.3</td>
<td>Check condition of enclosure / outside paint</td>
<td>• Damaged/corroded&lt;br&gt;• Missing parts such as module doors or covers&lt;br&gt;• Ventilation louver dusty/covered&lt;br&gt;• Roof plate contaminated/covered/obstructed/etc.&lt;br&gt;• Fastening of cable compartment doors, side and back panels&lt;br&gt;• Position of withdrawable modules in the cubicle (operating or isolated position)</td>
<td>1a 6m X</td>
<td></td>
</tr>
<tr>
<td>1.1.4</td>
<td>Accessibility</td>
<td>• Escape route ≥650 mm</td>
<td>1a 6m X</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Completion of the interior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.1</td>
<td>Equipment compartment</td>
<td>• Arrangement of modules in accordance with engineering documents&lt;br&gt;• Contamination, e.g. dust</td>
<td>1a 6m X</td>
<td></td>
</tr>
<tr>
<td>1.2.2</td>
<td>Cable compartment/cable terminal compartment</td>
<td>• Incoming feeder in accordance with documents (busbar/cable laterally/top/bottom)&lt;br&gt;• Sufficient room/strain relief&lt;br&gt;• Cable routing; bending radii&lt;br&gt;• Protective bellows</td>
<td>1a 6m X</td>
<td></td>
</tr>
<tr>
<td>1.2.3</td>
<td>Busbar compartment</td>
<td>• Color changes at bolted connections&lt;br&gt;• Proper installation of cover in partition wall 3&lt;br&gt;• Contamination or flashover&lt;br&gt;• Formation of cracks or creeping paths&lt;br&gt;• Shrink-on tube brittle</td>
<td>1a 6m X</td>
<td>Check using thermo-vision exposures</td>
</tr>
<tr>
<td>1.3</td>
<td>General inspection of the switchgear assembly (withdrawable or plug-in, disconnectable, rable technique)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.1</td>
<td>Design of conductors and conductor installation</td>
<td>Condition of insulation</td>
<td>2a 1a X</td>
<td>Measure the insulation resistance</td>
</tr>
<tr>
<td>1.3.2</td>
<td>Check electrical equipment installed</td>
<td>• Bracing&lt;br&gt;• Check contact corrosion, contact gaps, ionization, rated currents, settings and tripping&lt;br&gt;• Minimum creepage distance ≥12.5 mm&lt;br&gt;• Check minimum clearance for arcing space</td>
<td>For the complete maintenance work, observe the instructions of the equipment manufacturer</td>
<td>Cf. equipment manufacturer</td>
</tr>
<tr>
<td>Item no.</td>
<td>Work to be performed</td>
<td>Measured, test and limit values, operating and auxiliary materials</td>
<td>Frequency Install. category</td>
<td>Remarks</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>1.3.5</td>
<td>Required protection class</td>
<td>• EN 60529</td>
<td>A 2a</td>
<td>B 1a</td>
</tr>
<tr>
<td>1.3.6</td>
<td>Check efficiency of protective conductor connection</td>
<td>• Check continuity with signal test apparatus</td>
<td>2a</td>
<td>1a</td>
</tr>
<tr>
<td>1.3.7</td>
<td>Function test of the control device</td>
<td>• In accordance with circuit diagram</td>
<td>2a</td>
<td>1a</td>
</tr>
<tr>
<td>1.3.8</td>
<td>Check measuring loops</td>
<td>• In accordance with circuit diagram</td>
<td>2a</td>
<td>1a</td>
</tr>
<tr>
<td>2.0</td>
<td>Additional checks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Withdrawable technique</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1</td>
<td>Compact modules (BE/4 + BE/2)</td>
<td>• Check easy movement of module in compartment</td>
<td>2-3a</td>
<td>1a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Function test of mechanical interlock</td>
<td>2a1</td>
<td>1a1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check electrical contact-making</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Main contacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Control plugs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Visual inspection of module compartment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check efficiency of protective conductor connection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.2</td>
<td>Withdrawable modules ≥4E</td>
<td>• Check easy movement of module in compartment</td>
<td>2a1</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Function test of mechanical interlock</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check electrical contacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Main contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Control plug</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fastening of outgoing cable unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Protective conductor connection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Plug-in, disconnectable, reliable technique</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Direct connection (incoming and outgoing feeders with circuit breaker)</td>
<td>• Visual inspection of main connections</td>
<td>1a</td>
<td>6 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Color change at switch main connections</td>
<td>1a</td>
<td>6 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Condition of main and eroded contacts</td>
<td>1a</td>
<td>6 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Function test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fastening of transformers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Secondary cable routing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Condition of transformer housings</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check screwed connections</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mechanical condition of supporting plate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Formation of creepage paths</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check supports at angle and connection sets</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check screwed connections</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check cable strain relief</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cable routing, min. bending radii, edge protection, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>Reactive power compensation system</td>
<td></td>
<td>1a</td>
<td>6 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Master switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Circuit breaker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item no.</td>
<td>Work to be performed</td>
<td>Measured, test and limit values, operating and auxiliary materials</td>
<td>Frequency</td>
<td>Remarks</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------</td>
<td>---------------------------------------------------------------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Visual inspection</td>
<td>Install. category</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• On-off condition</td>
<td>A B C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Closed properly</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fuse continuity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Contact lubrication</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Clamp spring examination, discoloration or exception</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Visual inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Abnormal sound</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Whether insulation paper turns yellow or not</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Noise</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Temperature. For the limit, refer to manufacturer’s instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Whether components, such as temperature control switches, are normal or not</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Discharge resistor inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Basic parameter re-check</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• C/K value</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cos setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Step size control. Its suggested value is greater than 40 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Discoloration or aging</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Bolt tightening. For tightening force, refer to manufacturer’s instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ventilation window shall be intact and unblocked</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fans shall run properly</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Primary contact pressure, refer to manufacturer’s instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 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%.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Whether harmonic distribution matches with reactance rate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

ABB Connect helps you to find product information and stay connected to the latest news and tools. It’s a digital assistant that enables customers to connect to the broadest range of electrification solutions in one place.

• Easy to find what you need by search
• Get all information about our products, applications, selection guides, installation manuals, service, certificates, and engineering tools etc.
• Saving documents locally, updating automatically.
• Receive your expected massages
• Online customer service

You can use ABB Connect on iOS, Android and Windows 10 device

Scanning QR code to enter ABB Connect

Technical information and certificates
Offering, industries and services
Catalogs
Tools
Save documents
Contact us
Personal workspace
News and activities