# ZS1

## Air-insulated medium voltage switchgear, 24 kV

## Instruction manual BA 398/03 E


ABB Power Distribution

# Your safety first – always!

That's why our instruction manual begins with these recommendations:

- Only install switchgear and/or switchboards in enclosed rooms suitable for electrical equipment.
- Ensure that installation, operation and maintenance are carried out by specialist electricians only.
- Comply in full with the legally recognized standards (DIN VDE / IEC), the connection conditions of the local electrical utility and the applicable safety at work regulations.
- Observe the relevant information in the instruction manual for all actions involving switchgear and switchboards.
- ⚠ Danger!

  Pay special attention to the hazard notes in the instruction manual marked with this warning symbol.
- Make sure that under operation condition of the switchgear or switchboard the specified data are not exceeded.
- Keep the instruction manual accessible to all persons concerned with installation, operation and maintenance.
- The user's personnel are to act responsibly in all matters affecting safety at work and the correct handling of the switchgear.


If you have any further questions on this instruction manual, the members of our field organization will be pleased to provide the required information.

# 1 Summary

## 1.1 General

The metal-clad, three-pole air-insulated switchgear panels without disconnectors from the ZS1 series are factory-assembled, type-tested indoor switchgear panels for a rated voltage of 24 kV. They are designed as withdrawable module type panels, and fitted with a single busbat system. The withdrawable parts are preferably fitted with vacuum circuit-breakers.

Detail of the technical design and configuration of individual switchgears, such as the technical data, detailed equipment lists for the individual panels and comprehensive circuit documentation, etc., can be found in the relevant order documents.

## 1.2 Standards and specifications

ZS1 switchgear panels comply with the standards and specifications for factory-assembled, metalclad and type tested high voltage switchgears to VDE 0670 and the relevant IEC publications 60298 and 60694. In addition, in accordance with DIN VDE 0470 and the equivalent IEC 60529, the switchtgear panels have degrees of protection.

IP 4X (IP 5X on request) for the enclosure and IP 2X for the partitions.

All other relevant VDE specifications, especially DIN VDE 0101, VDE 0105 and DIN VDE 0141, the corresponding IEC publications, the national or local safety at work regulations and the safety regulations for production materials are to be followed during erection and operation of these systems. Above and beyond this, the order-related data from ABB are to be taken into account.

## 1.3 Operating conditions

### 1.3.1 Normal operating conditions

The switchgears are fundamentally designed for the normal operating conditions for indoor switchgears to DIN VDE 0670 part 1000 / IEC Publication 60694. The following limit values, among others, apply:

Ambient temperature:

| | |
|---|---|
| Maximum | +40°C |
| Maximum 24 h average | +35°C |
| Minimum (according to “minus 5 indoor class“) | -5°C |

VDE 0670 part 6 amends the content of VDE 0670 part 1000 with respect to humidity as follows: With indoor installation, it is assumed that the humidity within the enclosure can reach high values, but that there is mormally no condensation on the installed equipment. Condensation can be prevented by appropriate configuration of the station building or switchgear room.

The maximum site altitude is 1000 m above sea level.

### 1.3.2 Special operating conditions

According to VDE 0670 part 1000, the manufacturer and user may agree on special operating conditions which deviate from the mormal operating conditions. The manufacturer must be consulted in advance about each special operating condition. Examples are as follows:

- At site altitudes above 1000 m, the effects of the reduction in dielectric strength of the air on the insulation level are to be taken into account (please refer to diagramme figure 1/1).
- Increased ambient temperatures must be compensated for in the design of the busbars and tee-off conductors as well as for the withdrawable parts, or the current carrying capacity will be limited. Heat dissipation in the switchgear panel can be assisted by fitting additional ventilation facilities.

Note on any special climatic operating conditions:

When switchgears are operated in areas with high humidity and/or major rapid temperature fluctuations, there is a risk of dew deposits which must remain an exception in normal operating conditions for indoor switchgear. Preventive action (e.g. fitting electric heaters) must be taken in consultation with the manufacturer to avoid such condensation phenomena and the possibly resulting corrosion and other adverse effects. The control of the heaters depends on the relevant project and details are to be taken from the order documents.

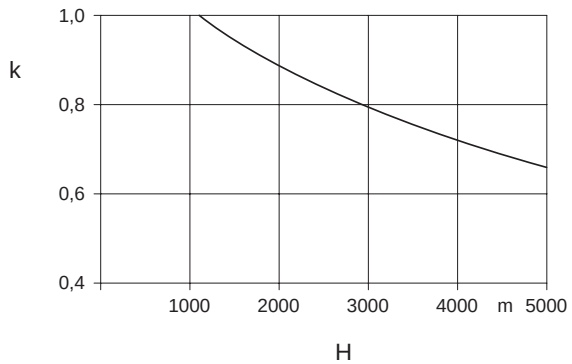



*Figure 1/1: Curve for determination of the altitude factor k in relation to the altitude H.*

# 2 Technical data

## 2.1 **Electrical ata**

| | | |
|---|---|---|
| Rated voltage | kV | 24 |
| Rated power frequency withstand voltage | kV | 50 |
| Rated lightning impulse withstand voltage | kV | 125 |
| Insulation to: | | DIN VDE/IEC list 2 |
| Rated frequency | Hz | 50/60 |
| Rated current of busbars | A | …2500 |
| Rated current of tee-offs | A | …2500[3)] |
| • circuit breaker | A | …1000 |
| • switch disconnector | A | …1000 |
| Rated peak withstand current[1)] | kA | …63 |
| Rated short-circuit breaking current of circuit-breaker | | kA …25 |
| Rated short-time current 3 s[1)] | kA | …25 |
| Auxiliary voltage | V | DC[2)] 60, 110, 120; AC 110, 220 |

[1)] Take the short-circuit withstand capability of the instrument transformers into account separately.

[2)] Special DC voltages on request.

[3)] [a)] 2000 A; by additional cooling due to ventilation grids in the horizontal partition plate and due to pressure relief flap made from expanded metal instead of sheet steel plates on the circuit-breaker compartment

[b)] 2500 A; by design as stated under item a and additional expanded metal on the cable connection department and the busbar compartment instead of pressure relief flaps made from sheet steel plates and additional ventilation grids in the horizontal partition plate.

For data of the individual switching devices, see the instruction manual for the the switching device concerned, as listed under 7.1.

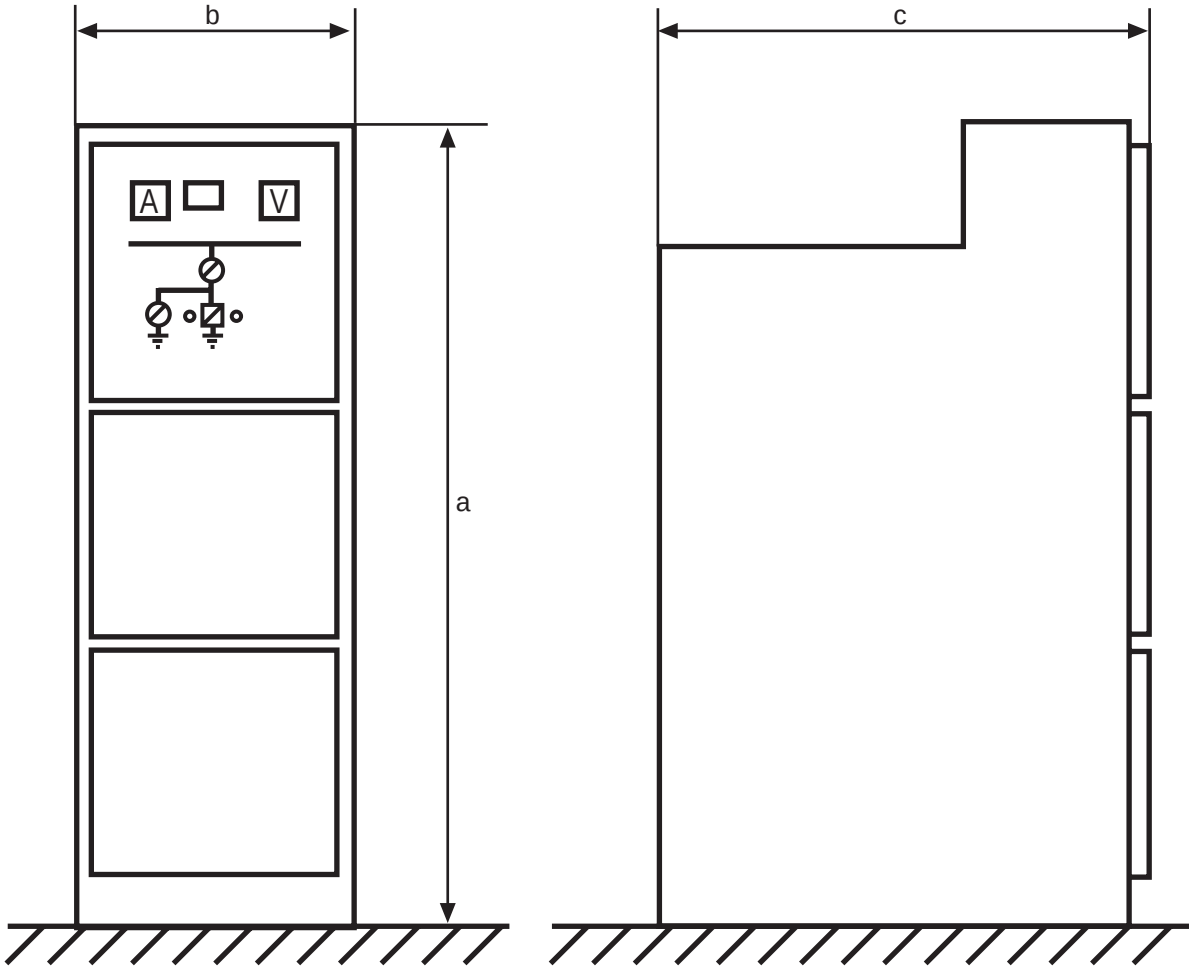
## 2.2 **Resistance to internal arc faults**

The fault withestand capability is 25 kA 1 s. Criteria 1 to 6 of PEHLA guideline no. 4 (in conjunction with VDE 0670 part 6 and IEC 60298) are fulfilled. In individual cases, depending on the configuration of the switchgear panels and/or the switchroom conditions (e.g. low ceiling height), additional measures may be necessary to ensure compliance with criterion 5.

## 2.3 Dimensions and weights

| Dimensions | | | |
|---|---|---|---|
| Rated voltage | | kV | 24 |
| Height | Dimension a | mm | 2325[1)] |
| Width | Dimension b | | |
| • Feeder panels up to 1250 A | | mm | 800[2)] |
| • Feeder panels over 1250 A | | mm | 1000 |
| Depth | Dimension c | mm | 1500[3)] |

[1)] Optionally 2200 mm
[2)] Available as special version with 1000 mm
[3)] 1520 mm for feeders from 1600 to 2500 A




Weights:

Feeder panel 850 to 1200 kg, depending on equipment installed.

Detailed individual data can be found in the tables in sections 5.2.1 and 5.2.2.

# 3 Panel design and equipment

## 3.1 Basic structure and variants

(Figures 3/1 to 3/3)

The basis for the ZS1 panel is the incoming/ outgoing feeder panel with vacuum circuit-breaker using insertion technology. It is divided into busbar compartment A, circuit-breaker compartment B, cable compartment C and the control cabinet D for the secondary equipment. Apart from this, there are variants for all operating needs. The pictures 3/1 to 3/3 show possible configurations of a panel including electrical equipment.

For a busbar sectionalizing, two panels are necessary, the coupling panel with the withdrawable circuit-breaker part and a bus riser panel (optional with busbar metering and earthing). When setting up the switchgear in two rows, the busbar sectionalizing can be combined with a bar connection between the two sets of switchgear. In equipment without busbar sectionalizing, a direct bar connection between the busbars will be established.

With ZS1 panels it is possible to set up a double busbar installation in accordance with the two breaker method. This duplex arrangement is possible both with back to back or front to front positioning.

Apart from this, panels with fixed-mounted switch-disconnectors of type C3 (e.g. for feed to a station service transformer) are provided.

Depending on rated short-time current and the ceiling height of the circuit-breaker compartment, a pressure relief duct on the panel would perhaps be required.

Further details about the installation and equipping of the switchgear can be obtained from the order documents.

## 3.2 Enclosure and partitioning

(Figure 3/3, 5/11, 5/27)

Enclosure and internal partitioning of the panels are of high quality aluminium-zinc coated steel sheets, 2 mm thick. The three high voltage compartments (busbar compartment circuit-breaker compartment and cabel connection compartment) are equipped with top-mounted, secured pressure relief flaps. These open in the case of overpressure due to an internal arc fault.

The front of the panel is closed off by pressure resistant doors which open to an angle of almost 180°. Cable and circuit-breaker compartments have their own doors. The circuit-breaker compartments are equipped with sight glasses made of security glass. Neighbouring panels are partitioned from one another by the side walls of each panel and the air cushion which remains between these walls as a result of the design when the panels are joined together.

The enclosure is completed by top-mounted pressure-relief flaps which are, according to the rated tee-off conductor current, made of sheet steel or expanded metal and below by means of the floor-covering 17 made of sheet steel which cannot be magnetized. The pressure-relief flaps are secured with steel screws on one longitudinal side and on the other longitudinal side with plastic screws. In the case of internal overpressure, the plastic screws are the point of rupture.

An $I_{th}$ limitation can be achieved under arc fault conditions by undelayed breaker release effected by auxiliary switches 11.5 (figure 5/27) which control the pressure relief devices (standard equipment for higher short-circuit capacity).

The necessary safety measures to counteract the effects of an internal arc fault must be ensured in connection with the ceiling height. This may in individual cases possibly necessitate additional operator protection measures on the switchgear panels. Such measures include:

1. Mounting of a pressure relief duct 50 on the top of the switchgear, with further channels leading out of the switchroom in an appropriate form for the building design. The shock wave and arc discharge are channelled off in ducts (figure 5/11)
2. Mounting of a pressure relief duct with blow-out apertures located above the duct at the ends of the switchgear and pointing towards the centre of the switchgear. The shock wave and arc discharge then emerge in an extremely attenuated form and at a location which is not critical for the operating personnel.

Part of the internal partitioning are the busbars-rear wall of the busbar compartment 84, the intermediate wall 9, the mounting plate 12 with the shutters 12.1/12.2 and the horizontal partition 20. The internal partitioning makes it possible to have safe access to the circuit-breaker and cable compartments even when the busbars are live.

The low voltage compartment for the secondary equipment is completely protected from the high voltage area due to its steel-sheet casing.

On the end sides, cover plates ensure a good appearance and are mechanically and thermically arc fault proof in case of such an event in the end panel.

Doors and rear walls as well as the cover plates are thoroughly cleaned and treated against corrosion before receiving a high-quality double coating of paint. The finishing coat is in the standard colour RAL 7035 (special colours by agreement). The stoving procedure completes the work and imparts a notable insensitivity to impacts and corrosion.

### 3.2.1 **Ventilation of the panels**

(Figures 3/1 to 3/3, 5/27, 6/21, 6/22)

For the purpose of ventilation in cases of certain rated currents in the busbar and tee-off bars, openings in the outer enclosure are necessary.

For incoming air to the circuit-breaker compartment, the horizontal partition is provided with air-vents 20.2. The degree of protection IP4X and safety in case of releases of hot gas caused by an arc fault are provided by the flap 20.3 in the raised false floor. In the case of outgoing air, the presssure relief flaps are provided made of expanded metal instead of clad metal sheets. The form and size of the vents in the expanded metal provide the degree of protection IP4X.

In case of an increased ambient temperature (>40 °C) and/or increased frequency (60 Hz) may it by necessary to install a fan into the horizontal partition at an increased current (2500 A). This is no standard. Please refer to figure 6/21 and 6/22.

The controlling of this fan depends on the condition of the contract and is available in the contract documents.

## 3.3 **Compartments in the panels**

### 3.3.1 Busbar compartment

(Figures 3/3, 5/9, 5/15 to 5/21)

The busbars 3 have a D-shaped cross-section made of copper or aluminium and are laid in sections from panel to panel. According to the current rating, single or double configuration is used. They are held by the flat tee-off conductor 2 and if installed the busbar bushings 29. No special connecting clamps are needed.

Busbars and tee-off conductors are insulated by means of shrink-on sleeves. The bolt connections in the busbar system are covered by insulating covers 58, so that the entire configuration is completely free of arc fault points of origin.

In conjunction with bushing plates 28 (or 28.2) and 29, panel by panel partitioning is possible.

### 3.3.2 Circuit-breaker compartment

(Figures 3/3, 3/6 to 3/10, 3/14, 3/17, 6/7, 6/9, 6/10, 6/23)

The circuit-breaker compartment contains all the necessary equipment for the mutual functioning of the withdrawable part and the panel. It is, as the busbar compartment, metally partitioned on all sides.

The isolating tulips 5 together with the fixed isolated contacts are in the mounting plate 12. Also included are the metal shutters 12.1/12.2 which cover the insertion openings. The shutters are opened by means of the actuating bars 13.16 of the withdrawable breaker part using lever 38 when inserting into the service position and are closed when it is removed. In the test/disconnected position of the withdrawable part, a partitioning by separation is established in the main circuit current. The connection of the control wiring which must be established for test purposes need not be interrupted when in the test/disconnected position.

In the test/disconnected position, the withdrawable part is still completely inside the panel with the door closed. The ON/OFF push button located on the breaker, and the mechanical indicators for ON/OFF and CHARGED/DISCHARGED can be observed through a sight glass.

The switching operations are carried out with the doors closed. Installation of an additional mechanical switching device for manual operation of the circuit-breaker in the service position is also possible.

The socket 10.1 for the control wiring is fixed-mounted in the circuit-breaker compartment.

### 3.3.3 Withdrawable parts

(Figures 3/3, 3/6 to 3/8, 3/10 to 3/13, 3/15 to 3/21)

1. Withdrawable circuit-breaker parts

   The withdrawable circuit-breaker forms a complete module consisting of the circuit-breaker type VD4, type VM1 or $SF_6$ circuit-breaker type HA, the withdrawable assembly 13.15, the isolated contact arm 4.2 with the contact system 4.3 and the control wiring plug 10.2.

The withdrawable assembly 13.15 and the circuit-breaker are coupled via a multipole control-wiring plug connection 10.3.

The withdrawable assembly establishes the mechanical connection between the panel and the circuit-breaker. The fixed part is connected to the panel by forking, form-coded on both sides. The movable part with the circuit-breaker is moved manually or by a motor by way of a spindle, between the service or test/disconnected positions with the front doors closed. Service and test/disconnected positions are exactly registered by means of auxiliary switches, which register the final position reached and the angular position of the spindle.

The earthing connection between the withdrawable part and the panel is established by its rollers and the travel rails 42 which are bolted into the panel. The surfaces of all the parts of the earthing circuit are zink-galvanized.

Withdrawable parts of the same design are mutually interchangeable. In the case of the withdrawable parts having the same dimensions, but different equipping of the circuit-breaker, the

codification of the control wiring plug prevents non-permitted connections between the withdrawable part and the panel.The coding is indicated in the order documents.

2. Other withdrawable parts

In place of the circuit-breaker type VD4, the withdrawable part can also be fitted to act as a "disconnecting device" with a fixed current-bridge in VD4 pole-casing or with a $SF_6$ circuit-breaker (fabricated by ABB Sace).

The withdrawable part is used in the metering panel with voltage transformers 95.1 with or without HRC fuses as required. The HRC fuses are located in the insulated contact arms which are fixed to the P.T.s.

### 3.3.4 Cable connection compartment

(Figures 3/3, 5/12 to 5/14, 5/28 to 5/30)

The cable compartment contains current transformer 7, voltage transformer 8 and earthing switch 6 in each case according to the individual operating requirements.

The cable compartment is constructed for the installation of three current transformers. Should all three current transformers not be required, dummies will be installed instead with the same installation and connection procedures.

The fixed-mounted voltage transformers are connected on the primary side with flexible, completely insulated wirings which are inserted into the transformers.

In certain circumstances it is possible to use removable voltage transformers. They can be equipped with HRC fuses similar to the design in the metering panel.

The earthing switch type EK6 can be used either with manual or motor-operated mechanism. Its switching position will be indicated by means of the auxiliary switch both mechanically and electrically.

In the 800 mm wide panel, it is possible (according to choice) to prepare for up to three parallel three-core cables if required. In the standard version, the intended equipping is a plastic cable with single cable core protection.

In the 1000 mm wide panel up to six parallel plastic cables can be connected also with single cable core protection and push-on sealing ends.

An alternative could be the 800 mm wide panel socket-contacts with inner cones for connection to the cable plugs. Customer wishes regarding the connections to bars or special cable or sealing-end types must be clarified during the order-planning phase.

In place of three cable cores, three surge arrestors can be fixed-mounted. An alternative would be, under certain conditions, to have these in a withdrawable form.

In the Duplex version, the cable compartment is modified as follows:

- In the back to back version, the connection between the two panels consists of flat copper bars.
- In the front to front version it consists of made-up plastic insulated cables or insulated busbar capacitance grading device, depending on the current.

### 3.3.5 Control cabinet

(Figures 3/3, 3/5, 5/26 and 5/27)

The control cabinet is for all matters of control and protection suitable for both conventional or modern control technology.

Apart from the usual case, a control cabinet of 580 mm or 705 mm in height, there is also a 1100 mm high version for especially comprehensive secondary technology, which has a panel height of 2720 mm.

If the secondary devices are not intended for door installation, they are mounted on perforated metal sheet 37.3. This is stored folded-up to enable any subsequent changes to the wiring. In place of the perforated metal steet are installed profile rails for fixing control equipment. In the lower part of the control cabinet, three rows of terminal strips are on the swivelling terminal strips holder 37.4 and below these, auxiliary switch 10.4 for the control wiring plug is easily accessible.

For doors in which devices with higher voltage than that of low-voltage protection are installed, a secure and complete protection conductor connection must be established. The corrosion protected hinge of the control cabinet corresponds to these requirements (DIN VDE 0660 part 500). Protection against contact to clamps and devices corresponds to VGB 4.

Secondary wiring internal to the panel is in a duct on the right side of the panel. The left side of the panel is for the external wiring. The ducts are covered with steel sheet metal 43. At the side of the control cabinet are holes for sliding in the ring conductors.

Detailed information about the secondary technology and to the relevant material used in each case can be obtained from the secondary check-list pertaining to the order.

## 3.4 Interlocks/protection against maloperation

### 3.4.1 Panel internal interlocking

(Figures 3/3, 3/6, 3/7, 6/5, 6/7, 6/23)

To prevent dangerous situations and maloperation, a series of interlocks exist to protect both personnel and equipment.:

- The withdrawable part can only be moved from the test/disconnected position (and back) when the circuit-breaker and earthing switch are off (i.e., the switch must be off beforehand.) In the in-between position, the switch is mechanically interlocked, in the case of circuit-breakers with electrical release, the interlock is also electrical.
- The circuit-breaker can only be switched on when the withdrawable part is in the test or service position. In the in-between position, the switch is mechanically interlocked, in circuit-breakers with electrical release there is an electrical interlock too.
- In panels with digital control technology, prevention of maloperation of the switch basically takes place by means of the panel's software.
- In the service or test positions, the circuit-breaker can only be switched off manually when no control voltage is applied and cannot be closed (electromechanical interlock).
- Connecting and disconnecting of the control wiring plug 10.2 is only possible in the test/ disconnected position of the withdrawable part.
- Switch-disconnector and the earthing switch integrated therein are normally mechanically interlocked from each other and in each case only one of the two can be switched on.
- The earthing switch 6 can only be switched on if the withdrawable part is in the test/disconnected position or outside of the panel (mechanical interlock[1)]).
- If the earthing switch is on, the withdrawable part cannot be moved from the test/disconnected position to the service position (mechanical interlock).
- Details of other possible interlocks e.g. in connection with a blocking magnet on the withdrawable part and/or earthing switch drive, can be obtained from the relevant order documents .

### 3.4.2 Interlocks between panels

(Figure 3/1-4, 3/1-5, 3/1-8, 3/3)

- The busbar earthing switch can only be closed when all withdrawable parts in the relevant busbar section, are in the test/disconnected position (electromechanical[2)] interlock).
- When the busbar earthing switch is closed, the withdrawable parts in the earthed busbar section cannot be moved from the test/ disconnected position to the service position (electromechanical[2)] interlock).

### 3.4.3 Locking devices

(Figures 6/14, 6/23)

- The shutters 12.1/12.2 can be secured independently of each other with padlocks when the withdrawable circuit-breaker part has been removed.
- Access to the operating-shaft 14.1 of the earthing switch can be restricted with a padlock.
- Access to the circuit-breaker compartment and the cable compartment as well as to the withdrawable part controls can be restricted with a padlock (no standard).

## 3.5 VD4 circuit-breaker run on-block

In case of any irregularity in the area of the inner control mechanism and of the charging function of the stored-energy spring mechanism, the run-on block disables the immediately subsequent switching operation.

This is a protective measure to prevent damage to the circuit-breaker.

Release of the run-on block is described in instruction manual BA 383/E.

## 3.6 Coding of the control wiring plug connection

(Figure 3/21)

Coding of the control wiring plug connector allows withdravable parts for switching devices to be assigned to particular panels. This ensures, for example, that withdrawable parts with different rated currents or different control wiring circuits can only be used in the panels for which they are intended.

Coding pins are fitted in the control wiring sockets 10.1 or control wiring plugs 10.2 and engage in the corresponding bores of the relevant plug 10.2 or socket 10.1 when the two parts are connected.

Coding of the plug connector is order-related, and is noted in the relevant wiring documentation.

---

1) The mechanical interlock is replaced by a blocking magnet in the case of a duplex configuration.

In the case of a motor drive, the mechanical interlock or the blocking magnet is replaced by electrical interlock of the earthing switch. The emergency manual switch is not locked!

2) The blocking magnet is not installed in the case of a motor drive; busbar earthing switches or the withdrawable parts are electrically locked. The emergency manual switch is not locked!

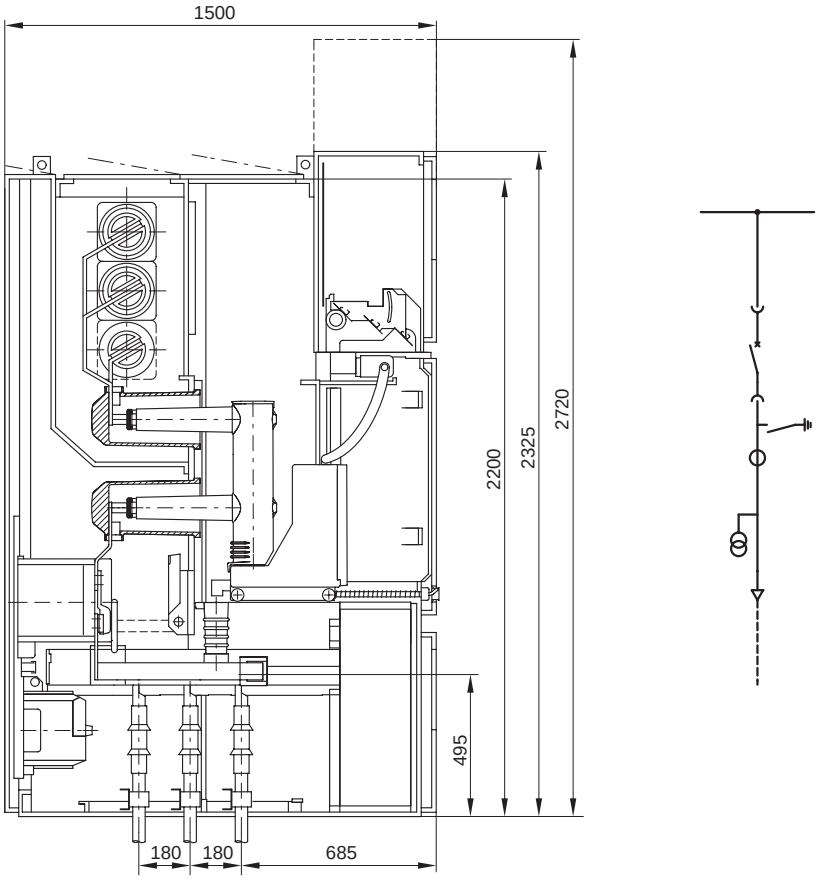



*Figure 3/1-1: Outgoing feeder, 24 kV, …1250 A, 25 kA with fixed installed voltage transformers alternatively with low voltage compartment 1100 mm height*

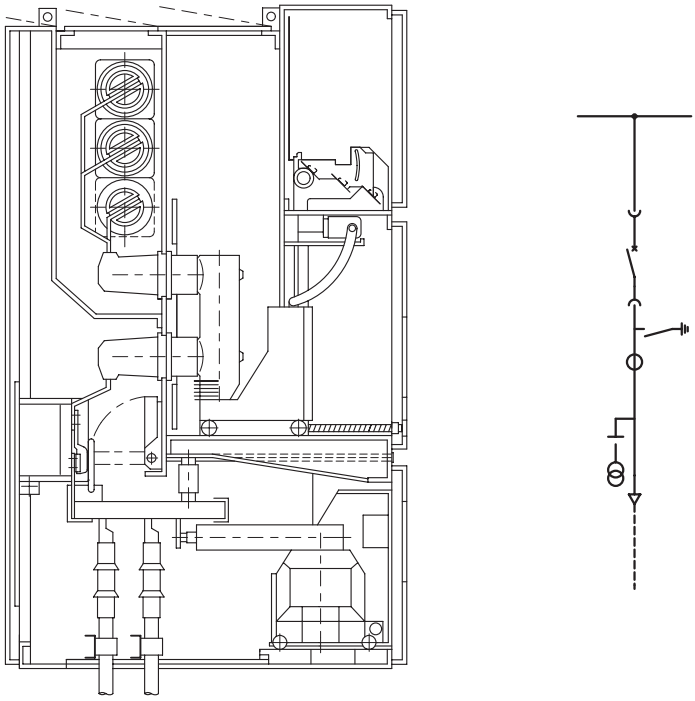
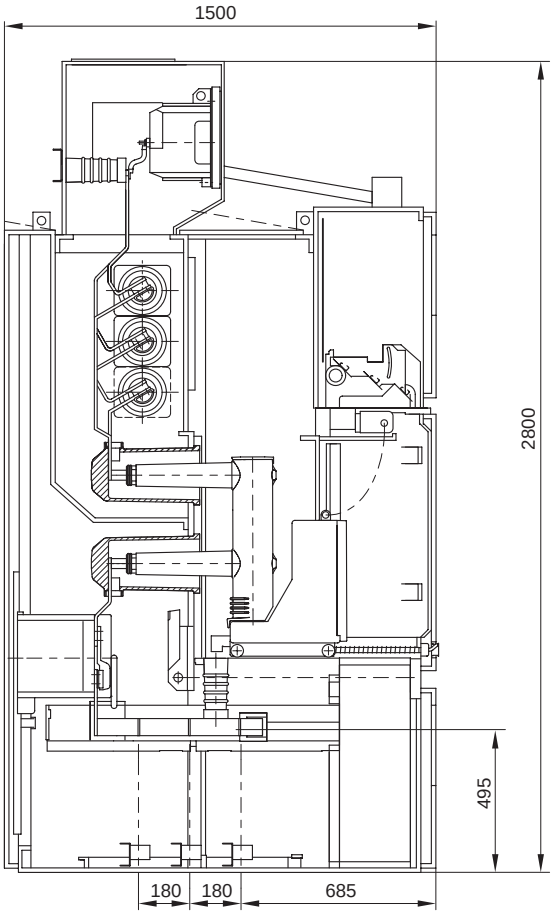


*Figure 3/1-2: Outgoing feeder, 24 kV, …1250 A, 25 kA voltage transformers withdrawable*



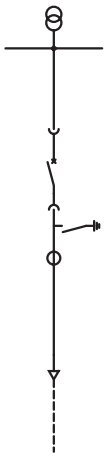
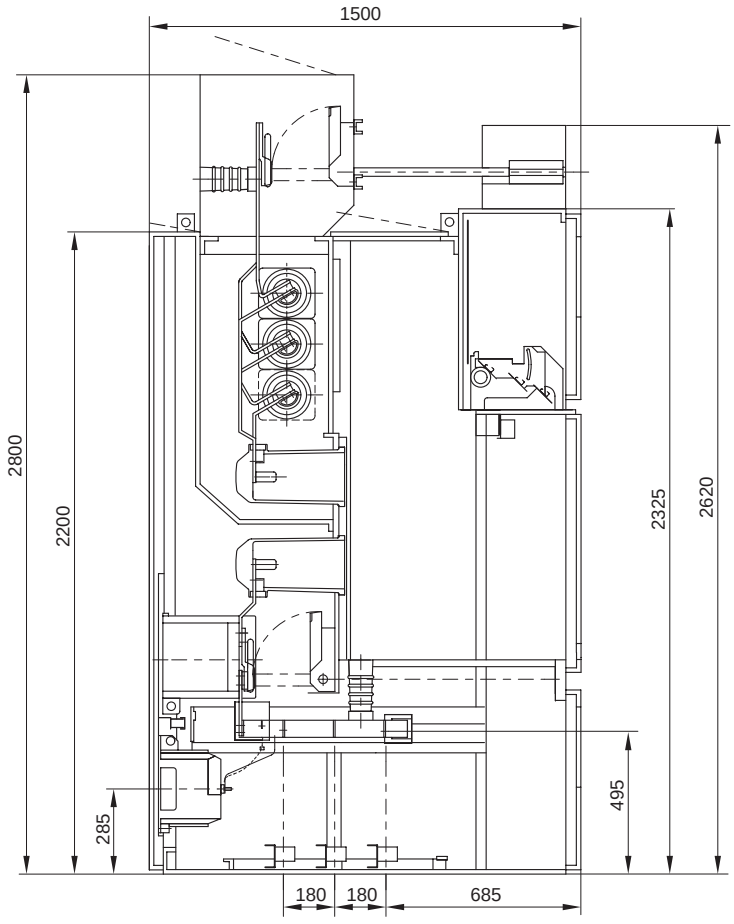



*Figure 3/1-3: Outgoing feeder, 24 kV, …1250 A, 25 kA with voltage transformers in top mounted box for busbar metering*



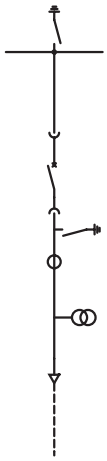



*Figure 3/1-4: Outgoing feeder, 24 kV, …1250 A, 25 kA with earthing switch in top mounted box for busbar earhing (panel shown without withdrawable part)*

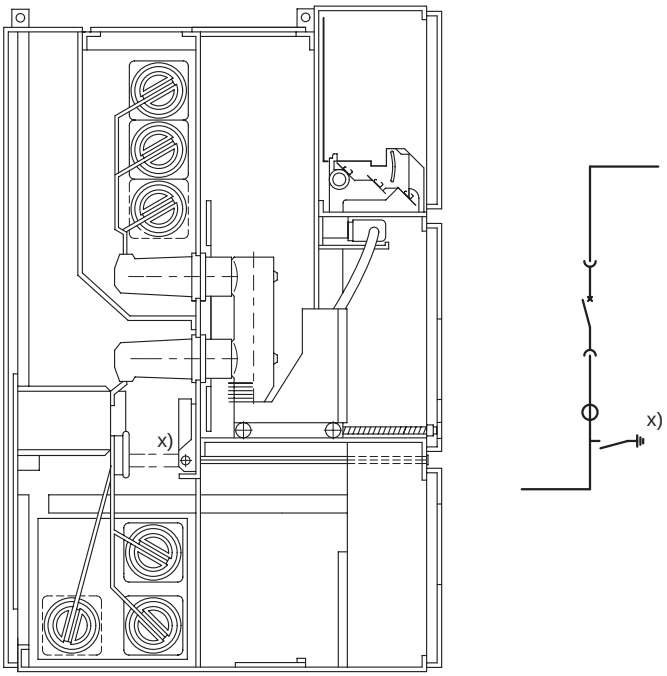



*Figure 3/1-5: Busbar sectionalizing, 24 kV, 1250 A, 25 kA with earthing switch Type EK6*
*x) earthing switch optional*

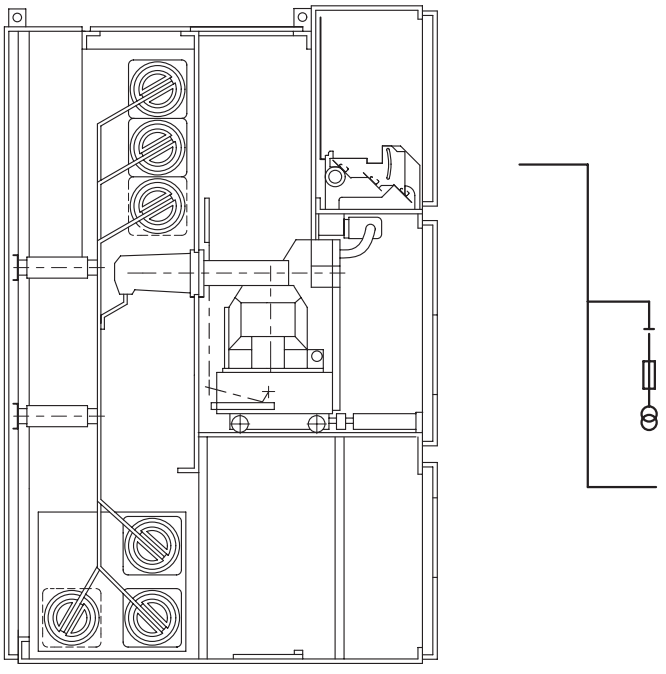
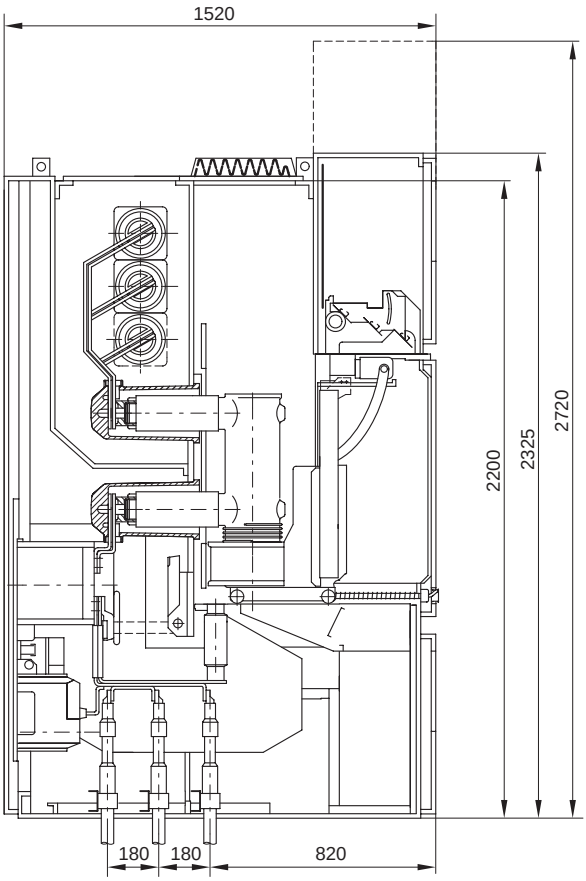


*Figure 3/1-6: Busbar rizer, 24 kV, 1250 A, 25 kA with withdrawable metering unit*



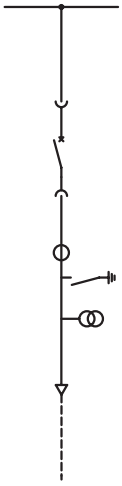
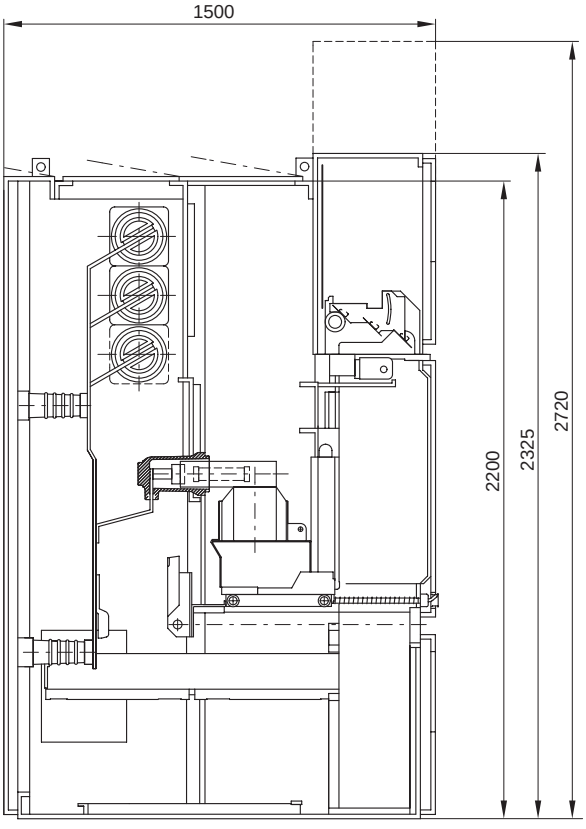



*Figure 3/1-7: Outgoing feeder, 24 kV, 2000 A, 25 kA with natural cooling*



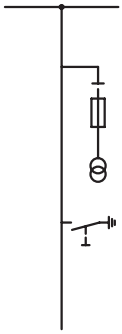



*Figure 3/1-8: Busbar metering 24 kV voltage transformers withdrawable, with busbat earthing switch*

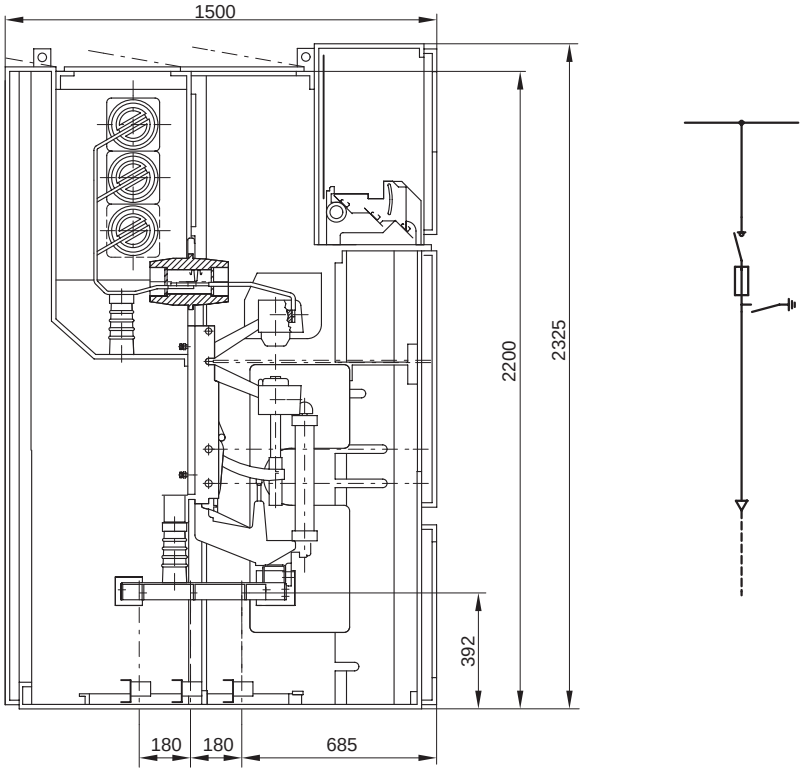



*Figure 3/1-9: Outgoing feeder 24 kV 630 A with switch-disconnector with fuses and integrated earthing switch*

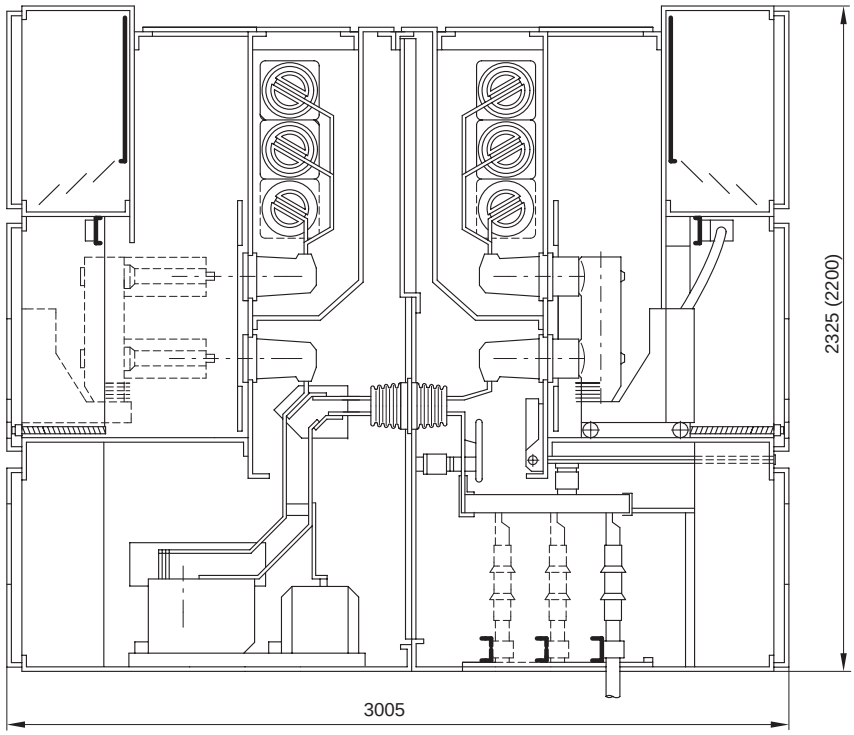



*Figure 3/2: ZS1 Duplex - switchgear 24 kV, 1000 A, 25 kA, double busbar switchgear according to the two-breaker method, panel installation back to back.*

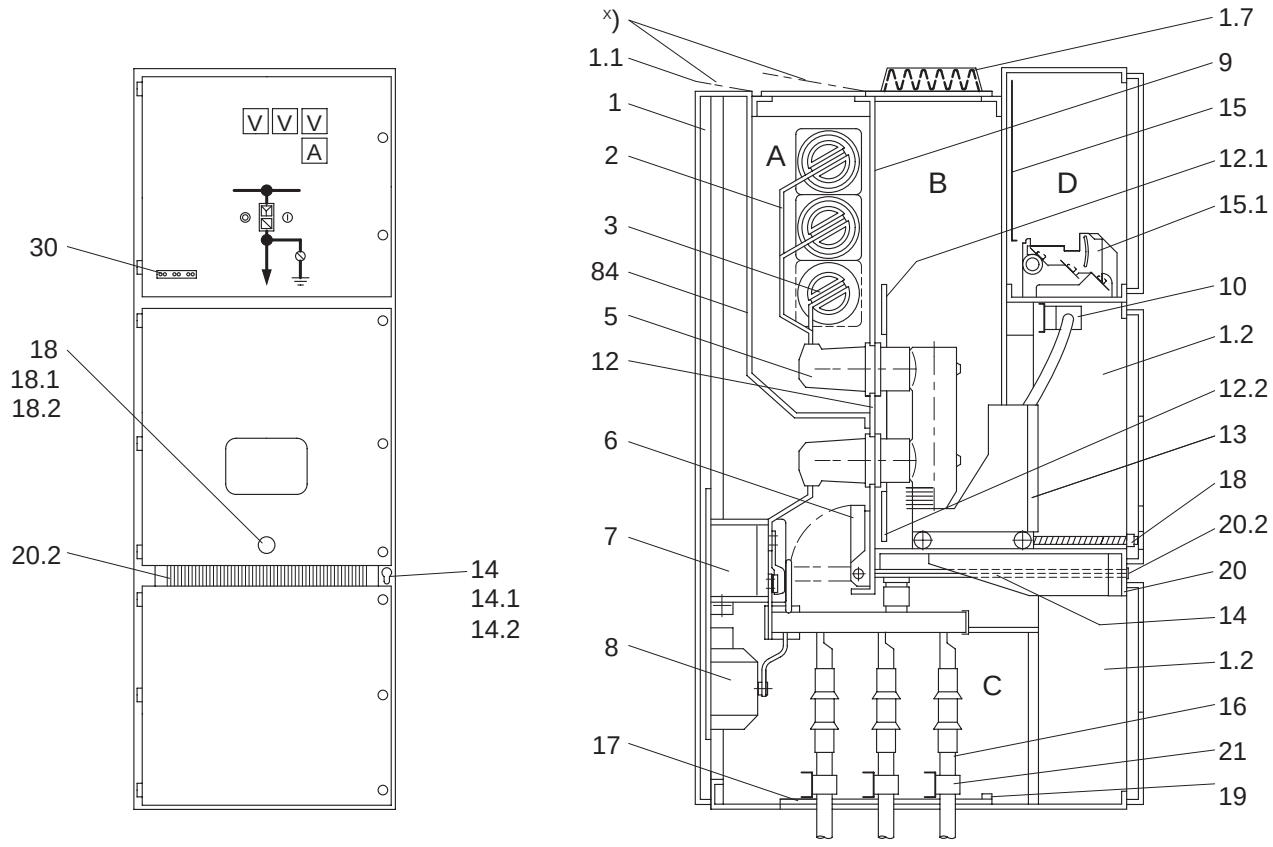



*Figure 3/3: Outgoing feeder, 24 kV, …1250 A, 25 kA*

*x) Pressure relief flaps from expanded metal if circuit-breaker 2500 A installed*

*A Busbar compartment*
*B Circuit-breaker compartment*
*C Cable compartment*
*D Low-voltage compartment*

*1 Enclosure*
*1.1 Pressure relief flap*
*1.2 Control wiring duct*
*1.7 Pressure relief plate from expanded metal (for circuit-breaker 2000 A)*
*2 Tee-off conductor*
*3 Busbar*
*5 Isolating tulip*
*6 Earthing switch*
*7 Current transformer*
*8 Voltage transformer*
*9 Partition, removable*
*10 Control wiring plug connection*
*12 Mounting plate*
*12.1 Top shutter*
*12.2 Lower shutter*
*13 Withdrawable part (shown with circuit-breaker, type VD4)*
*14 Earthing switch operating mechanism*
*14.1 Operating shaft for earthing switch*
*14.2 Slide*
*15 Perforated plate for wiring*
*15.1 Terminal rack*
*16 Cable sealing end, max. 6 parallel cables*
*17 Floor cover, split*
*18 Spindle mechanism*
*18.1 Spigot on spindle*
*18.2 Scene head on spindle*
*19 Main earthing bar*
*20 Horizontal partition, removable*
*20.2 Ventilation grid*
*21 Cable clamp*
*30 Measuring sockets (LRM - System)*
*84 Partition*

*Figure 3/4: Panels of type ZS1*

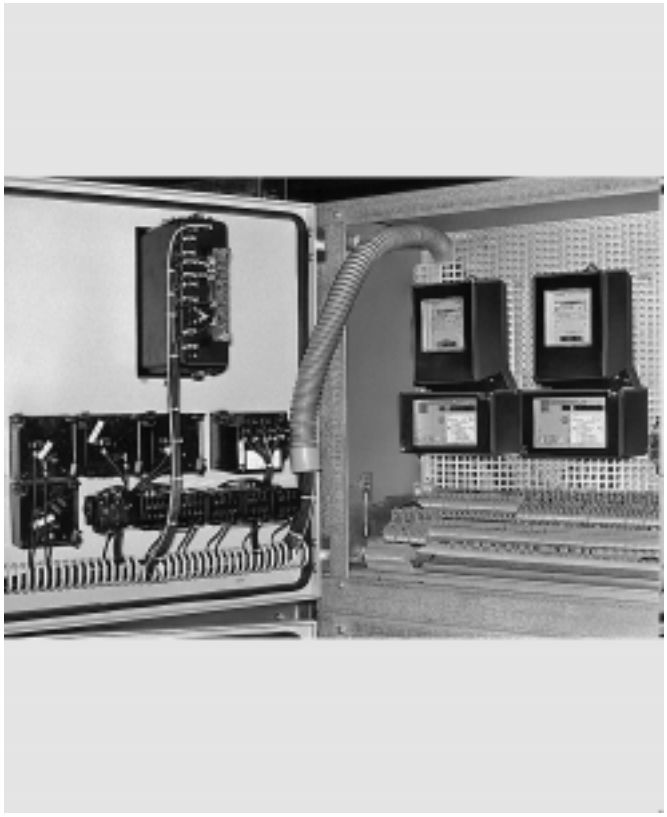


*Figure 3/5: Low-voltage compartment, internal view. Terminal strip group can be swung up. Laying and connection of the control wiring can be carried out without problems.*

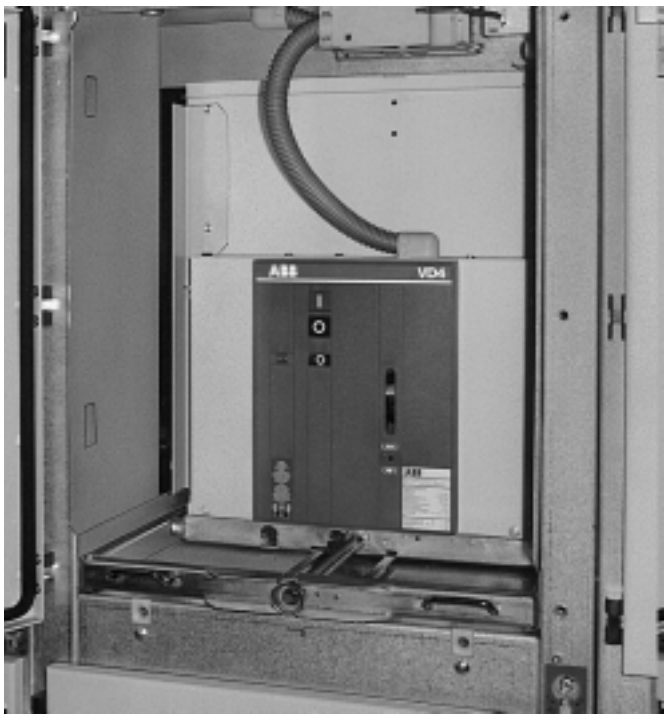


*Figure 3/6: Circuit-breaker compartment, opened. Withdrawable part in service position.*

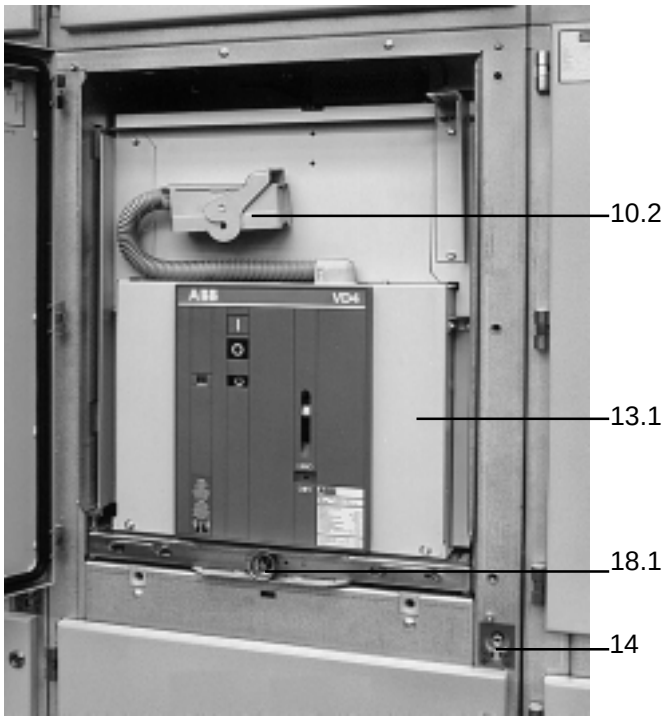



*Figure 3/7: Circuit-breaker compartment, opened. Withdrawable part in disconnected position, control wiring plug connector open.*

*10.2 Control wiring plug*
*13 Withdrawable part (here equipped with VD4 circuit-breaker)*
*14 Earthing switch operating mechanism*
*18.1 Square spigot*

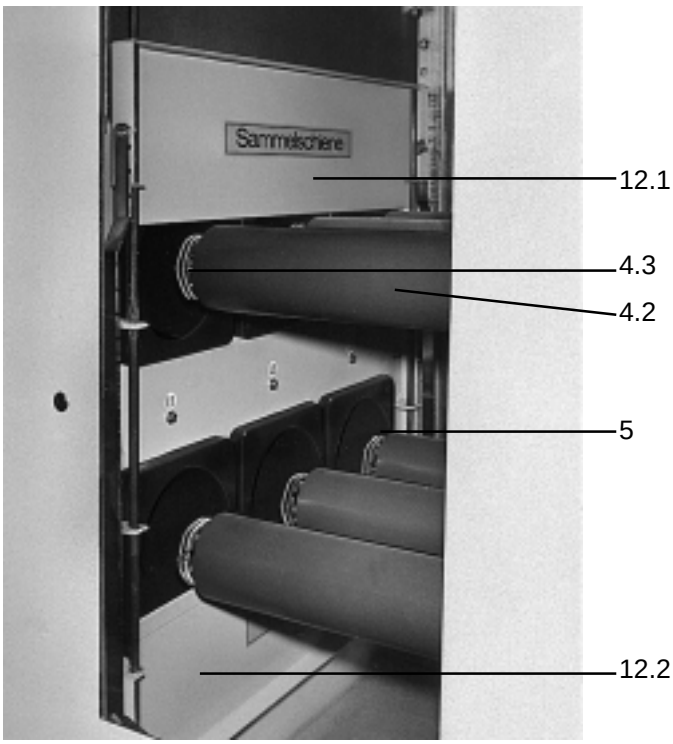



*Figure 3/8: Withdrawable part during insertion into the service position, shutters not yet fully opened*

*4.2 Contact arm, with insulating sleeve*
*4.3 Contact system*
*5 Isolating tulip*
*12.1 Top shutter*
*12.2 Lower shutter*

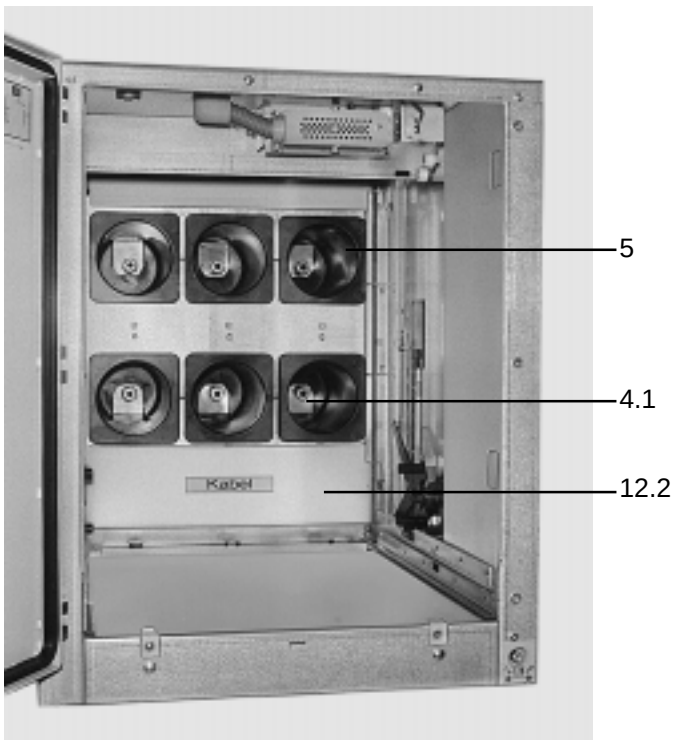



*Figure 3/9: View into the circuit-breaker compartment, withdrawable part removed, shutters opened*

*4.1 Isolating contact*
*5 Isolating tulip*
*12.2 Lower shutter*

*Figure 3/10: Service truck with withdrawable part in front of the open circuit-breaker compartment in a switchgear*


*Figure 3/11: Withdrawable part with circuit-breaker, type VD4, operating mechanism side*

*13.15 Withdrawable assembly*


*Figure 3/12: Withdrawable part with circuit-breaker, type VD4, pole side*

*13.10 Pole tube lid*

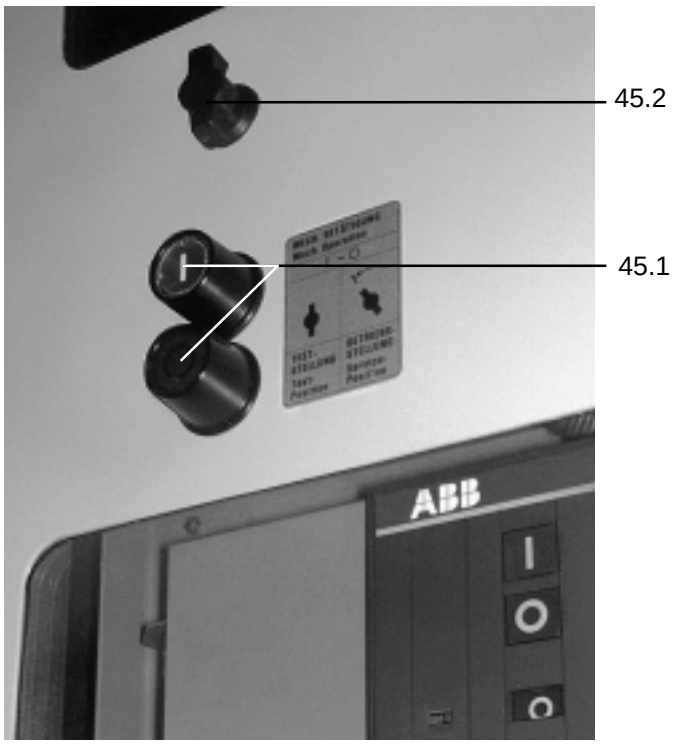



*Figure 3/13: Push button for mechanical ON/OFF breaker operation with the door closed (non-standard). If the withdrawable part is in the service position, operation is effected with the knob which swings a push rod extension out.*

*45.1 Mechanical push button*
*45.2 Turning knop*

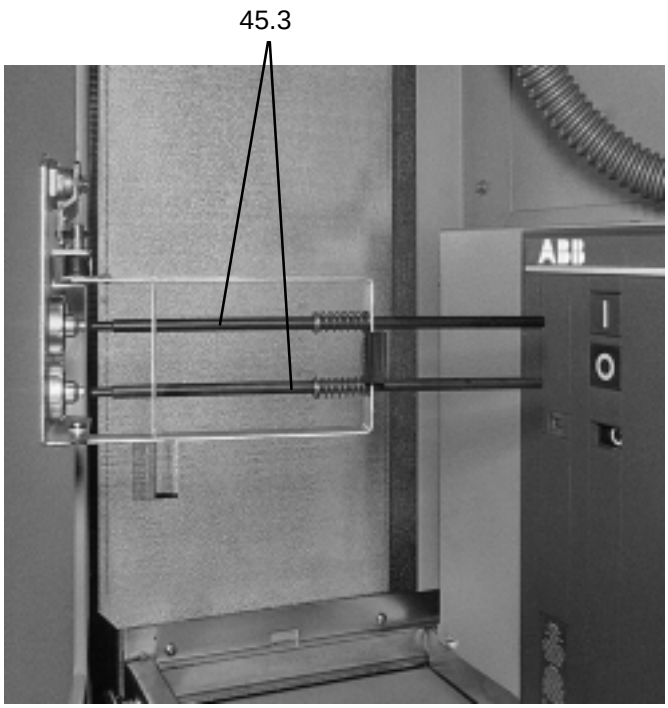



*Figure 3/14: View of the push rod extension swung out by the knob at the front with the withdrawable part in the service position and the door open*

*45.3 Swivelling push rod*

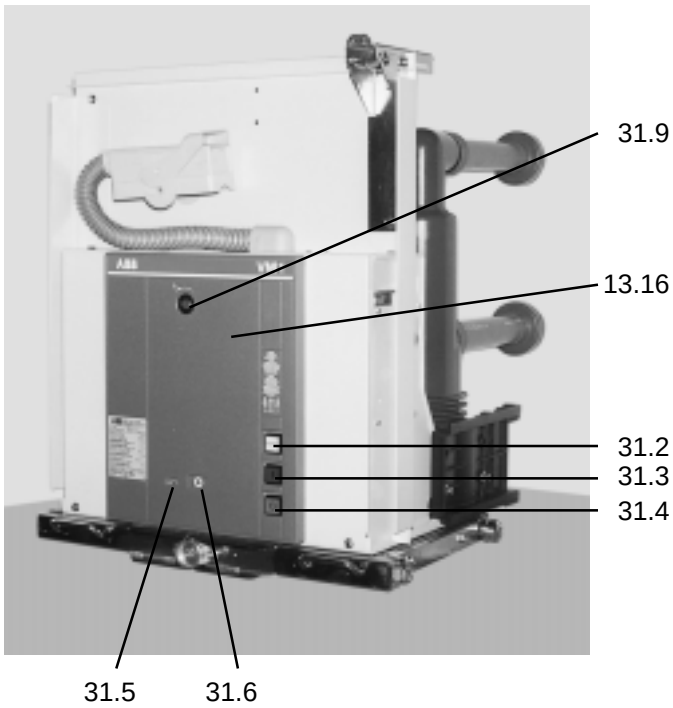



*Figure 3/15: Withdrawable part with circuit-breaker, type VM1, operating mechanism side*

*13.16 Front cover plate (VM1)*
*31.2 Ready display (VM1)*
*31.3 ON push-button (VM1)*
*31.4 OFF push-button (VM1)*
*31.5 Mecanical operating cycle counter (VM1)*
*31.6 Mechanical switch position indicator (VM1)*
*31.9 Catch for emergency manual operation lever*

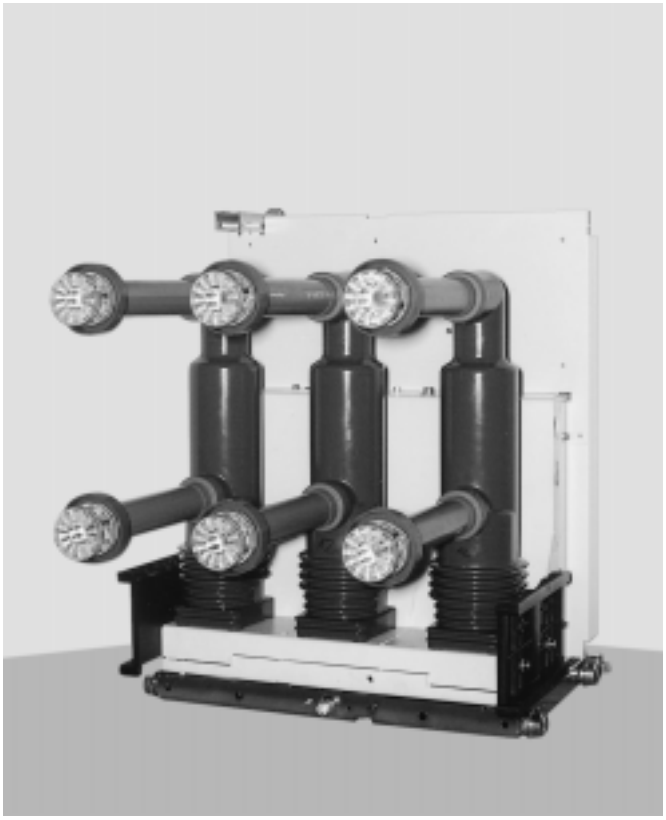


*Figure 3/16: Withdrawable part with circuit-breaker, type VM1, pole side*


*Figure 3/17: Withdrawable part with circuit-breaker, type HA, shown in test/disconnected position*

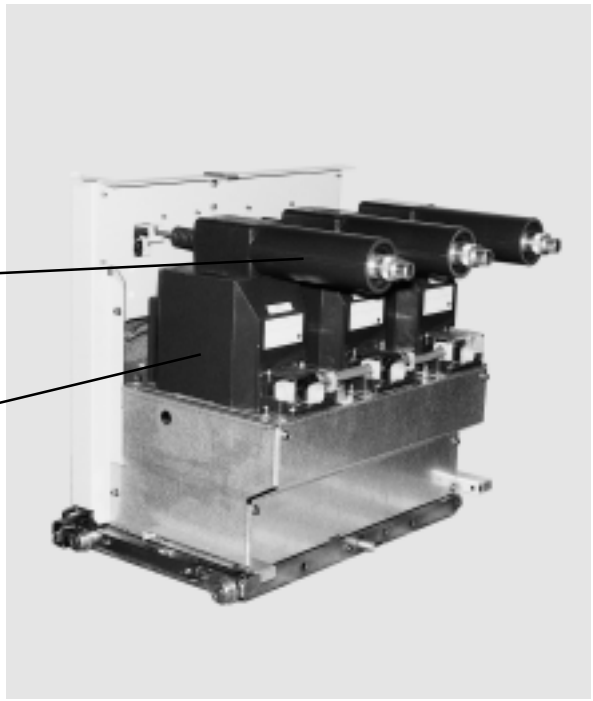



*Figure 3/18: Withdrawable part with metering unit*

*95.1 Voltage transformer*
*95.2 Cast resin tube (with fuse cartridge)*

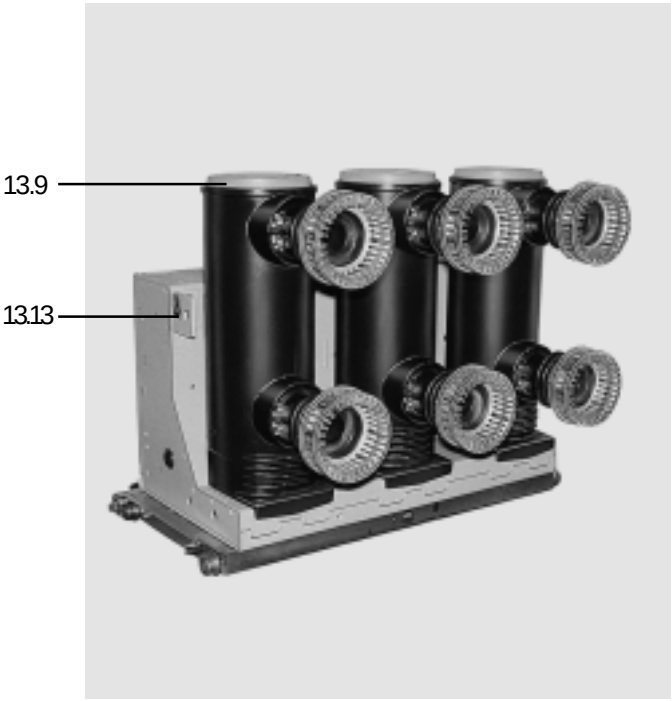



*Figure 3/19: Withdrawable part with high current circuit-breaker, type VD4, pole side*

*13.9 Transport caps (to be removed on commissioning)*
*13.13 Lifting lug (to be removed on commissioning)*

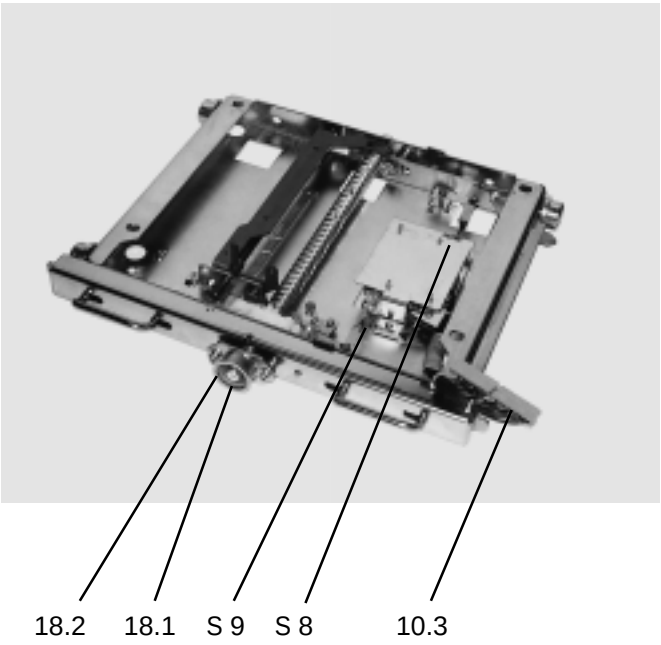



*Figure 3/20: Withdrawable assembly for circuit-breaker, with auxiliary switch*

- *S8 Test position indicator*
- *S9 Service position indicator*
- *10.3 Control wiring plug connector for withdrawable assembly*
- *18.1 Square spigot*
- *18.2 Scene head on spindle*

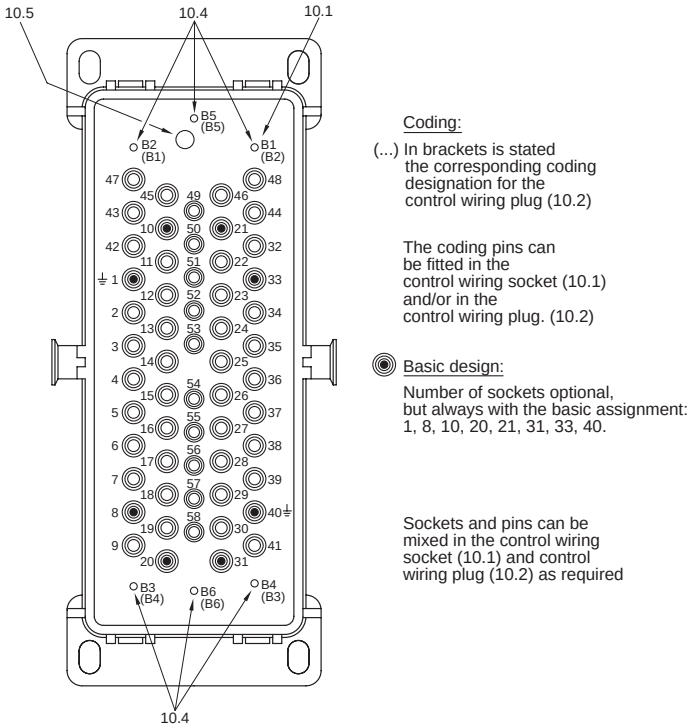



*Figure 3/21: Coding of the control wiring plug connector, shown for a 58 pole connection*

- *10.1 Control wiring socket*
- *10.4 Centres for coding pins and bores*
- *10.5 Bore for the actuating pin on the control wiring plug for controling the auxiliary switch 36, figure 7/4.*

## Sample for coding

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Control | Code | B1 | B2 | B3 | B4 | B5 | B6 |
| wiring | Pin | | x | | x | | |
| Socket | Hole | | | | | | |
| Control | Hole | x | | x | | | |
| wiring | Pin | | | | | | |
| Socket | Code | B1 | B2 | B3 | B4 | B5* | B6 |

* B5 is used in special cases only

# 4 Despatch and storage

## 4.1 Condition on delivery

At the time of despatch, the ZSI panels are factory-assembled, the withdrawable parts inserted into the service position and the doors closed.

The factory-assembled panels are checked at the works for completeness in terms of the order and simultaneously subjected to routine testing (normally without AC voltage testing of the busbars) to VDE 0670 part 6 or IEC publication 60298, and thus tested for correct structure and function.

The busbars are not assembled. The busbar material, fasteners and accessories are packed separately.

## 4.2 Packaging

According to the kind of transport and country of destination, the panels remain unpackaged or are welded in foil and packed in seaworthy crates. To protect against moisture, a drying agent is provided:

- Panels with basic packaging or without packaging.
- Panels with seaworthy packaging or similar (including packaging for containerized shipments):
  - Sealed in polythene sheeting,
  - Transport drying agent bags included,
  - Moisture indicator included,
  - When aluminium composite sheeting is used, a sight window is fitted for checking.
- Observe the directions for use of the drying agent bags to DIN55 473. the following applies:
  - Coloured indicator blue: contents dry,
  - Coloured indicator pink: contents moist (relative humidity above 40%).

## 4.3 Transport

(Figure 4/1)

The transport units normally comprise individual panels, and in exceptional cases small groups of panels or panel assembled back to back. The panels are each fitted with four lifting lugs.

Transport panels upright. Take account of the high centre of gravity. Only ever carry out loading operations when it has been ensured that all precautionary measures to protect personnel and materials have been taken and using a

- crane,
- fork-lift truck and/or
- manual trolley jack.

**Loading by crane:**

- Fit lifting ropes of appropriate load capacity with shackles (opening width above 30 mm, fastening bore diameter 30 mm)
- Maintain an angle of at least 60° from the horizontal for the ropes leading to the crane hook.

## 4.4 Delivery

The responsibilities of the consignee when the switchgear arrives at site include, but are not limited to, the following:

- Checking the consignment for completeness and freedom from damage (e.g. also for moisture and its detrimental effects). In cases of doubt, the packaging must be opened and then properly resealed, fitting new drying agent bages, when intermediate storage is necessary.
- If any short quantities, defects or transport damages are noted:
  - To be documented on the respective shipping document.
  - Notify the relevant carrier or forwarding agent immediately in accordance with the relevant liability regulations.

Note:

Always take photographs to document any major damage.

## 4.5 Intermediate storage

Optimum intermediate storage as far as this is necessary at all- without detrimental consequences depends on compliance with a number of minimum conditions for the panels and assembly materials

1. Panels with basic packaging or without packaging:
   - A dry well-ventilated store room with a climate in accordance with VDE 0670 part 1000/IEC 60694.
   - The room temperature must not fall below –5°C.
   - There must not be any other unfavourable environmental influences.
   - Store the panels upright.
   - Do not stack panels.

- Panels with basic packaging:
  - Open the packaging, at least partially.
- Panels without packaging:
  - Loosely cover with protective sheeting.
  - Ensure that there is sufficient air circulation.
- Check regularly for any condensation until the start of installation.

2. Panels with seaworthy or similar packaging with internal protective sheeting:
   - Store the transport units:
     - protected from the weather,
     - in a dry place,
     - safe from damage.
   - Check the packaging for damage.
   - Check the drying agent ( see also section 4.2):
     - on arrival of the consignment,
     - later at regular intervals.
   - When the maximum storage period, starting from the date of packaging, has been exceeded:
     - the protective function of the packaging can no longer be guaranteed,
     - take suitable action if intermediate storage is to continue.

Note:

Do not walk on the roof of the panels (rupture points in pressure relief devices)!

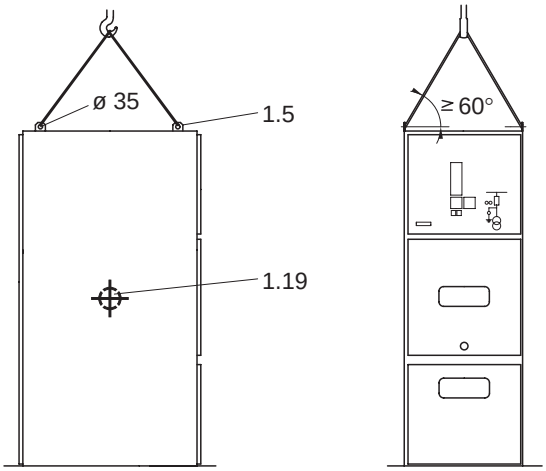



*Figure 4/1: Handling by crane*

*1.5 Lifting lug*
*1.19 Marking on the centre of gravity*

# 5 Assembly of the switchgear at site

In the interests of an optimum installation sequence and the insurance of a high quality standard, site installation of the switchgear should only be carried out by specially trained skilled personnel, or at least supervised and monitored by responsible persons.

## 5.1 General site requirements

On commencement of installation at site, the switchroom must be completely finished, provided with lighting and the electricity supply, lockable, dry and with facilities for ventilation. All the necessary preparations such as wall openings, ducts, etc., for laying of the power and control cables up to the switchgear must already be complete. Where switchgear panels have topmounted structures for earthing switches or instrument transformers, it must be ensured that the ceiling height is sufficient for the opening travel of the pressure relief plates.

The ceiling height is also to be checked when there is a top-mounted pressure relief duct.

Compliance with the conditions for indoor switchgear to VDE 0670 part 1000, including the conditions for the “minus 5 indoor” temperature class must be ensured.

## 5.2 Foundations

(Figures 5/1 to 5/8)

The switchgear is preferably to be erected on a floor frame set into the switchroom floor or on a raised false floor.

The guideline structural data listed below facilitate a rough calculation of the space required and preliminary planning of the room design for a switchgear project. When the final construction documents are compiled, the binding data supplied by ABB must always be taken into account!

The stipulations of DIN 43 661 are also to be complied with when the foundation is laid. This particulary applies to evenness and straightness tolerances as a protection for perfect installation of the switchgear.

Note:

The construction data for the ceiling openings for incoming conductors do not apply to trunking bars without earthed coatings. Wider ceiling openings are required in such cases.

### 5.2.1 Floor frame on a concrete floor

The Floor frame, consisting of one or more parts depending on the size of the switchgear, can be supplied with the switchgear by ABB Calor Emag; it is usually laid by site personnel and should if possible be aligned and inspected under the supervision of a ABB specialist.

Installation of the floor frame:

- If the floor frame consists of several parts 60.1/ 60.2, bolt these together at the prepared joint locations using links 60.3 in the specified sequence and so as to achieve a level surface.
- Place the floor frame precisely in the specified position on the concrete floor in accordance with the installation drawing.
- Enter jacking screws 60.8 and place steel strips 60.4 below them.
- Carefully align the floor frame horizontally along the entire surface and to the correct height by screwing the jacking screws down by a appropriate amount and using a levelling instrument. The top edge of the floor frame should be 2 mm above the finished floor surface. This facilitates erection and alignement of the switchgear panels. In some cases , this means that the material thickness of an additional floor covering to be fitted later must betaken into account seperately. Tolerances for laying of the frame to DIN 43 661, version A,

  e.g. evenness tolerance:
  ± 1 mm within a measuring length of 1m,

  e.g. straightness tolerance:
  maximum 1 mm per m, but not more than 2 mm over the entire length of the frame.
- Slide brackets 60.5 against the frame at two points – for each 3m of frame length -, secure them to the concrete floor with plugs 60.7, and weld them to the frame. The set position of the frame on the concrete floor must not be altered during this operation!
- Weld the floor frame parts together. Grind projecting parts and weld seams on the top of the frame flat.
- Make the necessary preparations for the perfect earthing of the floor frame with 30 x 4 mm galvanized steel strip. Two connections are necessary for long switchgears.
- When the floor topping is applied, carefully backfill the floor frame, leaving no gaps.
- The floor frame must not be subjected to any injurious impacts or pressures, particulary during the installation phase.

If the conditions are not fulfilled, problems during assembly of the switchgear and possibly with movement of the withdrawable parts and opening an closing of the doors cannot be ruled out.

Structural data

Table for figures 5/1 to 5/4

| Rated voltage | | | 24 kV | | | |
|---|---|---|---|---|---|---|
| Panel type | | | ZS1 | ZS1 | ZS1 | ZS1 |
| System | | | With-drawable | With-drawable | Fixed | Fixed |
| Panel width | T | mm | 800 | 1000 | 800 | 1000 |
| Aisle width | G[1)] | mm | 1200 | 1400 | 1200 | 1400 |
| Assembly openings | | | | | | |
| In ceilings: | | | | | | |
| Width: | | mm | 1000 | 1200 | 1000 | 1200 |
| Heidth: | | mm | 1800 | 1800 | 1800 | 1800 |
| in doors: | | | | | | |
| Width: | TB | mm | 1000 | 1200 | 1000 | 1200 |
| Heidth: | TH[2)] | mm | 2750 | 2750 | 2750 | 2750 |
| Panel weight | | kg | 1000 | 1200 | 850 | 1000 |
| Ceiling load | | kg/m$^2$ | 900 | 850 | 750 | 700 |
| Dimension: a | | mm | 600 | 800 | 600 | 800 |

[1)] Determinated by VDE 0101 and the data for maximum panel width.

[2)] Applies to low voltage compartements of standard height. Add 500 mm for top mounted low voltage compartements and costomized low voltage compartements.

### 5.2.2 Raised false floor

(Figures 5/5 to 5/8)

Procure the raised false floor locally from a suiteable supplier (ABB can arrange if necessary). It must meet all the specific requirements of the switchgear. The additional intermediate frame required for variant 1 can be supplied and installed by ABB.

Table for figures 5/6 to 5/8

| Rated voltage | | | 24 kV | | | |
|---|---|---|---|---|---|---|
| Panel type | | | ZS1 | ZS1 | ZS1 | ZS1 |
| System | | | With-drawable | With-drawable | Fixed | Fixed |
| Panel width | T | mm | 800 | 1000 | 800 | 1000 |
| Aisle width | G[1] | mm | 1000 | 1200 | 1000 | 1200 |
| Assembly openings | | | | | | |
| in ceilings: | | | | | | |
| Width: | | mm | 1000 | 1200 | 1000 | 1200 |
| Height: | | mm | 1800 | 1800 | 1800 | 1800 |
| in doors: | | | | | | |
| Width: | TB | mm | 1000 | 1200 | 1000 | 1200 |
| Height: | TH[2] | mm | 2750 | 2750 | 2750 | 2750 |
| Panel weight | | kg | 1000 | 1200 | 850 | 1000 |
| Ceiling load | | kg/m$^2$ | 900 | 850 | 750 | 700 |

1) Determinated by VDE 0101 and the data for maximum panel width.

2) Applies to low voltage compartements of standard height. Add 500mm for top mounted low voltage compartements and customized low voltage compartements.

## 5.3 Assembly of the switchgear panels

(Figures 3/3, 5/9 to 5/31)

Use DIN screws of tensile class 8.8. The tightening torques for the busbar screw connections with dished washer are as follows:

| Thread | Recommended Tightening torque[1)2)] Nm | |
|---|---|---|
| | Lubricant[3)] | |
| | Without | Oil or grease |
| M 6 | 10,5 | 4,5 |
| M 8 | 26 | 10 |
| M 10 | 50 | 20 |
| M 12 | 86 | 40 |
| M 16 | 200 | 80 |

*1) The rated tightening torques for fasteners without lubrication are based on a coefficient of friction for the thread of 0.14 (the actual values are subject to an unavoidable, partly not inconsiderable, spread).*

*2) Rated tightening torques for fasteners with lubrication in accordance with DIN 43 673.*

*3) Thread and head contact surface lubricated.*

Any tightening torques which deviate from those in the general table (e.g. for contact systems or device terminals) are to be taken into account as stated in the detailed technical documentation.

It is recommended that the threads and head contact surfaces of bolts should be lightly oiled or greased, so as to achieve a precise rated tightening torque.

The individual installation stages are as follows:

- Remove withdrawable parts 13 from the switchgear panels and store them with suiteable protection.
- Dismantle lifting lugs 1.5.
- Transport the switchgear panels to the prepared installation point in the sequence shown on the switchgear plan.
- Remove vertical partitions 9 in front of the bus-bar compartements by releasing the fastening screws.
- Release the fastening screws and draw out horizontal partition 20 below the withdrawable part travel rails.
- Release and remove floor cover 17.
- Remove covers 43.2 and 43.3 from the vertical control wiring ducts at the front right and left of the panel.

- If any top mounted enclosures with busbar earthing switches or instrument transformers have been removed for transport, bolt these in place in the specified position where the rear and middle pressure relief plates would otherwise be located on the switchgear panels, and reestablish the internal connections. (figures 5/11, 5/22, 5/23, 5/31).
- Fit and screw the seperate mechanism enclosures for any top mounted earthing switches in the specified position on the low voltage compartement with the front edge flush.

Note the correct positions of the parts fitted on the hexagon drive shaft supplied loose, and then remove the parts from the shaft, discarding the rubber ring at the front.

Insert the drive shaft step by step at the front of the mechanism enclosure until it is completely fitted, threading on the individual parts in the correct positions for the open position of the earthing switch.

Secure the setting rings. Adjust the mounting positions and operating instants of the auxiliary switches:

1. Adjust the positions of the limit position auxiliary switches in their slots in such a way that there is a run-on of 0.5 mm in the fully operated position before the plunger reaches the stop (for safety reasons).
2. Limit position auxiliary switch 78.4 for earthing switch ON must be operated immediately after the dead centre position of the toggle spring mechanism is reached in the closing process and the automatic quick-closing process has started.
3. Limit position auxiliary switch 78.5 for earthing switch OFF must be operated during the opening motion of the slide 1 mm before the tongue of the slide makes contact the armature of the unexited blocking magnet.

Fit and screw down the lids.

- Align the switchgear panels on the floor frame one after another for correct position and vertical alignment (deviations of the panel edges from the vertical must not exceed 2 mm, particulary at the front) and bold the panels together. It is advisable to start from the centre when assembling switchgears with more than ten panels.
- When bolting together switchgear panels without busbar barriers, insert a shim 27 between the panels above the busbar apertures.
- On switchgears with busbar barriers, also install and screw bushing plates 28/28.2 externally to the right or left hand panel wall.
- When the switchgear has been properly assembled, fasten the panels to the concrete floor using plugs, or weld or adequately bolt them to the foundation frame.

## 5.4 Installation of the busbars and bushings

(Figures 5/16 to 5/23)

- Install bushings 29 (for switchgears with busbar barriers only).

Note:

- (Upper) busbar system:

  Insert bushing 29 for the lower busbar into bushing plate 28 from the right in contrast to the procedure for other two bushings.

- (Lower) tie bus system:

  Insert bushing 29 for the rear, lower tie bus into bushing plate 28.2 from the right in contrast to the procedure for the other two bushings.

- Always check that there is proper contact between the metal tube in the bushing and the busbar via the contact spring 29.3. Ensure that the contact spring is in the correct position!
- Clean the insulation on the busbar sections with a dry, soft cloth, and check for insulation damage. Remove greasy or adhesive dirt as discribed in section 7.2.
- Busbar connections:
  - The silver plated surfaces of the connections are to be cleaned with a metal free non-woven cleaning cloth and thinly and evenly coated with Isoflex Topas NB 52 grease.
  - The non-silver plated surfaces of the connections are either brushed under grease with a wire brush, preserving the grease film, or cleaned with a metall-free non-woven cleaning cloth and evenly greased with a thin coat of Isoflex Topas NB 52.
- Prepare insulating covers 58 and lids 58.5 to suit the relevant busbar connections and thread them onto the busbar.
- Install the busbars panel by panel. Screw on the individual busbar elements one obove the other (depending on the system layout) and in line with the flat tee-off conductor. Use the hexagon socket head screws 163 as provided. For tightening torque see the table above. Use two dished washers for each screw.
- Bolt one holder 58.1 to each end of the busbars to support the insulating cover 58.

  The screws for holder 58.1 are to be tightened with lower torque.

- Position insulating covers 58 and lids 58.5 over the relevant bolted joint, and slide the lid onto the cover until it clicks into place.

## 5.5 Installation of the top mounted boxes

Due to reasons of transports, attachments to the panels are not completed at our works. As far as possible however, they are pre-mounted.

### 5.5.1 Voltage transformer for busbar metering

(Figures 3/1-3, 3/1-6, 5/31)

- Top mounted box 79 with screwing material in the group of bags ”Top mounted box for metering” is to be mounted on the busbar compartement.

  Notes:

  – In panels without the busbar bushing plate 28, the partitioning between the busbar compartement and the top mounted box is necessary. They are installed at the works in the top mounted box.

  – As far as equipment with busbar parttioning is concerned (i.e. with bushing plate 28), the space between the busbar compartement and the top mounted box must remain open for purposes of pressure relief.

- Connecting bars 2.3 with the tee-off conductors 2 at the junction point are to be screwed together according to figure 5/31. However, if necessary, the additional spacer plate 3.2 and threaded plate 3.4 as well as the screwing material from the group of bags ”top mounted box for metering” are to be used.
- Insulating cover 58 is to be brought into position as is discribed in section 5.4.
- Intermediate box 79.1 with the screwing material from the group of bags ”top mounted box for metering” is to be mounted on the control cabinet. The conduction tube 79.2 is to be positioned and inserted into the reducer rings 79.3.
- Secondary circuits from the voltage transformers are to be led to the terminal strips and connected according to the cable core markings and circuit diagramm.

### 5.5.2 Earthing switch for busbar earthing

(Figures 3/1-4, 3/1-5, 3/1-8, 5/22, 5/23)

- Top mounted box 77 with screwing material from the group of bags ”top mounted box for earthing” is to be mounted on the busbar compartement.
- Operating mechanism box 78 with screwing material from the group of bags ”top mounted box for earthing is to be mounted on the control cabinet.
- Pre-mounted single parts of the hexagonal shaft 78.1 are to be removed.

  Please pay attention to the sequence and angle of the parts!

- Hexagonal shaft from the operating mechanism box is to be pushed through into the bevel gear of the earthing switch.

Sequence and angles of the part are to be restored!

- Connecting bars 2.2 with the tee-off conductors 2 at the junction point are to be screwed together according to figure 5/22. However, if necessary, the additional spacer plate 3.3 and threaded plate 3.4 as well as the screwing material from the group of bags ”top mounted box for earthing” are to be used.
- Insulating cover 58 is to be brought into position as discribed in section 5.4.

Note:

The auxiliary switches for the earthing switch are adjusted at the works. Problem-free functioning is only guaranteed if the functioning elements on the hexagonal shaft are correctly mounted.

Due to the final installation of the earthing switch and operating mechanism at the site, it may be necessary to undertake an exact adjustment of the auxiliary switches. In this case the following is important:

- The auxiliary switch OFF 78.5 must be operated
  – before the slide 78.2 has uncovered half of the opening in front of the hexagonal shaft and
  – before the lower edge of the slide has touched the anker of the blocking magnet 78.6.
- The auxiliary switch ON 78.4 must be operated
  – before the toggle spring of the earthing switch has reached its dead point.
- The pushrod of the auxiliary switch must still have about 0,5 mm to go to the end position in the operated position.

## 5.6 Pressure relief ducts

(Figures 5/11)

- The pressure relief duct is supplied dismantled in single parts. The rear wall and the front wall correspond, as far as length is concerned, to the appropriate panel width. They are joined together by means of the attachement strips.
- The screwing material is contained in the group of bags ”pressure relief duct”. Rivet nuts are already present in the metal sheets.

Note:

The rear pressure relief flap must be mounted according to figure 5/11.

Detail regarding connection to the wall and a discharge grating for pressure relief outside of the switchroom will be agreed with the customers

concerned. In the case of pressure relief within the switchroom, absorber grating, which is also supplied together with the rest of the equipment, is to be installed.

## 5.7 Connection of the cables

### 5.7.1 Power cables

(Figures 3/3, 5/12 to 5/14, 5/28 to 5/30

1. Standard equipment:

   a) Panel width 800 mm:

   - Connection points for up to 9 single cores with M12 socket head bolts
   - 3 to 9 cable clamps for diameters 36 – 52 mm
   - 3-section floor covering with reducing rings
   - M10 connection points for the earth connections of the cable screens.

   b) Panel width 1000 mm:

   - Up to 1250 A corresponding to the 800 mm width panel
   - Connection points for up to 18 single cores with M16 and M20 socket head bolts
   - Up to 18 cable clamps for diameters 50-75 mm
   - 3-section floor covering with reducing rings
   - M10 connection points for the earth connections of the cable screens.

2. Method:

   - Power cable is to be inserted, cut to length and stripped.
   - Reducer rings 17.2 are to be adapted to the cable diameter and fitted.
   - Cable sealing ends 16 are to be prepared and secured according to the manufacturer‘s instructions.
   - Cable cores are to be connected to the prepared cable connection bar 23 with strain relief.

     Cable core crossing are to be avoided.

Other agreed equipment is prepared at the factory, e.g. for the connection of insulated busbar capacitance grading devices. Should any particular work in the panels be necessary during erection at site, construction drawings and parts lists according to which this work can be performed are supplied with the delivery.

### 5.7.2 Control cables

(Figures 3/3, 3/5, 5/3, 5/9, 5/14, 5/26)

- Control cables are to be inserted into the lefthand side ducts for control cables 1.2.

  For the purposes of inserting the control cables, the floor of the panel on the left-hand side has been omitted. The wiring is protected by a sheet-metal duct which extends into the control cabinet. The duct is covered laterally by 43.1 and 43.2 and therefore closed off. In the control cabinet floor, drill holes for reducer rings are intended.
- The control cable is to be stripped and secured at the top end of the duct and the cores inserted into low voltage compartement D after swinging the terminal-strip frame upwards.
- The control cable is to be connected to the terminal strip as shown in the wiring diagram.
- The control wiring connections are to be made to the adjacent panel using bushing 24.

## 5.8 Earthing of the switchgear

(Figures 3/3, 5/1, 5/2, 5/5, 5/6, 5/12, 5/13, 5/17 to 5/20)

- Connect main earthing bar 19 with links 19.1 supplied in every panel.
- Protection wiring connection of the floor frame or the erected raised false floor respectively, should be made.
- Connect the earthing conductor comming from the earth electrode, preferably via a removable bolted link for testing purposes, to the main earthing bar 19 of the switchgear.

## 5.9 Laying the ring circuits

The ring circuits are supplied rolled up as a bundle in the control cabinet. They are marked and fitted with ferrules at both ends. Openings are provided in the side walls of the control cabinet for these lines to looped through from panel to panel.

## 5.10 Final erection work

- Check painted areas of the switchgear for possible damage, touching up where required (see also section 7.4.1).
- Check bolt connections and tighten where required, in particular all those carried out in onsite erection of the busbars and earthing system.
- The auxiliary switch for the $I_{th}$ limitation 11.5 (according to the relevant order) must if necessary, be effected via the pressure relief flaps after removing the lifting lug:
  - Auxiliary switch push-rod is to be inserted into the horizontal into the drillhole in the pressure relief flap.
  - Auxiliary switch holder is to be adjusted into the horizontal position (Figure 5/27)

- Clean the switchgear thoroughly.
- Remove all foreign bodies from the panels.
- Replace properly all coverings, etc., removed during erection and connection.
- In the enclosure, the openings which may remain are to be closed if they are no longer needed.
- Check the isolating contacts and interlock mechanisms for smooth motion, and regrease with Isoflex Topas NB 52 where required (see section 7.4.1).
- Withdrawable circuit-breaker parts are to be inserted and the control wirings connected.
- Panels doors are to be properly closed.

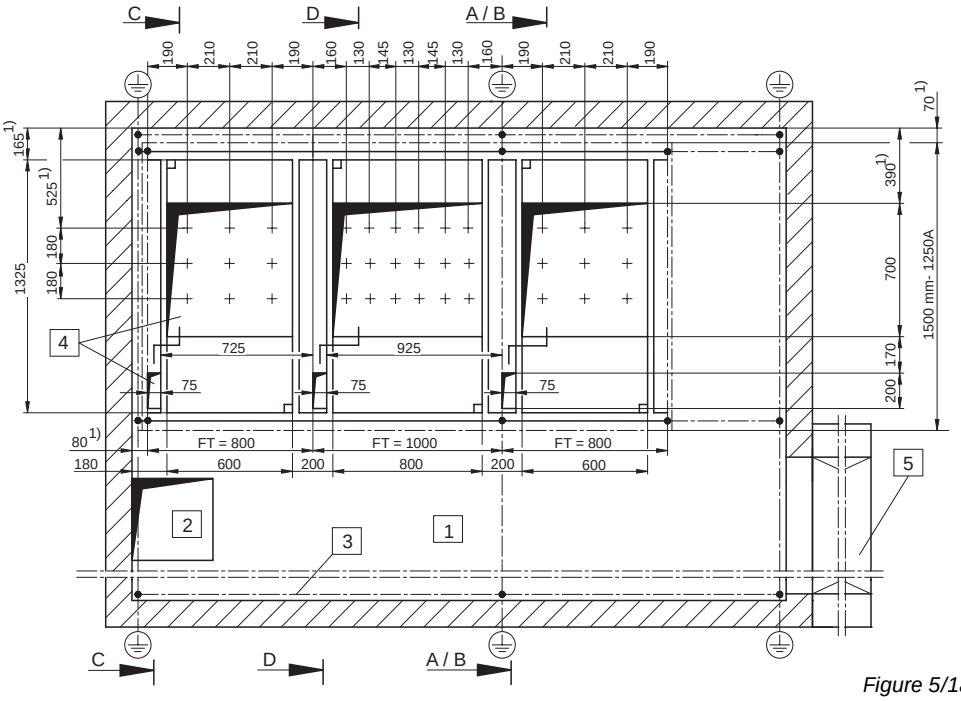



*Figure 5/1a: Panels Type ZS1, 24 kV for outgoing current up to 1250 A panel width 800/ 1000 mm*

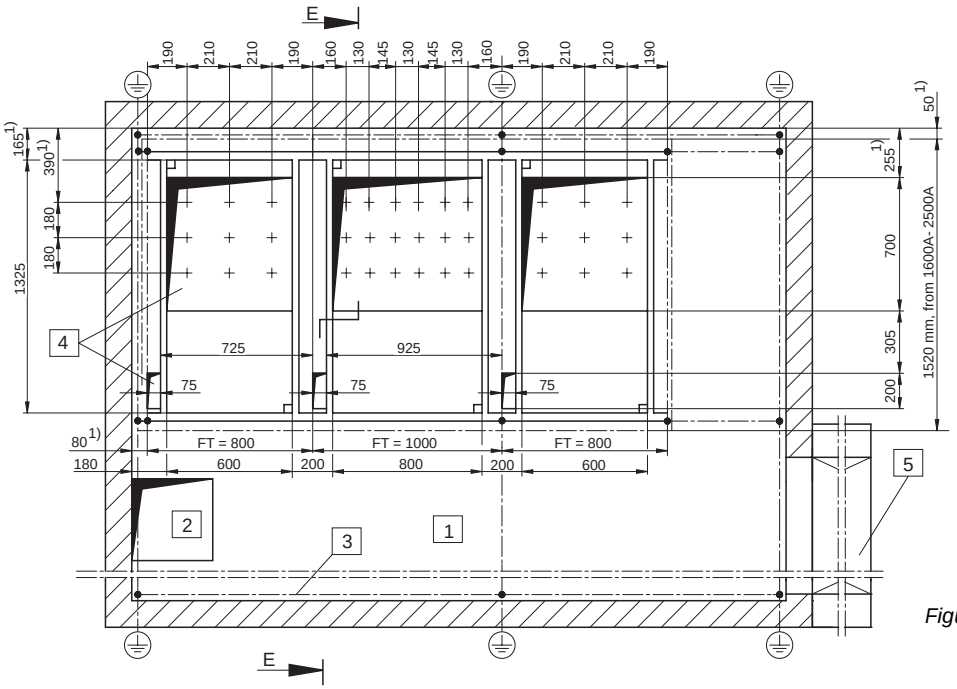



*Figure 5/1b: Panels Type ZS1, 24 kV for outgoing current 1250 A and for 1600 A to 2500 Panel width 800/ 1000 mm*

*Figure 5/1: Guideline connection data for foundation frame on a concrete floor*

*See figure 5/2 for sections*
*FT = panel width*
*1) Minimum dimensions*

1 *Operator aisle*
2 *Basement entrance*
3 *Main earthing bar*
4 *Instead of individual openings, continuous openings or drilled holes are possible*
5 *Platform*
6 *Control cabinet, optional*
7 *Absorber*
8 *Opening for ventilation*
9 *Height of cable basement as required*
10 *Screed, see also figure 5/3*
11 *To main earthing bar*
12 *Opening for power cable*
13 *Opening for control cable*
14 *Door*
15 *Busbar metering or busbar earthing*
16 *Wall opening for pressure relief*
17 *Pressure relief duct*
18 *Diverter*

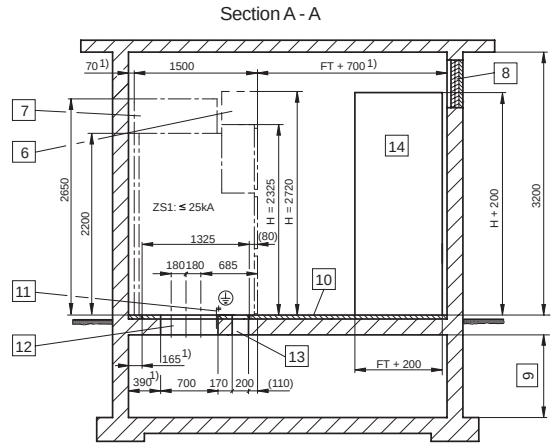



*Figure 5/2a: Switchgear with pressure relief via absorber into the switchroom.*
*Panel width: 800/1000 mm.*
*Rated feeder current up to 1250 A*

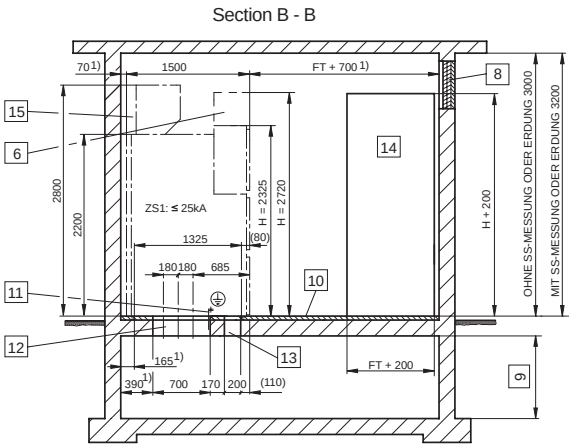



*Figure 5/2b: Switchgear without pressure relief duct,*
*Panel width: 800/1000 mm.*
*Rated feeder current up to 1250 A*
*With busbar metering or busbar earthing*

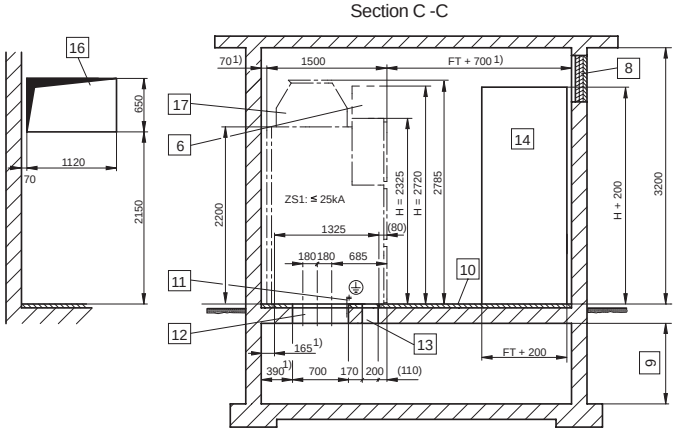



*Figure 5/2c: Switchgear with pressure relief outside.*
*Panel width: 800/1000 mm.*
*Rated feeder current up to 1250 A*

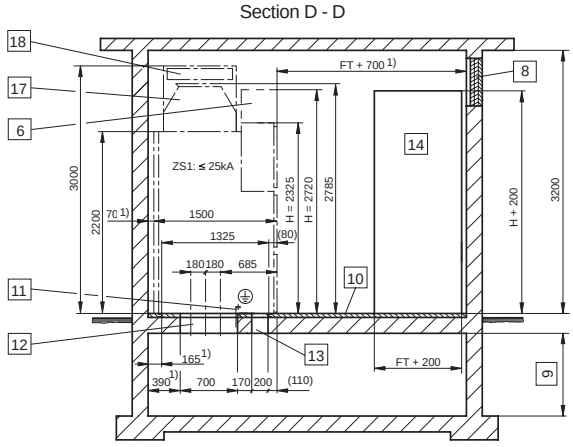



*Figure 5/2d: Switchgear with pressure relief via absorber and deverter into the switchroom.*
*Panel width: 800/1000 mm.*
*Rated feeder current up to 1250 A.*

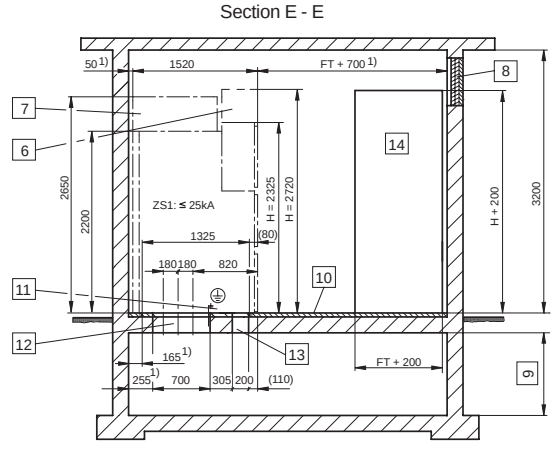



*Figure 5/2e: Switchgear with pressure relief to the outside.*
*Panel width: 800/1000 mm.*
*Rated feeder current 1250 A and from 1600 A to 2500 A.*

*Figure 5/2 Section for figure 5/1*

*See figure 5/1 for legend*
*FT = panel width*
*1) Minimum dimensions*

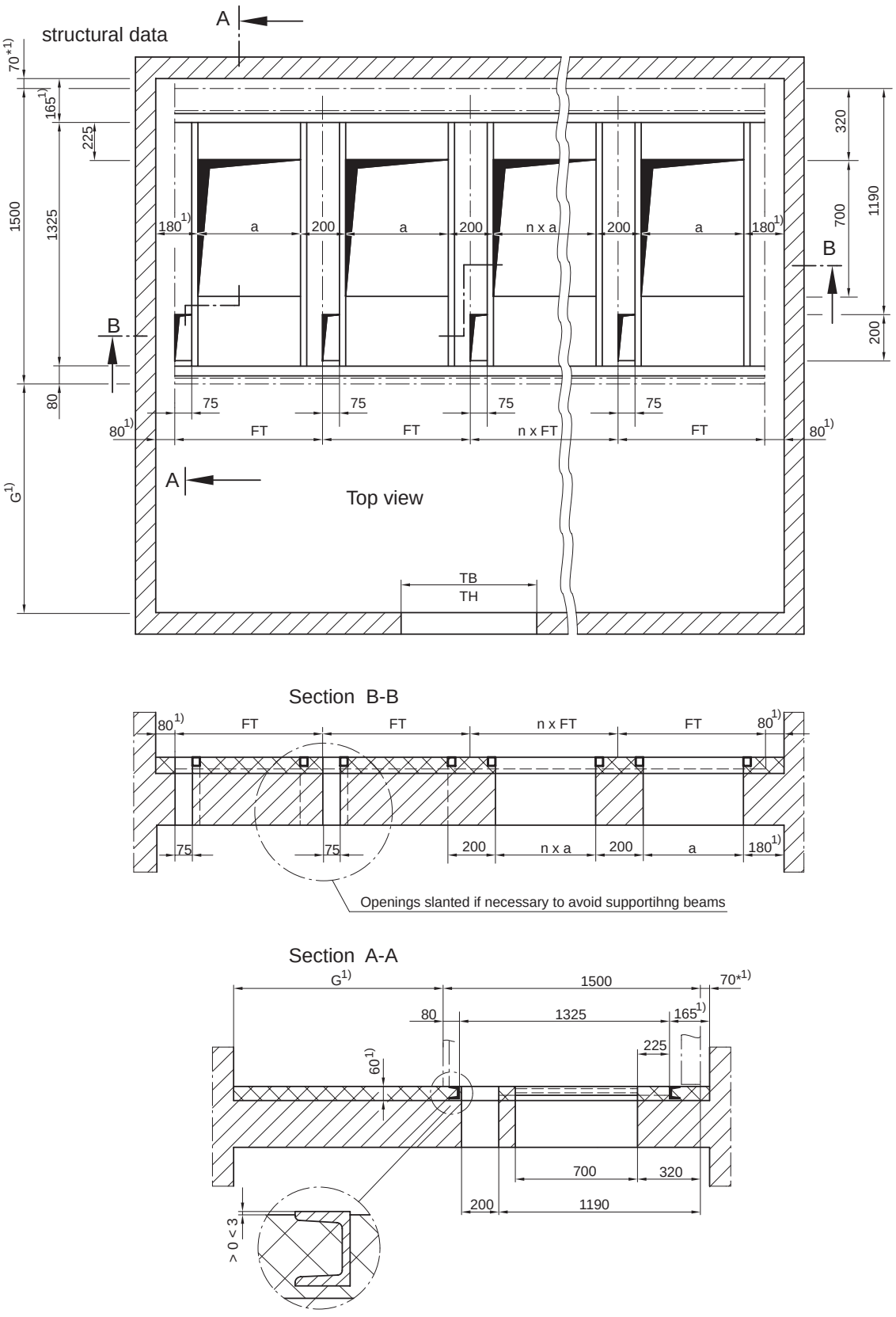
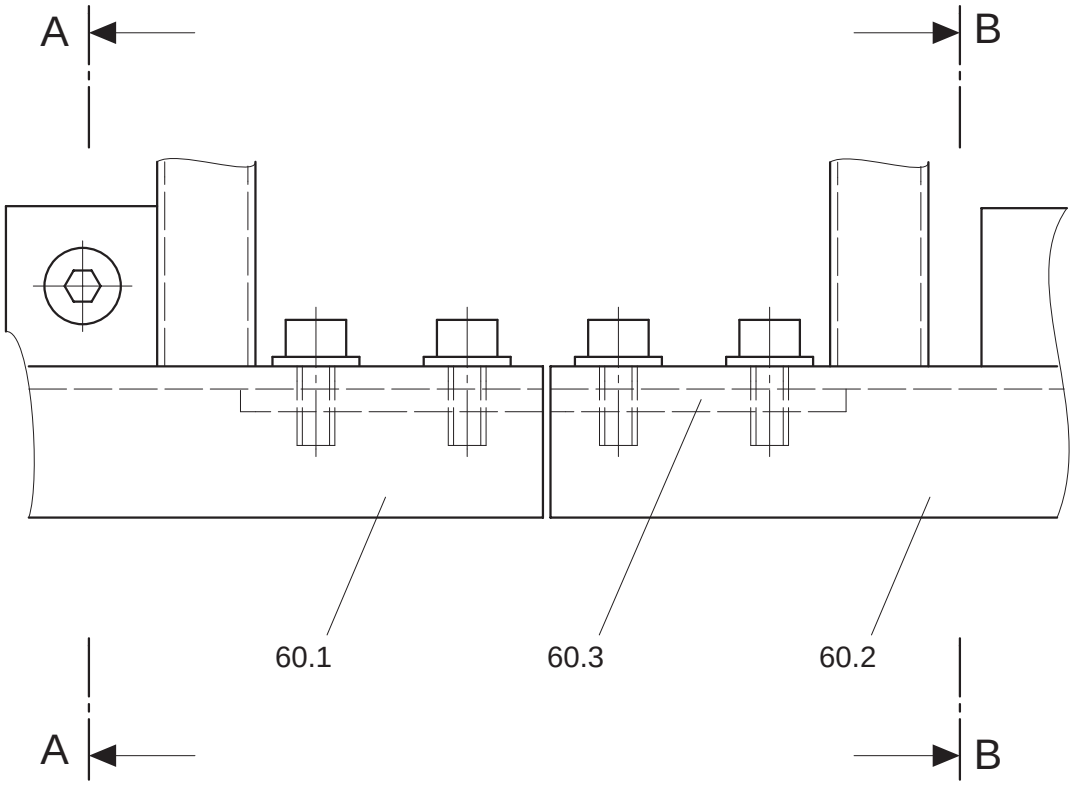



*Figure 5/3: Guideline structual data for foundation frame on a concrete stations*

*1) Min. dimensions*
**) 200 mm for pre-fabricated concrete stations*
*G Wide of operating aisle*
*FT Panel width*
*TB Door width = FT plus 200 mm*
*TH Door height = panel height plus 200 mm*




Sections

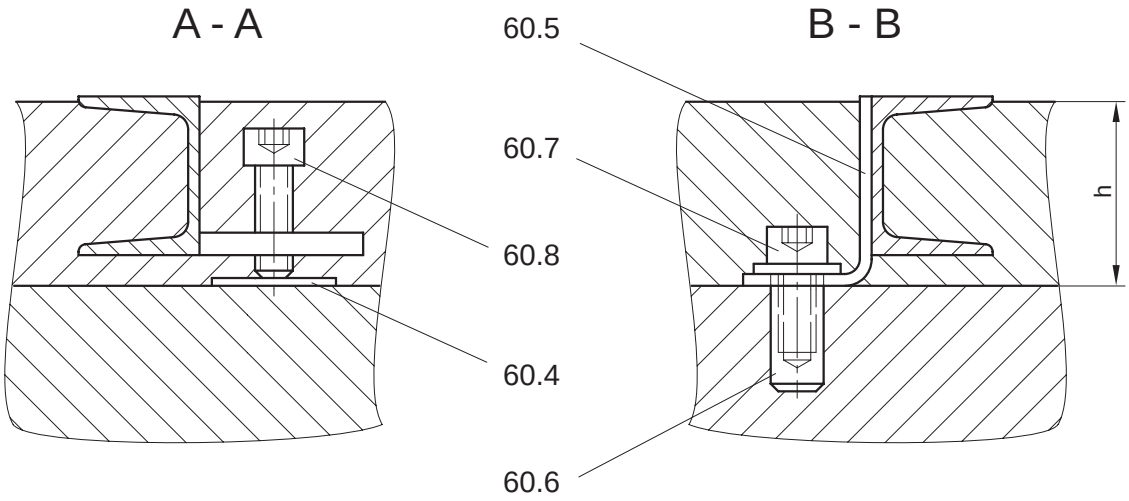



*Figure 5/4: Assembly of the floor frame, for figure 5/1*

*60.1 Floor frame part*
*60.2 Floor frame part*
*60.3 Link*
*60.4 Steel strip*
*60.5 Bracket*
*60.6 Plug*
*60.7 Bolt*
*60.8 Jacking screw*

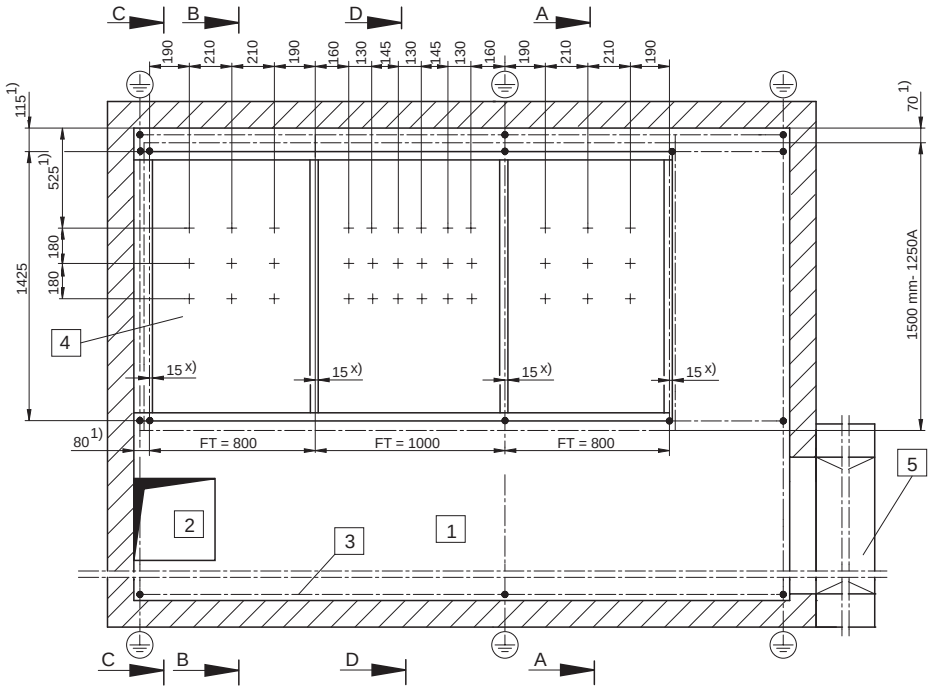



*Figure 5/5a: Panels Type ZS1, 24 kV for outgoing current up to 1250 A panel width 800/1000 mm*

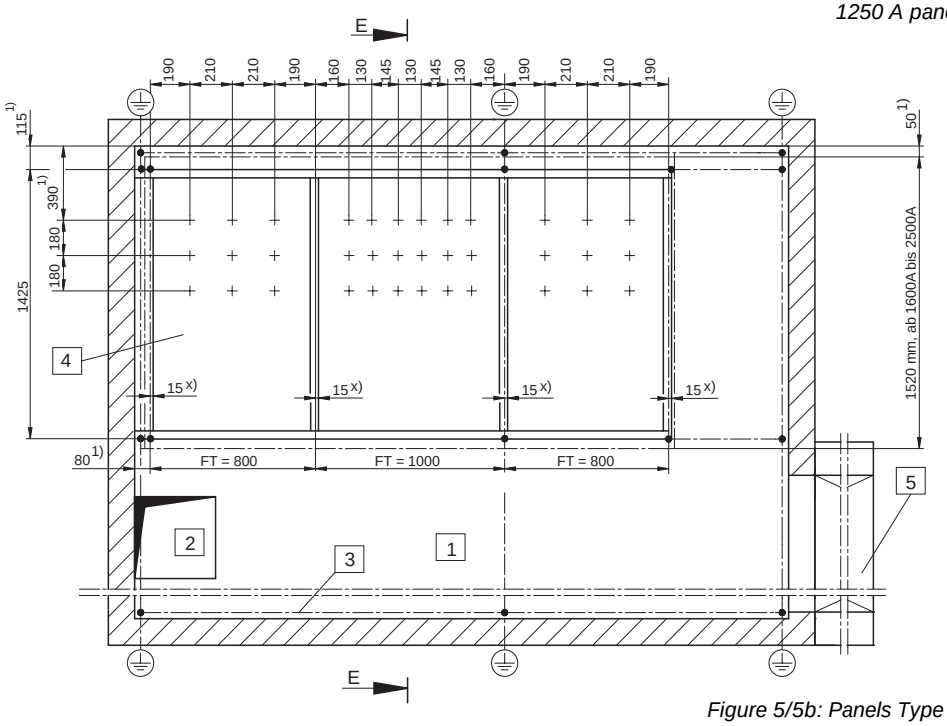



*Figure 5/5b: Panels Type ZS1, 24 kV for outgoing current 1250 A and for 1600 A to 2500 A*

*Figure 5/5: Guideline connection data for a raised false floor*

*See figure 5/6 for sections*
*FT = panel width*
*[1]) Minimum dimensions*
*[x]) Maximum dimensions*

*1 Operator aisle*
*2 Basement entrance*
*3 Main earthing bar*
*4 Raised false floor structure, only shown in the vicinity of the switchgear*
*5 Platform*
*6 Control panel, optional*
*7 Absorber*
*8 Opening ventilation*
*9 Height of cable basement as required*
*10 Covering, site supply*
*11 Raised false floor, site supply, top of false floor 0 to 3 mm above of finished floor*
*12 Power cable*
*13 To main earthing bar*
*14 Door*
*15 Busbar metering or busbar earthing*
*16 Wall opening for pressure relief*
*17 Pressure relief duct*
*18 Diverter*

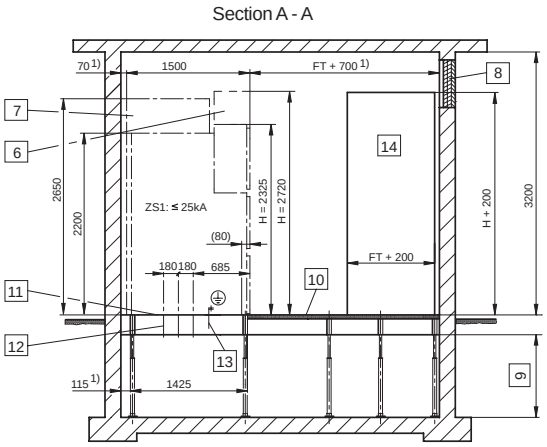



*Figure 5/6a: Switchgear with pressure relief via absorber into the switchroom.*
*Panel width: 800/1000 mm.*
*Rated feeder current up to 1250 A*

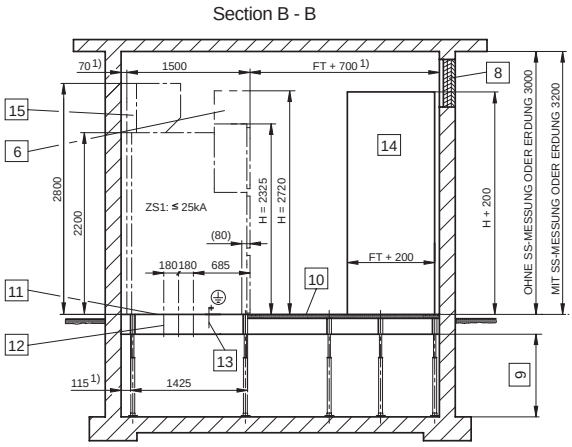



*Figure 5/6b: Switchgear without pressure relief duct,*
*Panel width: 800/1000 mm.*
*Rated feeder current up to 1250 A*
*With busbar metering or busbar earthing*

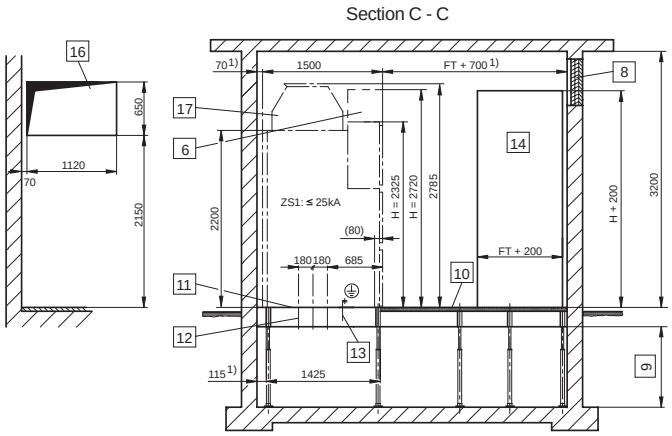



*Figure 5/6c: Switchgear with pressure relief outside.*
*Panel width: 800/1000 mm.*
*Rated feeder current up to 1250 A*

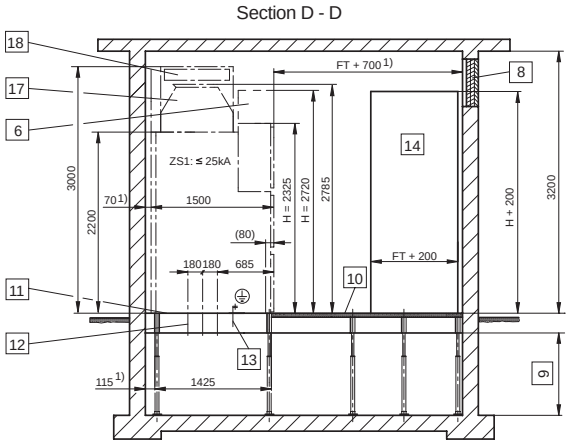



*Figure 5/6d: Switchgear with pressure relief via absorber and deverter into the switchroom*
*Panel width: 800/1000 mm.*
*Rated feeder current up to 1250 A*

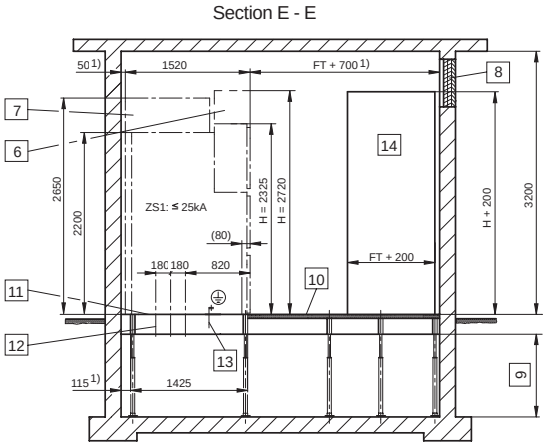



*Figure 5/6e: Switchgear with pressure relief to the outside.*
*Panel width: 800/1000 mm.*
*Rated feeder current 1250 A and from 1600 A to 2500 A*

*Figure 5/6: Section for figure 5/5*
*See figure 5/5 for legend*

*FT = panel width*
*1) Minimum dimensions*

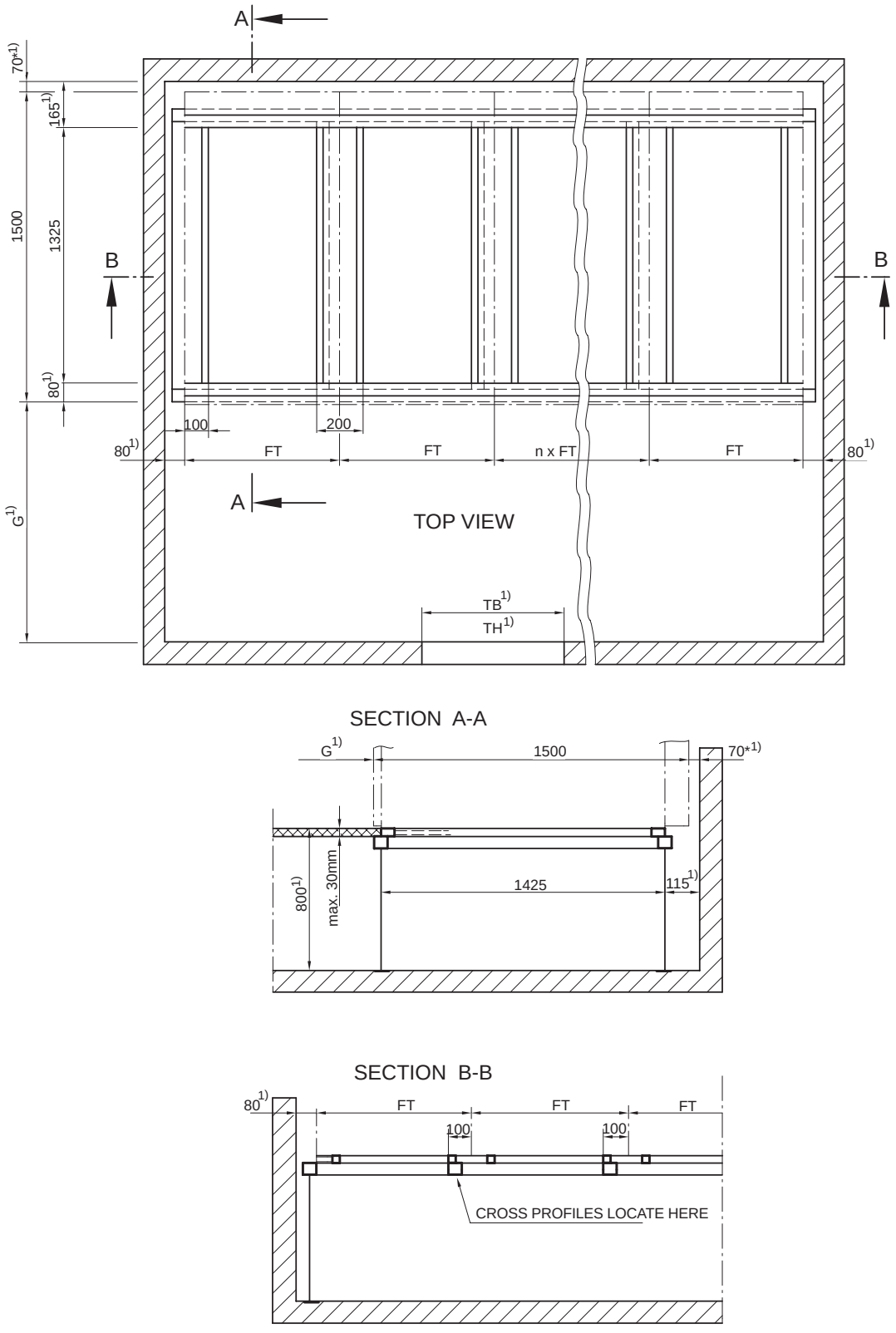
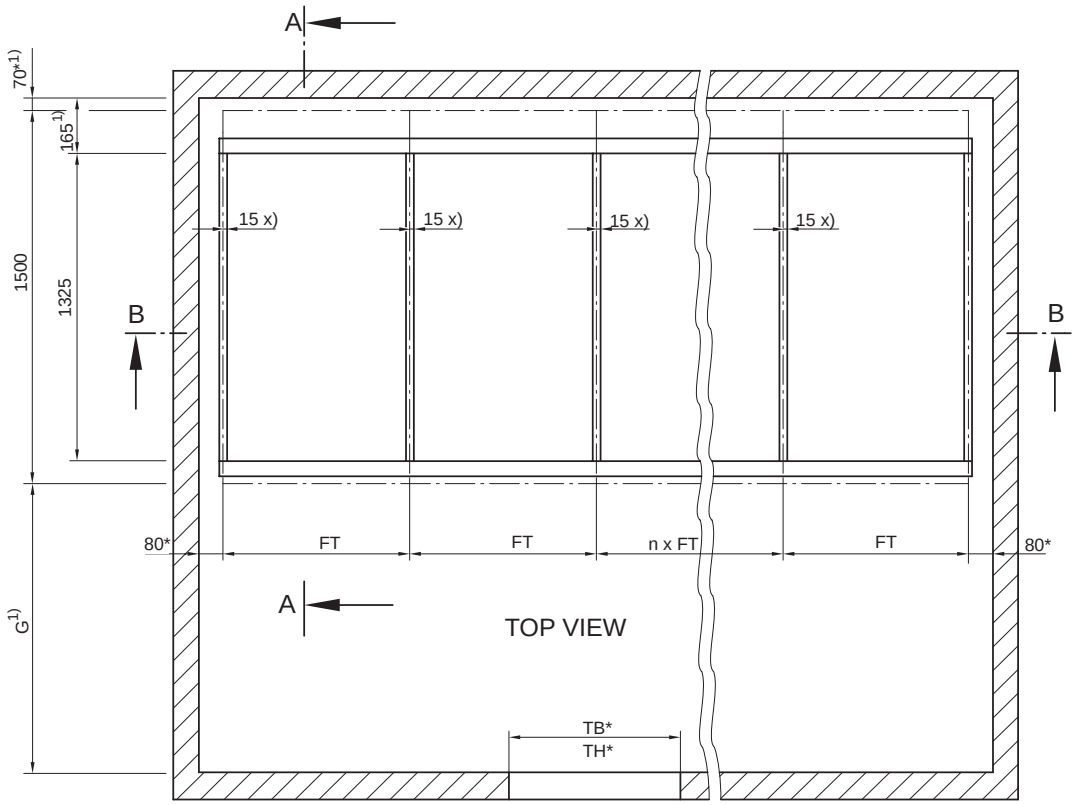


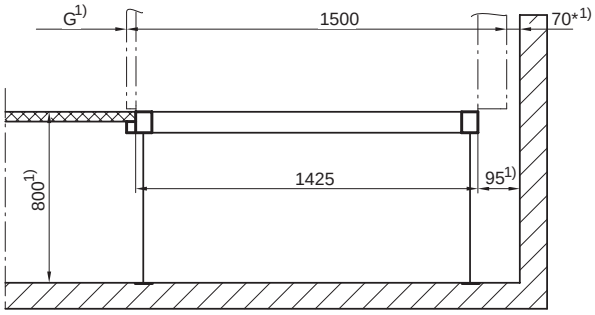

*Figure 5/7: Guideline for the erection of the floor frame on a raised false floor for panels up to 1250 A, 1500 mm depth*

*Variation 1: With second frame, required if the bottom plates are laying on the length beam of the raised false floor*

*1) Min. dimensions*
**) 200 mm for pre-fabricated concrete stations*
*G Wide of operating aisle*
*FT Panel width*
*TB Door width = FT plus 200 mm*
*TH Door height = panel height plus 200 mm*




SECTION A-A




SECTION B-B

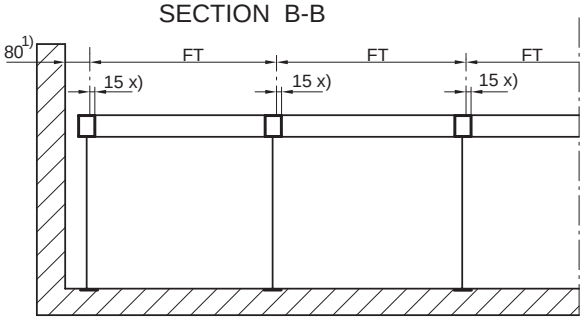
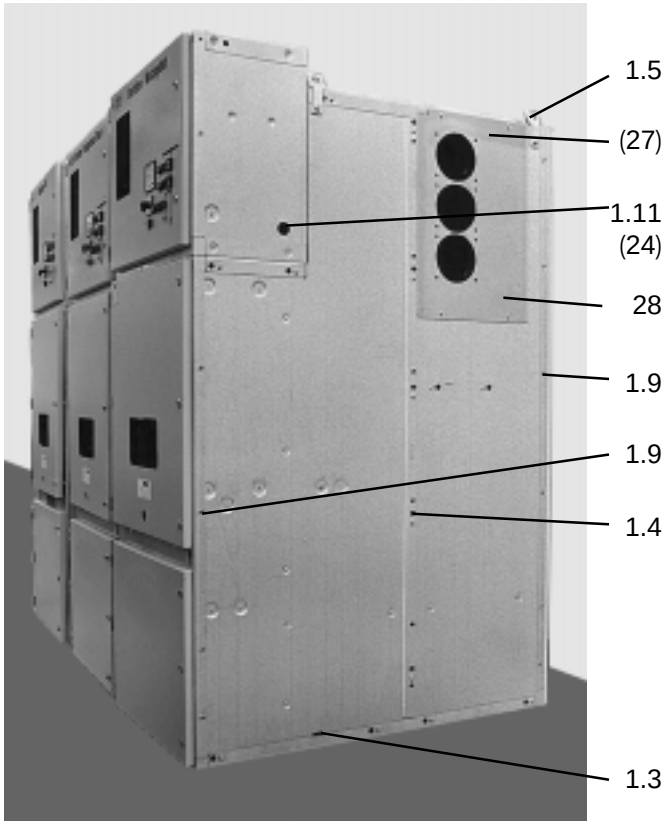



*Figure 5/8: Guideline for the erection of the floor frame on a raised false floor for panels up to 1250 A, 1500 mm depth*

*Variation 2: Without second frame*

*1) Min. dimensions*
*x) Max. dimensions*
**) 200 mm for pre-fabricated concrete stations*
*G Wide of operating aisle*
*FT Panel width*
*TB Door width = FT plus 200 mm*
*TH Door height = panel height plus 200 mm*



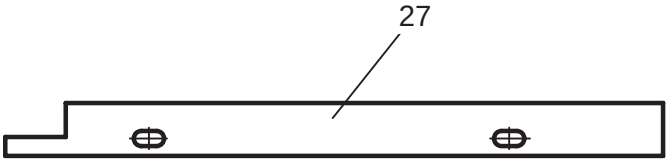




*Figure 5/9: For bolting of the switchgear panels together, through holes are provided on the left-hand side and threaded bushes on the right-hand side near the front and rear edges of the side walls, and through holes on both sides in the central part of the walls.*

*1.3 Aperture, for main earthing bar*
*1.4 Bore*
*1.5 Lifting lug*
*1.9 Threaded bush, for switchgear assembly*
*1.11 Bore, for control wiring bushing 24*
*27 Shim, to be inserted above the opening when bolting together panels without busbar barriers*
*28 Bushing plate*

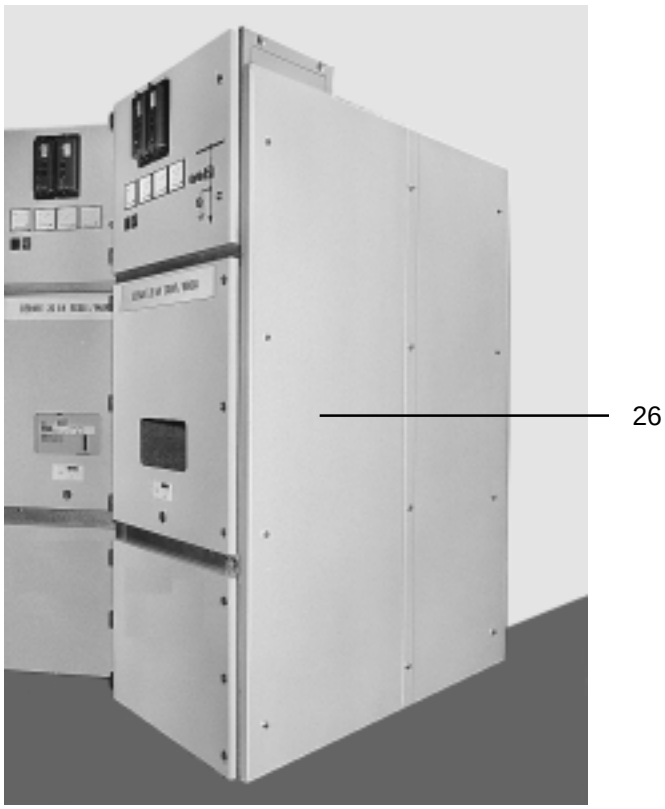



*Figure 5/10: End of panel of a switchboard with bolted-on cover plates*

*26 Cover plate*

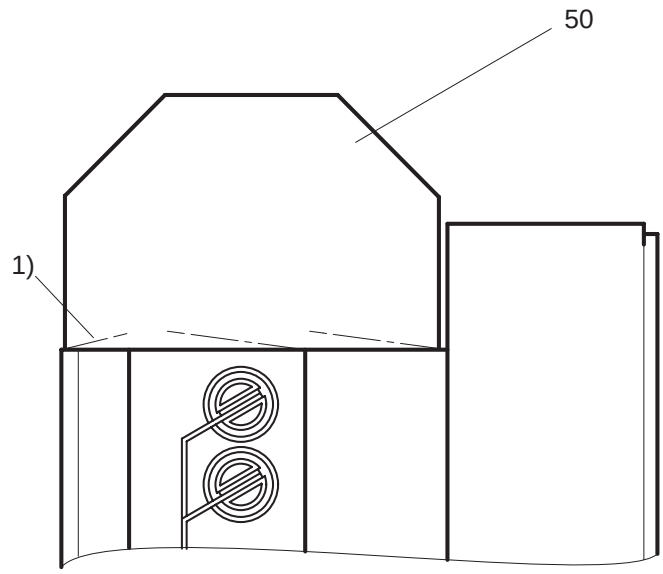



*Figure 5/11: Schematic diagram of the pressure relief duct. The components are assembled panel by panel and bolted together with overlaps at the panel joints.*

*50 Pressure relief duct*
*1) Note*
*If the switchgear is equipped with a pressure relief duct the pressure relief flap for the cable connection departement is fixed to the rear side of the panel and will open to the front (into the duct) in case of an arc fault.*

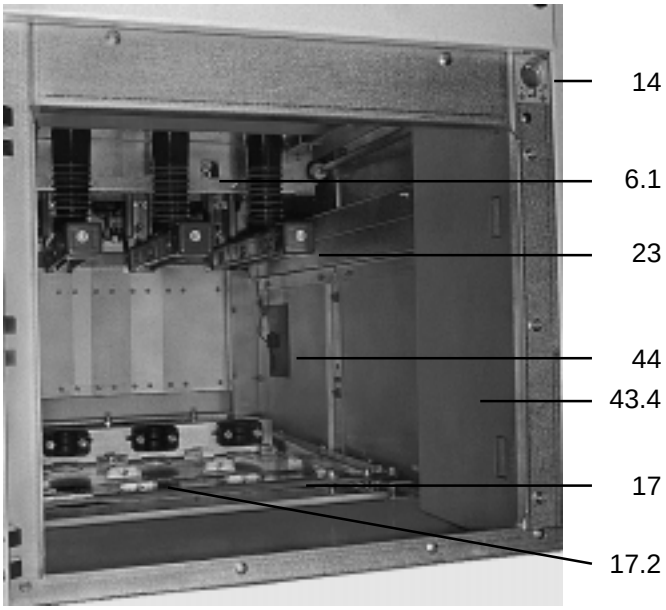



*Figure 5/12: View into cable connection compartement, max. six parallel cables possible (see also figures 5/28 to 5/30)*

*6.1 Earthing switch position indicator*
*14 Earthing switch operating mechanism*
*17 Floor cover split*
*17.2 Reducer ring*
*23 Cable connection bar*
*43.4 Duct cover for internal wiring*
*44 Heater plate (non-standard)*

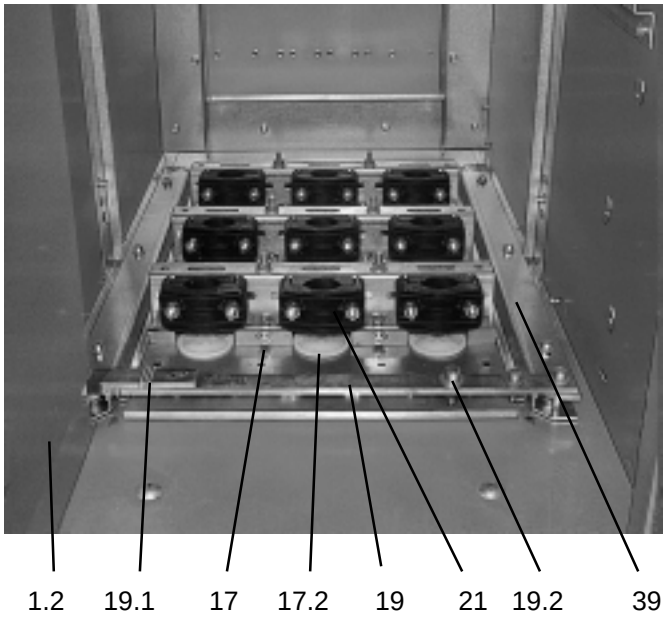



*Figure 5/13: Partial view of the cable connections compartement, prepared here for connection of triple cables*

*1.2 Duct for external control cables*
*17 Floor cover, split*
*17.2 Reducer ring*
*19 Main earthing bar*
*19.1 Connecting link*
*19.2 Earthing connection pin*
*21 Cable mounting, connected to earth potential*
*39 Mounting rail, connected to earth potential*

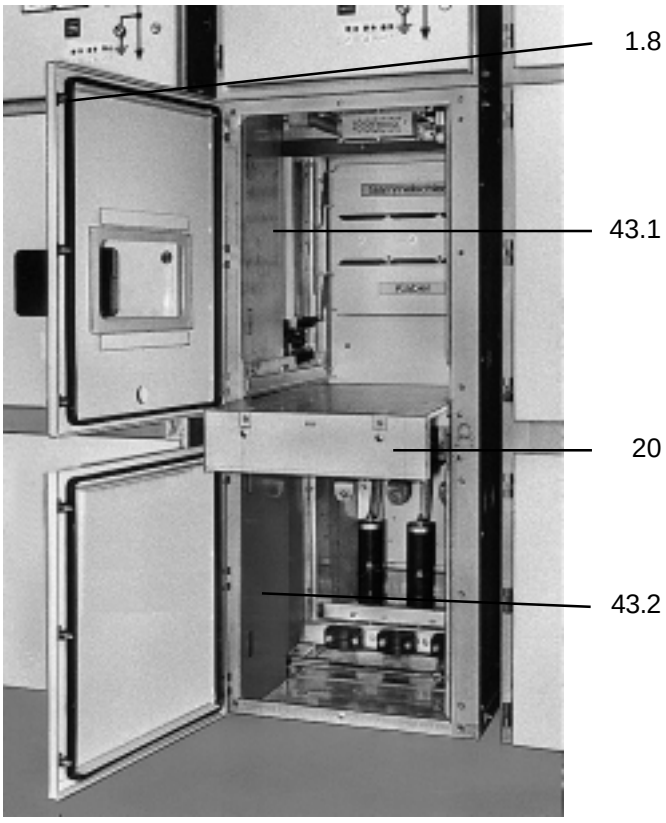



*Figure 5/14: View into the high-voltage area at the front, with the removable horizontal partition released and drawn forwards*

*1.8 Screw coupling*
*20 Horizontal partition, removable*
*43.1 Duct cover for external control cables*
*43.2 Duct cover for external control cables*

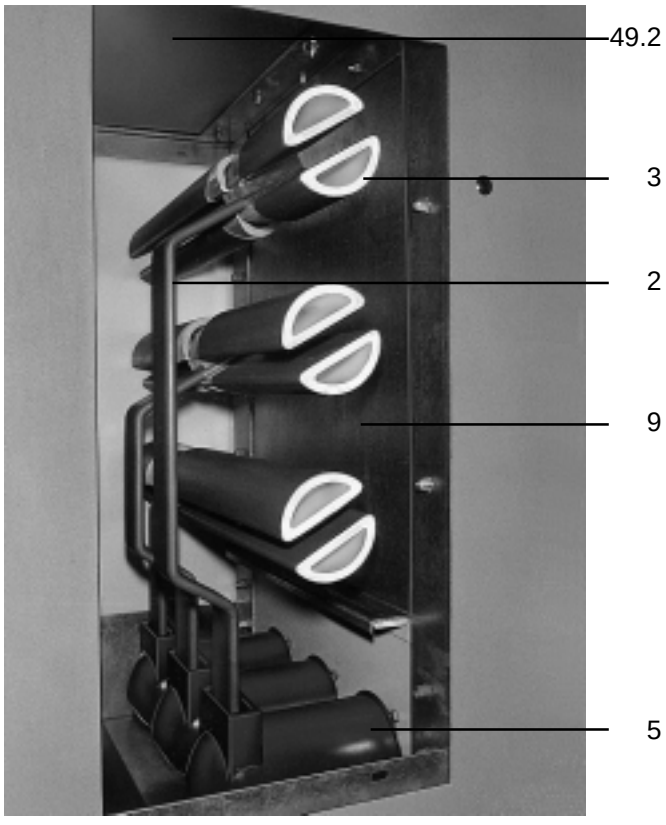
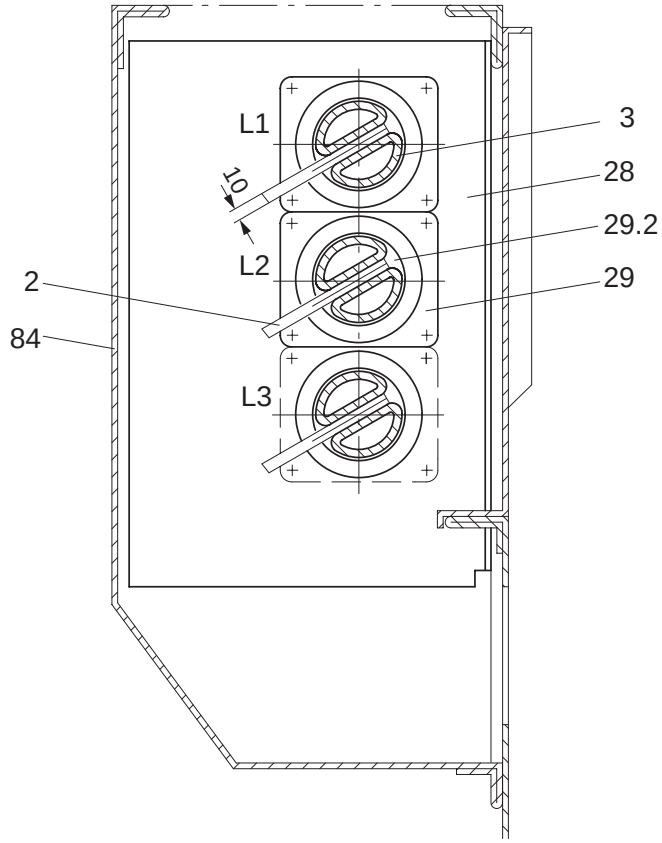
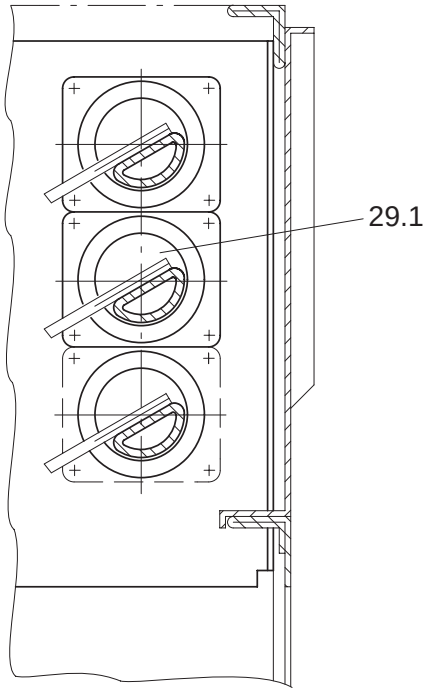



*Figure 5/15: View into the busbar compartement, shown without partition and insulting covers*

*2 Tee-off conductor*
*3 Busbar*
*5 Isolating tulip*
*9 Partition, removable*
*49.2 Pressure relief flap, made from sheet steel*



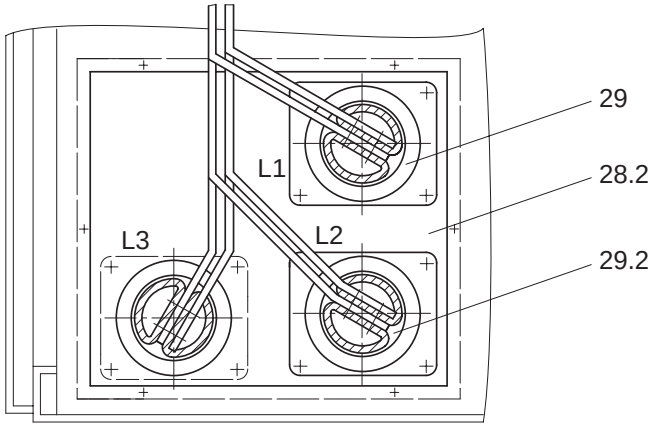

a) *Bushings with busbar mountings for busbar systems with double conductor*



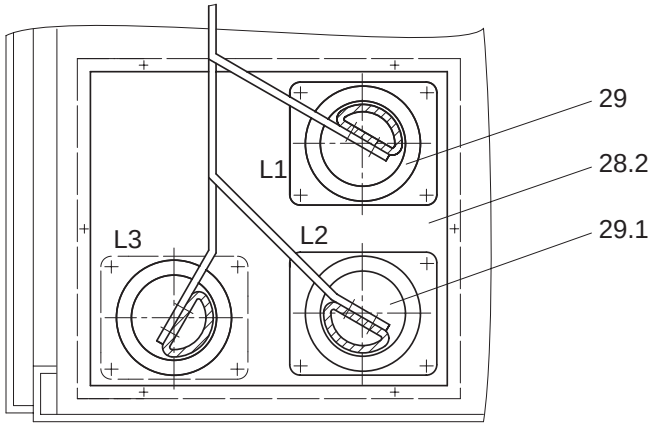

b) *Version with busbar mountings for busbar systems with single conductor. Conductor arrangement at bottom required*

*Figure 5/16 Arrangement of the bushing plate and busbar bushings on the right-hand panel side wall with busbar barriers. View of the inside*

*2 Tee-off conductor*
*3 Busbar section*
*28 Bushing plate*
*29 Busbar bushing*
*29.1 Busbar mounting for single conductor*
*29.2 Busbar mounting for double conductor*
*84 Partition*



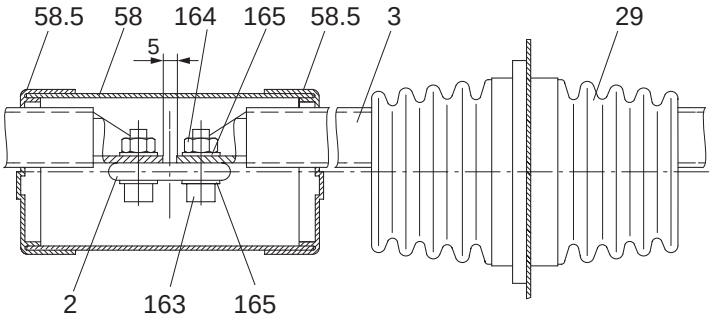

a) *Bushings with busbar mountings for busbar systems with double conductor*

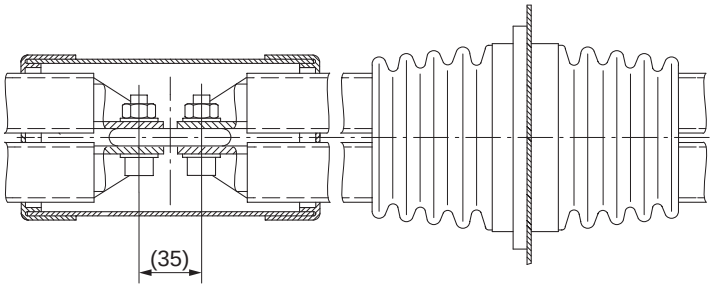


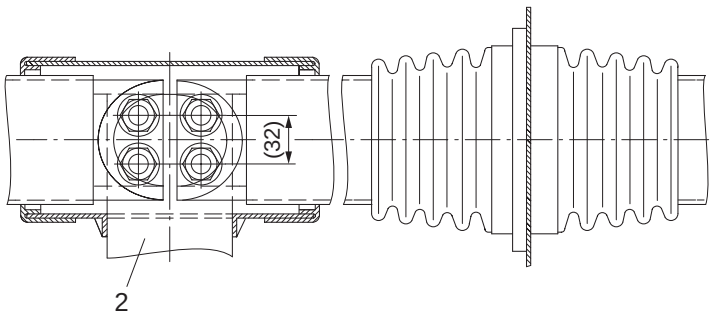

b) *Version with busbar mountings for busbar systems with single conductor. Observe the conductor arrangement*

*Figure 5/17: Arrangement of the bushing plate and busbar bushings on the right-hand panel side wall in bus tie panels. View of the inside*

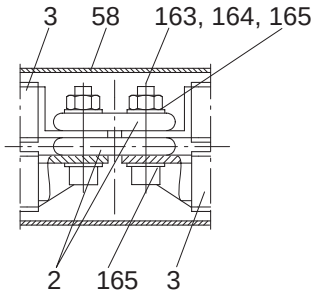
*28.2 Bushing plate*
*29 Busbar bushing*
*29.1 Busbar mounting for single conductor*
*29.2 Busbar mounting for double conductor*



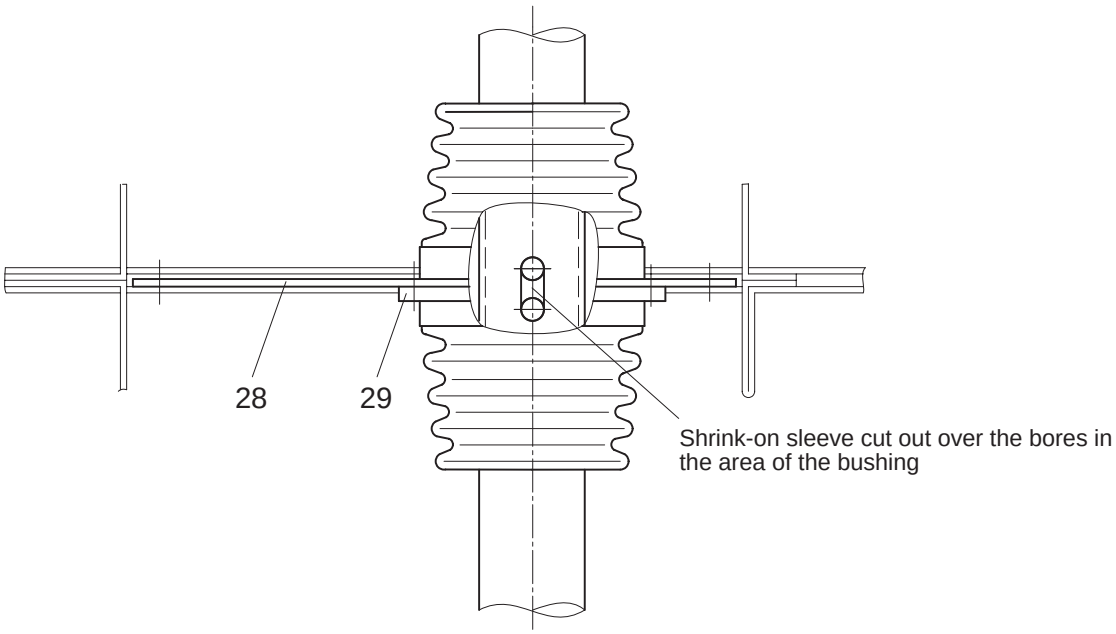

a) *Arrangement for 1250 A tee-off current and 1600 or 2500 A busbar current.*




b) *Arrangement for 2500 A tee-off and busbar current*

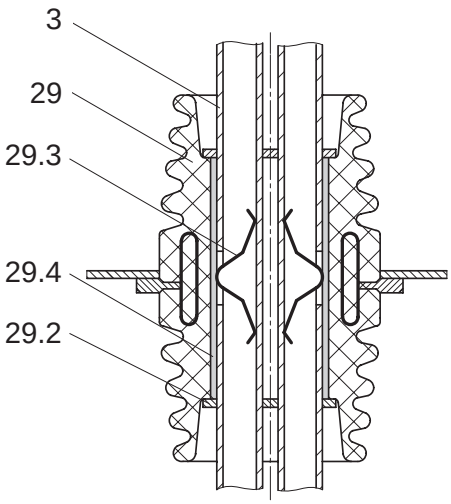
*Figure 5/18: Arrangement and bolting of single and double conductor busbars with single and double tee-off bars. Ensure that screws and accessoreis of the specified quality are used! Use 2 disched washers per screw.*

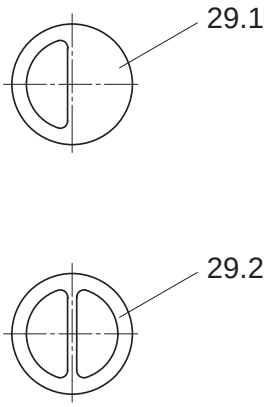
*2 Tee-off conductor*
*3 Busbar*
*28 Busbar bushing*
*58 Insulating cover*
*58.5 Lid for insulating cover*
*163 M10 hexagon socket head screw*
*164 M10 nut*
*165 10 mm disched washer*




*a) Installation position of the phase barriers, viewed from top*

*28 Bushing plate*
*29 Busbar bushing*




*b) Detail of a busbar bushing, sectional view*

*4 Busbar*
*30 Busbar bushing*
*29.1 Busbar mounting for single conductor*
*29.2 Busbar mounting for double conductor*
*29.3 Contact spring*
*29.4 Metal tube*

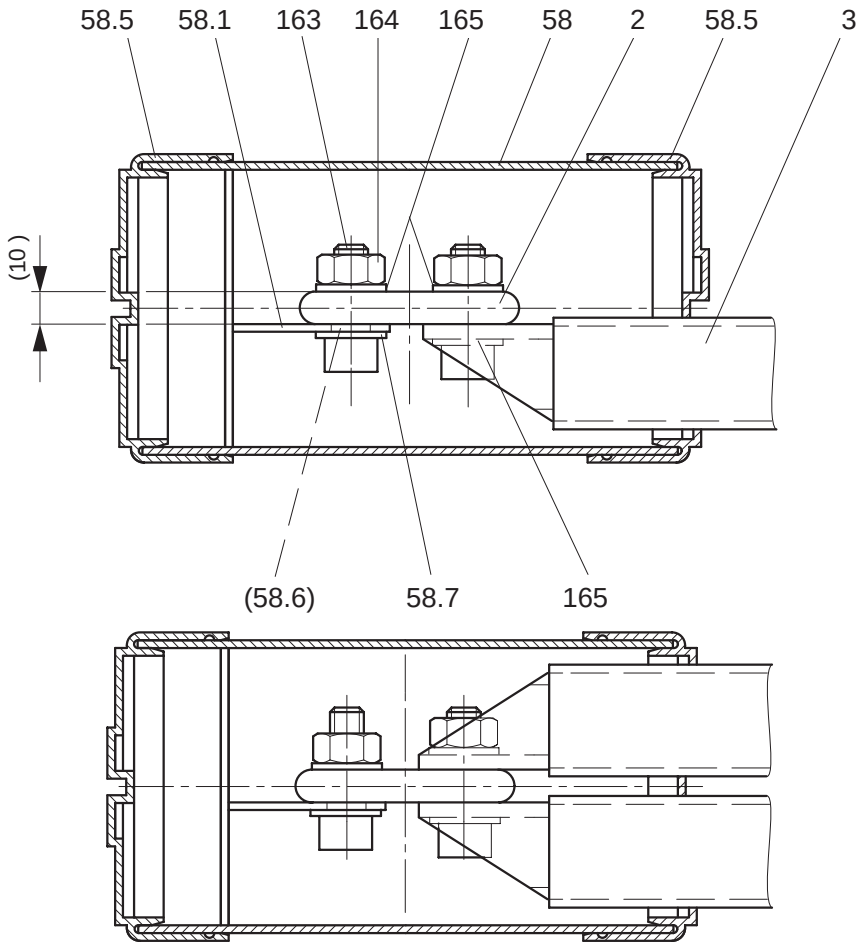
*Figure 5/19: Busbar barriers*

Note:

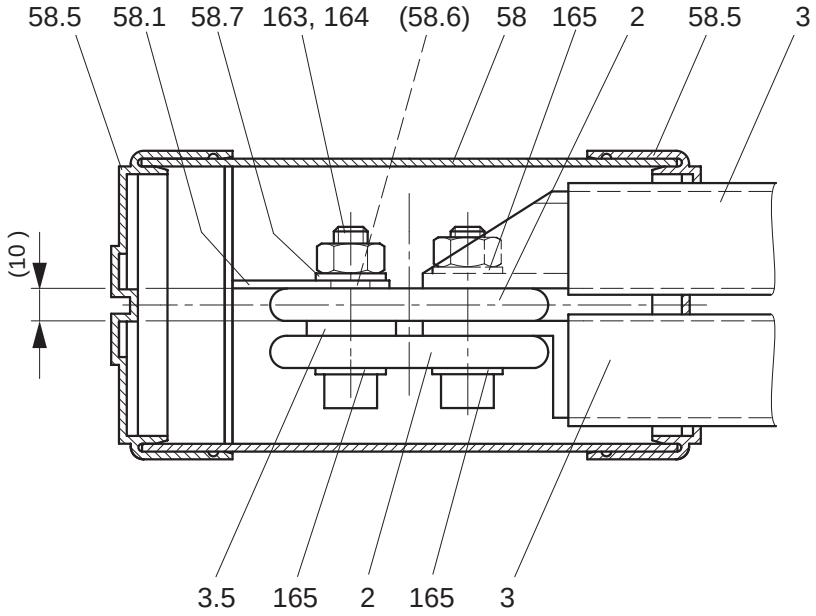
The contact springs 29.3 must be inserted during the installation of busbars. These contact springs make the connection between the busbar 3 and the metal tube 29.4 and prevent damages of the bushing by glow charges inside the bushing on life busbars.

Always check that there is proper contact between the metal tube 29.4 in the bushing and the busbar via the contact spring.

During assembly, cut out the insulating cover and lid to fit the cross-section of the feeder bar or busbar.



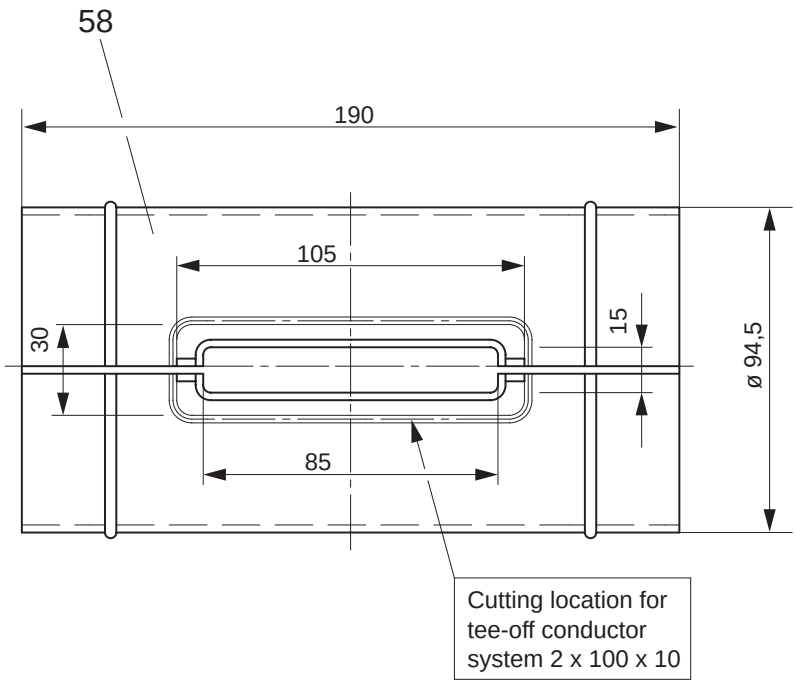

*a) Arrangement for 1250 A tee-off current and 1600 or 2500 A busbar current.*

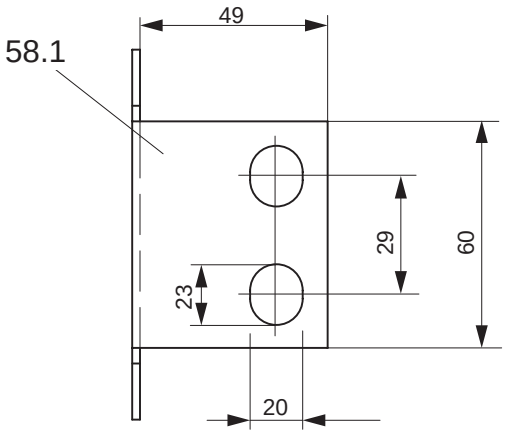



*b) Arrangement for 2500 A tee-off and busbar current*

*Figure 5/20: Arrangement of the busbar and tee-off conductors at the busbar ends*

*2 Tee-off conductor*
*3 Busbar*
*3.5 Spacer plate*
*58 Insulating cover*
*58.1 Lid holder*
*58.5 Lid for insulating cover*
*(58.6) Washer 2 mm*
*58.7 Washer 3 mm*
*163 M10 hexagon socket head screw*
*164 M10 nut*
*165 10 mm washer*



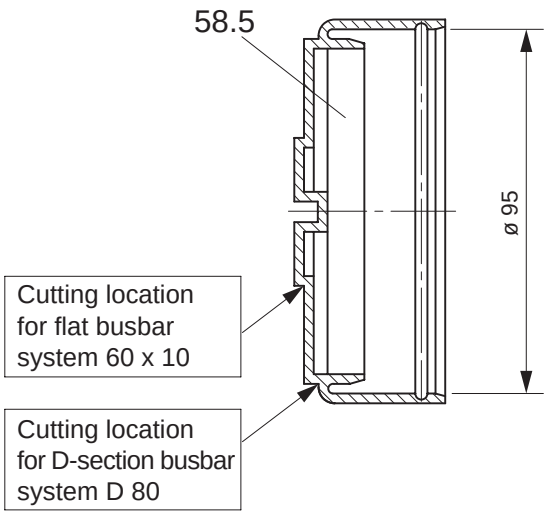
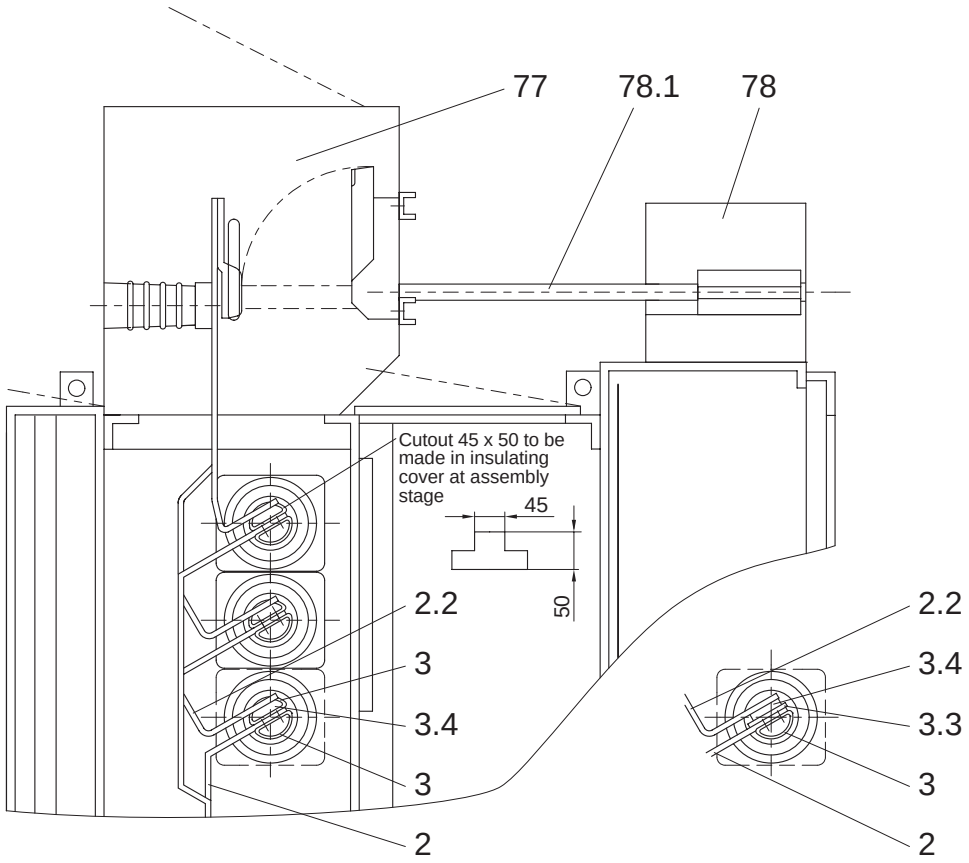




*Figure 5/21: Insulating covers for busbars*

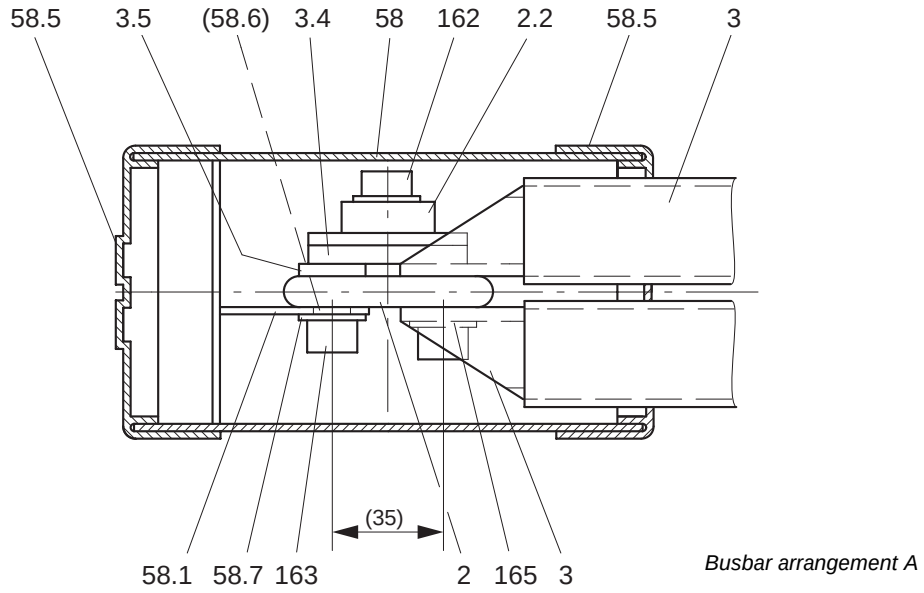
*58 Insulating cover*
*58.1 Lid holder*
*58.5 Lid for insulating cover*



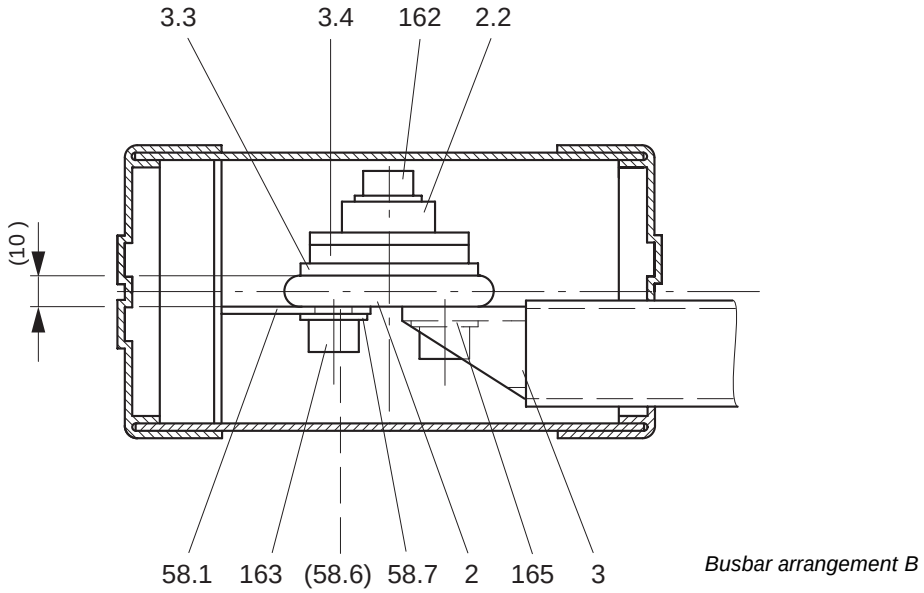

*Busbar arrangement A* *Busbar arrangement B*

*Figure 5/22: Bolted busbar joint for top mounted earthings switch, shown for the left-hand busbar end (right-hand busbar end configured accordingly). Side view without (universal) insulating cover and its mountings.*

*2 Tee-off conductor*
*2.2 Tee-off conductor to earthing switch*
*3 Busbar*
*3.3 Spacer plate, (5 mm thick)*
*3.4 Threaded plate*
*77 Top mounted box for earthing switch*
*78 Operating mechanism box*
*78.1 Hexagonal shaft*




*Busbar arrangement A*




*Busbar arrangement B*

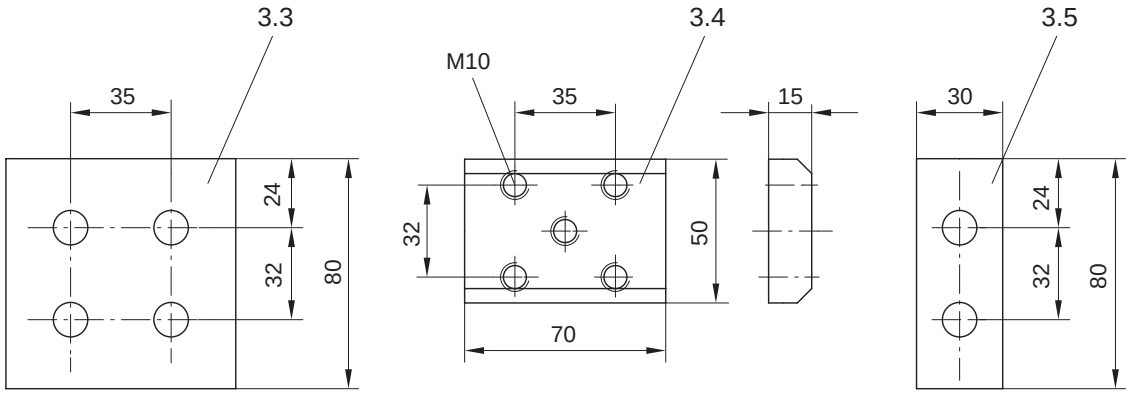



*Figure 5/23: Bolted busbar joint for top mounted earthing switch, shown for the left-hand busbar end. Make the bolted connection of the tee-off conductors for a top mounted earthing switch in the course of the busbar similary, but without mounting 58.1 and without spacer plates 3.5.*

*2 Tee-off conductor*
*2.2 Tee-off conductor to earthing switch*
*3 Busbar section*
*3.3 Spacer plate, 5 mm thick*
*3.4 Threaded plate*
*3.5 Spacer plate*
*58 Insulating cover*
*58.1 Lid holder*
*58.5 Lid for insulating cover*
*(58.6) Washer, 2 mm*
*58.7 Washer, 3 mm*
*162 Cylinder screw*
*163 M10 hexagon socket head screw*
*165 10 mm spring washer*

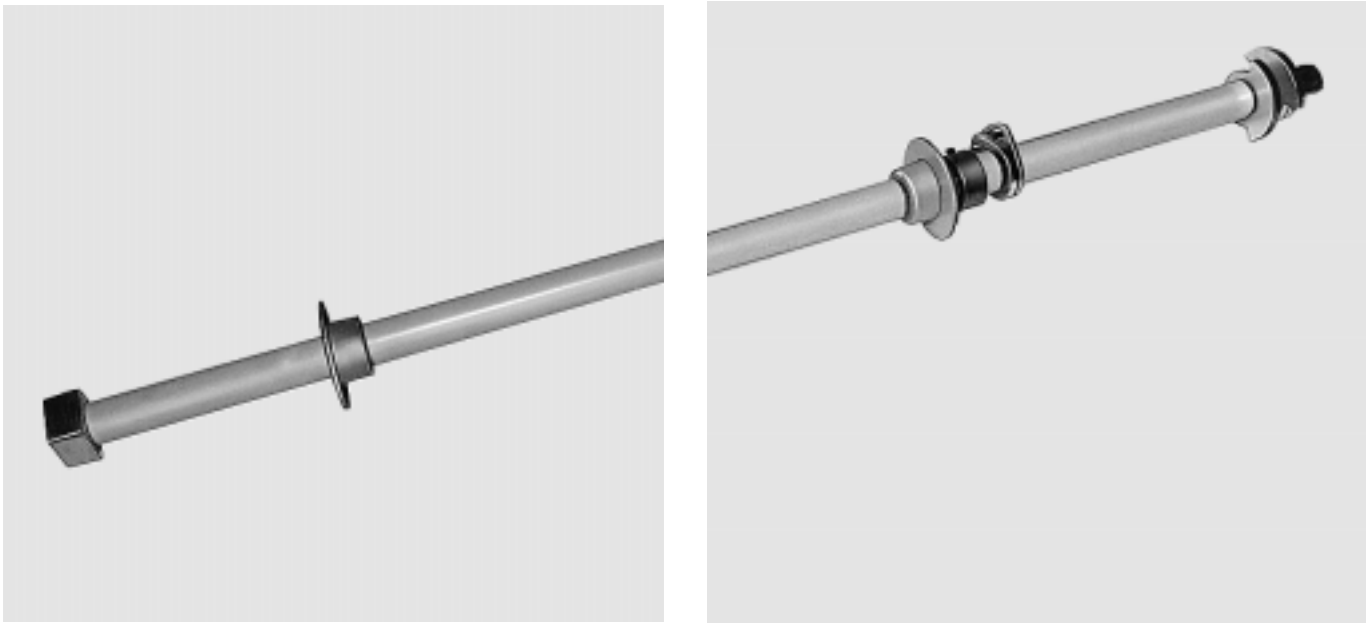


*Figure 5/24: The earthing switch drive shaft is supplied loose when the top mounted enclosures are removed for transport purposes. View for the open position of the earthing switch with individual mechanism parts fitted in the positions for correct function.*

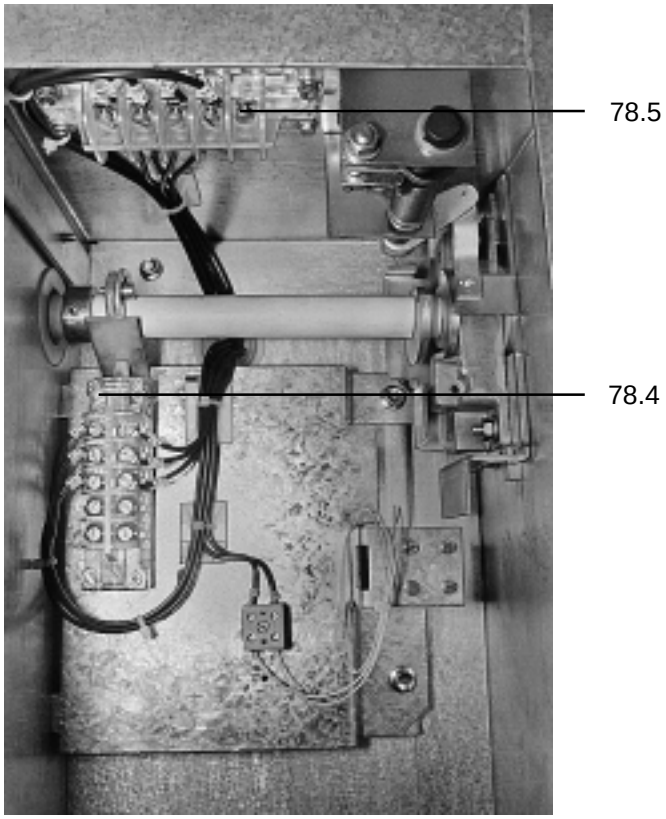



*Figure 5/25: Operating mechanism area of a top mounted earthing switch in detail. Precisely follow the sequence and arrangement of the parts on the drive shaft when assembling. The figure shows the arrangement for the open position of the earthing switch.*

*78.4 Limit position auxiliary switch for earthing switch ON*
*78.5 Limit position auxiliary switch for earthing switch OFF*

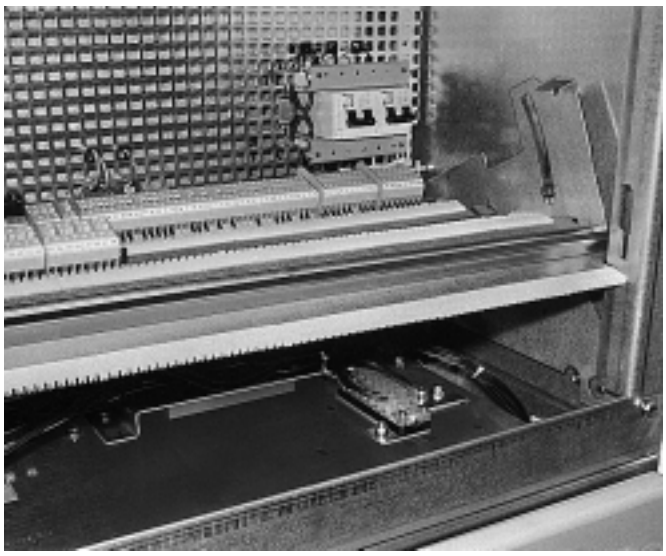


*Figure 5/26: Terminal strip frame swung up for connection work*

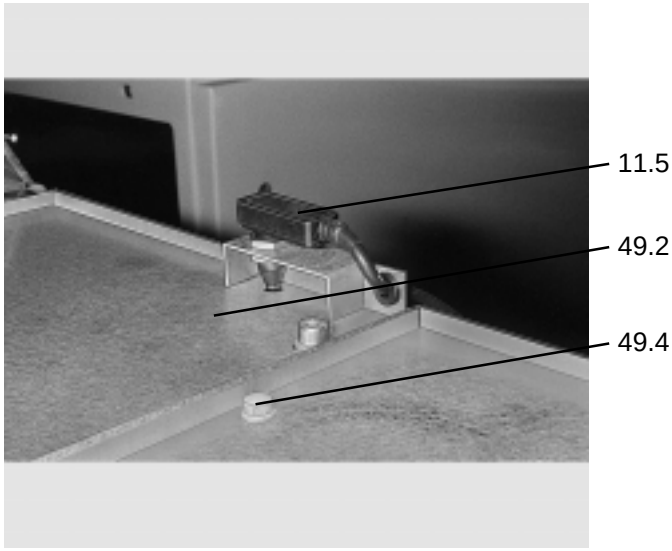
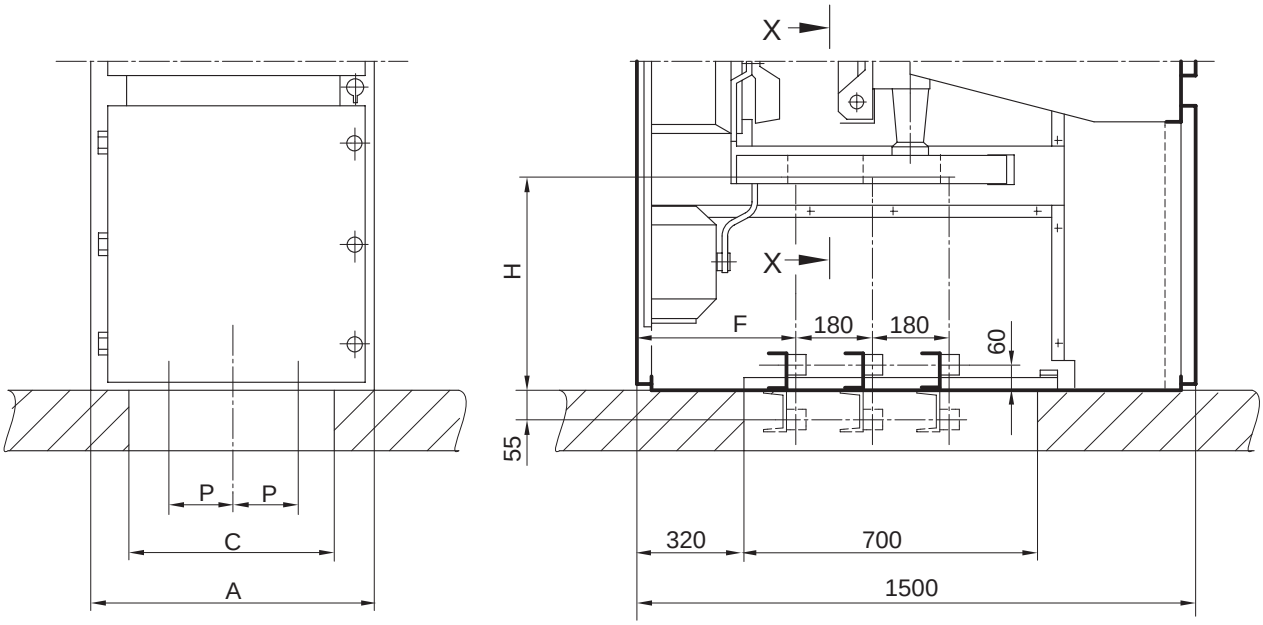



*Figure 5/27: Auxiliary switch for $I_{th}$ limitation. It may be necessary to move the auxiliary switches into their service position when lifting lugs have been removed.*

*11.5 $I_{th}$ limiter*
*49.2 Pressure relief flap, made from sheet steel*
*49.4 Rupture bolt (plastic)*




*Section X-X see figure 5/30*

Selection table:

| $U_N$ | $I_N$ | $I_{th}$ | $I_S$ | Panel width | Cable connection | Line number | Circuit-breaker |
|---|---|---|---|---|---|---|---|
| Rated voltage | Rated current | Short time current | Peal short-circuit current | | Diagram | | |
| KV | A | kA | kA | mm | | | |
| 24 | 630...1250 | 16...25 | 40...63 | 800 | D | 1 | VD4, HA, CP |
| | 630...1250 | 16...25 | 40...63 | 1000 | D | 2 | VD4, CP |
| | 1600...2500 | 16...25 | 40...63 | 1000 | E | 3 | VD4, HA |

CP: cable to SS

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 1000 | 800 | 340 | 460 | 275 | 6 |
| 2 | 1000 | 800 | 455 | 495 | 275 | 3 |
| 1 | 800 | 600 | 455 | 495 | 210 | 3 |
| line no. | A | C[a)] | F | H | P | max. cable |

a) Floor panel section

*Figure 5/28: Cable connection compartment of a circuit-breaker panel*

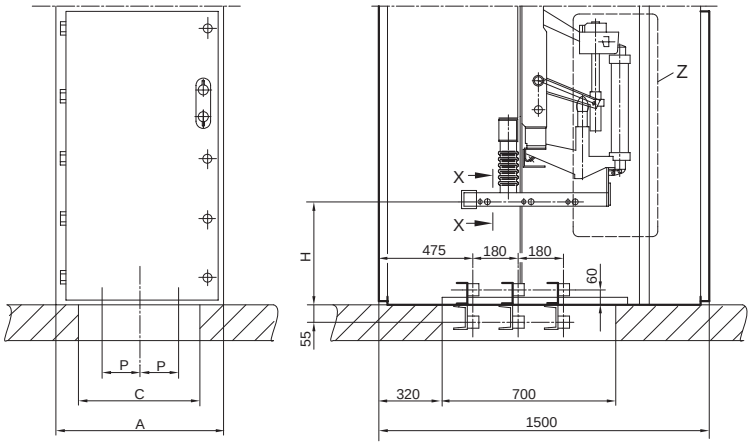



*Diagram A:*
*Panel with fuse,*
*up to 3 cables per phase*

*Section X-X see figure 5/30*

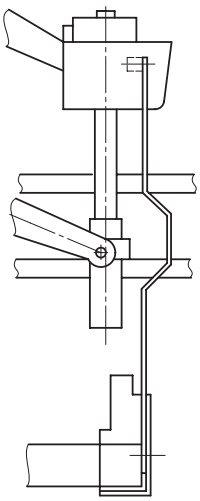


*Diagram B:*
*Detail Z, without fuse,*
*up for 3 cables per phase*

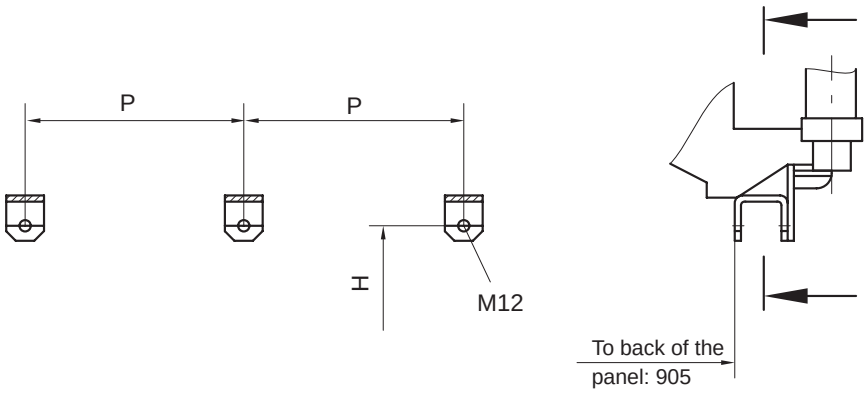



*Diagram C:*
*Detail Z, with fuse,*
*for 1 cable per phase*

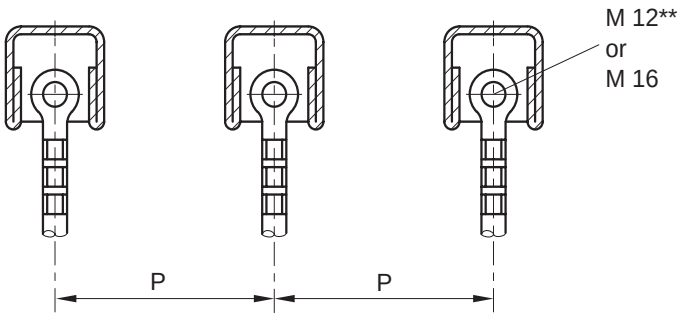
Selection table:

| $U_N$ | $I_N$ | Panel width | Cable connection | Line number | Circuit-breaker |
|---|---|---|---|---|---|
| Rated voltage KV | Rated current A | mm | Diagram | | |
| 24 | ...630 | 800 | B and D | 5 | CK, CK...E |
| | ...400 | 800 | E or A and D | 4 or 6 | CR...U, CR...L |
| | ...630 | 1000 | B and D | 7 | CK, CK...E |
| | ...400 | 1000 | B and D or C | 8 or 9 | CR...U, CR...L |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | 1000 | 800 | 450 | 275 | * | | 1 |
| 8 | 1000 | 800 | 390 | 275 | * | | 3 |
| 7 | 1000 | 800 | 485 | 275 | | * | 3 |
| 6 | 800 | 600 | 390 | 210 | * | | 3 |
| 5 | 800 | 600 | 485 | 210 | | * | 3 |
| 4 | 800 | 600 | 450 | 210 | * | | 1 |
| Line no. | A | C[a)] | H | P | [b)] | [c)] | max. cable |

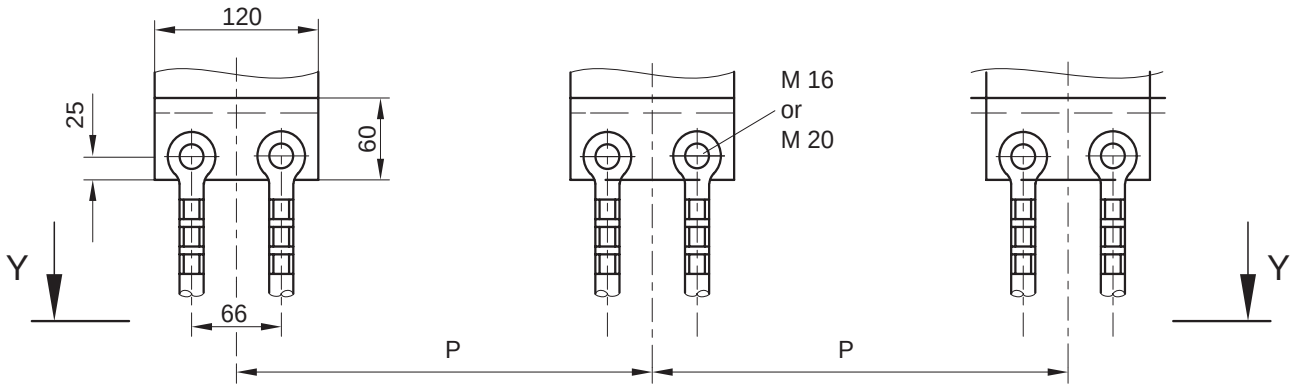
*a) Floor panel section*
*b) With fuse*
*c) Without fuse*

*Figure 5/29: Cable connection compartment of a switch disconnector panel*




**) There is a bore hole for M12 and M16 at every connection point

*Diagram D: Section X-X, up to 3 cables per phase*




Section Y-Y (corresponds to floor plate 17)

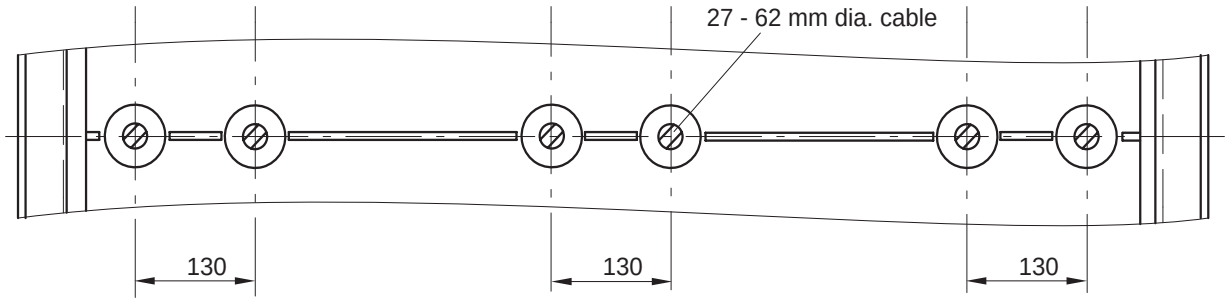



*Diagram E: Section X-X, up to 6 cables per phase*

*Figure 5/30: Section X-X for figures 5/28 and 5/29*

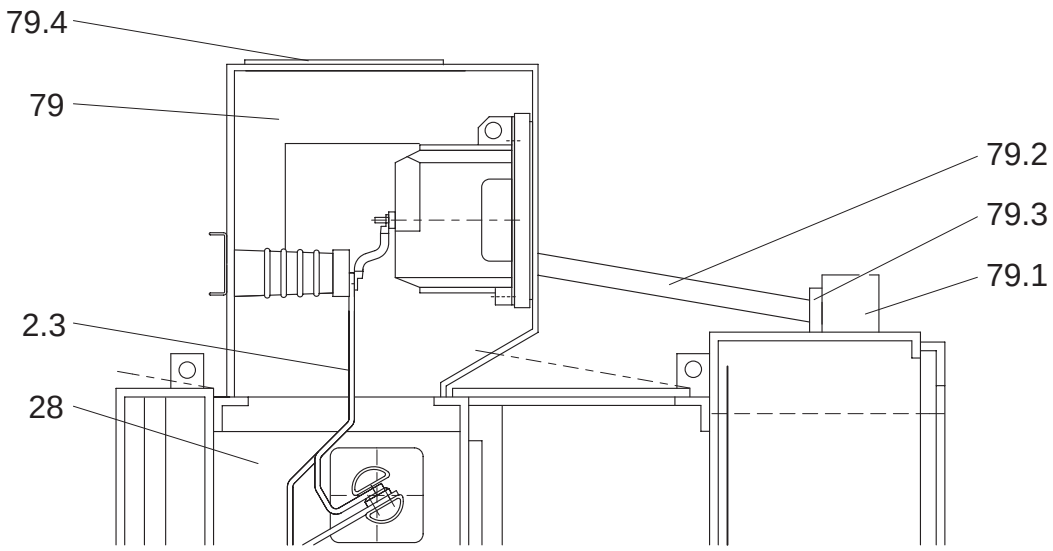



*Figure 5/31: Top mounted box with high voltage transformers for busbar metering. The figure (non-standard equipment) shows the arrangement in panels with the busbar bushing plate 28 and bushings 29.*

*2.3 Flat tee-off conductors (for voltage transformers)*
*28 Bushing plate*
*79 Top mounted box for busbar voltage transformers*
*79.1 Intermediate box*
*79.2 Conductor tube*
*79.3 Reducer ring*
*79.4 Pressure relief flap*

# 6 Operation of the switchgear

Note on safety at work

The relevant work and operating procedures are to be carried out carefully by trained specialists familiar with the installation, taking into a account all the relevant safety regulations to DIN VDE/IEC and the other relevant professional bodies, and other local and work regulations and instructions. Special attention is also to be paid to VDE 0105 (Operation of electrical installations).

Note:

Do not walk on the top surfaces of the switchgear panels (rupture points for pressure relief).

## 6.1 **Commissioning**

### 6.1.1 Preparatory work

(Figures 3/12, 3/19)

In preparation for commissioning, the following work should be carried out prior to connection with the high-voltage power supply:

- Check the general condition of the switchgear for detrimental circumstances of all kinds.
- Perform a visual examination of the switching devices, withdrawable parts, isolating contacts, insulating parts, etc.
- Check the connection of the main earthing bar to the station earthing conductor (observing the requirements of DIN VDE 0141).
- Check the paintwork for damage and touch up as described in section 7.4 where necessary.
- Remove all materials residues, foreign bodies and tools from the switchgear.
- Clean the switchgear, rubbing down insulating parts with a clean, soft, non-fraying and dry cloth. Remove greasy or adhesive dirt as described in section 7.3.
- Properly refit all covers etc. removed during assembly and testing processes.
- Transport cabs 13.9 on vacuum circuit-breakers – if still fitted – must be removed.
- Pole tube lids 13.10 may be fitted in certain systems and on certain circuit-breakers. Check their correct fit.
- Lifting lugs 13.13 on high current circuit-breakers must be removed if still fitted.
- Perform AC voltage testing of the main circuits according to VDE 0670 part 6 (IEC 60298) as far as necessary. Pay special attention during this procedure to voltage transformers and cables, etc. A testing and earthing module 142 can be used to make the connections (see sections 6.3.3).
- Switch the auxiliary and control voltage on.
- Carry out test operations of switching devices manually or by electrical control, and simultaneously observe the relevant position indicators.
- Check mechanical and electrical interlocks for effectiveness, without using force.
- Set the protective devices in the switchgear to the required values and check their function with test equipment.
- In switchgear panels with an additional ventilation system for high-current circuit-breakers (required for increased ambient temperature - >40 °C and/or higher frequency - 60Hz - according to section 1.3 and figure 6/21 and 6/22) the flap 20.3 hanging in partition 20 must loosely rest against leaf spring 20.4 (with the centrifugal fan at a standstill - if fitted -). This is no standard.

To check:

  – Insert a suitable screwdriver through opening 20.5 in horizontal partition 20 and into bracket 20.6 on flap 20.3.
  – Swing flap 20.3 upwards and allow it to rest loosely again on leaf spring 20.4.
  – If the flap is in blocked position, use the screwdriver to press leaf spring 20.4 downwards by approx. 5mm to release the block before swinging the flap.
  – If any centrifugal fans controlled in relation to primary current are fitted, also check that they function correctly.

- On motorized withdrawable parts, check the direction of rotation of the travel motor in accordance with section 7.5.4.
- For any other questions on the function of the withdrawable circuit-breaker part and testing facilities for the withdrawable part, see section 7.5.
- Instruct the local operators in the fundamental details of regular handling of the switchgear.
- Check the readiness for operation and switching status of electrical systems upstream and downstream from the switchgear.

Depending on the allocation of responsibilities, it may also be necessary to check the following equipment in areas adjacent to the switchgear:

- power cables
- auxiliary cables
- auxiliary power source
- remote control system
- complete earthing system, to DIN VDE 0141
- switchroom equipment
- switchroom condition

6.1.2 Start-up

- Comply with all relevant safety regulations.
- Ensure that the circuit-breakers and switch disconnectors in the system are in the OFF position.
- Remove any existing earthing and short circuiting connections in the critical switching area.
- Energize the feeder cables.
- Connect the switchgear step by step, observing the signals and indicators.
- Check that relevant conductors are in phase, as far as necessary when several incoming feeder cables and switchgear sections are concerned (see also section 6.3.2).
- Carry out all measurements and check all functions dependant on the high voltage power supply being connected.
- Watch out for irregularities of any kind.

## 6.2 Switching operations

Carry out switching operations with the front doors closed.

### 6.2.1 Withdrawable circuit-breaker part

(Figures 6/1, 6/3, 6/5 to 6/11)

Manual insertion from the test/disconnected position to the service position:

- Connect control wiring plug 10.2
- Close the front door.
- Ensure that the circuit breaker is in the OFF position.
- Fit hand crank 121 on square spigot 18.1 of the spindle mechanism 18.
- Turn the crank clockwise through approx. 30 turns until the stop is reached and the withdrawable part is in the service position.
- Observe the position indicator.
- Remove hand crank 121.

It has to be considered that the spring loaded piece of scenery 18.2 will lie completely on the rear side of the panel door when the hand crank will be moved from the square spigot 18.1 of the spindle mechanism 18. This ensures that the rear part of the scenery has been shift on the hexagon cap of the spindle and prevents the unintentional wrenching of the spindle during the service of the panel. The wrenching may lead to a blocking of the circuit-breaker.

Note:

The withdrawable part must not be stopped at any position in the travel range between the service position and test/disconnected position!

Manual withdrawal from the service position into the test/disconnected position:

- Ensure that the circuit-breaker is in the OFF position.
- Reserve the procedure discribed above for insertion into the service position.

Note:

Do not use force to move withdrawable parts with blocking magnet Y0 in the event of a voltage drop. If this occurs they are blocked along the whole travel range between the service position and test position. To remove the interlock, consult section 7.5.5.

Motorized movement of the withdrawable part:

- Briefly operate the electrical control for insertion or withdrawal (the withdrawable part then automatically moves into the opposite position).
- Observe the position indicator.

Note:

When the drive motor is faulty, the withdrawable part can be moved in the emergency manual operation. If the drive motor fails during movement of the withdrawable part, the withdrawable part must be moved into a limit position in emergency manual operation.

Emergency manual operation is carried out with hand crank 121 on spindle mechanism 18, in a similar manner to operation of a withdrawable breaker part with manual systems. To disengage the motorized withdrawable part, consult section 7.5.1.

- Switch off the auxiliary power (m.c.b.), since the motor would otherwise be braked electrically.
- Turn hand crank 121 in the required direction.

When the withdrawable part moves, the motor turns. The motor functions in such a case like a generator, i.e. it can lead to reserve voltages in the terminals.

The motor fuse must not be changed from the specified type and rated value, otherwise the behavior of the permanent magnet motor could be irreversibly impaired!

Caution.

In emergency manual operation of a motorized withdrawable circuit-breaker part, the interlock with the earthing switch is not effective!

Withdrawal from the test/disconnection position onto the service truck:

- Open the door of the circuit-breaker compartment.
- Release control wiring plug 10.2 and engage it in the storage position on the withdrawable part.

- Position service truck 124 with the guide pins 124.2 of the adjustable bench top at teh correct height facing the panel front, and allow catch 124.3 to engage.
- Move sliding handles 13.11 inwards against the springs to release withdrawable part 13, draw the withdrawable part out onto the service truck and secure it in the catches on the truck.
- Press the release lever 124.4 (at the front underneath the bench top) and release the service truck from the switchgear panel.
- Secure the position of the shutters with a pad lock 130.

Insertion from the service truck into the test/ disconnected position:

- Carry out the procedure as discibed above for withdrawal, changing the order accordingly.

6.2.2 Circuit-breaker, type VD4

(Figures 3/6 to 3/8, 3/11, 3/12, 3/15 to 3/17)

Charging the stored energy spring system:

- On the circuit-breaker with charging motors, charging is carried out automatically. If the charging motor should fail, the charging procedure can be carried out or completed by hand.
- On breakers with manual charging systems, open the door with the withdrawable part in the disconnected position, insert charging lever 128 into the recess and pump for approx. 25 strokes

Operating sequence

Example 1: Circuit-breaker, type VD4, with motorized charging mechanism, withdrawable part in service position

| Operating sequence | Result of operation<br>Breaker Position | Charging Condition | Possible subsequent switching operation |
|---|---|---|---|
| Switch on charging motor<br>Automatic charging | 0 |  | On-Off |
| Close breaker... and | I |  | Off |
| automatically (re)charge | I |  | Off-On-Off or autoreclosing sequence |
| Open breaker | 0 |  | On-Off |
| Close breaker... and | I |  | Off |
| automatically (re)charge | I |  | Off-On-Off or autoclosing sequence |
| Autoreclosing Off | 0 |  | |
| Sequence (Excitation via protection system) On | I |  | (automatically charging starts) |
| Off | 0 |  | |
| Automatically charging Completed | 0 |  | On-Off |
| Close breaker... and | I |  | Off |
| Automatically (re)charge | I |  | Off-On-Off or autoreclosing sequence |

Test switching of the circuit-breaker, type VD4, without primary voltage can be carried out with the withdrawable part in the test position (with the control wiring plug fitted).

Example 2: Circuit-breaker, type VD4, with manual charging mechanism

| Operating sequence (with cubicle doors closed, exept during charging) | Result of operation<br>Beraker Position | Charging Condition | Possible subsequent switching operation |
|---|---|---|---|
| Withdrawable part in test/ Disconnected position, control wiring plug inserted in socket | 0 |  | - |
| Charging<br>Move withdrawable part into service position | 0 |  | On-Off |
| Close breaker | I |  | Off |
| Open breaker<br>Move withdrawable part in test/disconnected position | 0 |  | - |

Test switching of the circuit-breaker, type VD4, without primary voltage can be carried out with the withdrawable part in the test position (with the control wiring plug fitted).

until the charged condition is indicated. When the charged condition is reached, the charging mechanism is automatically disengaged, and any further strokes of the lever have no effect.

Meaning of the charging condition symbols:

Discharged

Carged

Opening and closing the circuit-breaker type VD4:

- Opening and closing operations with the withdrawable part in the service position should only be performed with the door closed.
- Operate the local or remote electrical control.
- Observe the switch position indicator.

The switching operation counter 13.5 for the circuit-breaker compartment enables mechanical operation of the circuit-breaker with the door closed and with the withdrawable part in either position (figures 3/13, 3/14 and 6/8):

- Press the relevant mechanical push button, previously turning knob 45.2 anti-clockwise to the stop if the withdrawable part is in the service position.
- Observe the switch position indicator.

6.2.3 Circuit-breaker, type VM1

(Figures 3/15, 3/16, 6/24, 7/8, 7/9, 7/15)

The maintenance free VM1 circuit-breaker is applying a combination of moulded-in vacuum interruptors, magnetic actuator and electronic controller without auxiliary switches and with sensors.

For details refer to Manual BA 433/E.

Before connecting the primary voltage:

- Connect the auxiliary voltage. OFF command (closed – circuit release) and closing lock-out must be energized before the circuit-breaker can be closed.

The auxiliary voltage has been established when the (Ready) LED 31.2 lights up.

- Perform test closing and opening of the circuit-breaker by pressing push-buttons 31.3 and 31.4.
- Closing:
  - by remote control via closing contacts or locally by pressing ON push-button 31.3.
- Opening:
  - by remote control via closing contacts or locally by pressing OFF push-button 31.4.

- Opening on failure of the auxiliary power supply:
  - Electrical opening is still possible within the first 200 s.
  - After a period of 200 s, emergency manual opening is necessary:
  - Insert emergency manual operation lever 31.28 onto the spigot of the emergency shaft 31.9 in the front plate and turn it anticlockwise to open the circuit-breaker.

    Just before the final stop will be reached a small resistance on the emergency shaft has to be overcome.
- Closing on failure of the auxiliary power supply:
  - Closing is not appropriate and not possible.
- After each operating cycle (ON-OFF), the operating cycle counter 31.5 is incremented by one full digit.

  On termination of a switching operation, the position indicator 31.6 in the window of front plate displays the relevant switch position.
- Anti-pumping system
  (see VDE 0101, section 5.2.3.2)
  - The circuit-breaker controller ensures that closing of the circuit-breaker is blocked when an opening command is active.
  - When closing on a subsequent opening command, further closing with the still active closing command is blocked. The closing command must be issued again for the next closing operation.

### 6.2.4 Withdrawable metering parts

(Figures 3/1-6, 3/1-8, 3/18)

The handling of the withdrawable metering part in the metering panel is as described in section 6.2.1, without however the switching operations and interlocking functions.

Withdrawable metering parts in incoming and outgoing feeder panels are inserted into the cable compartment using a ramp. They reach their service position immediately and engage there in the panel ground by means of the two locking pins at the sides. The voltage transformers used correspond to the type used in the metering panel, and therefore HRC fuses can also be used along with the voltage transformers.

### 6.2.5 Earthing switch, type EK6

(Figures 3/1, 6/12, 6/13, 6/25)

The earthing switch, type EK6, has a snap-action closing mechanism which is independant of the rotation of the drive shaft. An earthing switch 6 allocated to a circuit-breaker is only enabled for switching when the withdrawable part 13 is in the test/disconnected position or removed from the switchgear panel. Only switch earthing switches on when the doors are closed.

Manual opening and closing:

- Press slide 14.2 on the operating lever recess socket down. (When the switch is closed, it is already in this position!)
- Fit operating lever 122 to hexagonal shaft 14.1,which is now released for operation.

Note:

Put the operating lever 122 in such a way pointed upwards or downwards on the hexagonal shaft that sufficient room for movement of the operating lever remains even if space is constricted at the sides.

- Turn the lever clockwise through approx. 180° until the stop is reached to close the earthing switch, or anti-clockwise until the stop is reached to open the earthing switch.
- Observe the mechanical/electrical switch position indicator.
- Remove operating lever 122. Slide 14.2 remains open if the earthing switch is in the closed position.

Make sure that the operating lever is turned right up to the stop in the opening process, to ensure that the earthing switch is in its defined limit position. The manual operating mechanism can also be fitted with a blocking magnet.

Opening and closing with motorized operating mechanism:

The earthing switch can also be fitted with a motorized operating mechanism.

- Briefly operate the electrical control for opening or closing. The earthing switch is then switched automatically into the opposite position.

Emergency manual operation:

If a fault should develop in the motorized operating mechanism, the earthing switch can be switched in emergency manual operation with lever 122, in a similar way to manually operated earthing switches.

Caution!

During emergency manual operation of a motorized earthing switch, the interlock is not functional!

On emergency manual operation, the coupling with the motorized operating mechanism is automatically released. To disengage the coupling to the motorized operating mechanism, first turn the lever 122 further in the preselected direction up to the relevant stop (small angle of turn). On the next operation with the motorized mechanism after its function has been restored, the coupling automatically engages again.

Note:

The lever may only be fitted temporarily for performance of an emergency manual switching operation. The power to the motorized operating mechanism must be switched off to the duration of any breakdown.

6.2.6 Busbar earthing switch.

(Figures 3/1-4, 3/1-8, 3/22 to 3/25)

To earth the busbars, earthing switches, also of type EK6, are used. Their operating mechanism is identical with that of the tee-off earthing switches (see section 6.2.5).

The conditions for panel to panel interlocking of the busbar earthing switches are described in section 3.4.2.

6.2.7 Switch disconnector

Figure (3/1-9, 5/29, 6/13, 6/15)

Only operate switch disconnectors and earthing switches when the panel doors are closed.

Notes:

- Fit operating lever 122 to the hexagon shaft pointing either upwards or downwards for each switching operation in such a way that it is not obstructed at the sides, even in limited space.
- Ensure that the lever is moved fully into the limit position in all switching operations.

1. Opening an closing of a switch disconnector with snap action ON mechanism and snap action OFF mechanism (Type CK 3):
   - Close the switch disconnector by turning the operating lever 122 clockwise through approx. 180° up to the stop, or open the switch disconnector by turning the operating lever anti-clockwise through approx. 189° up to the stop.
2. Opening and closing of a switch disconnector with snap action ON mechanism and rechargeable stored energy spring OFF mechanism (Type CK3):
   - Close the switch disconnector by turning the operating lever 122 clockwise through approx. 180° up to the stop.
   - Recharge the stored energy springs immediately after the closing operation by turning the lever through 180° in an anti-clockwise direction up to the stop.

     The disconnector is then ready to open, also in response to fuse tripping, shunt and undervoltage releases.
   - Open the switch disconnector by turning the lever clockwise through approx. 15°. Then turn the lever back anti-clockwise until the stop is reached.
   - Observe the switch position indicator (see also section 6.2.9).
3. Opening and closing of a switch disconnector with snap action On Mechanism an stored energy spring OFF mechanism (Type CS 3):
   - Close the switch disconnector by turning the operating lever 122 clockwise through approx. 180° up to the stop, or open the switch disconnector by turning the operating lever anti-clockwise through approx. 180° up to the stop. When the disconnector is then ready to open, it will also respond to fuse tripping, shunt and undervoltage releases.

Special case:

Charge and engage the closing springs by turning the lever anti-clockwise through approx. 180° up to the stop (pretensioning).

This action is only required:

- on initial installation (stored energy springs then normally discharged).
- for indirect operation (tripping by HRC fuse, shunt and undervoltage release).

4. Opening and closing an intergrated earthing switch:
   - Switching of a normally interlocked earthing switch is only enabled when the switch disconnector is in the open position.
   - Turn the operating lever clockwise through approx. 180° to the stop to close the earthing switch or anti-clockwise through approx. 180° to the stop to open the earthing switch
   - Observe the switch position indicator (see also section 6.2.9).
5. Opening and closing with a motorized mechanism:

   Switch disconnectors and earthing switches can also be fitted with motorized operating mechanisms.
   - Operate the electrical control to open/close the switch (briefly), and the switch disconnector or earthing switch will then be switched automatically into the opposite position, or the stored-energy springs for the switch disconnector charged.

Emergency manual operation:

If a fault develops in the motorized mechanism, the switch disconnector and earthing switch can be operate manually in emergencies with operating lever 122, in a similar manner to a switch with manual mechanism. To disengage the coupling to the motorized operating mechanism, first turn the lever up to the relevant stop (small angle of turn).

On the next operation with the motorized mechanism after its function gas been restored, the coupling automatically reengages.

Note:

The lever may only be fitted temporarily for performance of an emergency manual switching operation.

The power to the motorized operating mechanism must be switched off for the duration of any breakdown.

6.2.8 Insulating guard plate

(Figure 6/15)

With the isolating distance of the switch disconnector open, an insulating guard plate can be inserted into the relevant panel on rails.

Notes:

- Always clean an inspect insulating guard plates before use.
- When moisture and dirt cause layers of foreign matter to build up on a guard plate, there is danger due to possible leakage currents.
- Insulating guard plates are only suitable as protection against accidental contact and not as protection against reclosing.
- The service duration of inserted guard plates is fundamentally limited by the influence of moisture, temperature, contamination and the adjacency of live parts.
- Observe the details listed in section 7.2 and 7.3 with regard to the insulating guard plates.

6.2.9 Electrical/mechanical display/monitoring

When the switchgear is in operation, observe all the operating data and condition indications in the secondary area.

Switch position indicator for switch disconnectors:

Use the opportunity to view the switch position through the sight glass.

- Type CK3: The switch position is identical to the mechanism position.
- Type CR3: Switch position indication is only possible with a separate display
- Type CS3: The switch position is identical to the mechanism position when operation is direct.

  For indirect operation (by fuse or electrical release), the opening operation results in different positions for the switch and mechanism.

6.2.10 Earthing and short-circuiting with earthing cable sets

(Figures 6/12, 6/16 to 6/20)

The relevant shutter 12.1 (12.2) is moved to the open position with a withdrawable testing and earthing module 142.

This special withdrawable part is to be inserted in a similar manner to a withdrawable circuit-breaker part, using the same hand crank 121 after insertion into the test/disconnected positions. The individual steps of the earthing and short-circuiting process are as follows:

- Bolt the two actuating bars 142.1 to the required position on the withdrawable testing and earthing module:
  - At the bottom for opening of the top shutter.
  - At the top for opening of the bottom shutter.
- Fit the isolating contacts to the testing and earthing module 142 at the required position:
  - At the bottom to earth the cable area.
  - At the top to earth the busbar area.
- Isolate the area to be earthed and secure against reconnection.
- Carefully observe all relevant safety regulations.
- Remove the withdrawable circuit-breaker part from the relevant switchgear panel.
- Insert testing and earthing module 142 into the test/disconnected position and move it fully into the service position with hand crank 121.
- Check the area to be earthed for the off-circuit condition, e.g. with voltage tester 125 in measuring sockets 30 respectively, or with a high-voltage tester on the relevant contacts 142.7 in bushing 142.6 on module 142, or on the cable connection.
- First firmly bolt the common earthing cable 133.1 to earth terminal 19.3, and then use insulated rod 133.3 to connect the conductor earthing cables 133.2 in a short-circuit-proof manner to contact pins 142.7.
- Display earthing warning plate 135 on the switchgear panel.
- Secure neighbouring live areas ( e.g. feeder cables) to prevent inadvertent contact.

## 6.3 **Test procedures**

### 6.3.1 Testing the off-circuit conditon

(Figures 6/4, 6/16)

The panels are fitted with a capacitive voltage indication system including the corresponding (hand-held) plug-in indicator for testing of the off-circuit condition.

A distinction must be made between the low resistance (LRM) system and the high resistance (HR) system. For further details, see draft standard VDE 0682 Part 415 or IEC 61243-5.

The two systems differ in several respects, including different voltage levels which constitute the display thresholds. The capacitive voltage dividers installed in the panels are correspondingly of different ratings, and the measuring sockets and indicators units are of different types.

Note:

The only permissible indicators are those which satisfy the requirements of the IEC and VDE standards and correspond to the technical design of the indication system in the relevant switchgear !

The measuring sockets must on no account be short-circuited, except for voltage tests on the switchgear (e.g. at power frequency withstand voltage and/or impulse voltage).

Testing for the off-circuit condition is effected using a plug-in indicator at the corresponding socket pairs located among the controls on the panels.

Use of the indicator unit:

- Carry out a functional test on the unit immediately before use, e.g. with interface tester KSP. The display must be clearly perceptible.
- The presence of operating voltage is displayed by a signal.
- Always follow the details given in the instructions for the particular indicator unit for your switchgear system.

Interface testing:

- Perform an interface test as a functional test on all coupling components, e.g. with interface tester KSP.
- The interface test is a repeat test as specified in IEC 61243-5 and VDE 0682 Part 415.

### 6.3.2 Testing for in-phase condition

Testing for the in-phase condition, e.g. when there is more than one incoming feeder, can be carried out with a suitable phase comparator coupled to the measuring sockets of the capacitive voltage indication system (if fitted).

Test procedure:

- Only use phase comparators which comply with the IEC and VDE standards and are of suitable design for the indication system in the relevant switchgear.
- Check the function of the unit immediately prior to use.
- Ensure that the maximum permissible length of the measuring cables for each phase is not exceeded.
- Connect the measuring cables to precisely the corresponding main conductor sections.
- Follow the directions for the phase comparator in detail!

### 6.3.3 Current and voltage testings

(Figures 6/4 , 6/16, 6/20)

Testing and earthing module 142 is available for the performance of current and voltage tests. It is equally suitable for primary current injection to any current transformers which may be fitted during measurements in the protection circuit and, for example, for the application of a test voltage during insulating testing.

- Isolate and secure the working area in accordance with the safety regulations of DIN VDE/IEC.
- For primary current feed, fasten the connecting cable of the test transformer to the contact pins 142.7.
- For AC voltage tests, ball 142.4 on the contact pin is required. The bore in the ball serves for connection of the voltage supply.
- For current tests, for example of small connected generators, the short-circuit bridge 142.8 is to be fastened onto the contact pins.

Note:

With voltage tests at power frequency withstand voltage and/or impulse voltage, observe the following:

- Short-circuit the measuring sockets 30 in the relevant panels for the duration of the test procedure (only)!
- Disconnect any voltage transformers and cover with an insulating plate.

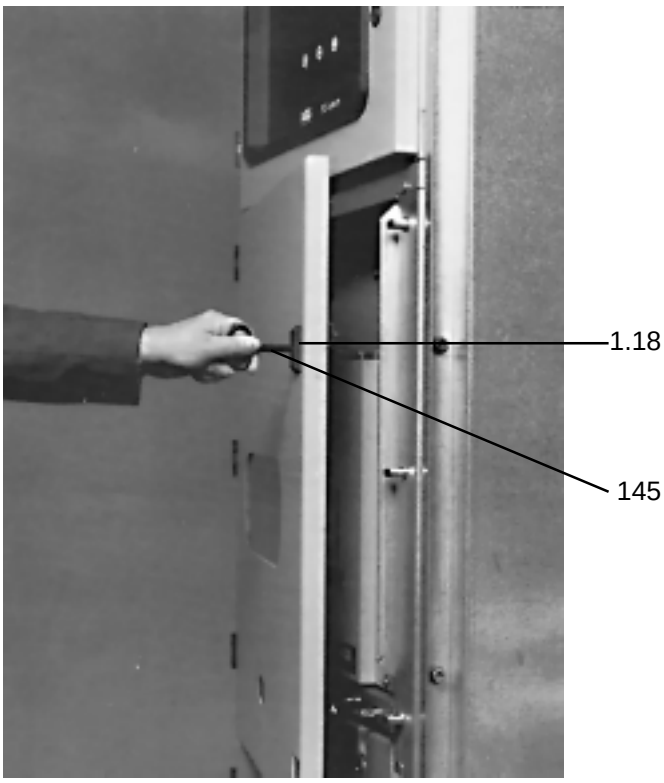



*Figure 6/1: Operation of a door catch*

*1.18 Central catch of the high voltage compartment door*
*145 Double bit key*

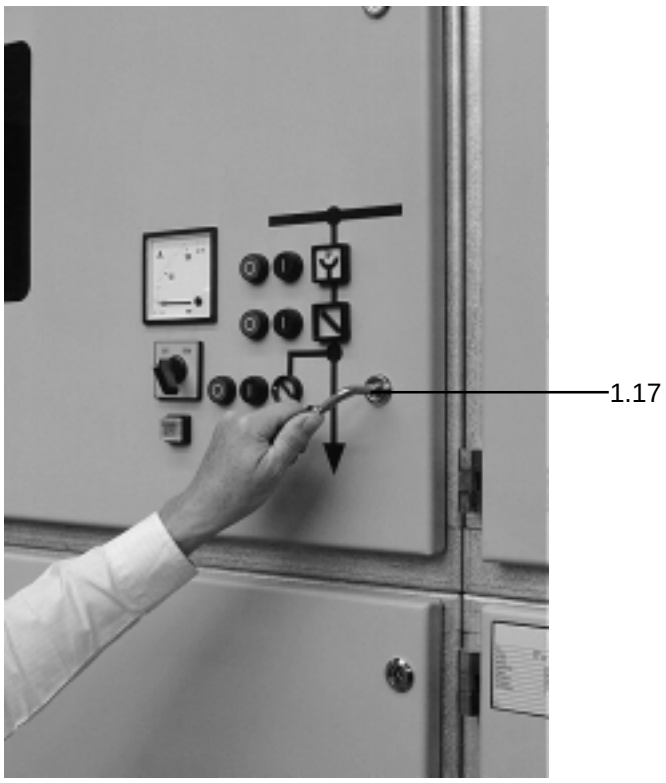



*Figure 6/2: Operation of a door catch, with the handle of the universal key in the turning position*

*1.17 Door catch, 90° turn of the key to open or close a low-voltage compartment*

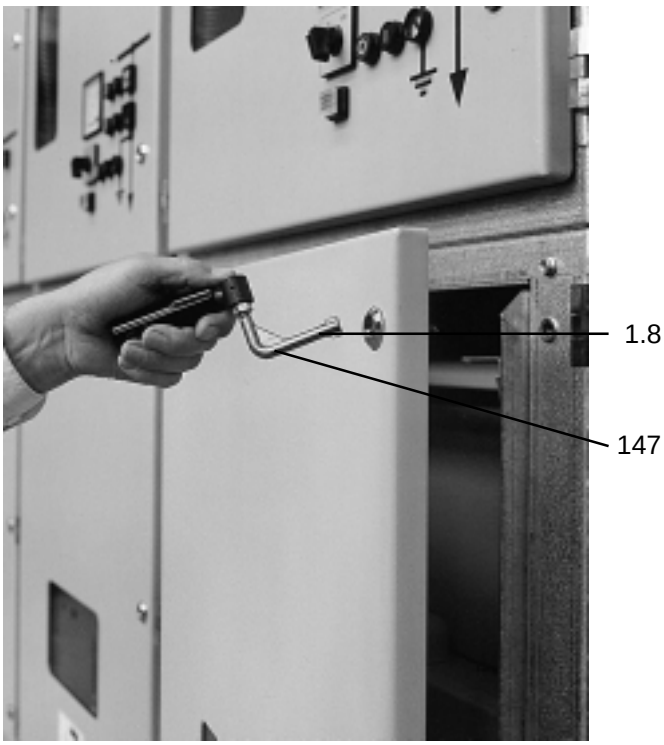



*Figure 6/3: Operation of a screw-type door catch, with the handle of the universal key in the crank position*

*1.8 Screw-typ door catch, on the doors of the high-voltage compartments*
*147 Hand crank (for use on the central catch or screw type door catch)*

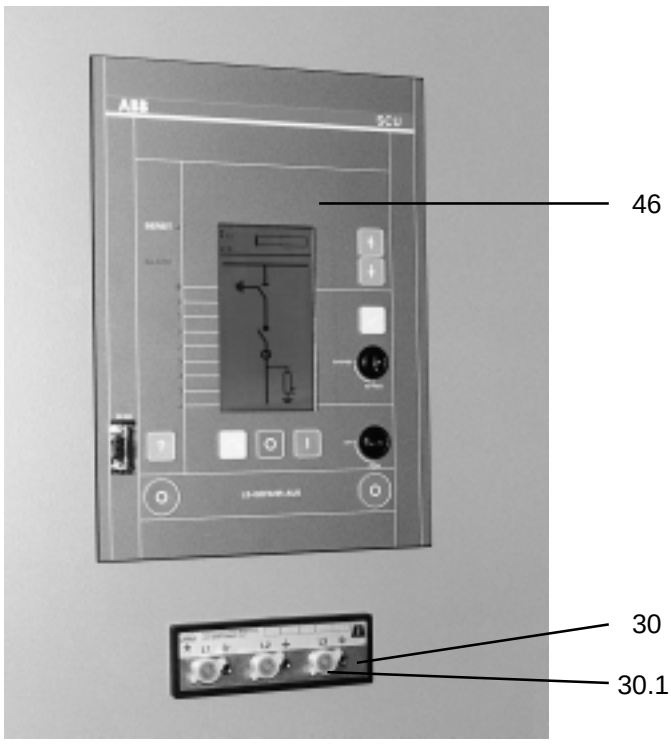



*Figure 6/4: Operation and annunciation via digital control system*

*30 Measuring socket (LRM- System)*
*30.1 Protection cover for measuring socket*
*46 Bay control and protection unit REF542*

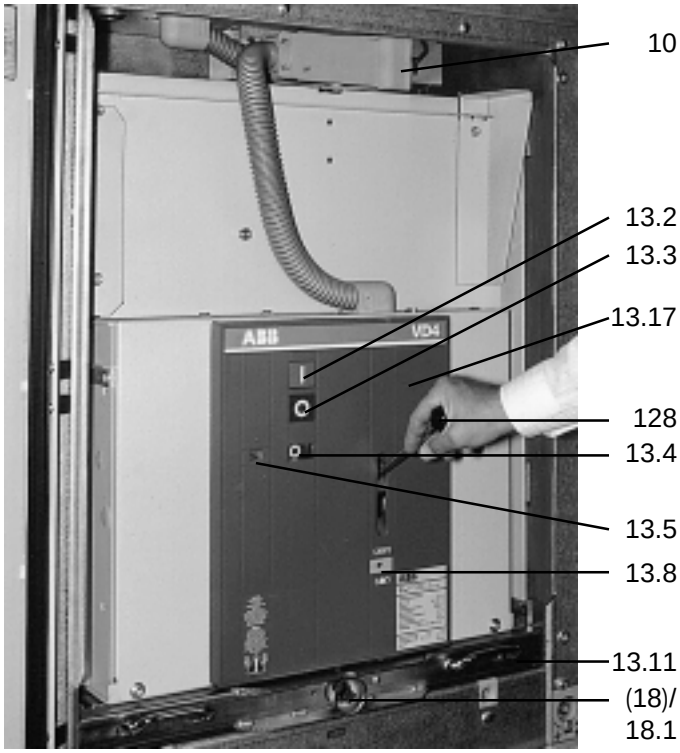



*Figure 6/5: Manual operation and mechanical indicators of a withdrawable part, shown here in the test/disconnected position*

*10 Control wiring plug connection, closed*
*13.2 Mechanical ON push button*
*13.3 Mechanical OFF push button*
*13.4 Mechanical switch position indicator*
*13.5 Mechanical operating cycle counter*
*13.8 Charging condition indicator*
*13.11 Sliding handle, connected with the catch on the withdrawable part baseframe*
*13.17 Front cover plate on circuit-breaker, Type VD4*
*(18) Spindle mechanism*
*18.1 Square spigot*
*128 Charging lever*

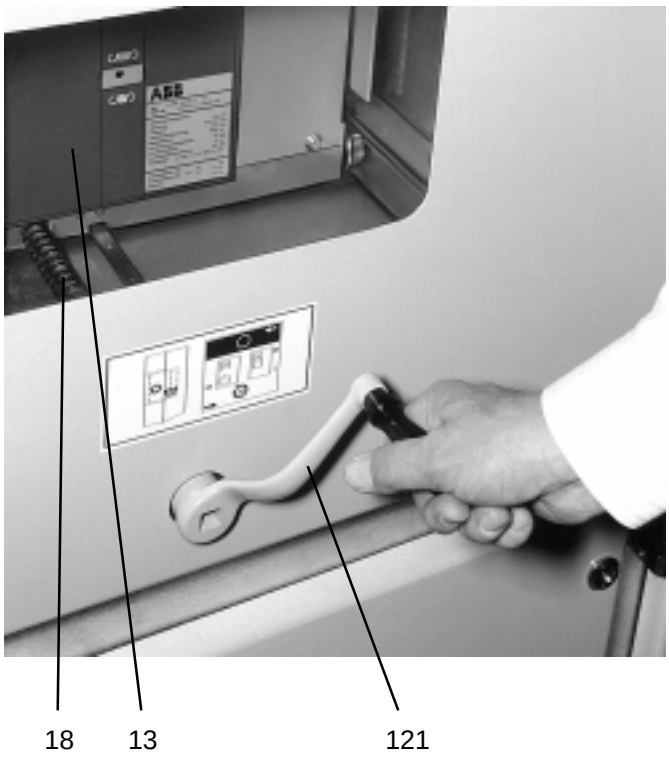



*Figure 6/6: Movement of the withdrawable part between the test/ disconnected position and the service position, with approx. 30 turns of the crank, clockwise up to the stop for the service position and anti-clockwise for the test/ disconnected position*

*13 Withdrawable part*
*18 Spindle mechanism*
*121 Hand crank*

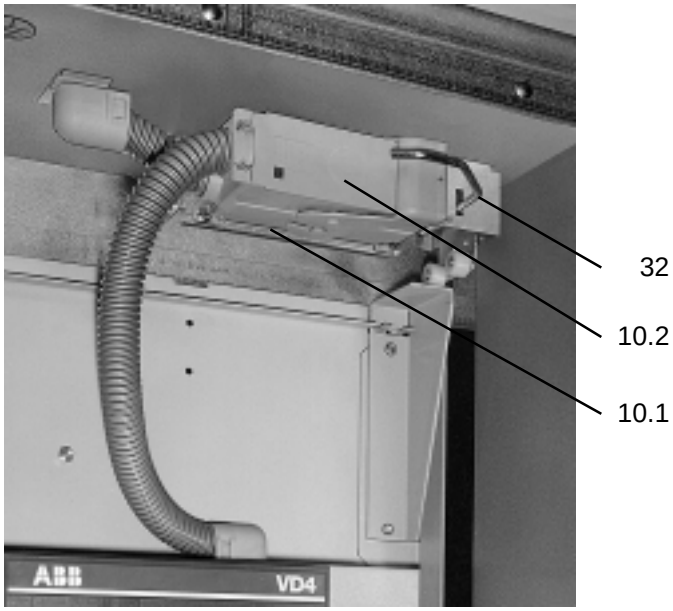



*Figure 6/7: Control wiring plug connector blocked to prevent disconnection with the withdrawable part in the service position*

*10.1 Control wiring socket*
*10.2 Control wiring plug*
*32 Interlock*

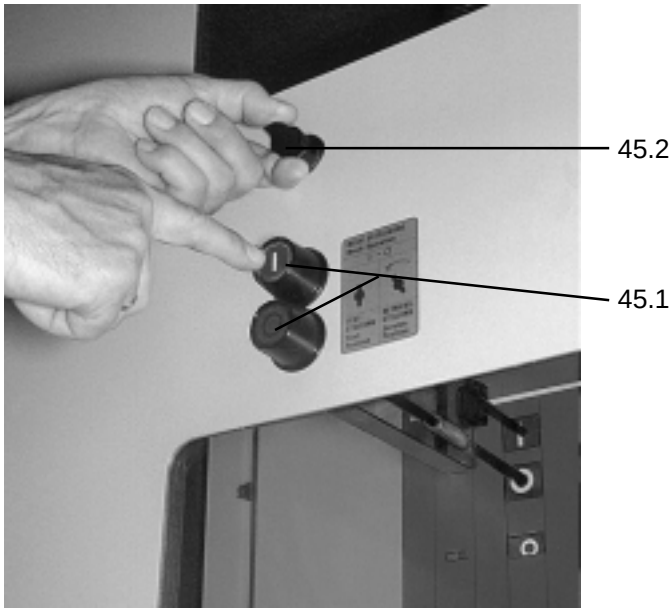



*Figure 6/8: Handling of the mechanical circuit-breaker operation in the switchgear panel door (non-standard equipment) with the withdrawable part in the service position*

*45.1 Mechanical push button*
*45.2 Turning knob*


*Figure 6/9: Service truck engaged with the switchgear panal. Withdrawable part released for withdrawal with the handles slid inwards.*

*13 Withdrawable part*
*13.11 Sliding handle*
*124 Service truck*


*Figure 6/10: Withdrawable part standing on service truck and secured in the catches*

*13 Withdrawable part (with circuit-breaker type VD4)*
*13.11 Sliding handle*
*13.12 Catch (connected to sliding handle)*
*124 Service truck*
*124.1 Height adjuster (for the bench top)*
*124.4 Release lever for catch pin (124.3)*

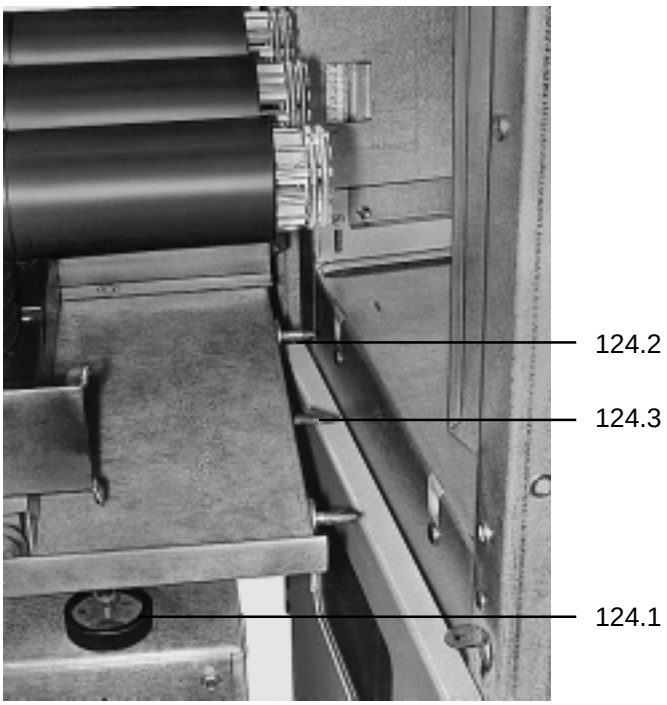



*Figure 6/11: Positioning the servic truck with the guide pins on the adjustable height bench top at the correct height for approach to the swithchgear panel, and engaging the catch*

*124.1 Height adjuster*
*124.2 Guide pin*
*124.3 Catch pin*

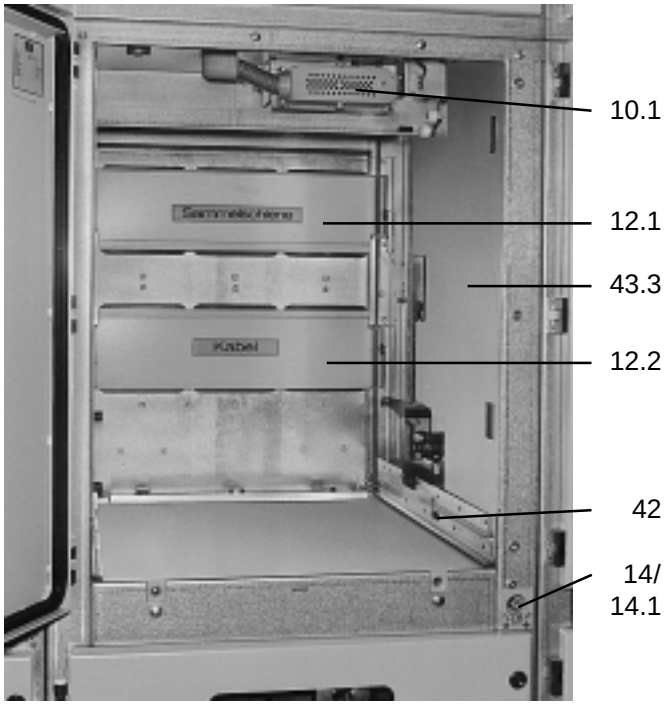



*Figure 6/12: View into the circuit-breaker compartment*

*10.1 Control wiring socket*
*12.1 Top shutter*
*12.2 Lower shutter*
*14 Earthing switch operating mechansim*
*14.1 Drive shaft*
*42 Right-hand travel rail*
*43.3 Duct cover, top right*

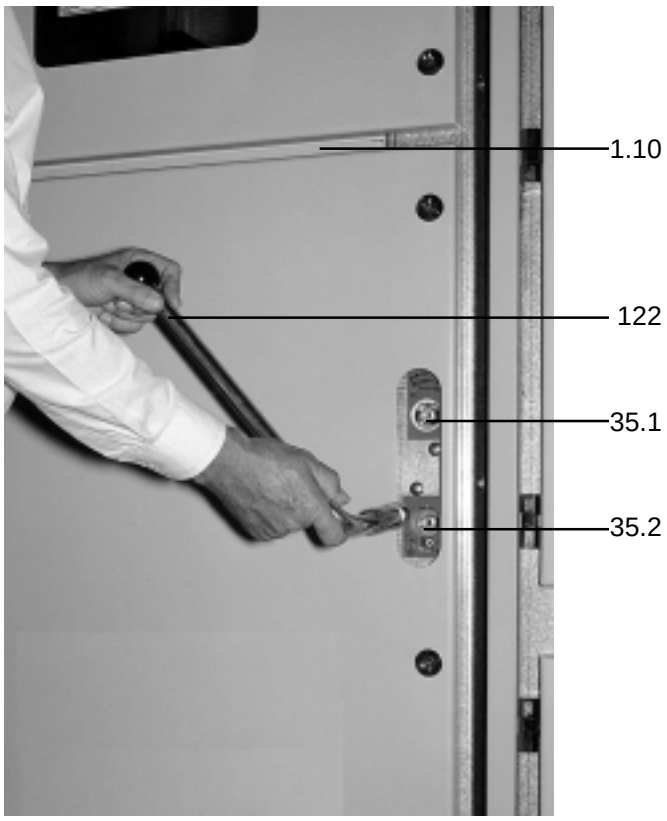



*Figure 6/13: Preparation for operation of a switch disconnector and/ or integrated earthing switch*

*1.10 Slot cover, for insulating guard plate (hinged and sping loaded)*
*35.1 Switch disconnector operating mechanism*
*35.2 Earthing switch operating mechansim*
*122 Operating lever*

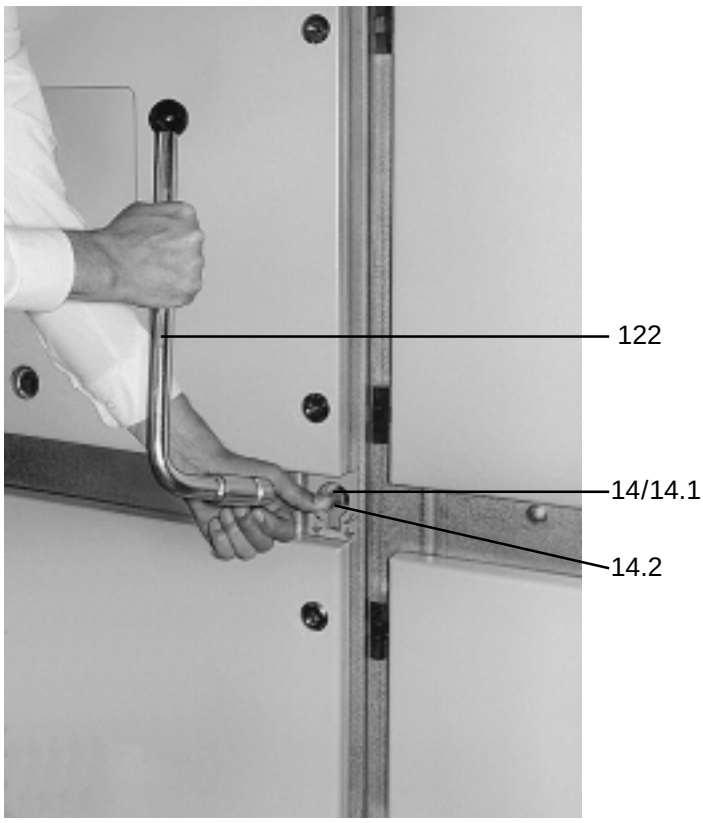



*Figure 6/14: Preparation for operation of the tie-off earthing switch in a circuit-breaker panel*

*14 Earthing switch operathing mechansim*
*14.1 Operating shaft for earhing switch*
*14.2 Slide*
*122 Operating lever*

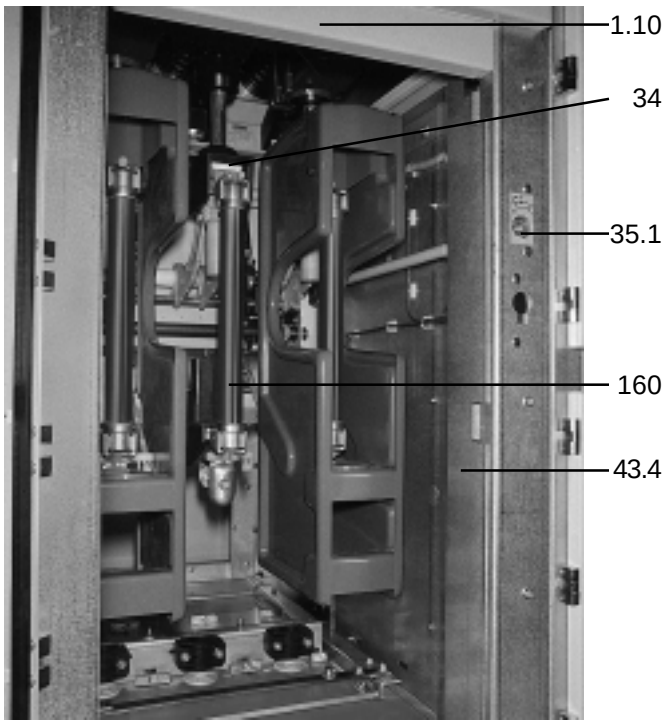



*Figure 6/15: Switchgear panel with switch disconnector and fuse assembly*

*1.10 Slot cover for insulating guard plate*
*34 Switch disconnector*
*35.1 Switch disconnector operating mechansim*
*43.4 Duct cover for internal wiring*
*160 HRC fuses*

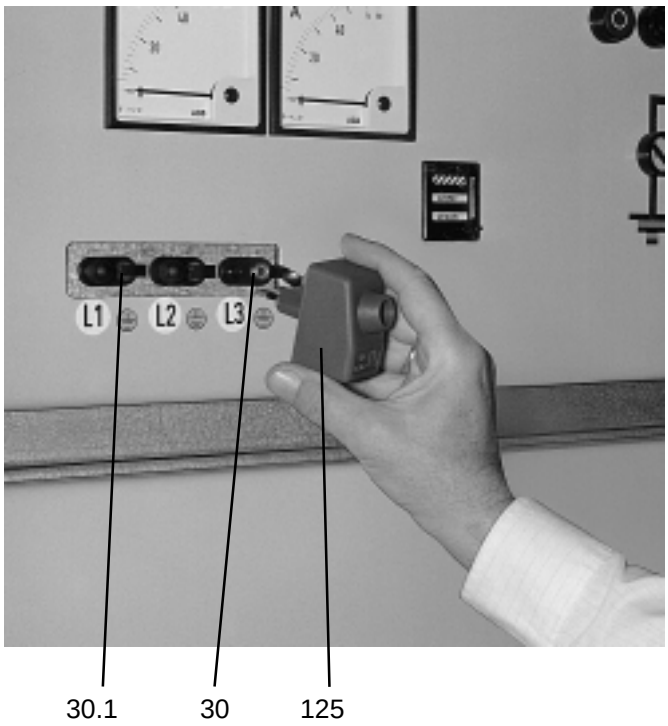



*Figure 6/16: Fitting a (high-impedance) voltage indicator, type DSA2, manufacturer Pfisterer*

*30 Voltage measuring sockets*
*30.1 Protective cover for measuring sockets*
*125 Voltage indicator*

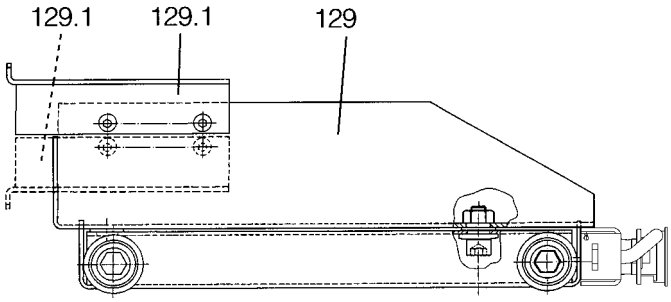



*Figure 6/17: Shutter operating module, side view-actuating bars to be bolted on in the top position (for operation of the bottom shutters) or the buttom position (for operation of the top shutters) as required (example version).*

*129 Shutter operating module*
*129.1 Actuating bars (one pair), removable*

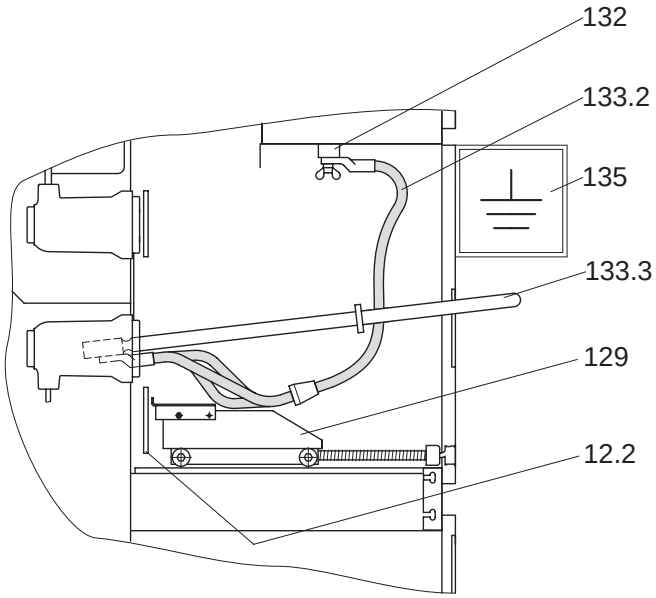



*Figure 6/18: Earthing at the bottom contact pins a 800 mm wide panel*

*12.2 Lower shutter*
*129 Shutter operating module*
*132 Fixed point for earthing, M12*
*133.2 Earthing rope (spider)*
*133.3 Insulated operating rod*
*135 Warning label*

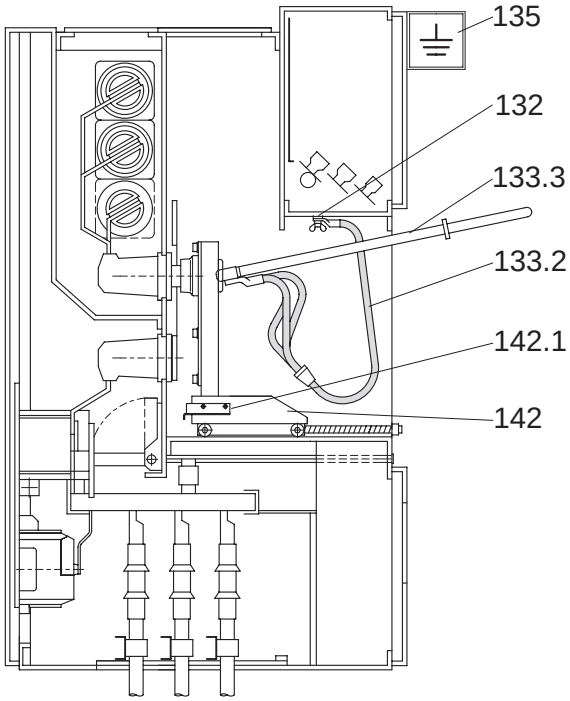



*Figure 6/19: Fitting of an earthing cable set after insertion of a testing and earthing module (example)*

*132 Fixed point for earthing, M12*
*133.2 Earthing rope (spider)*
*133.3 Insulated operating rod*
*135 Warning label*
*142 Testing and earthing module*
*142.1 Actuating bars (one pair)*

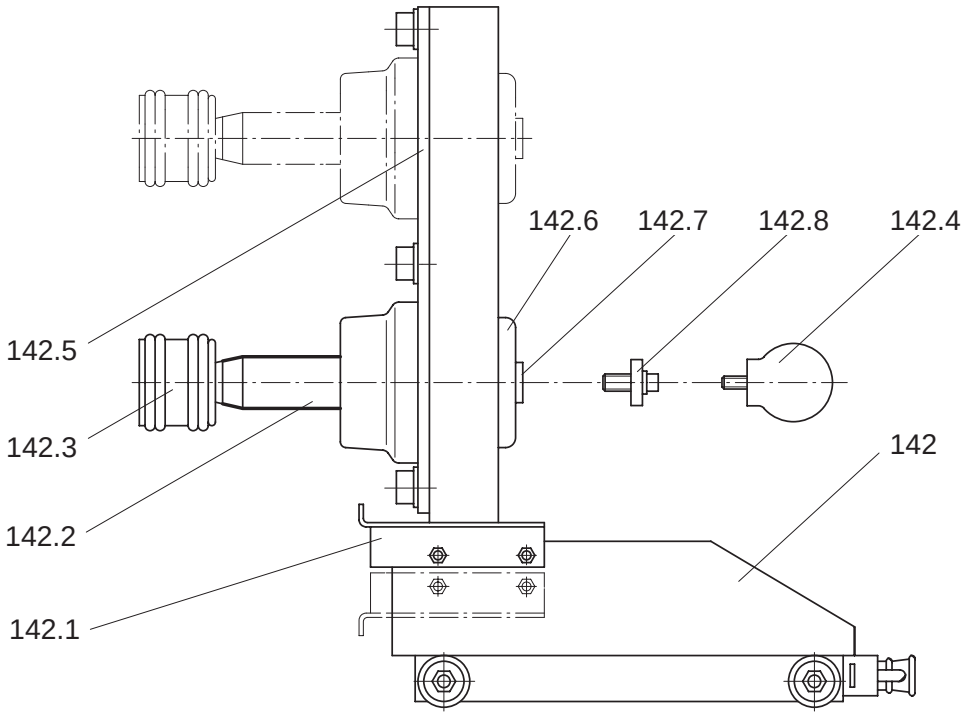



*Figure 6/20: Testing and earthing module with:*

- *Actuating bars, removable*
  - *top position for bottom shutter*
  - *bottom position for top shutter*
- *Contact arms, removeable*
  - *bottom position for cable area*
  - *top position for busbar area*
- *Insulating plate, with alternative mounting positions for cable or busbar earthing (turn through 180° for busbar earthing)*
- *Contact systems, replaceable for different contact pin diameters on the switchgear*
- *Ball handels, removable, for voltage tests*
- *Short-circuiting link, replaceable by ball handles*

*142 Testing and earthing module*
*142.1 Actuating bars (1 Pair)*
*142.2 Contact arms (3 pcs.)*
*142.3 Contact systems*
*142.4 Ballhandels (3 pcs.)*
*142.5 Insulating plate with 3 removeable bushings*
*142.6 Bushing*
*142.7 Contact pin*
*142.8 Short-circuiting link, complete*

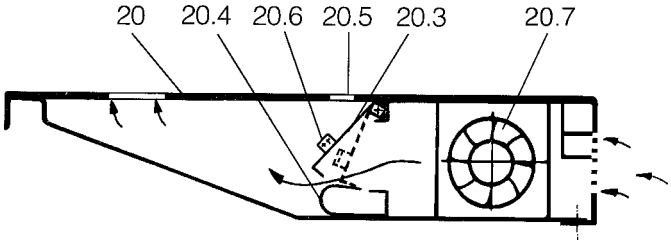



*Figure 6/21: Fitting of the horizontal partition 20 with additional ventilation for high current circuit-breakers required due to increased ambient temperature ( > 40 °C ) and/or increased frequency ( 60 Hz ) according to section 1.3. The internal flap is shown in the service position (open !). Side view, but without the wind vane with microswitch required with a fan. No Standard.*

*20 Horizontal partition, here fitted with additional ventilation facilities for the circuit-breaker*
*20.3 Flap*
*20.4 Leaf spring*
*20.5 Inspection opening*
*20.6 Bracket*
*20.7 Centrifugal fan*

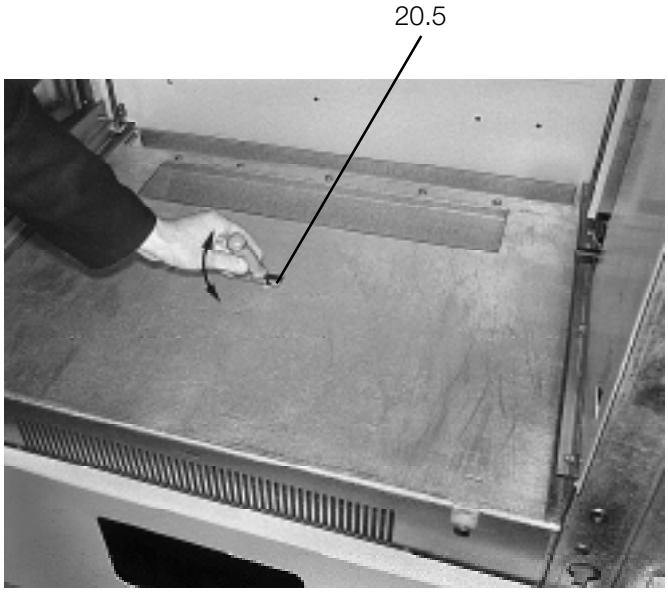



*Figure 6/22: Horizontal partition with additional ventilation facilities checking of unimpeded motion of the internal flap (20.3)*

*20.5 Inspection opening*

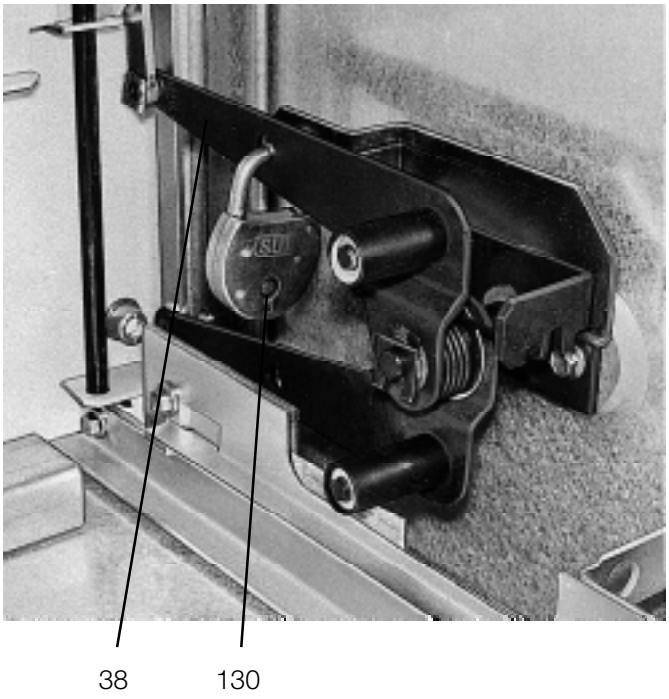



*Figure 6/23: Lower shutter secured with padlock to prevent unauthorized operation*

*38 Lever for shutter operation*
*130 Padlock (customer component)*

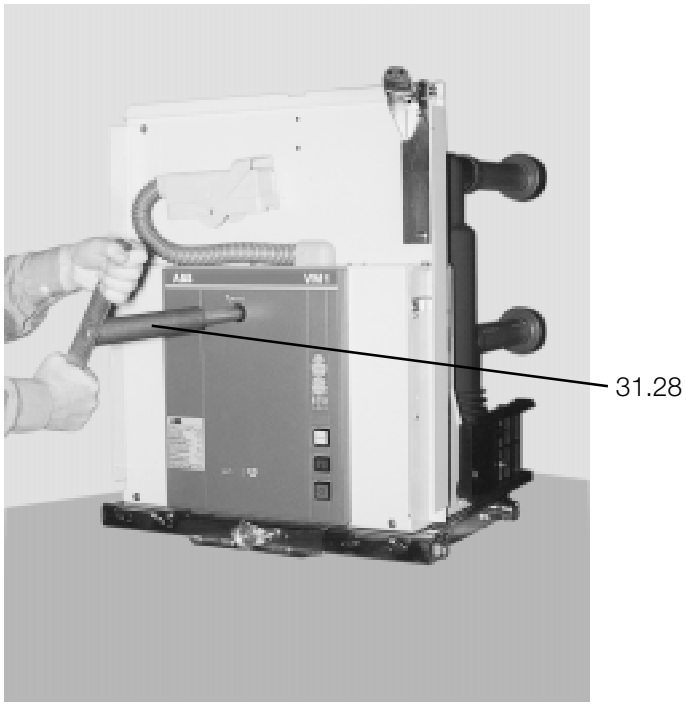



*Figure 6/24: Manual emergency – OFF operation of the VM1 vacuum circuit-breaker with magnetic actuator*

*31.28 Emergency manual opening lever (for switching off circuit-breaker, type VM1)*

Note:
On the operation with the emergency operation lever 31.28 there has to overcome a mechanical resistance after the tension of the auxiliary spring 31.29 and at the end of the turning motion.

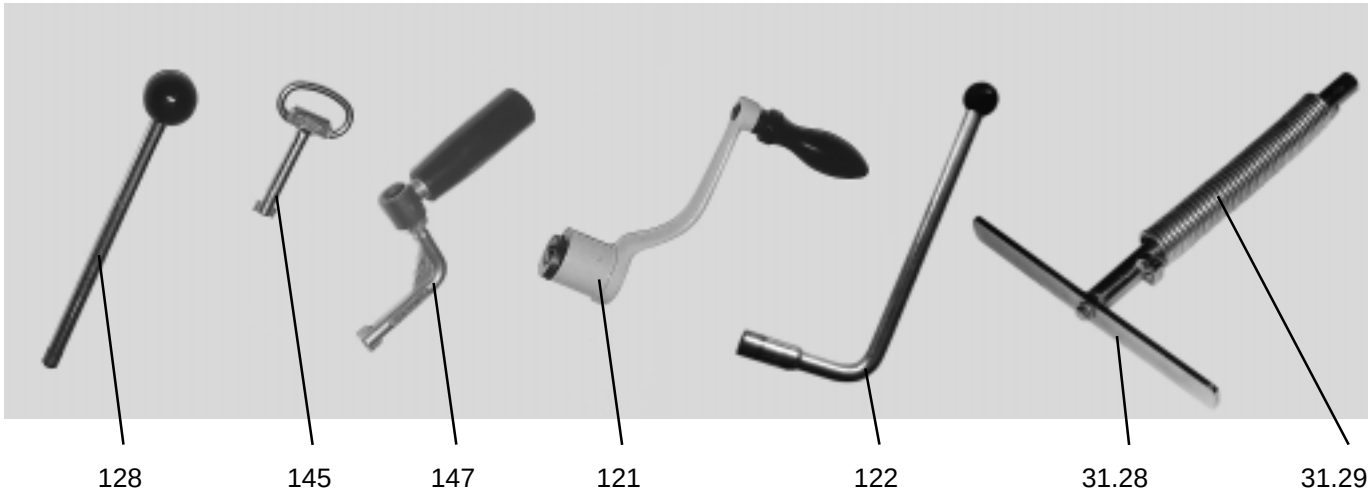



*Figure 6/25: Operating accessories*

*31.28 Emergency manual opening lever (for switching off circuit-breaker, type VM1)*
*31.29 Auxiliary spring to secure the opening capacity (for circuit-breaker, type VM1)*
*121 Hand crank (for moving the withdrawable part inside the panel)*
*122 Operating lever (for earthing switch)*
*128 Charging lever (for circuit-breaker, type VD4)*
*145 Double bit key (for using the central catch and screw type door catch)*
*147 Hand crank (for using the central catch or screw type door catch)*

# 7 Maintenance

## 7.1 General

Maintenance serves to preserve trouble-free operation and achieve the longest possible working life of the switchgear. In accordance with DIN 31 051, it comprises the following closely related activities:

Inspection: Determination of the actual condition

Servicing: Measures to preserve the specified condition

Repair: Measures to restore the specified condition

Note:

When carrying out all maintenance work, the regulations in the country of installation must be strictly complied with. In Germany these comprise the following safety regulations and standards:

– Health and safety at work standard VBG 1

– Health and safety at work standard VBG 4

– VDE 0105 "Operation of electrical installations"

Maintenance work may only be performed in a careful manner by trained personnel familiar with the characteristics the individual switchgear, in accordance with all relevant safety regulations to VDE/IEC and of other technical authorities, and with other overriding instructions. It is recommended that ABB service personnel be called in to perform servicing and repair work detailed below.

The inspection and servicing intervals for some of the equipment/components (e.g. parts subjects to wear) are determined by fixed criteria such as switching frequency, length of service and number of short-circuit breaking operations. For other parts, on the other hand, the length of the intervals may depend, for example, on the different modes of operation in individual cases, the degree of loading, and also environmental influences (including pollution and aggressive air).

The following operating instructions must also be observed together with this instruction manual in the individual cases concerned:

| | |
|---|---|
| Vacuum circuit-breaker<br>Type VD4 | BA 352E |
| Vacuum circuit-breaker<br>Type VD4E | BA 377E |
| Vacuum circuit-breaker<br>Type VD4- high-current | BA 359E |
| Vacuum circuit-breaker with<br>magnetic actuator mechanism<br>Typ VM1 | BA 433E |
| Earthing switch<br>Type EK6 | BA 304E |
| Rod-type switch disconnector<br>Type C3 | BA 275E |

If necessary, further details can be taken from the technical documentation for the switchgear installation (including, for example, any agreed special operating conditions).

## 7.2 Inspection

- Before inspection, where required, the working area must be isolated and secured against reconnection in accordance with the “Safety Regulations” specified by DIN VDE/IEC.
- Proper condition of the switchgear should be monitored by regular inspections.
- Under normal operating conditions, inspection should be conducted once every four years by specially trained professional electricians.
- Under unusual operating conditions (including adverse climatic conditions) and/or peculiar environmental stresses (among other strong pollution and aggressive atmosphere), inspection may be necessary at shorter intervals.
- Inspection is primarily to constitute a visual check for grime, corrosion and moisture:
  - Effects of high temperature on the main circuits,
  - Traces of partial discharge on the insulating material parts,
  - Traces of leakage current on the insulating material parts,
  - Surfaces of the contact systems.
- However, inspection is also to include the proper mechanical/electrical function of the following facilities: switching devices, actuating, interlocking, protection and signalling facilities.

Special conditions:

- On panels with additional ventilation devices due to increased ambient temperature (see also section 1.3):

  1. Check flap 20.3 for correct function. (See also section 6.1.1 and figures 6/21 and 6/22.)
  2. The centrifugal fan (if fitted) doesn’t require any special maintenance. Its working life, depending on the service conditions - one significant parameter being the room temperature - is approx. 20,000 to 30,000 operating hours.

     Checking of the readiness for operation can be carried out as follows:

     a) Load-dependent functional test with controllable primary current injection of the relevant instrument transformer. At current rise:

1. to approx. 70% of the rated instrument transformer current, the fan must start,

and

2. to 80 % of the rated instrument transformer current, the fan must have reached the required minimum air flow. Corresponding monitoring/signalling by the wind vane with microswitch.

b) Basic checking with temporary operation of the centrifugal fan with an external power supply of 220 V AC.

c) In both cases, check for unimpeded normal running of the fan and listen for any unusual bearing noise. Remove any dirt on the fan rotor.

d) Check the unimpeded function of the wind vane and microswitch by starting the fan several times.

e) The wiring to the removable horizontal partition 20 can be disconnected behind the right-hand side duct cover 43.4 (figure 5/12). Observe the circuit diagram and carefully reconnect the wiring on completion.


Caution: instrument transformer circuit.

- With regard to the switching devices, their separate Instruction manual should be observed.
- Check all switchgear accessories and auxiliary facilities (e.g. storage batteries).
- No external discharge may occur on the surfaces of equipment at operating voltage. This can, for example, be detected by characteristic noises, a clearly perceptible smell of ozone, or visible glowing in the dark.
- Visual checking of the contact system. We recommend to turn alternately the contact system in order to clean the inner contact points of the contact system.

  The contact points should be cleaned if signs of unperminable overheating (discoloured surface) are visible (see section 7.4).
- If irregular conditions are detected, then corresponding repair measures should be initiated.

## 7.3 Servicing

If, on the occasion of an inspection in accordance with section 7.2, the necessity of cleaning measures has been established, proceed as follows:

- Before cleaning, where required, the working area must be switched off and secured against reconnection in accordance with the “Safety Regulations” specified by DIN VDE/IEC.
- Cleaning the surfaces in general:
  - Weakly adhering dry dust deposits with a soft dry cloth.
  - More strongly adhering grime with mildly alkaline household cleanser or with Rivolta BWR 210.
- Cleaning insulating surfaces and conductive components:
  - Minor pollution with Rivolta BWR 210.
  - Strongly adhering pollution with Cold cleanser 716.
- Observe the manufacturers’ directions and in particular ABB Instruction manual BA 1002/E and BA 1006/E on safety at work.
- Wipe down after cleaning, using clean water, and dry properly.
- Should external discharges occur as a result of condensation, application of a thin silicone film on the surface concerned is often effective as a temporary remedy. It is advisable to request advice from the ABB after-sales service department on permanent solutions to such unusual problems.

## 7.4 Repair

### 7.4.1 Switchgear in general

Repair of surface damage:

- Carry out repair work immediately after a defect has been discovered.
- Completely remove all rust from damaged paintwork areas on steel sheet and other steel parts by mechanical means, e.g. with a wire brush.
- Lightly grind the surrounding paint coat and carefully degrease the entire area. Then immediately apply an anti-rust primer and, after an appropriate hardening time, apply the top coat. Only use suitable and compatible paint products.

  Apply the top coat in standard colour RAL 7035, or the relevant special colour.
- Carefully remove any white rust on aluminium/zinc surfaces with a wire brush or cleaning pad, e.g. Scotch-Brite, and clean loosely adhering particles with a dry, non-fraying cloth. Next treat the cleaned parts with zinc spray or zinc dust paint and, finally, treat with aluminium spray for colour matching.
- Carefully remove any white rust from passivated functioning parts and rust formation on phosphatised parts with a wire brush or metal-free cleaning pad, e.g. Scotch-Brite, and clean with a dry cloth. Then grease evenly (with Isoflex Topas NB 52).

Switchgear in general:

- Observe the maintenance instructions in the manuals for the individual equipment components.
- Check that the bolt connections at the contact points in the busbar system and the earth connections are tight, and that the contact system functions correctly.
- Where required, regrease or thoroughly clean slide plates and bearings in the panel and regrease them with Isoflex NB 52 lubricant.
- Top up grease on contact areas in the contact system when corroded or otherwise as necessary, or, when lubrication is inadequate or missing, thoroughly clean the areas concerned and regrease with Isoflex Topas NB 52 lubricant.
- Remove the contact system for thoroughly cleaning as described below (Figures 7/1 to 7/3):
  - Slide the two inner annular tension springs 4.4 facing the breaker pole to a position beside the other two outer annual tension springs, thus releasing contact system 4.3, and remove the contact system from contact arm 4.2.
  - The contact pin of the contact system and the slot on the contact arm are to be cleaned and greased.. Fit contact system back to front on the thin end of arbor 127 or 127.2, and slide it forwards onto the thicker part of the shank.
  - Fit arbor 127 or 127.2 onto the relevant contact arm 4.2, slide the contact system 4.3 over onto the contact arm, and withdraw the arbor.
  - Check all contact fingers and annular tension springs for perfect fit.

Note:

The set installation position of contact arms 4.2 must not be changed by the improper use of force.

Replacement of the contact pins when the surface is damaged:

(Figure 3/9)

After any required replacement of contact pins 4.1, the latter should be retightened using the socket head bolts.

| Thread | Rated tightening torque ungreased |
|---|---|
| M 10 | 46 Nm |
| M 20 | 250 Nm |

7.4.2 Replacement of complex functional groups

(Figures 3/3, 3/20, 7/4 to 7/14)

The precise matching of functions for control, interlocking and signalling only permits the replacement of individual components to a limited extent.

The following assemblies are prefabricated and tested at the works, maintaining high quality standards. In the case of faults, they are therefore to be completely replaced.

1. Withdrawable assembly with circuit-breaker type VD4:
   - Disconnect plug connector 10.3,
   - Remove interlock rod 13.91 with pin 13.27 from the withdrawable assembly.
   - For motor-operated withdrawable assemblies, remove the two socket head bolts (M4) which are accessible from below the assembly.
   - Remove the circuit-breaker from the withdrawable assembly (4 x M12 bolts).
   - Mount the circuit-breaker on a new withdrawable assembly in the reverse order, using new circlip and special pliers for pin 13.27.
   - Check the setting of interlocking rod 13.91:
     - Turn spindle 18 anti-clockwise to the stop for the disconnected position:

       The distance between lever 13.26 and cam 13.25 must be $2^{+1}$ mm.

       The distance between roller 13.24 and angle lever 13.92 must be 0.5 mm.
     - Turn spindle 18 clockwise to the stop for the service position:

       The distance between lever 13.26 and cam 13.25 must be $2^{+1}$ mm.

       The distance between roller 13.24 and angle lever 13.92 must be 0.5 mm.
     - Loosen bolts 13.91.2 or 13.92.1 for any necessary adjustment.
2. Motor-operated mechanism for the earthing switch:
   - Disconnect the terminals.
   - Loosen the grub-screw in the set collars.
   - Withdraw operating shaft 14.1.

     Observe the position of blocking disc 14.6 relative to cam 14.7!
   - Replace the motor-operated mechanism.
   - Slide the operating shaft through from the front.

Observe the position of blocking disc 14.6 relative to cam 14.7!

- Tighten the grub-screw in the set collars.
- Connect the control wiring.
- Set the operating mechanism manually in an intermediate position and only then perform a test run to determine the direction of rotation.

  Ensure that the motor shuts down correctly in the final positions!

Note:

The auxiliary switches of the interchangeable groups are adjusted at works.

When the final installation of the earthing switch and drive takes place on site, it may be necessary to undertake a further exact adjustment of the auxiliary switch. In this case, the following should be taken into account:

- There must be a run-on of 0.5 mm in the fully operated position before the plunger reaches the stop (for safety reasons).
- Limit auxiliary switch 11.4 for earthing switch ON must be operated immediately after the dead centre position of the toggle spring mechanism is reached in the closing process and the automatic quick-closing process has started.
- Limit auxiliary switch 11.3 for earthing switch OFF must

  a) be operated on earthing switches with manual mechanisms during the opening motion of the slide 14.2 before half of the hexagon shaft has become visible, or 1 mm before the tongue of the slide makes contact with the armature of the unexcited blocking magnet.

  b) be operated on earthing switches with motor-operated mechanisms (no slide 14.2 then fitted) immediately after the toggle spring mechanism has passed the dead centre position during rotation to the OFF position.

## 7.5 Testing withdrawable parts with a VD4 type circuit-breaker

(Figures 7/4 to 7/7)

When functional tests are carried out on withdrawable parts, compliance with the conditions listed below should also be checked.

### 7.5.1 Motor-driven withdrawable parts

(not standard)

Carry out testing of motor-driven withdrawable parts in the same way as for manually operated withdrawable part:

- Switch off the auxiliary power (m.c.b.), since the motor could otherwise be braked electrically.
- Turn hand crank 121 in the required direction.
- Ensure that the spindle nut is correctly lubricated.

Note:

When the withdrawable part moves, the motor turns. The motor functions in such a case like a generator, i.e. it can lead to reverse voltages in the terminals.

### 7.5.2 Checking the correctness of dimensional settings

(Figures 7/5, 7/13, 7/14)

1. The distance between lever 13.26 operated by link rod 13.91 and plastic cam 13.25 should be **$2^{+1}$ mm**.

   If adjustment is required, loose the two bolts 13.91.1 and 13.91.2. Deviations from the specified value can have the following effects:

   - Dimensions too large, blocking system for the drive spindle deactivated.
   - Dimensions too small, proper action of the electrical interlock no longer guaranteed.

2. The distance between roller 13.24 and angle lever 13.92 should be **0.5 mm** when the circuit-breaker is closed.

   If adjustment is required, loose the two bolts 13.91.2 and 13.92.1.

### 7.5.3 Checking auxiliary switch settings on withdrawable parts

(Figures 3/20, 7/5, 7/7)

Compliance with the interlock conditions in the test/disconnected and service position areas is ensured by position signalling switches S8 and S9 located in the withdrawable assembly and factory-set.

In test operations, the withdrawable part must be moved by hand with the crank fitted with the motor power switched off.

1. Settings in the area of the test/disconnected position:

   - Move the withdrawable part out of the test/ disconnected position towards the service position with a few turns of the crank.
   - Slowly move the withdrawable part back to the stop.

     Auxiliary switch S8 must then switch over just before the stop is reached.

   - Slowly insert the withdrawable part from the test/disconnected position towards the

service position until auxiliary switch S8 just operates.

In this position, it must still just be possible to move closing push rod 13.2.1. For this test, the function of the blocking magnet Y0 must be deactivated manually.

This condition ensures that the electrical interlock takes effect before the mechanical interlock in the motion sequence involved.

2. Settings in the area of the service position:

   - Move the withdrawable part out of the limit position towards the test/disconnected position with a few turns of the crank.
   - Slowly move the withdrawable part forwards again to the stop.

     Auxiliary switch S9 must then switch over just before the stop is reached.

7.5.4 Checking the direction of rotation of the travel motors on motor-driven withdrawable parts

- Move the withdrawable part by hand into a central position between the test/disconnected position and the service position.
- Remove the hand crank.
- Switch the auxiliary voltage for the travel motor on.
- Use the local electrical controls to check that the withdrawable part moves in the correct direction.

Caution:

Do not allow the withdrawable part to run up against a block when the travel direction is incorrect! Switch the motor power off immediately (the travel process functions electrically by a seal-in system with limit position switch-off).

There may be a danger of injury when the door is open!

7.5.5 Testing of interlock conditions

(Figures 3/7, 3/20, 6/5 to 6/7, 7/7, 7/10)

1. The withdrawable part must only be movable from the test/disconnected position into the service position when the circuit-breaker is open and the earthing switch is open.

   Check the following conditions individually:

   - With the circuit-breaker closed, insertion of the withdrawable part towards the service position must be blocked after only half a turn of the crank in the clockwise direction, and the travel motor on motor-operated withdrawable parts must not be capable of being switched on.
   - With the earthing switch closed, insertion of the withdrawable part towards the service position must be blocked after only two clockwise turns of the crank, and the travel motor on motor-operated parts must not be capable of being switched on.

     Use no force!

2. The withdrawable part must only be movable from the service position into the test/ disconnected position with the circuit-breaker open.

   Check this condition as follows:

   - With the circuit-breaker closed, withdrawal movement of the withdrawable part must be blocked after only half a turn of the crank in anti-clockwise direction, and the travel motor on motor-operated withdrawable parts must not be capable of being switched on.

3. Closing of the circuit-breaker must only be possible when the withdrawable part is in the defined test/disconnected position or service position.

   The control wiring plug 10.2 must previously have been inserted.

   Check this condition as follows:

   - It must not be possible to close the circuit-breaker with the withdrawable part in any position between the test/disconnected position and the service position.

     Enabling of switching when the withdrawable part moves into the service position is effected electrically by operation of auxiliary switch S9 in the withdrawable assembly, and mechanically slightly earlier; the latter corresponds to a position approximately half a turn of the crank before stop.

   - For motion into the test/disconnected position, the same enabling conditions apply analogously, in this case by means of auxiliary switch S8 in the withdrawably assembly.

4. It must only be possible to open the circuit-breaker (manually) when the withdrawable part is in the service position or test/disconnected position and the control voltage has failed.

   Check this condition.

5. Withdrawable parts with order-related blocking magnet Y0 may not be moved in case of control power failure, or when there is no control power. Do not forcibly move blocked withdrawable parts! The blocking magnet Y0 is only present on manually operated withdrawable parts.

   Releasing the blocking magnet Y0:

   - Remove front plate 13.17,
   - Disengage blocking magnet Y0 by pulling the magnet armature,

- While doing so, turn crank 121 about one half turn (either direction of rotation is permissible).

  The blocking magnet is only active in the test position and service position. In intermediate positions it has no effect.

6. Disconnection of the control wiring plug 10.2 as well as later insertion must be blocked in the withdrawable part's service position.

   Check this condition:

7. Operation of the earthing switch must only be possible when withdrawable part 13 is in the test/disconnected position or the removed position (subject to any additional electro-magnetic interlocks in individual cases!).

   Check this condition:

   - With the withdrawable part in the test/ disconnected position, it must be possible to press slide 14.2 in front of the earthing switch operating shaft 14.1 downwards to the opening position. The earthing switch can then be operated.
   - With the slide pressed down, it must also be impossible to start the travel motor on motor-driven withdrawable parts.
   - If the slide is pressed down slightly when the travel motor is running, the motor must then automatically switch off immediately.

     The selected travel direction is continued by pressing the button.

     It is only possible to press slide 14.2 down fully with a running travel motor when the latter is in the start-up phase.
   - When the withdrawable part is moved inwards towards the service position, pressing down of the slide 14.2 must be blocked after only one and a half clockwise turns on the crank.

## 7.6 Tests on the panel

### 7.6.1 Auxiliary switch settings on the earthing switch

(Figures 7/10, 7/11)

1. There must be a run-on of **0.5 mm** in the fully operated position before the plunger reaches the stop (for safety reasons).
2. Limit auxiliary switch 11.4 (Q8S2) for earthing switch ON must be operated immediately after the dead centre position of the toggle spring mechanism is reached in the closing process and the automatic quick-closing process has started.
3. Limit auxiliary switch 11.3 (Q8S1) for earthing switch OFF must
   a) be operated on earthing switches with manual mechanisms during the opening motion of the slide 14.2 before half of the hexagon shaft has become visible, or **1 mm** before the tongue of the slide makes contact with the armature of the unexcited blocking magnet.
   b) be operated on earthing switches with motor-operated mechanisms (no slide 14.2 then fitted) immediately after the toggle spring mechanism has passed the dead centre position during rotation to the OFF position.

Note:

Check the direction of rotation of the motor after repair work.

Do not allow the motor to run up against a block if the direction of rotation is incorrect (see also section 7.5.4).

## 7.7 Spare parts, auxiliary materials, lubricants

### 7.7.1 Spare parts

A spare parts list is available on request for procurement of spare parts. It fundamentally comprises moving parts and parts subject to wear. When parts are required, the serial number of the relevant switchgear or switching device should always be quoted.

### 7.7.2 Auxiliary materials, lubricants

| | Part no. (order ref.) |
|---|---|
| Lubricant: | |
| • Isoflex Topas NB 52 | GCE0007249P0100 |
| Halogen-free cleansers: | |
| • Rivolta BWR 210 (for general cleaning) | GCE0007707P0100 |
| Corresponding ABB operating instructions BA 1002/E | GCEA901002P0102 |
| • Cold cleanser 716 (for use with conductive components, components of insulating materials and in case of serious grime!) | GCE0007706P0100 |
| Corresponding ABB operating instructions BA 1006/E | GCEA901006P0102 |
| Touch-up paint: | |
| Standard colour RAL 7035 | |
| • 1kg-box | GCE9014060R0103 |
| • Spray tin | GCE0007895P0100 |

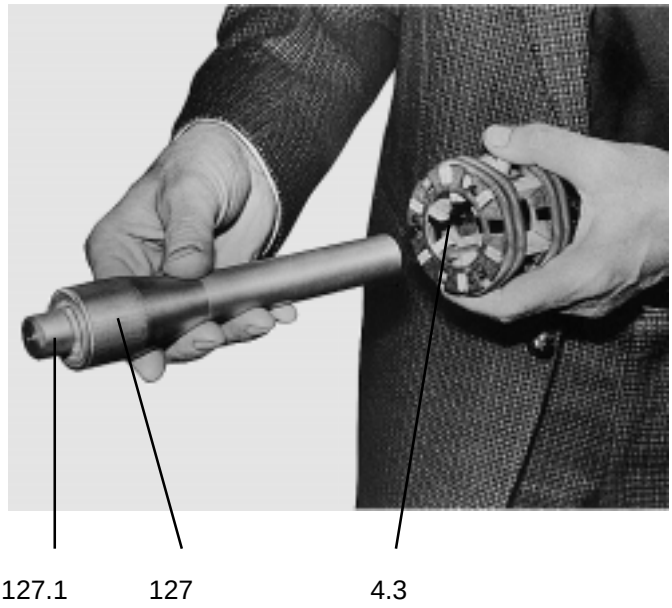



*Figure 7/1: Fit the contact system back-to-front on the thin end of the arbor an slide it onto the thicker shank area*

*4.3 Contact system*
*127 Arbor*
*127.1 Journal*

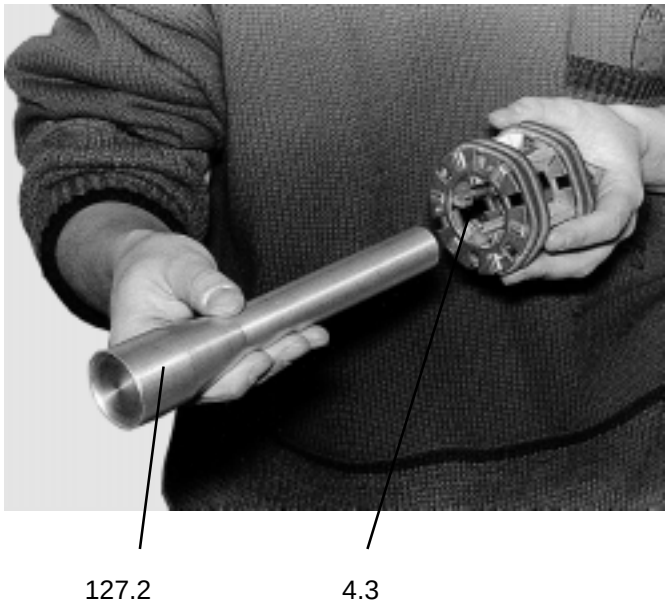



*Figure 7/2: Preparation for assembly of the VD4E contact system. Handling as described in figure 7/1*

*4.3 Contact system*
*127.2 Arbor for VD4E*

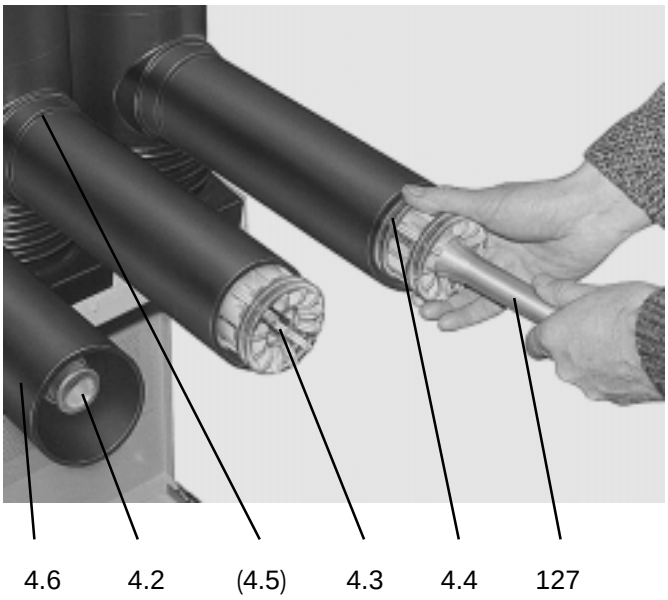



*Figure 7/3: Slide the contact system over from the arbor onto the isolating contact arm and allow it to engage there*

*4.2 Contact arm*
*4.3 Contact system*
*4.4 Internal tension springs*
*4.5 Hexagon socket head screw*
*4.6 Insulating sleeve*
*127 Arbor*

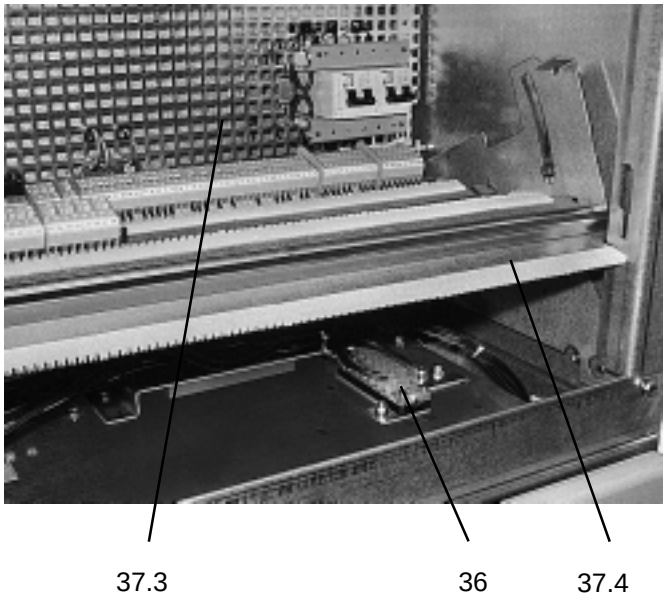



*Figure 7/4: Control cabinet, terminal-strip holder swung upwards*

*36 2 or 5 pole auxiliary switch (S2), optional (operated by the control wiring plug 10.2)*
*37.3 Perforated metal sheet*
*37.4 Terminal strip holder*

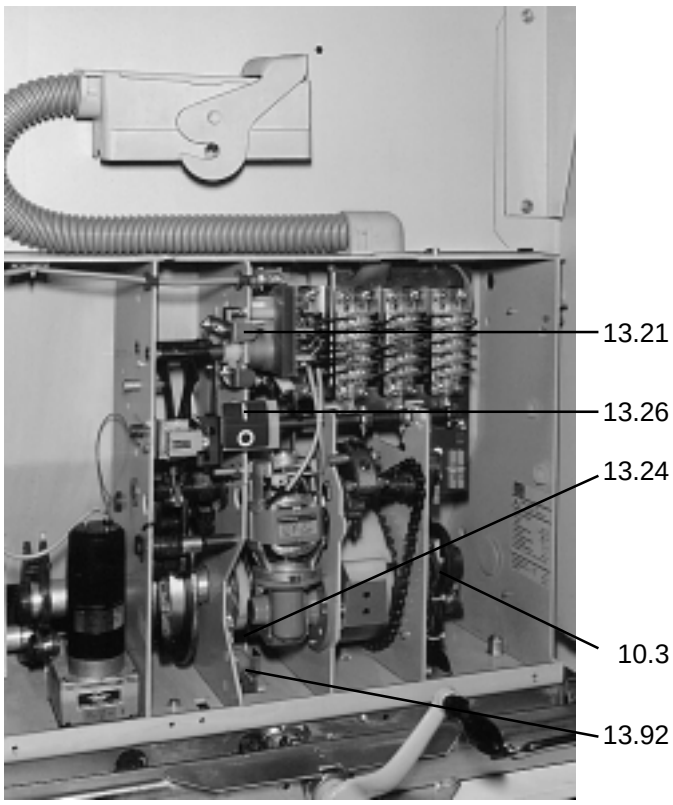



*Figure 7/5: Motorized withdrawable part with circuit-breaker type VD4 in an intermediate position close to the test/disconnected position, with fitted crank for manual operation and breaker front panel removed*

*10.3 Control wiring plug connector for withdrawable assembly*
*13.2.1 ON push rod*
*13.24 Roller*
*13.26 Lever*
*13.92 Angle lever*

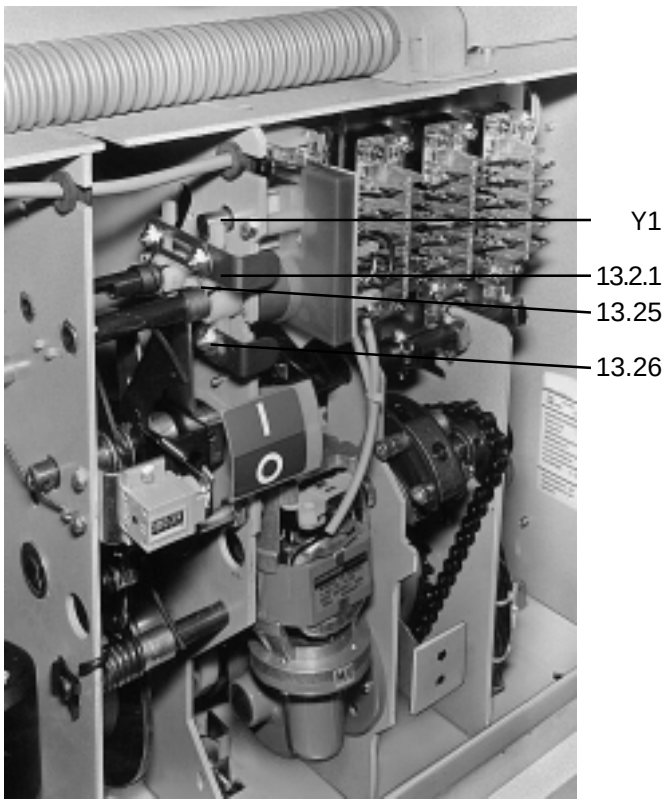



*Figure 7/6: Detailed view of the opening and closing mechanism (circuit-breaker type VD4)*

*13.2.1 ON push rod*
*13.25 Plastic cam*
*13.26 Lever*
*Y1 Blocking magnet*


*Figure 7/7: Manually moveable withdrawable part, front panel removed.*

*Y0 Blocking magnet*

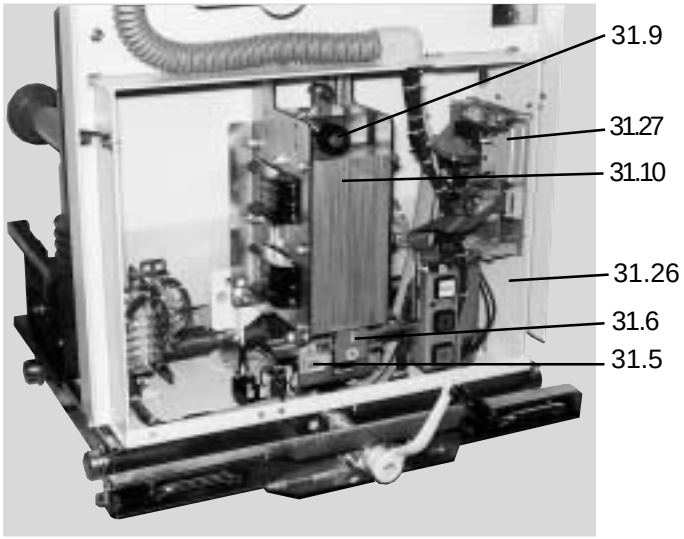



*Figure 7/8: View of the magnetic actuator mechanism with auxiliary systems, front plate removed (circuit-breaker, type VM1)*

*31.5 Mechanical operating cycle counter*
*31.6 Mechanical switch position indicator*
*31.9 Catch for emergency manual operation lever*
*31.10 Actuator*
*31.26 Storage capacitor*
*31.27 Circuit-breaker control unit*

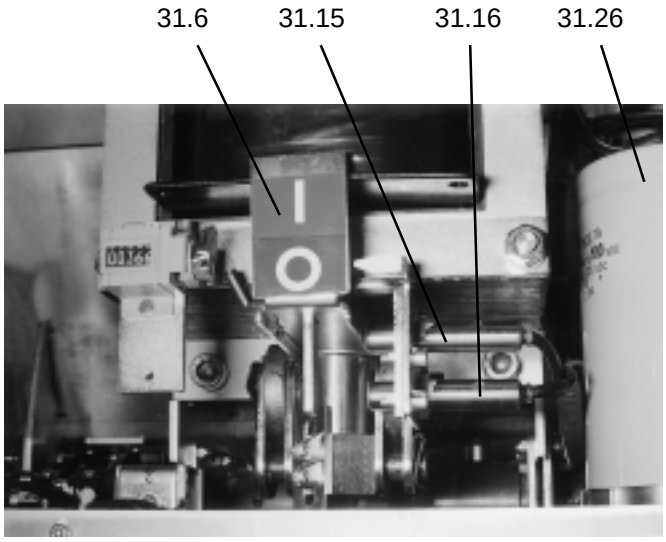



*Figure 7/9: Circuit-breaker, type VM1, switch position indicator*

*31.6 Mechanical switch position indicator*
*31.15 Sensor for VM1 circuit-breaker OFF signal*
*31.16 Sensor for VM1 circuit-breaker ON signal*
*31.26 Storage capacitor*

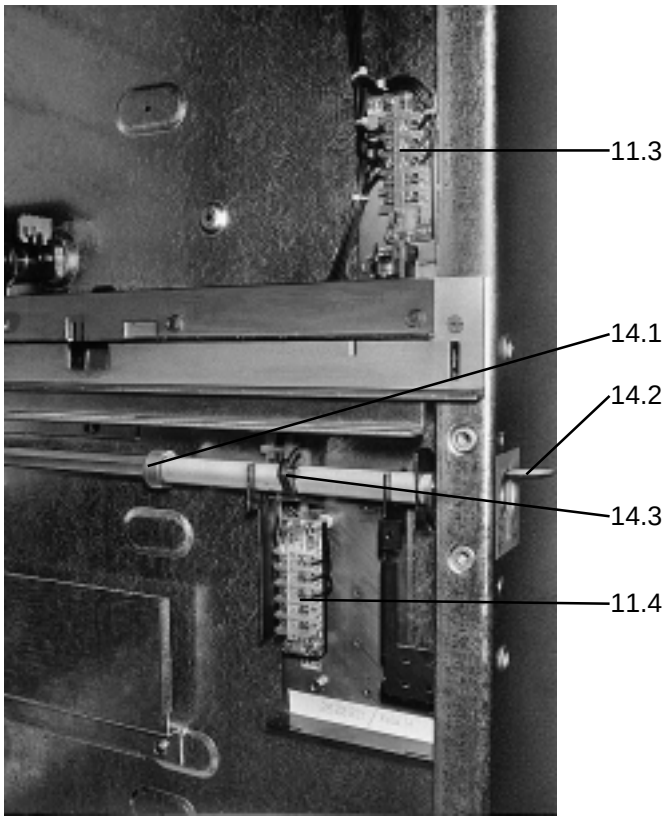



*Figure 7/10: Manual earthing switch mechanism with auxiliary switches, side cover removed*

*11.3 Auxiliary switch Q8S1 earthing switch OFF*
*11.4 Auxiliary switch Q8S2 earthing switch ON*
*14.1 Drive shaft (earthing switch)*
*14.2 Slide*
*14.3 Cam plate, adjustable*

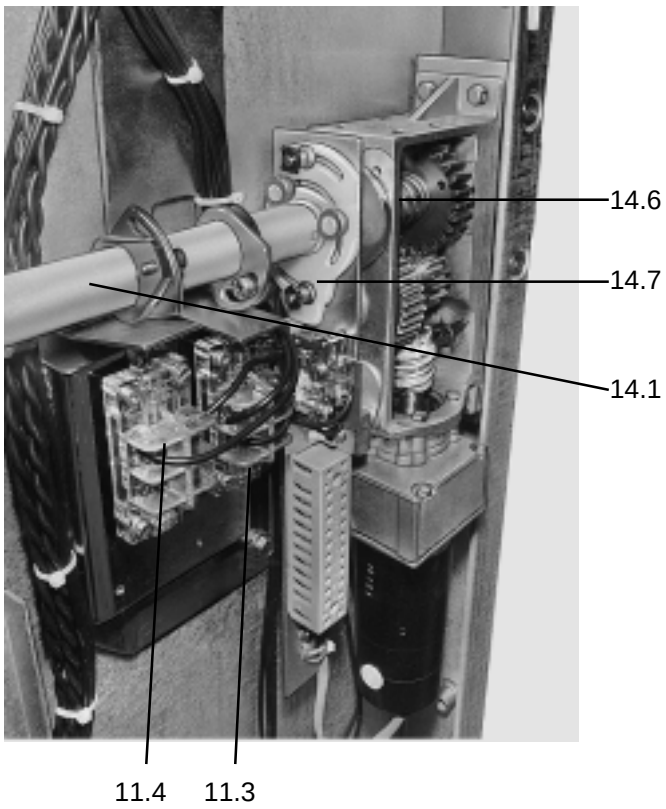



*Figure 7/11: Motorized earthing switch mechanism with auxiliary switches as installed, covers removed*

*11.3 Auxiliary switch Q8S1, earthing switch OFF*
*11.4 Auxiliary switch Q8S2, earthing switch ON*
*14.1 Operating shaft for earthing switch*
*14.6 Blocking disk*
*14.7 Cam*

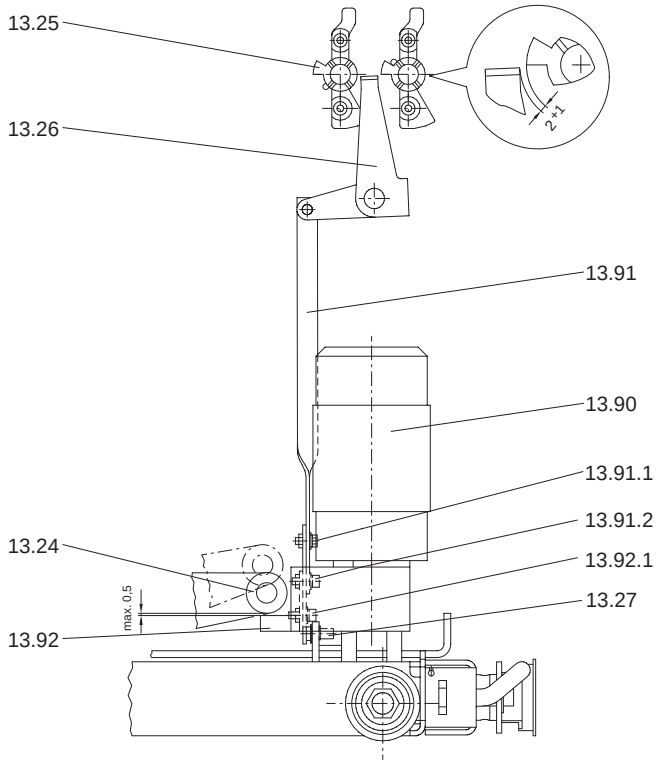



*Figure 7/12: Detail in the area of a withdrawable part with circuit-breaker type VD4, with travel motor, viewed from the left-hand side*

*13.24 Roller*
*13.25 Plastic cam*
*13.26 Lever*
*13.27 Pin*
*13.90 Travel motor*
*13.91 Link rod*
*13.91.1 Bolt*
*13.91.2 Bolt*
*13.92 Angle lever*
*13.92.1 Bolt*

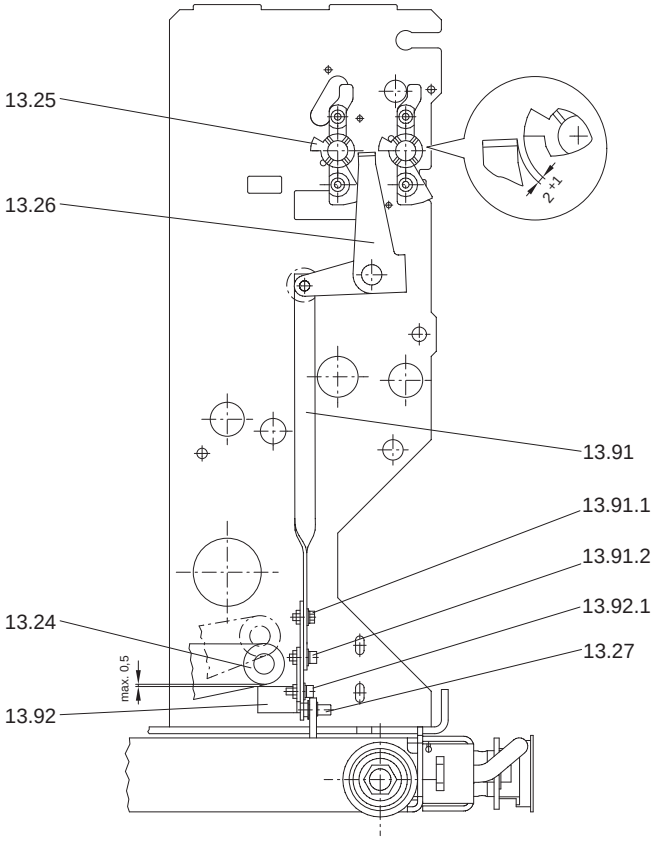



*Figure 7/13: Mechanical interlock, withdrawable assembly/circuit-breaker, type VD4, with manually operated withdrawable part*

*13.24 Roller*
*13.25 Plastic cam*
*13.26 Lever*
*13.27 Pin*
*13.91 Link rod*
*13.91.1 Bolt*
*13.91.2 Bolt*
*13.92 Angle lever*
*13.92.1 Bolt*

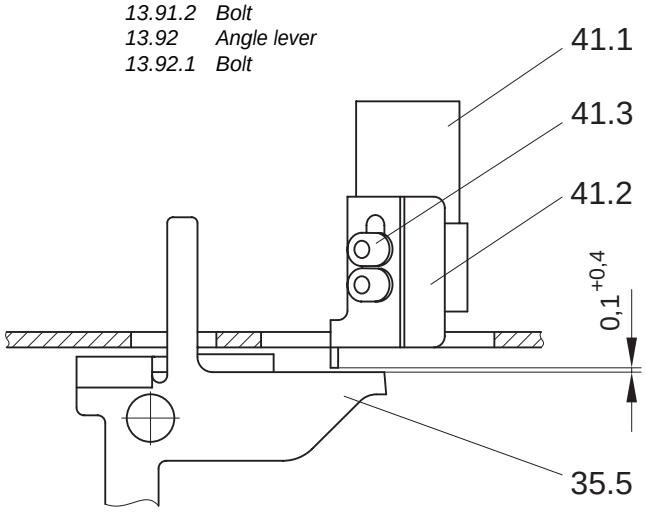



*Figure 7/14: Mechanical interlock between the withdrawable assembly and the circuit-breaker type VM1, setting of the slide blocker.*

- *Circuit-breaker in closed position*

*35.5 Pawl in the withdrawable assembly*
*41.1 Link to the actuator*
*41.2 Slide blocker*
*41.3 Screw*

*For further information please refer to instruction manual BA 433/E*

Instruction manual **no. GCEA 68 0398 P0102** Printed in Germany (06.00-500-PPI)



**ABB Calor Emag Mittelspannung GmbH**

Oberhausener Strasse 33
D-40472 Ratingen

Petzower Strasse 8
D-14542 Glindow

Phone: +49(0)21 02/12-12 30, Fax: +49(0)21 02/12-19 16
E-Mail: calor.info@de.abb.com
Internet: http://www.abb.de/calor

**ABB Sace T.M.S. S.p.A**

Via Friuli, 4
I-24044 Dalmine

Phone: +39 035/395111, Fax: +39 035/395874
E-mail: sacetms.tipm@it.abb.com
Internet: http://www.abb.com