Technical catalog TK 636/05 en

ZX2 Version for ANSI markets

Gas-insulated medium voltage switchgear

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1 Introduction

Switchgear systems and their components rank among the most important facilities for electrical power transmission and distribution. Their versatile functions and the opportunities they provide contribute to safety in general, they secure the availability of electrical energy.

Our ZX product family, consisting of panel types:

ZX0.2:	**... 27 kV**	**... 2500 A**	**... 31.5 kA**
ZX2:	**... 38 kV**	**... 3000 A**	**... 40 kA**
ZX2.2:	**... 38 kV**	**... 2500 A**	**... 40 kA**

covers the entire spectrum of primary distribution applications.

Flexible combination, reliability, availability and economy are the attributes that make it easy for our clients in industry and utilities to decide in favor of ZX series products. With complete conventional solutions utilizing the use of digital protection and control technology, sensor systems and plug-in connections ensures that ZX systems are unrestrictedly fit for the future, and the primary function of reliable power distribution is undoubtedly fulfilled. This is ensured by ABB's uncompromising approach to quality, which leaves no customers´ wishes unfulfilled. Aligned to each need, the panel types of the ZX family offer a solution for each requirement. In over 70 countries customers rely on gas-insulated switchgears from ABB.

The ZX series leave our factory as tested panels and - as a SF_6 filled switchgear, are exemplary in terms of safety, economy and availability. Their compact design allows installation in even the most constricted spaces. The hermetically sealed enclosures make the systems shockproof and protect the high voltage components from all environmental influences.

ABB AG's Medium Voltage Products division develops, manufactures and installs switchgear systems and components for electrical power distribution in the medium voltage range. The knowledge, global experience and local partners for the panels' supply and turnkey medium voltage switchgear systems are based in Ratingen, Germany.

2 Applications

Power supply companies

- Power stations
- Transformer substations
- Switching substations

Industry

- Steel works
- Paper manufacture
- Cement industry
- Textiles industry
- Chemicals industry
- Food an beverage industry
- Automobile industry
- Petrochemicals
- Raw materials industry
- Pipeline systems
- Foundries
- Rolling mills
- Mining

Marine

- Platforms
- Drilling rigs
- Offshore facilities
- Supply vessels
- Ocean liners
- Container vessels
- Tankers
- Cable laying ships
- Ferries

Transport

- Airports
- Harbors
- Railways
- Underground railways

Services

- Supermarkets
- Shopping centers
- Hospitals

3 Characteristics

Basic characteristics

- SF_6 gas-insulated with hermetically sealed pressure system
- Rated voltages up to 38 kV
- Up to 3000 A and 40 kA
- Single and double busbar design
- Up to 4000 A in single busbar design
- Stainless steel encapsulation, manufactured from laser cut sheet material
- Modular structure
- Switchgear with a leakage rate of less than 0.1 % annually
- Integrated leakage testing of the panels
- Indoor installation
- Also suitable for site altitudes over 3281 ft above sea level

Panel variants

- Incoming and outgoing feeder panels
- Cable termination panels
- Termination panels for fully insulated bars
- Sectionalizer
- Riser
- Metering panels
- Customized panel versions

Circuit-breaker, disconnect and three position disconnect

- Vacuum circuit-breaker
- Disconnect with functions for
  - Busbar connection
  - Disconnection
- Disconnect/grounding switch (three position disconnect) with functions for
  - Busbar connection
  - Disconnection
  - Grounding

Connections

- Inner cone cable plug system in sizes 2 and 3
- Outer cone cable connection system to EN 50181, type C
- Connection ability for surge arresters

Current and voltage metering

- Instrument transformers

Protection and control

- Combined protection and control devices
- Discrete protection devices with conventional control

Protection against maloperation

- Electrical switch interlocks
- Optional: additional mechanical interlocks

Pressure relief

- Via plenums into the switchroom
- Via plenums to the outside

Installation

- Panels joined together by plug-in connectors

4 Your benefit

Maximum operator safety

- All live components are enclosed to prevent accidental contact.
- As the high voltage compartments are independent of external influences (degree of protection IP65), the probability of a fault during operation is extremely low.
- As evidenced by arc fault testing, our switchgear systems are suitable for maximum operator safety.
- A further increase in operator safety can be achieved by providing pressure relief to outside the switchgear room.

Minimum overall costs

- The compact design of the panels reduces the space required and therefore the size of the station. The result is a lower investment requirement.
- No maintenance is achieved by constant conditions in the high voltage compartments in conjunction with the selection of suitable materials. The contaminating factors of dust, vermin, moisture, oxidation and polluted air in the high voltage compartments are precluded, as the gas-tight compartments are filled with inert gas.
  As a rule, therefore, isolation of the switchgear to perform maintenance work is not required.
- The panels are designed for an expected service life of over 40 years.
- The systematic selection of the materials used during the development process, provides for complete recycling or reuse of those materials at the end of the service life.
- The panels only leave our production facilities after documented routine testing. Thanks to the plug-in technology applied in the areas of the busbars, cables and secondary systems, extremely short installation times are possible.
- No gas work is required at site. Thus there is no need to evacuate and fill the high voltage compartments, test them for leakage or measure the dewpoint of the insulating gas at site.

Maximum availability

- The plug-in busbar technology without screw couplings allows simple and therefore safe assembly.
- Due to the extremely low failure probability of the ZX switchgear systems and the ability to repair the components in the gas compartments versus replace them, the ZX switchgear ensures a rapid return to service after repairs is possible.
- In gas-insulated switchgears, grounding of switchgear sections is performed by a high quality vacuum circuit-breaker. The circuit-breaker can close onto a short-circuit significantly more frequently and reliably than a positively making grounding switch.

5 Technical data

5.1 Technical data of the panel

Table 5.1.1: Technical data of the panel

				IEEE-ratings		
	Rated frequency	f_r	Hz	50 / 60		
Panels with inner cone cable connection system and all other panel variants without cable connection, panel width 26.62 in	Rated voltage	U_r	kV	15	27	38
	Maximum operating voltage		kV	15	27	38
	Rated power frequency withstand voltage	U_d	kV	36	60	70
	Rated lightning impulse withstand voltage	U_p	kV	95	125	150
	Rated normal current	I_r	A	...1200		
	Rated short-time withstand current	I_k	kA	...40		
	Rated peak withstand current	I_p	kA	..104 [1]		
	Rated duration of short-circuit	t_k	s	...3		
Panels with inner cone cable connection system and all other panel variants without cable connection, panel width 31.50 in or panel width 33.07 in	Rated voltage	U_r	kV	15	27	38
	Maximum operating voltage		kV	15	27	38
	Rated power frequency withstand voltage	U_d	kV	36	60	80
	Rated lightning impulse withstand voltage	U_p	kV	95	125	200
	Rated normal current (panel width 31.50 in)	I_r	A	...2000		
	Rated normal current (panel width 33.07 in)	I_r	A	...3000		
	Rated short-time withstand current	I_k	kA	...40		
	Rated peak withstand current	I_p	kA	..104 [1]		
	Rated duration of short-circuit	t_k	s	...3		
Panels with outer cone cable connection system, panel width 26.62 in	Rated voltage	U_r	kV	15	27	38
	Maximum operating voltage		kV	15	27	38
	Rated power frequency withstand voltage	U_d	kV	36	60	70
	Rated lightning impulse withstand voltage	U_p	kV	95	125	150
	Rated normal current	I_r	A	... 1200		
	Rated short-time withstand current	I_k	kA	... 40		
	Rated peak withstand current	I_p	kA	..104 [1]		
	Rated duration of short-circuit	t_k	s	...3		
Single busbar system	Rated normal current of busbars	I_r	A	...4000		
Double busbar system				...3000		
Insulating gas system [2] [3]						
Alarm level for insulation		p_{ae}	PSI	17.4		
Rated filling level for insulation		p_{re}	PSI	18.9		

Degree of protection for gas filled compartments			IP65
Degree of protection of low voltage compartment [4]			IP4X
Ambient air temperature, maximum [5]		°F (°C)	104 (40)
Ambient air temperature, maximum 24 hour averages [5]		°F (°C)	95 (35)
Ambient air temperature, minimum		°F (°C)	23 (-5)
Site altitude [6]		ft	...3281

[1] 100 kA for rated frequency of 50 Hz
[2] Insulating gas: SF_6 (sulphur hexafluoride)
[3] All pressures stated are absolute pressures at 68°F (20 °C)
[4] Higher degrees of protection on request
[5] Higher ambient air temperature on request
[6] Higher site altitude see section "Non standard operating conditions"

Internal arc classification

The panels are arc fault tested in accordance with IEC 62271-200.

Table 5.1.2: Internal arc classification of the switchgear in accordance with IEC 62271-200		
All panels	Classification IAC	AFLR
	Internal arc	40 kA 1 s

Key to table 5.1.2:

IAC Internal arc classification

AFLR
- R — Accessibility from the rear (R - rear)
- L — Accessibility from the sides (L - lateral)
- F — Accessibility from the front (F - front)
- A — Switchgear installed in closed rooms with access estricted to authorised personnel only

With pressure relief into the switchgear room, the IAC qualification requires a switchgear installation consisting of at least four panels. If a plenum leading to the outside is used, at least two panels are required for the IAC qualification.

AFLR according to IEC 62271-200 is similar to type 2B acc. to IEEE C37.20.7 for air insulated switchgear.

Loss of Service Continuity to IEC 62271-200

The various LSC categories of the standard define the possibility to keep other compartments and/or panels energized when opening a main circuit compartment.
Gas-filled compartments cannot be opened, as they would then lose their functionality. This means that there is no criterion for loss of service continuity of inaccessible compartments.

Table 5.1.3: Loss of Service Continuity of the switchgear	
Loss of Service Continuity of the switchgear	LSC2

Key to table 5.1.3:

LSC2: When accessing the cable terminations of a panel, the busbar and all other panels can remain energized.

Note from VDE 0671-200:2012-08 / IEC 62271-200 Edition 2.0:
“The LSC category does not describe ranks of reliability of switchgear and controlgear.“

Partition class to IEC 62271-200

The partition class to IEC 62271-200 defines the nature of the partition between live parts and an opened, accessible compartment.

Table 5.1.4: Partition class in accordance with IEC 62271-200	
Partition class	PM

Key to table 5.1.4:

PM: partition of metal

Panels of partition class PM provide continuous metallic and grounded partitions between opened accessible compartments and live parts of the main circuit.

5.2 Technical data of the circuit-breaker

Table 5.2.1: Technical data of the circuit-breaker

			IEEE-ratings		
Rated voltage	U_r	kV	15	27	38
Maximum operating voltage		kV	15	27	38
Rated power frequency withstand voltage	U_d	kV	36	60	80
Rated lightning impulse withstand voltage	U_p	kV	95	125	200
Rated frequency	f_r	Hz	50 / 60		
Rated normal current	I_r	A	...3000		
Rated short-circuit breaking current	I_{sc}	kA	...40		
Rated short-circuit making current	I_{ma}	kA	...104 [1]		
Rated short-time withstand current	I_k	kA	...40		
Rated duration of short-circuit	t_k	s	...3		
Operating sequence			O - 0.3 s - CO - 3 min - CO [2]		
Closing time	t_{cl}	ms	ca. 60		
Rated opening time	t_3	ms	≤ 45		
Rated break time	t_b	ms	≤ 60		
Rated auxiliary voltage		V DC	110, 220 [3]		
Power consumption of charging motor		W	max. 260		
Power consumption of closing coil		W	250 - 310		
Power consumption of opening coil		W	250 - 310		
Power consumption of blocking magnet		W	10		
Power consumption of undervoltage release		W	11		
Power consumption of indirect overcurrent release		W	15		

Permissible numbers of operating cycles of the vacuum interrupters

20000 - 30000 [4] x I_r	(I_r = Rated normal current)
50 x I_{SC}	(I_{SC} = Rated short-circuit breaking current)

Classification according IEC 62271-100

All circuit-breakers for panels, Cable and line charging	C2 [5], E2, M2

1) 100 kA for rated frequency of 50 Hz
2) Different operating sequences on request
3) Different auxiliary voltages on request
4) Dependent on the vacuum circuit-breaker
5) Back-to-back capacitor switching on request

5.3 Technical data of the disconnect and three position disconnect

Table 5.3.1: Technical data of the disconnect and the three position disconnect

				IEEE-ratings		
Panels with inner cone cable connection system and all other panel variants without cable connection Panel width 26.62 in	Rated voltage	U_r	kV	15	27	38
	Maximum operating voltage		kV	15	27	38
	Rated power frequency withstand voltage across the isolating distance	U_d	kV	39.6	66	88
	Rated lightning impulse withstand voltage across the isolating distance	U_p	kV	104.5	137.5	220
	Rated normal current	I_r	A		...1200	
	Rated short-time withstand current	I_k	kA		...40	
	Rated peak withstand current	I_p	kA		...104 [1]	
	Rated duration of short-circuit	t_k	s		...3	
Panels with inner cone cable connection system and all other panel variants without cable connection Panel width 31.50 in or panel width 33.07 in	Rated voltage	U_r	kV	15	27	38
	Maximum operating voltage		kV	15	27	38
	Rated power frequency withstand voltage across the isolating distance	U_d	kV	39.6	66	105
	Rated lightning impulse withstand voltage across the isolating distance	U_p	kV	104.5	137.5	220
	Rated normal current (panel width 31.50 in)	I_r	A		...2500	
	Rated normal current (panel width 33.07 in)	I_r	A		...3000	
	Rated short-time withstand current	I_k	kA		...40	
	Rated peak withstand current	I_p	kA		...104 [1]	
	Rated duration of short-circuit	t_k	s		...3	
Panels with outer cone cable connection system, Panel width 26.62 in	Rated voltage	U_r	kV	15	27	38
	Maximum operating voltage		kV	15	27	38
	Rated power frequency withstand voltage across the isolating distance	U_d	kV	39.5	60	105
	Rated lightning impulse withstand voltage across the isolating distance	U_p	kV	104.5	125	220
	Rated normal current	I_r	A	... 1200		
	Rated short-time withstand current	I_k	kA	... 40		
	Rated peak withstand current	I_p	kA	...104 [1]		
	Rated duration of short-circuit	t_k	s	...3		

Rated auxiliary voltage	V DC	110, 220 [3]	
Rated normal current [2]	A	...1200	...3000
Power consumption of mechanism motor	W	approx. 180	
Motor running time on opening or closing the disconnect [4]	s	approx. 18	approx. 20
Motor running time on opening or closing the grounding switch [4]	s	approx. 18	approx. 20

Classification according IEC 62271-102
E0, M1 (2000 operating cycles)

[1] 100 kA for rated frequency of 50 Hz
[2] Higher operating currents on request
[3] Different auxiliary voltages on request
[4] At rated auxiliary voltage

6 Fundamental structure of the panels

Modular structure

Each feeder panel consists of the circuit-breaker compartment (A), one or two busbar compartments (B), the cable termination compartment (C), the plenum for the circuit breaker compartment and for the cable termination compartment (D), one or two plenums for the busbar compartments (E) and the low voltage compartment (F).

The circuit-breaker compartment and the busbar compartments are filled with SF_6 gas. There are no gas connections between the two or three compartments or to gas compartments in adjacent panels.

Fig. 6.1: Feeder panel 1200 A, single busbar at front

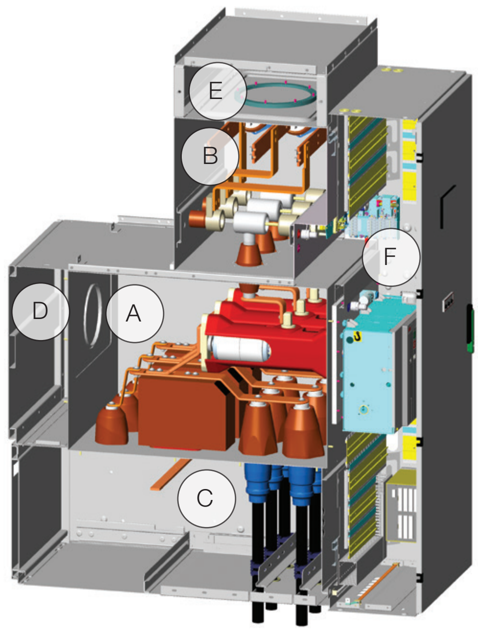


Fig. 6.2: Feeder panel 2000 A, single busbar at rear

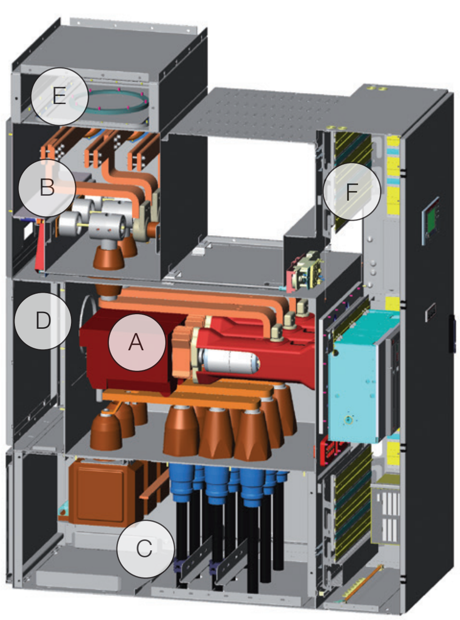
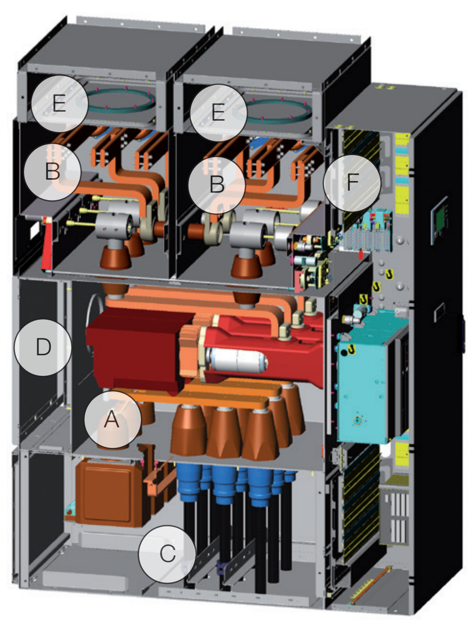


Fig. 6.3: Feeder panel 2000 A, double busbar



The circuit-breaker compartment (A)

The cable sockets (1.3) and test plug sockets (1.4) and the circuit-breaker poles (1.1) are located in the circuit-breaker compartment .

The current-carrying connection between the circuit-breaker and the three position disconnect in the busbar compartment is effected via single pole cast resin bushings (1.12).

There are two basic versions of circuit-breaker compartments available:

- Current detection by blocktype transformers (Fig. 6.4) with maximum two cable sockets per phase
- Current detection by current transformer (Fig. 6.5)

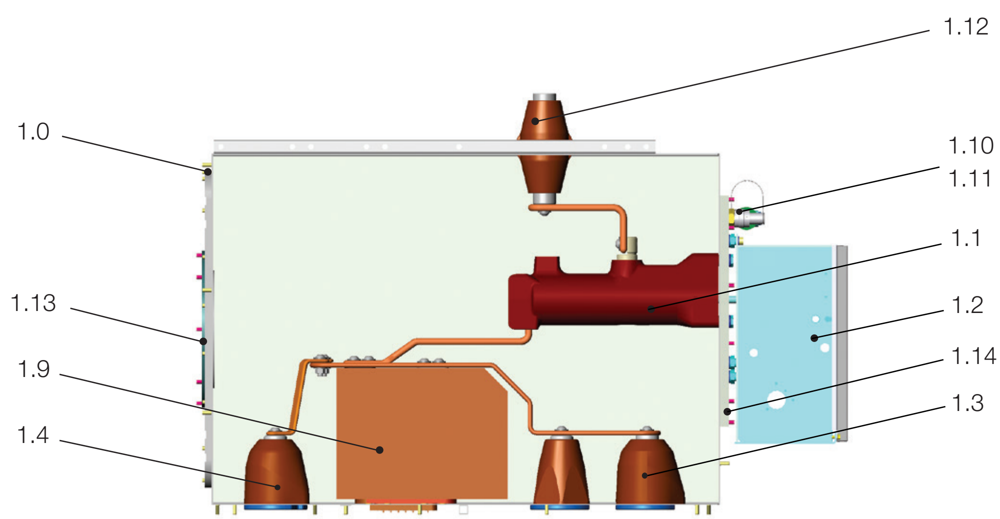
Sockets (1.4) for plug-in voltage transformers are located underneath the circuit-breaker compartment. When voltage transformers are removed, the sockets can be used as test sockets. If no voltage transformers are used, the sockets are sealed and insulated with blanking plugs.

The pressure relief disk (1.13) of the circuit-breaker compartment is located in the rear wall of the enclosure. The circuit-breaker operating mechanism (1.2), the gas leakage sensor (1.10) and the filling valve (1.11) are located on the mounting plate of the circuit-breaker (1.14), which is bolted to the front wall of the enclosure.

The seals of the components are o-ring seals which are not exposed to any UV radiation.

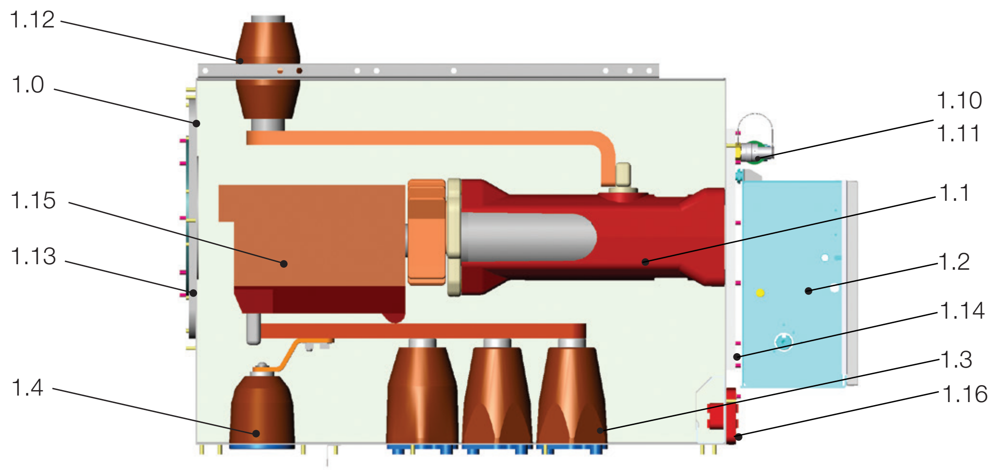
The circuit-breaker compartments in systems consisting of several panels have no gas connections to the neighboring panels, nor is there any gas connection to the busbar compartments located above the circuit-breaker compartments.

Fig. 6.4: Circuit-breaker compartment with block type transformer, 1200 A



1.0	Circuit-breaker compartment (enclosure)
1.1	Circuit-breaker pole
1.2	Circuit-breaker mechanism
1.3	Cable socket
1.4	Test socket (also for use with other plug-in devices)
1.9	Block-type transformer
1.10	Gas density sensor for circuit-breaker compartment
1.11	Filling valve for circuit-breaker compartment
1.12	Cast resin bushing to busbar
1.13	Pressure relief disk
1.14	Mounting plate
(green box)	Insulating gas SF_6

Fig. 6.5: Circuit-breaker compartment with current transformer, 2000 A



1.0	Circuit-breaker compartment (enclosure)
1.1	Circuit-breaker pole
1.2	Circuit-breaker mechanism
1.3	Cable socket
1.4	Test socket (also for use with other plug-in devices)
1.10	Gas density sensor for circuit-breaker compartment
1.11	Filling valve for circuit-breaker compartment
1.12	Cast resin bushing to busbar
1.13	Pressure relief disk
1.14	Mounting plate
1.15	Current transformer
1.16	Bushing for current transformer secondary wiring
	Insulating gas SF_6

The busbar compartment (B)

The busbar compartment (Figs. 6.6 and 6.7) consists of the busbar system (2.1), which is connected to the single-pole cast resin bushings (1.12) below via flat conductors (2.10) and the three position disconnect (2.3).

The pressure relief disk (1.13) of the busbar compartment is located in the roof of the enclosure.

Front busbar compartment

The three position disconnect operating mechanism (2.5), the gas leakage sensor (2.7) and the filling valve (2.8) are located on the front wall of the enclosure.

Rear busbar compartment

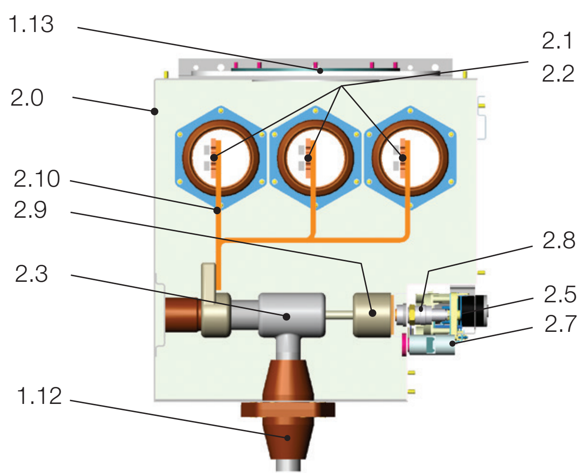
The disconnect operating mechanism (2.5), the gas leakage sensor (2.7) and the filling valve (2.8) are located on the rear wall of the enclosure. Emergency manual operation of the disconnect is effected from the low voltage compartment.

As a rule, the front busbar compartment contains a three position disconnect (with grounding function). The rear busbar compartment of the single busbar version also contains a three position disconnect. In the double busbar version the rear busbar compartment of cable termination panels contains a disconnect with no grounding function.

As with the circuit-breaker compartment, the seals on the components are o-ring seals which are not exposed to any UV radiation.

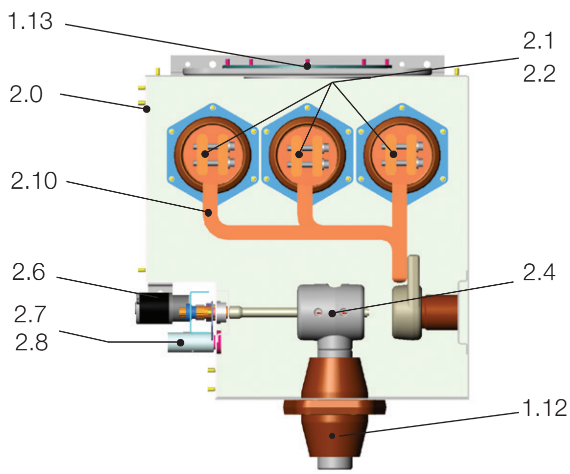
The busbar connection to the adjacent panels is effected by plug-in connectors (2.2) located at either side of the enclosure. The busbar compartments in switchgears consisting of several panels, have no gas connections with the neighboring panels, nor is there any gas connection to the circuit-breaker compartment located below the busbar compartments.

Fig. 6.6: Front busbar compartment (B), 1200 A



1.12	Cast resin bushing
1.13	Pressure relief disk
2.0	Busbar compartment (enclosure)
2.1	Busbar system
2.2	Plug-in busbar connector
2.3	Three position disconnect
2.5	Three position disconnect operating mechanism
2.7	Gas density sensor for busbar compartment
2.8	Filling valve for busbar compartment
2.9	Grounding contact
2.10	Flat conductor
	Insulating gas SF_6

Fig. 6.7: Rear busbar compartment (B), Double busbar, 2000 A



1.12	Cast resin bushing
1.13	Pressure relief disk
2.0	Busbar compartment (enclosure)
2.1	Busbar system
2.2	Plug-in busbar connector
2.4	Disconnect
2.6	Disconnect operating mechanism
2.7	Gas density sensor for busbar compartment
2.8	Filling valve for busbar compartment
2.10	Flat conductor
(light green swatch)	Insulating gas SF_6

The cable termination compartment (C) and rear plenum (D)

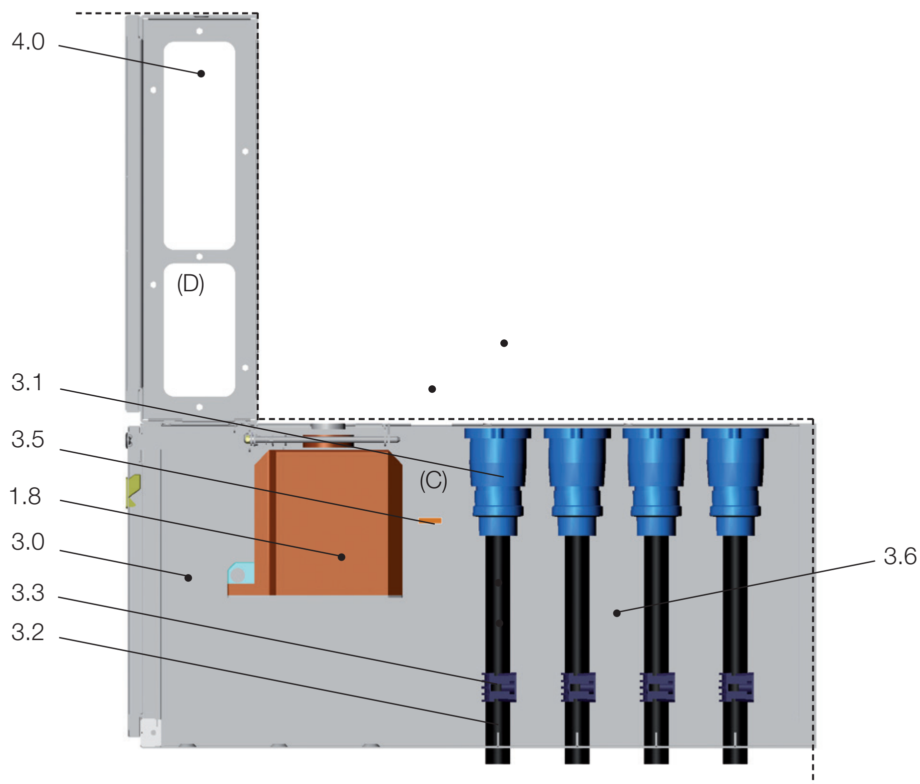
The cable termination compartment (Fig. 6.8) constitutes a support frame for the panel manufactured from bended zinc-plated sheet metal.

The cable termination compartment contains the main grounding bar (3.5), the high voltage cables (3.2) with fitted cable plugs (3.1), cable fasteners (3.3) and - where appropriate, surge arresters or voltage transformers.

An antimagnetic floor plate (3.6), split for cable installation, serves to partition the cable termination compartment off from the cable basement. The cable termination compartment is metal-enclosed on all sides and protected against accidental contact. The installation access at the rear of the cable termination compartment is closed off by a detachable plate.

In the unlikely event of an arc fault in the cable termination or circuit-breaker compartments, pressure is relieved through the rear plenum (4.0).

Fig. 6.8: Cable termination compartment (C) and rear plenum (D)



1.8	Voltage transformers
3.0	Cable termination compartment (C)
3.1	Cable plugs
3.2	High voltage cables
3.3	Cable fastener
3.5	Main grounding bar (mounted on the circuit-breaker enclosure)
3.6	Floor plate
4.0	Rear plenum (D)

The pressure relief system for the busbar - compartment (E)

The upper pressure relief system serves to discharge the pressure in the unlikely event of an internal arc fault in the busbar compartment.

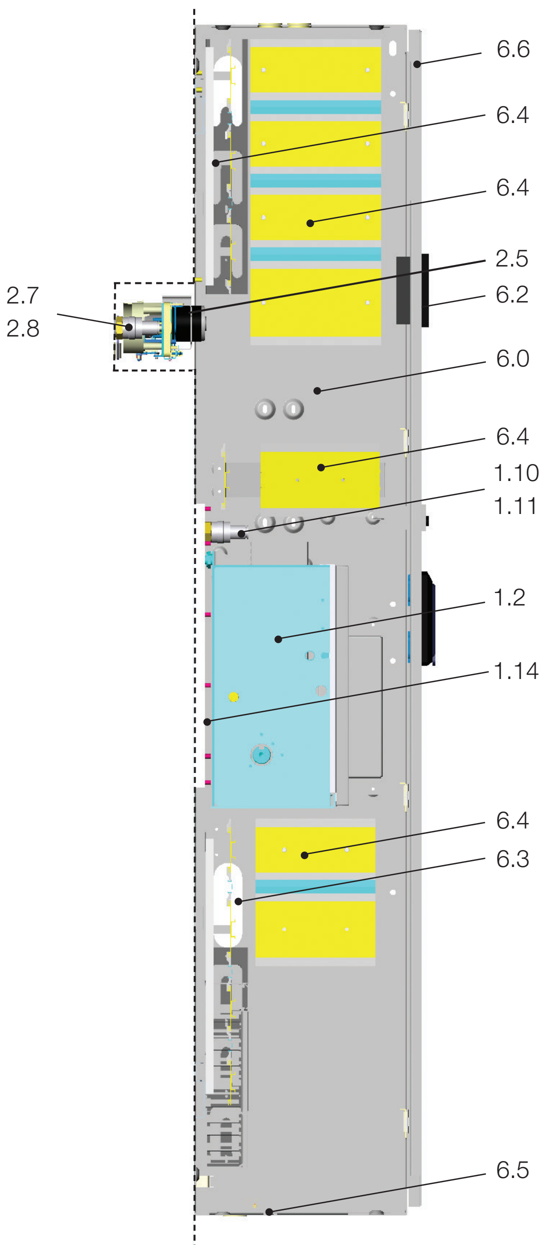
The low voltage compartment (F)

The operating mechanism for the circuit-breaker (1.2), the mechanism for the three position disconnect (2.5), sensors for gas density monitoring in the gas compartments (1.10 and 2.7), protection devices and further secondary devices and their wiring are located in the low voltage compartment (Fig. 6.9).

The entry for external secondary cables (6.5) is located in the base plate of the low voltage compartment.

As a rule the low voltage compartment depth amounts to 19.69 in.

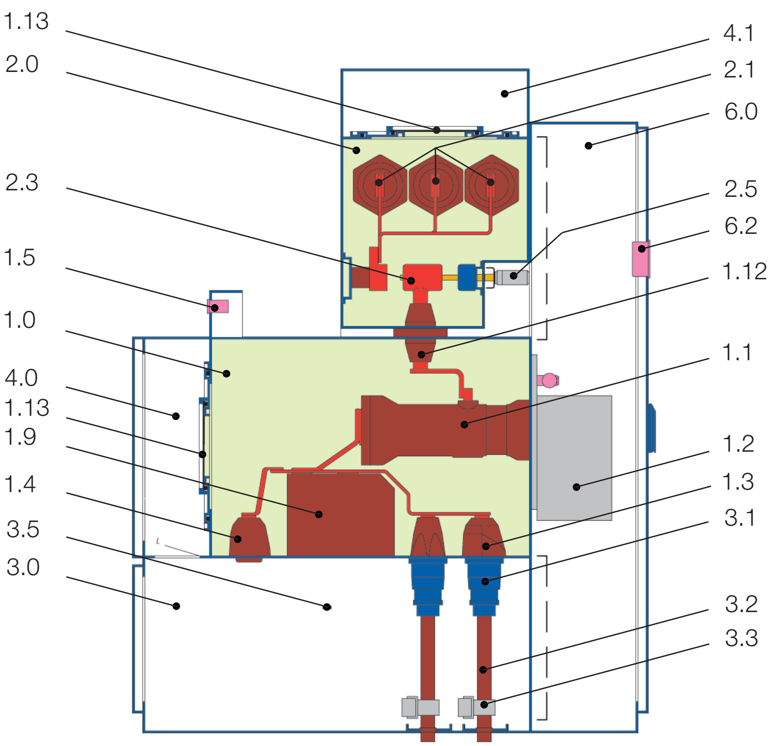
Fig. 6.9: Low voltage compartment (F)



1.2	Operating mechanism for the circuit-breaker
1.10	Sensors for gas density monitoring for Circuit-breaker compartment
1.11	Filling valve for circuit-breaker compartment
1.14	Mounting plate for circuit-breaker
2.5	Three position disconnect mechanism
2.7	Gas density sensor for front busbar compartment
2.8	Filling valve for front busbar compartment
6.0	Low voltage compartment
6.2	Human-machine interface of a combined protection and control device
6.3	Opening for loop lines
6.4	Wiring section
6.5	Secondary cable entry
6.6	Low voltage compartment door

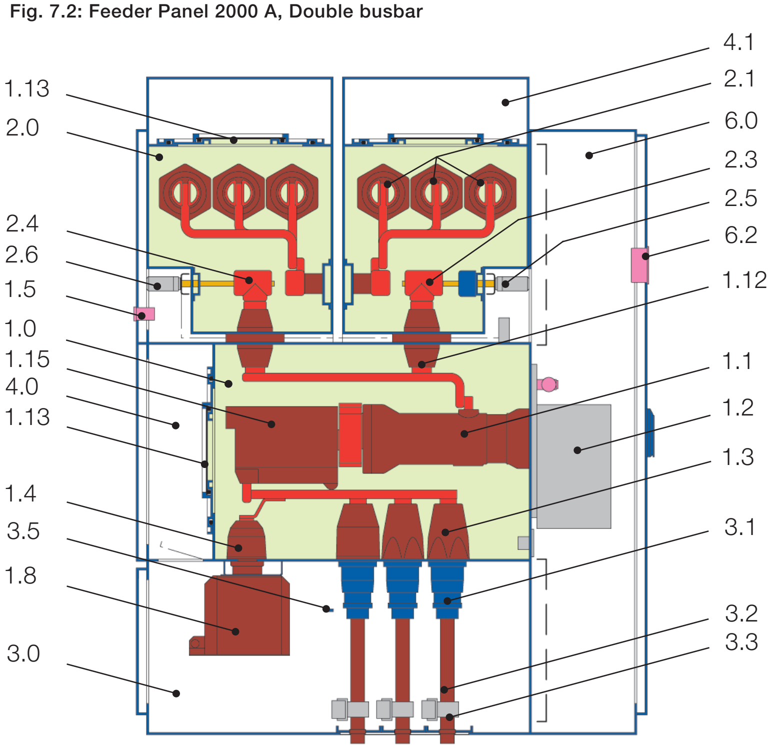
7 Components

Fig. 7.1: Feeder Panel 1200 A, Single busbar



1.0	Circuit-breaker compartment
1.1	Circuit-breaker pole
1.2	Circuit-breaker operating mechanism
1.3	Cable socket
1.4	Test socket (also for use with other plug-in devices)
1.5	Capacitive voltage indicator system
1.8	Voltage transformer
1.9	Block-type transformer
1.12	Bushing, circuit-breaker/busbar compartment
1.13	Pressure relief disk
1.15	Current transformer
2.0	Busbar compartment
2.1	Busbar system
2.3	Three position disconnect
2.4	Disconnect
2.5	Three position disconnect mechanism
2.6	Disconnect mechanism
3.0	Cable termination compartment
3.1	Cable plug
3.2	High voltage cable
3.3	Cable fastener
3.5	Main grounding bar
4.0	Plenum, rear (for circuit-breaker compartment and cable termination compartment)
4.1	Plenum, top (for busbar compartment)
6.0	Low voltage compartment
6.2	Protection and control device
	Insulating gas SF_6

Fig. 7.2: Feeder Panel 2000 A, Double busbar



7.1 Vacuum circuit-breaker

The fixed mounted vacuum circuit-breakers (Fig. 7.1.1) are three phase switching devices and fundamentally consist of the operating mechanism and the three pole parts. The pole parts contain the switching elements, the vacuum interrupters.

The pole parts are installed on a common mounting plate. The operating mechanism is on the opposite side from the mounting plate. Thus, the pole parts, mounting plate and operating mechanism form a single assembly. The mounting plate for this assembly is screwed to the front wall of the circuit-breaker compartment in a gas-tight manner at the factory.

The pole parts are located in the circuit-breaker compartment which is filled with SF_6, and are therefore protected from external influences. The operating mechanism is located in the low voltage compartment and is therefore easily accessible

Functions of the vacuum circuit-breaker

- Switching operating current on and off
- Short-circuit breaking operations
- Grounding function in conjunction with the three position disconnect

For grounding, the three position disconnect prepares the connection to ground while in the de-energized condition. Actual grounding is then performed by the circuit-breaker. A circuit-breaker functioning as an grounding switch is of higher quality than any other grounding switch.

Vacuum interrupter

The outer casing of the vacuum interrupter (Fig. 7.1.2) consists of ceramic insulators (1), whose ends are sealed off by stainless steel lids (2). The contacts (4 and 5) surrounded by the potential-free centre screen (3) are made of copper/chromium composite. As a consequence of the extremely low static pressure of less than 1.45×10^{-6} to 1.45×10^{-10} psi inside the interrupter chamber, only a relatively small contact gap is required to achieve a high dielectric strength. The switching motion is transmitted into the enclosed system of the vacuum interrupter via a metal bellows (6). An anti-rotation element (7) is fitted to protect the metal bellows from torsion and to guide the conductor leading to the moving contact. The connection to the operating mechanism is effected by a threaded pin (8) fastened in the feed conductor.

If contacts through which current is flowing are opened in a vacuum, a metal vapor arc arises under short-circuit conditions. This arc creates the charge carriers required to conduct the current inside the vacuum interrupter. The arc is extinguished at the first natural zero of the alternating current after switch-off (i.e. after separation of the contacts). With the rapid reestablishment of the contact gap in the vacuum, the current flow is then securely interrupted.

Fig. 7.1.1: Vacuum circuit-breaker

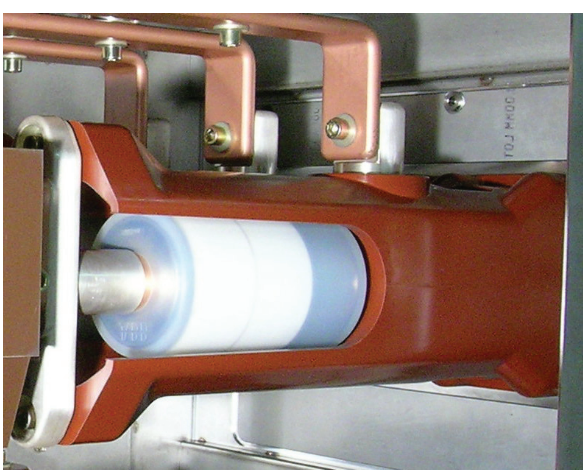
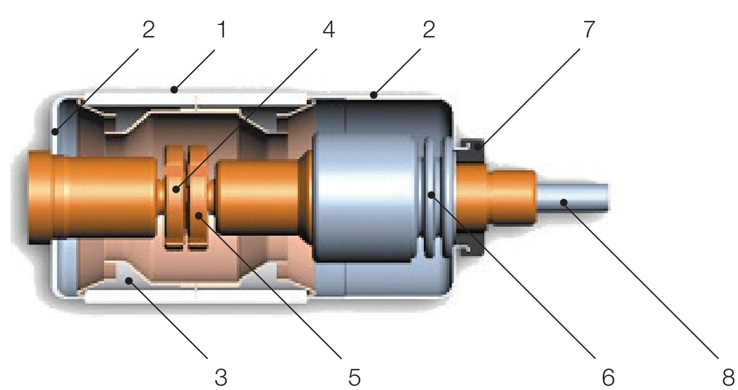


Fig. 7.1.2: Vacuum interrupter



Pole parts (Fig. 7.1.3)

The interrupter (9) inside the pole part is embedded in cast resin or located in a cast resin pole tube (10). With the breaker closed, the current flows from breaker terminal (11) to the fixed contact in the vacuum interrupter, and then onto the breaker terminal via the moving contact (12). The operating motions are effected by insulated actuating rods (8).

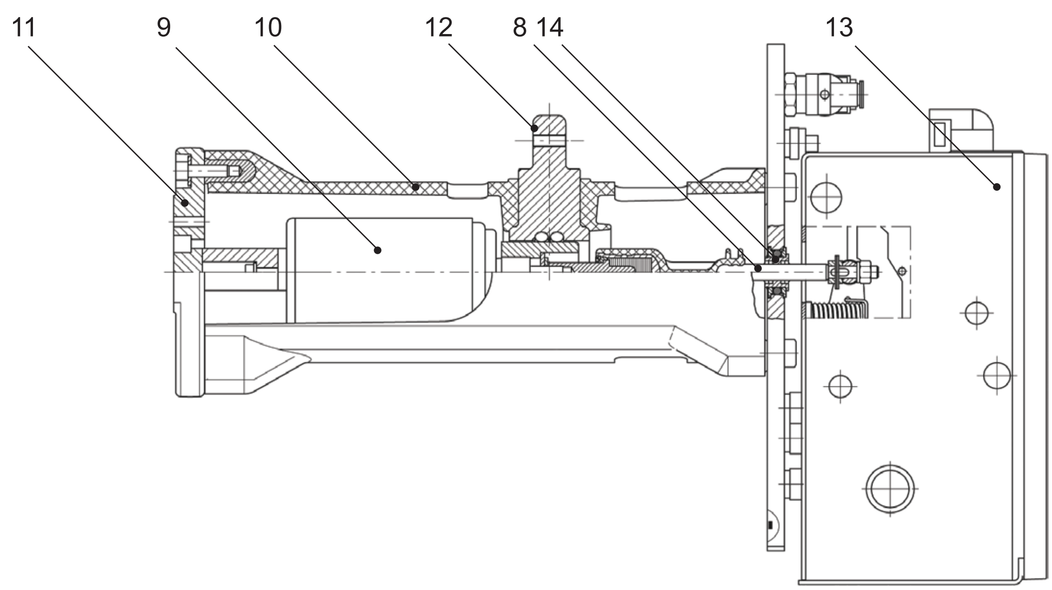
Circuit-breaker operating mechanism

The circuit-breaker operating mechanism (Fig. 7.1.3, item 13) is connected to the pole parts via gas-tight thrust bushings (14).

The circuit-breaker is equipped with a mechanical stored-energy spring mechanism. The stored-energy spring can be charged either manually or by a motor. Opening and closing of the device can be performed by means of mechanical pushbuttons or by electrical releases (closing, opening and undervoltage releases).

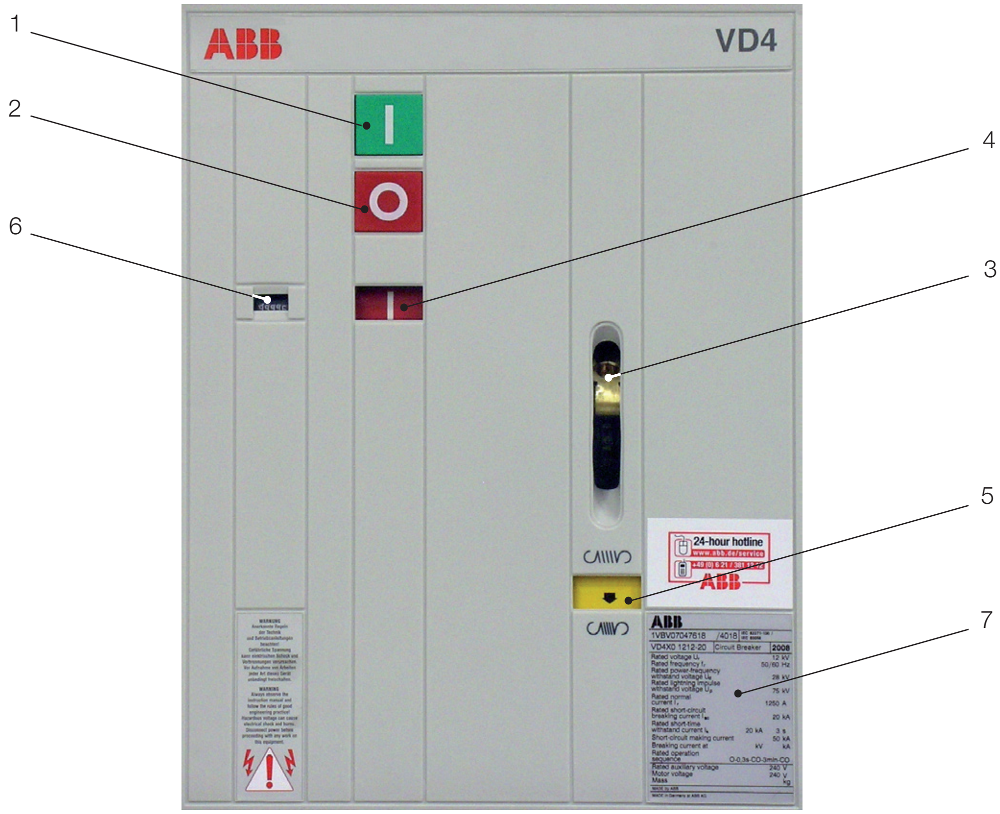
The operating mechanism can be configured for autoreclosing and with the short motor charging times involved, also for multi-shot autoreclosing.

Fig. 7.1.3: Pole part and operating mechanism



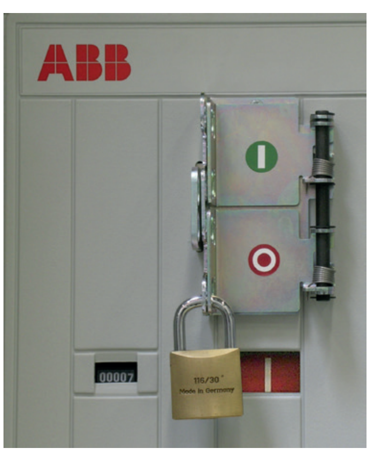
The front of the operating mechanism (Fig. 7.1.4) accommodates the mechanical on (1) and off (2) pushbuttons, the receptacle for manual charging of the stored-energy spring (3), the mechanical indicators for “Circuit-breaker ON” “Circuit-breaker OFF” (4), “Stored-energy spring charged”, “Stored-energy spring discharged” (5), an operating cycle counter (6) and the name plate for the circuit-breaker (7).

Fig. 7.1.4: Controls for the circuit-breaker operating mechanism



The mechanical push-buttons can optionally be fitted with a locking device (Fig. 7.1.5). When this option is selected, both buttons can be secured separately with padlocks.

Fig. 7.1.5: Optional locking device for mechanical push-buttons on the circuit-breaker



Example: OFF button secured

Example: OFF button enabled for operation

Secondary equipment for the circuit-breaker mechanism

Table 7.1.1 shows the secondary equipment for the circuit-breaker operating mechanism in an outgoing feeder panel. The "Standard" column indicates the equipment necessary for control of the panel. Furthermore, the use of further devices such as additional auxiliary switches is possible as an option to meet your specific requirements.

Table 7.1.1: Secondary equipment for the circuit-breaker mechanism in feeder panels

Designations	Equipment	Standard	Option
-MAS	Charging motor for spring mechanism	●	
-BGS1 [1)]	Auxiliary switch "Spring charged"	●	
-MBO1	Shunt release OFF	●	
-MBC	Shunt release ON	●	
-BGB1	Auxiliary switch "CB ON/OFF"	●	
-BGB2 [2)]	Auxiliary switch "CB ON/OFF"	●	
-BGB3 [2)]	Auxiliary switch "CB ON/OFF"		●
-KFN	Anti-pumping device	●	
-RLE1	Blocking magnet "CB ON"	●	
-BGL1	Auxiliary switch for blocking magnet	●	
-BGB4	Fleeting contact ≥ 30 ms for C.B. tripped indication		●
-MBU [3)]	Undervoltage release		●
-MBO3 [3)]	Indirect overcurrent release		●
-MBO2	2nd shunt release OFF		●

1) For certain versions of the circuit-breaker, auxiliary switches BGS1.1...1.5 are used.
2) For certain versions of the circuit-breaker, the auxiliary switch may not be required. In such cases the function is performed by auxiliary switch -BGB1.
3) Combination of -MBU with -MBO3 is not possible.

7.2 Three position disconnect

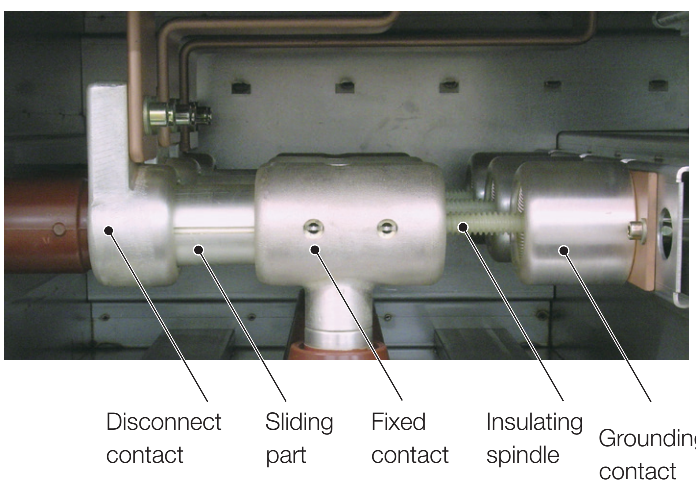
The three position disconnects are combined disconnect and grounding switches. The three switch positions: connecting, disconnecting and grounding, are clearly defined by the mechanical structure of the switch. Simultaneous connection and grounding is therefore impossible.

The three position disconnects are motor-operated rod-type switches, whose live switching components are located in the busbar compartment filled with SF_6, while the mechanism block is easily accessible in the low voltage compartment.

The switch (Fig. 7.2.1) has its disconnected position in the central position. In the disconnect ON and grounding switch ON limit positions, the moving contact (sliding part) driven by an insulating spindle reaches the fixed contacts (disconnect contact or grounding contact) which are fitted with one or two spiral contacts.

Series connected optional reed contacts (- switches operated by permanent magnets) detect the correct positions of the three contacts in the grounding switch ON position (Figs. 7.2.2 and 7.2.3).

Fig. 7.2.1: Three position disconnect in disconnect ON position



Three position disconnect operating mechanism

The operating mechanism block for the three position disconnect consists of the following functional groups (Figs. 7.2.4 to 7.2.6):

- Drive motor
- Functional unit with micro switches and auxiliary switches for position detection
- Mechanical position indicator
- Mechanical access interlock for emergency manual operation
- Hand crank receptacle for emergency manual operation

The various options for secondary equipment in the mechanism variants can be found in table 7.2.1.

Fig. 7.2.2: Partial view of the three position disconnect in the grounding switch ON position (reed contact switched on by permanent magnet)

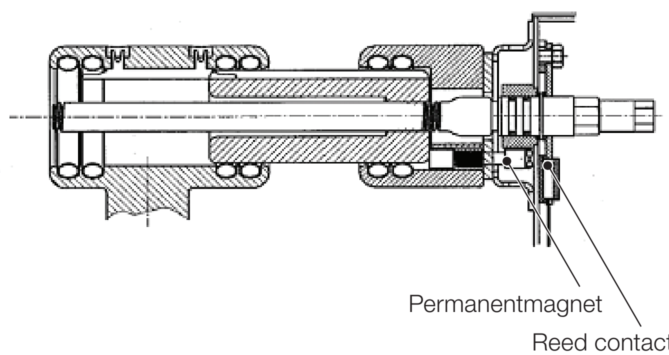


Fig. 7.2.3: Partial view of the three position disconnect in the central position

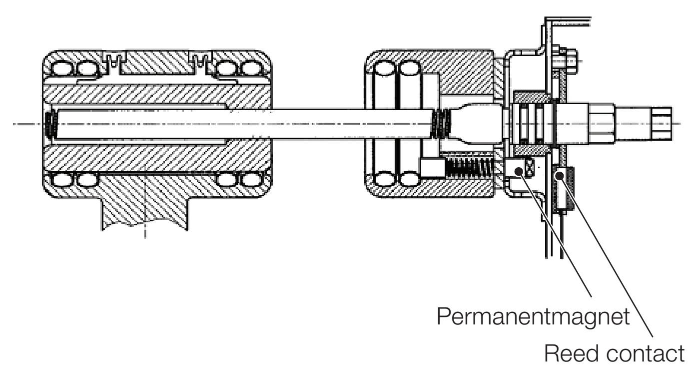


Fig. 7.2.4: Three position disconnect operating mechanism

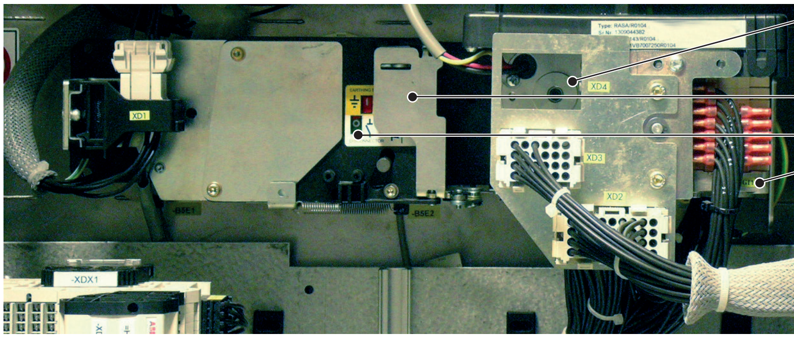


Fig. 7.2.5: Closed mechanical access interlock for emergency manual operation

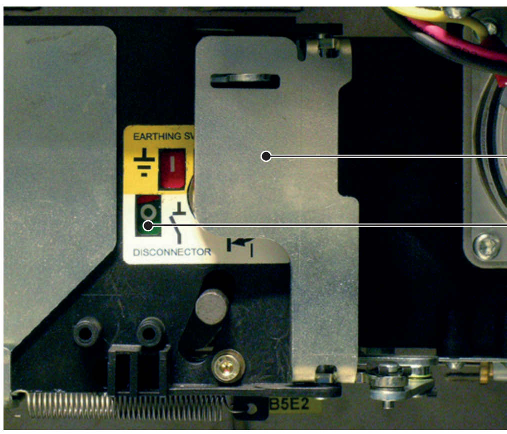
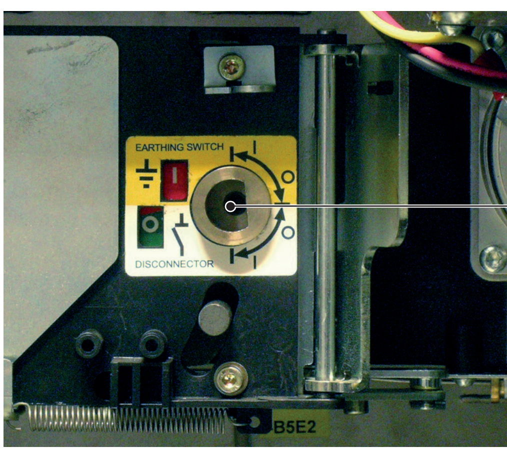


Fig. 7.2.6: Opened mechanical access interlock for emergency manual operation



Secondary equipment for the three position disconnect operating mechanism

Table 7.2.1 shows the secondary equipment for the three position disconnect operating mechanism in an outgoing feeder panel. The "Standard" column indicates the equipment necessary for control of the panel. Furthermore the use of further devices such as additional auxiliary switches is possible as an option to meet your specific requirements.

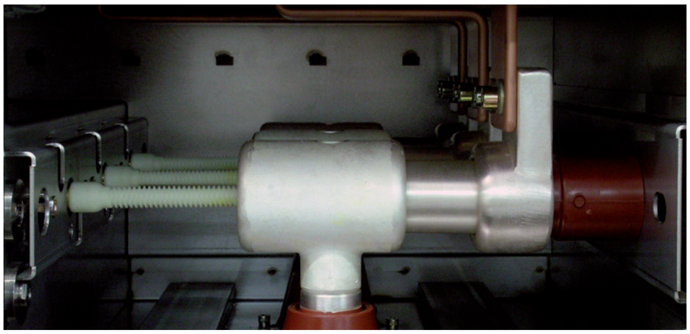
Table 7.2.1: Secondary equipment for the three position disconnect mechanism in feeder panels

Designations	Equipment	Standard	Option
-MAD	Drive motor	•	
-BGI15	Microswitch to detect switch position "Disconnect OFF"	•	
-BGI16	Microswitch to detect switch position "Disconnect ON"	•	
-BGE57	Microswitch to detect switch position "Grounding switch OFF"	•	
-BGE58	Microswitch to detect switch position "Grounding switch ON"	•	
-BGI1	Auxiliary switch to detect switch position "Disconnect OFF"	•	
-BGI1	Auxiliary switch to detect switch position "Disconnect ON"	•	
-BGE5	Auxiliary switch to detect switch position "Grounding switch OFF"	•	
-BGE5	Auxiliary switch to detect switch position "Grounding switch ON"	•	
-BGE3.1 -BGE3.2 -BGE3.3	Reed contacts to detect the "Grounding switch ON" switch position		•
-BGL1 -BGL2	Microswitch for (optional) access blocking of hand crank receptacle for emergency manual operation		•

7.3 Disconnect

Except for the lack of an grounding contact the design of the disconnect is the same as that of the three position disconnect. Accordingly the two switch positions are “connect” and “disconnect”.

Fig. 7.3.1: Disconnect in ON position



The two-part operating mechanism of the disconnect consists of the following functional groups (Figs. 7.3.2 to 7.3.5):

- Drive motor
- Functional unit with micro switches and auxiliary switches for position detection
- Mechanical position indicator
- Mechanical access interlock for emergency manual operation
- Hand crank receptacle for emergency manual operation

Fig. 7.3.2: Rear part of the disconnect operating mechanism with drive motor on the back of the panel

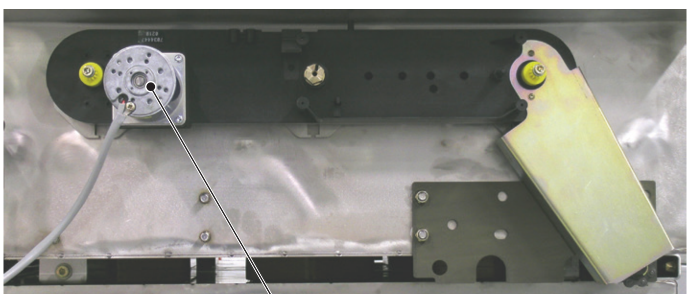


Fig. 7.3.3: Front part of the disconnect operating mechanism in the low voltage compartment. The operating mechanism of the three position disconnect is located above the disconnect operating mechanism.

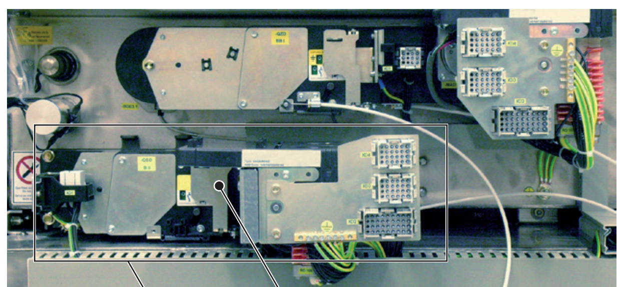


Fig. 7.3.4: Closed mechanical access interlock for emergency manual operation

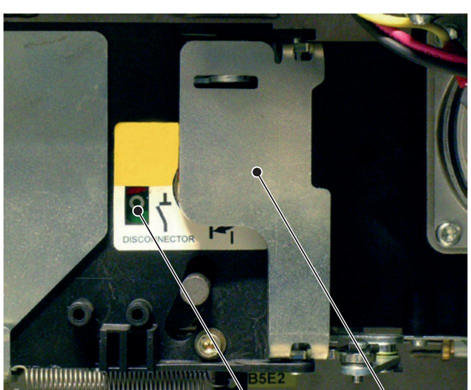
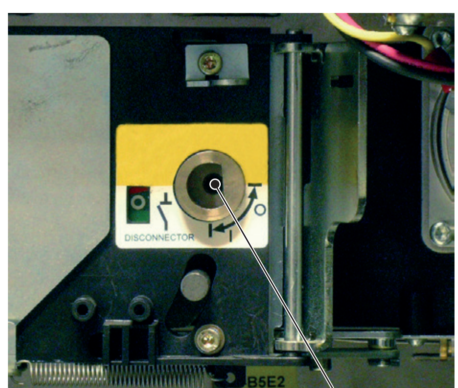


Fig. 7.3.5: Opened mechanical access interlock for emergency manual operation



Secondary equipment for the disconnect

Table 7.3.1 shows the secondary equipment for the disconnect operating mechanism in an outgoing feeder panel. The "Standard" column indicates the equipment necessary for control of the panel. Over and above this, the use of further devices such as additional auxiliary switches is possible as an option to meet your specific requirements.

Table 7.3.1: Secondary equipment for the disconnect mechanism in feeder panels

Designations	Equipment	Standard	Option
-MAD	Drive motor	•	
-BGI15	Microswitch to detect switch position "Disconnect OFF"	•	
-BGI16	Microswitch to detect switch position "Disconnect ON"	•	
-BGI1	Auxiliary switch to detect switch position "Disconnect OFF"		•
-BGI1	Auxiliary switch to detect switch position "Disconnect ON"		•
-BGL1 -BGL2	Microswitch for (optional) access blocking of hand crank receptacle for emergency manual operation		•

7.4 Optional view ports

The busbar compartments can be equipped with optional view ports to allow operators to verify the switching positions of the three position disconnect and the disconnect visually.

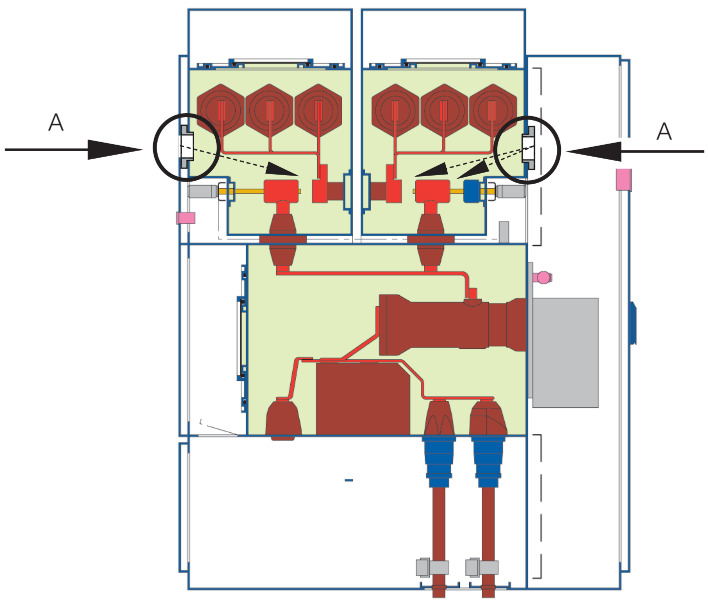
The view ports for the front busbar compartment are located in the low voltage compartment, and those for the rear busbar compartment are located in the cover of the busbar compartment at the rear of the panel (Fig. 7.4.1).

Using a flashlight to pear through the view ports, the operator can visually verify that the three position disconnect is disconnected, connected or in the grounded position.

The view ports will be covered by a slide mechanism.

Provided as an optional accessory, the camera system (Fig. 7.4.2) makes visual verification of the switches quick, simple and ergonomic. The camera system mounts directly to the view ports and the operator monitors the position of the disconnect via LCD screen. The camera system will be placed outside the gas compartment when it is needed. This way if a failure occurs with the camera it can be easily replaced without compromising safe operation of the gear or verification of the disconnect switch.

Fig. 7.4.1: Position of the optional view ports shown in the example of a double busbar panel



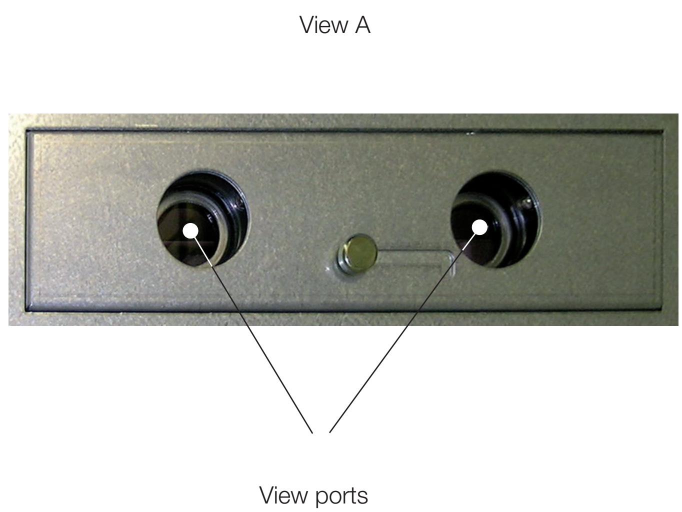
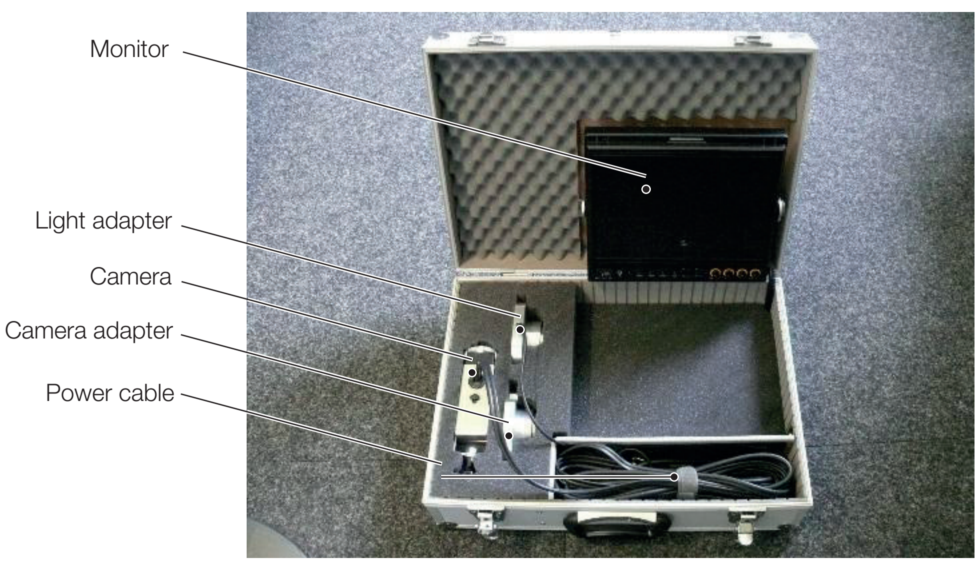


Fig. 7.4.2: Camera system case



7.5 Busbar

The busbars, located in the gas compartment of the panels, are connected together by plug-in busbar connectors (Figs. 7.5.1 to 7.5.3). The busbar connection consists of the cast resin busbar socket (1) mounted in the busbar compartment from the inside, the silicone insulating part (2), the contact tube (3) and the spiral contacts (4).

For a busbar current of maximum 1250 A, 2500 A and 3000 A, different cast resin busbar sockets and contact tubes are used. The number of spiral contacts varies depending on the busbar current. The design of these components is uniform within a switchgear block. For a busbar current > 2500 A, the use of heat sinks on the busbar spaces is required in accordance with chapter 8.4.2.

The electrically conductive connection from the embedded part of the cast resin busbar socket to the contact tube, is established by one, two or four spiral contacts, depending on the rated busbar current. The silicone insulating part isolates the high voltage potential from ground potential. The surfaces of all electrically conductive components (embedded part, spiral contact and contact tube) are silver plated. As the contact tubes are axially movable, no further compensation for expansion in the busbars running through a switchgear system is necessary.

The circuit-breaker and busbar compartments are separate chambers in the gas system. Busbar operation therefore continues to be possible in the event of a fault in the circuit-breaker compartment of an outgoing feeder panel. The gas systems of adjacent busbar compartments are also not connected to each other.

The plug connector system on the one hand facilitates the delivery of panels tested at the works for leakage and dielectric strength, and on the other hand no gas work is required during installation at site (with the exception of installation of heat sinks on busbar compartments at site).

Fig. 7.5.1: Busbar socket (1) with insulating part (2), contact tube (3) and spiral contacts (4)

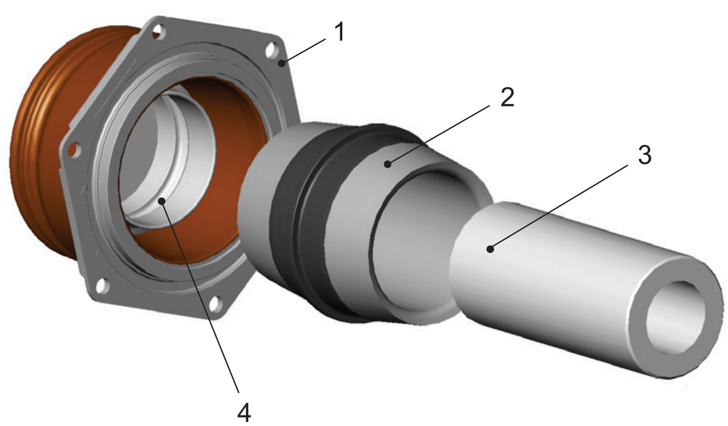


Fig. 7.5.2: Busbar connection, plugged in at one end

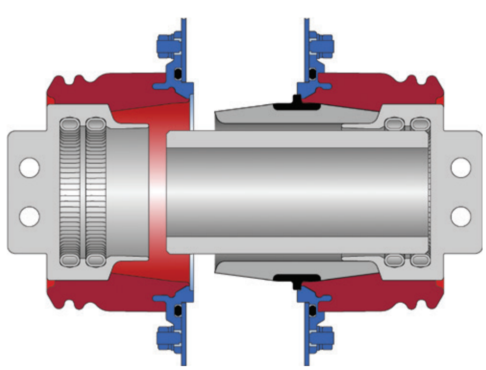
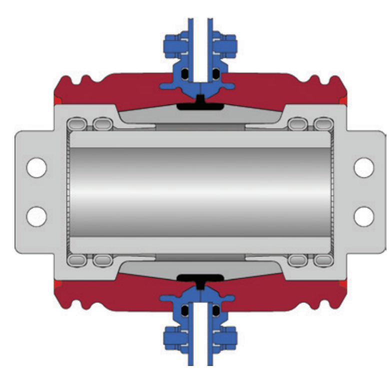


Fig. 7.5.3: Busbar connection between the panels



End panels

End panels are available in versions which permit extension. In these versions, the busbar sockets are dielectrically sealed off with blanking plugs. If extension is positively unnecessary, busbar end insulators (Fig. 7.5.4) are used in place of the conventional busbar sockets.

Removal of intermediate panels

The busbar connection with busbar socket, insulating part and contact tube can be dismantled when the busbar is grounded. The SF_6 is properly pumped out and the busbar compartment is opened. It is therefore possible to remove any panel from the middle of a switchgear installation.

The busbar interrupted by removal of the panel can be temporarily bridged with the aid of a coupler box.

Direct connection of fully insulated bars to the busbar

Fully insulated bars can be connected with special busbar sockets in an end panel (Fig. 7.5.5).

Fig. 7.5.4: Busbar enclosures with busbar end insulators (1) and busbar sockets (2)

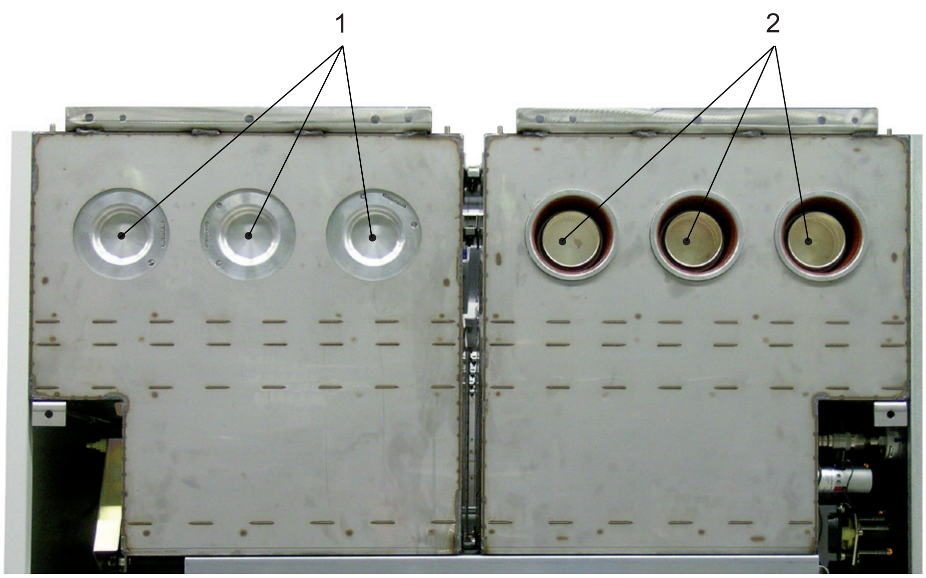
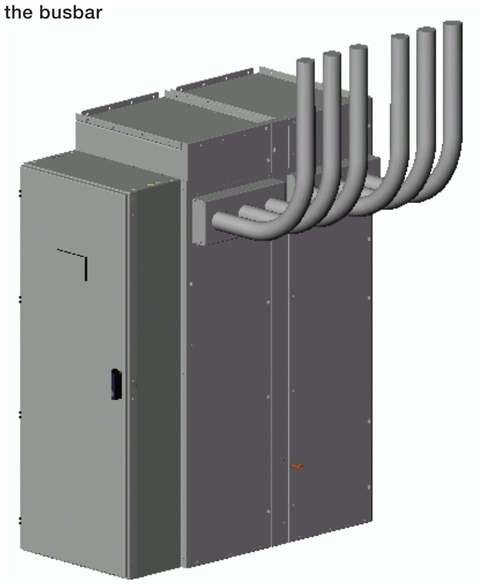


Fig. 7.5.5: Direct connection of fully insulated bars to the busbar



7.6 Inner cone termination system

Inner cone sockets (Fig. 7.6.1 - size 2 or 3) fitted in a gas-tight manner in the floor plate of the circuit-breaker compartment facilitate facilitate the connection of cables (Fig. 7.6.1.1), fully insulated bars (7.6.2.1) or surge arresters (7.6.3.1).

The inner cone termination system is above all notable for its total insulation and the associated protection against accidental contact.

7.6.1 Connection of cables

An overview of the maximum cross-sections of the cables to be connected and the cable plugs usable in various installation situations can be found in table 7.6.1.1. As the assignment of plug sizes to the actual cable used can depend on further cable data, these are to be discussed with the plug supplier.

The current carrying capacity of the panels as stated is achieved when all the sockets in the panel are evenly fitted with cables.

Tabelle 7.6.1.1: Cable plugs usable in various installation situations

Manufacturer	Plug size	Cable cross-section [kcmil (mm²)]
ABB	2	350 (185)
AB srl.		750 (400)
nkt		500 (300)
Pfisterer		750 (400)
Pfisterer	2 XL	750 (400)
Südkabel	2	500 (300)
Tyco / Raychem		750 (400)
ABB	3	750 (400)
AB srl.		1000 (630)
nkt		1000 (630)
		Round single wire: 1500 (800)
Pfisterer	3 (3-S)	1000 (630)
Pfisterer	3 XL	1500 (800)
Südkabel	3	1000 (630)
Tyco / Raychem		1000(630)

Fig. 7.6.1: View into the gas-insulated circuit-breaker compartment with inner cone sockets

Fig. 7.6.1.1: View into the cable termination compartment in air with cable plugs and cables

7.6.2 Connection of fully insulated bars

Connection of fully insulated bars (Fig. 7.6.2.1) in place of cables is possible using sockets of size 3 (up to 1200 A) or special sockets (up to 2500 A).

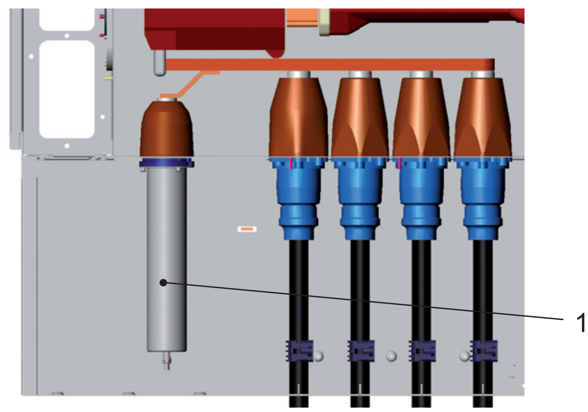
Fig. 7.6.2.1: Connection of a fully insulated bar using plug size 3

7.6.3 Connection of surge arresters

Connection of plug-in surge arresters (Fig. 7.9.6) of sizes 2 (12-38 kV) is possible (Fig. 7.6.3.1).

ABB-Polim® surge arresters are to be used. The surge arresters consist of zinc oxide varistors, which provide optimum protection from hazardous overvoltages. The varistors are located in an aluminium casing and embedded in silicone.

Fig. 7.6.3.1: Connection of surge arresters (1)



7.7 Outer cone cable connection system

Outer cone device termination components to EN 50181, fitted gas-tight in the wall between the panel module and the cable termination compartment, facilitate connection of cables and surge arresters (Figs. 7.7.1 to 7.7.2). When the shutter on the cable termination compartment has been removed, the cables are accessible from the rear of the system.

Shockproof cable connector systems are always to be used. A selection of connector systems which can be used within the space available is shown in tables 7.7.1.1 to 7.7.1.6. When making your selection, please take account of the current and short-circuit capacities of the cables and connector systems. Please consult the manufacturers for any additional requirement, precise ordering details and information on any coupling units required.

Fig. 7.7.1: View into the cable termination area with outer cones in air

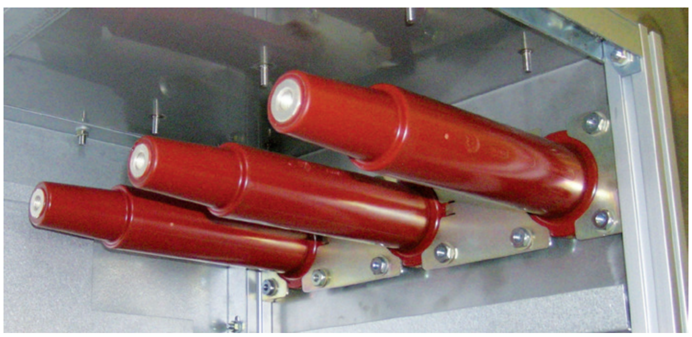
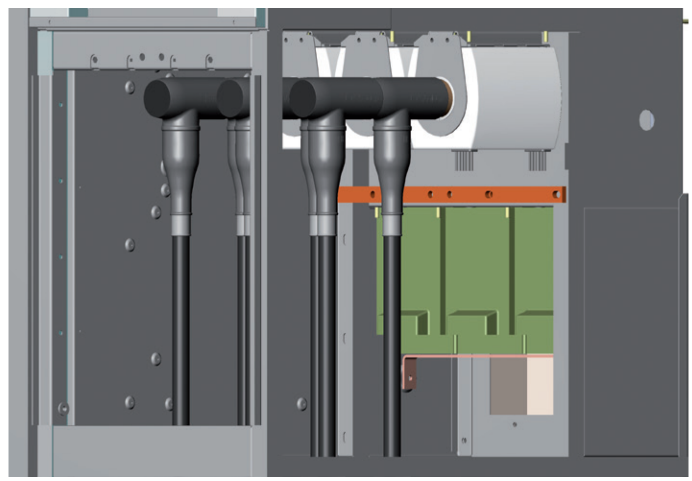


Fig. 7.7.2: View into the cable termination compartment in air with shockproof cable connectors (ABB type CSE-A) and cables



7.7.1 Selection of cable connectors

Table 7.7.1.1 a: Selection of cable connectors, panel width 23.62 in, 8.25 kV, max. 600 A

Maximum operating voltage	Maximum operating current	Cable cross-section	Cables fitted						Cable connector manufacturer / connector type				
			One cable	Two cables	Three cables	One cable + Surge arrester	Two cables + Surge arrester	Three cables + Surge arrester	ABB Kabeldon	EUROMOLD	nkt cables GmbH	Südkabel GmbH	Tyco
[kV]	[A]	[kcmil (mm²)]											
12	600	AWG 3 - AWG 2/0 (25 - 70)	•						CSE-A 12630-01				
				•					CSE-A 12630-01 CSEP-A 12630-01				
						•			CSE-A 12630-01 CSAP-A 12xx				
							•		CSE-A 12630-01 CSEP-A 12630-01 CSAP-A 12xx				
		AWG 3- 500 (25 - 300)	•							430TB	CB12-630		RSTI-58xx
				•						430TBM-P2	CB12-630 CC12-630		RSTI-58xx RSTI-CC-58xx
					•					430TBM-P3	CB12-630 2x CC12-630		
						•				430TB 300SA	CB12-630 CSA12-...		RSTI-58xx RSTI-CC-58SA
							•			430TBM-P2 300SA	CB12-630 CC12-630 CSA12-...		RSTI-58xx RSTI-CC-58xx RSTI-CC-58SA
								•			CB12-630 2x CC12-630 CSA12-...		
		AWG 1/0 - 500 (50 - 300)	•									SET12	
				•								SET12 SEHDK13.1	
						•						SET12 MUT13	
							•					SET12 SEHDK13.1 MUT13	
		AWG 1/0 - 1000 (50 - 630)	•							484TB/G			
				•						484TB/G 804PB/G			
					•					484TB/G 2x 804PB/G			
						•				484TB/G 800SA			
							•			484TB/G 804PB/G 800SA			

Table 7.7.1.1 b.: Selection of cable connectors, panel width 23.62 in, 8.25 kV, max. 600 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm²)]	Cables fitted: One cable	Cables fitted: Two cables	Cables fitted: One cable + Surge arrester	Cables fitted: Two cables + Surge arrester	Cable connector manufacturer / connector type: ABB Kabeldon	nkt cables GmbH	Südkabel GmbH	Cellpack
12	600	AWG 1/0 - 500 (50 - 300)	•				CSE-A 12630-02			
				•			CSE-A 12630-02 CSEP-A 12630-02			
					•		CSE-A 12630-02 CSAP-A 12xx			
						•	CSE-A 12630-02 CSEP-A 12630-02 CSAP-A 12xx			
		400 - 750 (185 - 500)	•					CB24-1250/2		
		600 - 750 (300 - 500)	•						SEHDT13	
		1000 (400) 1000 (500) 1000 (630)	•					CB36-630(1250)		
		1000 (400 - 630)	•				CSE-A 12630-03			
					•		CSE-A 12630-03 CSAP-A 12xx			
		1000 (500 - 630)	•							CTS 1250A 24kV
					•					CTS 1250A 24kV CTKSA
		1250 - 1750 (630 - 1000)	•					CB42-1250/3		
					•			CB42-1250/3 CSA12-...		

Table 7.7.1.2 a: Selection of cable connectors, panel width 23.62 in, 8.25 kV, max. 1200 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm²)]	Two cables	Three cables	Two cables + Surge arrester	Three cables + Surge arrester	Cable connector manufacturer / connector type: ABB Kabeldon	EUROMOLD	nkt cables GmbH	Südkabel GmbH	Tyco
12	1200	AWG 1/0 - 500 (50 - 300)	•					430TBM-P2	CB12-630 CC12-630		RSTI-58xx RSTI-CC-58xx
				•				430TBM-P3	CB12-630 2x CC12-630		RSTI-58xx 2x RSTI-CC-58xx
					•			430TBM-P2 300SA	CB12-630 CC12-630 CSA12...		RSTI-58xx RSTI-CC-58xx RSTI-CC-58SA
						•			CB12-630 2x CC12-630 CSA12...		RSTI-58xx 2x RSTI-CC-58xx RSTI-CC-58SA
		AWG 1/0 - 1000 (50 - 630)	•					484TB/G 804PB/G			
				•				484TB/G 2x 804PB/G			
					•			484TB/G 804PB/G 800SA			
						•		484TB/G 2x 804PB/G 800SA			
		AWG 4/0 - 500 (95 - 300)	•				CSE-A 12630-02 CSEP-A 12630-02				
				•			CSE-A 12630-02 2x CSEP-A 12630-02				
					•		CSE-A 12630-02 CSEP-A 12630-02 CSAP-A 12..				
						•	CSE-A 12630-02 2x CSEP-A 12630-02 CSAP-A 12..				
		600 - 750 (300 - 500)	•							2x SEHDT13	
		1000 (400) 1000 (500) 1000 (630)	•						CB36-630(1250) CC36-630(1250)		
				•					CB36-630(1250) 2x CC36-630(1250)		
					•				CB36-630(1250) CC36-630(1250) CSA12-...		
						•			CB36-630(1250) 2x CC36-630(1250) CSA12-...		

Table 7.7.1.2 b: Selection of cable connectors, panel width 23.62 in, 8.25 kV, max. 1200 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm²)]	Cables fitted: One cable	Two cables	Three cables	One cable + Surge arrester	Two cables + Surge arrester	Three cables + Surge arrester	Cable connector manufacturer / connector type: ABB Kabeldon	EUROMOLD	nkt cables GmbH	Tyco	Cellpack
12	1200	1000 (400 - 630)			•				CSE-A 12630-03 2x CSEP-A 12630-03				
								•	CSE-A 12630-03 2x CSEP-A 12630-03 CSAP-A 12..				
		1000 - 1500 (400 - 800)	•									RSTI-x95x	
				•								RSTI-x95x RSTI-CCx95x	
					•							RSTI-x95x 2x RSTI-CC-x95x	
						•						RSTI-x95x RSTI-CC-68SA	
							•					RSTI-x95x RSTI-CC-x95x RSTI-CC-68SA	
		1000 (500 - 630)	•										CTS 1250A 24kV
						•							CTS 1250A 24kV CTKSA
		1250 - 1750 (630 - 1000)	•								CB42-1250/3		
						•					CB42-1250/3 CSA12		
		1750 - 2000 (800 - 1200)	•							489TB/G			

Table 7.7.1.3 a: Selection of cable connectors, panel width 23.62 in, 15 kV, max. 600 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm^2)]	Cables fitted: One cable	Two cables	Three cables	One cable + Surge arrester	Two cables + Surge arrester	Three cables + Surge arrester	Cable connector manufacturer / connector type: ABB Kabeldon	EUROMOLD	nkt cables GmbH	Südkabel GmbH	Tyco
24	600	AWG 3 - AWG 2/0 (25 - 70)	•						CSE-A 24630-01				
				•					CSE-A 24630-01 CSEP-A 24630-01				
						•			CSE-A 24630-01 CSAP-A 24xx				
							•		CSE-A 24630-01 CSEP-A 24630-01 CSAP-A 24xx				
		AWG 3 - 400 (25 - 240)	•									SET24	
				•								SET24 SEHDK23.1	
						•						SET24 MUT23	
							•					SET24 SEHDK23.1 MUT23	
		AWG 3 - 500 (25 - 300)	•							K430TB	CB24-630		RSTI-58xx
				•						K430TBM-P2	CB24-630 CC24-630		RSTI-58xx RSTI-CC-58xx
					•					K430TBM-P3	CB24-630 2x CC24-630		
						•				K430TB 300SA	CB24-630 CSA24-...		RSTI-58xx RSTI-CC-58SA
							•			K430TBM-P2 300SA	CB24-630 CC24-630 CSA24-...		RSTI-58xx RSTI-CC-58xx RSTI-CC-58SA
								•			CB24-630 2x CC24-630 CSA24-...		
		AWG 1 - 1000 (35- 630)	•							K484TB/G			
				•						K484TB/G K804PB/G			
					•					K484TB/G 2x K804PB/G			
						•				K484TB/G 800SA			
							•			K484TB/G K804PB/G 800SA			

Table 7.7.1.3 b.: Selection of cable connectors, panel width 23.62 in, 15 kV, max. 600 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm^2)]	Cables fitted: One cable	Two cables	One cable + Surge arrester	Two cables + Surge arrester	Cable connector manufacturer / connector type: ABB Kabeldon	nkt cables GmbH	Südkabel GmbH	Cellpack
24	600	AWG 3/0 - (95 - 300)	•				CSE-A 24630-02			
				•			CSE-A 24630-02 CSEP-A 24630-02			
					•		CSE-A 24630-02 CSAP-A 24xx			
						•	CSE-A 24630-02 CSEP-A 24630-02 CSAP-A 24xx			
		400 - 750 (95 - 500)	•					CB24-1250/2		
		600 - 750 (300 - 500)	•						SEHDT23	
		1000 (400) 1000 (500) 1000 (630)	•					CB36-630(1250)		
		1000 (400 - 630)	•				CSE-A 24630-03			CTS 1250A 24kV
					•		CSE-A 24630-03 CSAP-A 24xx			CTS 1250A 24kV CTKSA
		1250 - 1750 (630 - 1000)	•					CB42-1250/3		
					•			CB42-1250/3 CSA24-...		

Table 7.7.1.4 a: Selection of cable connectors, panel width 23.62 in, 15 kV, max. 1200 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm²)]	Two cables	Three cables	Two cables + Surge arrester	Three cables + Surge arrester	Cable connector manufacturer / connector type: ABB Kabeldon	EUROMOLD	nkt cables GmbH	Südkabel GmbH	Tyco
		AWG 3 - 500 (25 - 300)	•					K430TBM-P2	CB24-630 CC24-630		RSTI-58xx RSTI-CC-58xx
				•				K430TBM-P3	CB24-630 2x CC24-630		RSTI-58xx 2x RSTI-CC-58xx
					•			K430TBM-P2 300SA	CB24-630 CC24-630 CSA24...		RSTI-58xx RSTI-CC-58xx RSTI-CC-58SA
						•			CB24-630 2x CC24-630 CSA24...		RSTI-58xx 2x RSTI-CC-58xx RSTI-CC-58SA
		AWG 1 - 1000 (35- 630)	•					K484TB/G K804PB/G			
				•				K484TB/G 2x K804PB/G			
					•			K484TB/G K804PB/G 800SA			
						•		K484TB/G 2x K804PB/G 800SA			
24	1200	AWG 4/0 - 500 (95 - 300)	•				CSE-A 24630-02 CSEP-A 24630-02				
				•			CSE-A 24630-02 2x CSEP-A 24630-02				
					•		CSE-A 24630-02 CSEP-A 24630-02 CSAP-A 24..				
						•	CSE-A 24630-02 2x CSEP-A 124630-02 CSAP-A 24..				
		600 - 750 (300 - 500)	•							2x SEHDT23	
		1000 (400) 1000 (500) 1000 (630)	•						CB36-630(1250) CC36-630(1250)		
				•					CB36-630(1250) 2x CC36-630(1250)		
					•				CB36-630(1250) CC36-630(1250) CSA12-...		
						•			CB36-630(1250) 2x CC36-630(1250) CSA12-...		

Table 7.7.1.4 b: Selection of cable connectors, panel width 23.62 in, 15 kV, max. 1200 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm²)]	Cables fitted: One cable	Two cables	Three cables	One cable + Surge arrester	Two cables + Surge arrester	Three cables + Surge arrester	Cable connector manufacturer / connector type: ABB Kabeldon	EUROMOLD	nkt cables GmbH	Tyco	Cellpack
24	1200	1000 (400 - 630)	•										CTS 1250A 24kV
24	1200	1000 (400 - 630)				•							CTS 1250A 24kV +CTKSA
24	1200	1000 (400 - 630)			•				CSE-A 24630-03 2x CSEP-A 24630-03				
24	1200	1000 (400 - 630)						•	CSE-A 24630-03 2x CSEP-A 24630-03 CSAP-A 24..				
24	1200	1000 - 1500 (400 - 800)	•									RSTI-x95x	
24	1200	1000 - 1500 (400 - 800)		•								RSTI-x95x RSTI-CCx95x	
24	1200	1000 - 1500 (400 - 800)			•							RSTI-x95x 2x RSTI-CC-x95x	
24	1200	1000 - 1500 (400 - 800)				•						RSTI-x95x RSTI-CC-68SA	
24	1200	1000 - 1500 (400 - 800)					•					RSTI-x95x RSTI-CC-x95x RSTI-CC-68SA	
24	1200	1250 - 1750 (630 - 1000)	•								CB42-1250/3		
24	1200	1250 - 1750 (630 - 1000)				•					CB42-1250/3 CSA24		
24	1200	1750 - 2000 (800 - 1200)	•							K489TB/G			

Table 7.7.1.5 a: Selection of cable connectors, panel width 23.62 in, 38 kV, max. 600 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm²)]	Cables fitted: One cable	Two cables	Three cables	One cable + Surge arrester	Two cables + Surge arrester	Three cables + Surge arrester	Cable connector manufacturer / connector type: ABB Kabeldon	EUROMOLD	nkt cables GmbH
38	600	AWG 3 - 500 (25 - 300)	•								CB36-630
				•							CB36-630 CC36-630
						•					CB36-630 CSA36-...
							•				CB36-630 CC36-630 CSA36-...
		AWG 1 - 1000 (35 - 630)	•							M484TB/G	
				•						M484TB/M-P2	
					•					M484TB/M-P3	
						•				M484TB/G 800SA	
							•			M484TB/M-P2 800SA	
								•		M484TB/M-P3 800SA	
		AWG 1/0 - AWG 2/0 (50 - 70)	•						CSE-A 36630-01		
				•					CSE-A 36630-01 CSEP-A 36630-01		
		AWG 1/0 - 400 (50 - 240)	•							M430TB	
			•							M400TB/G	
				•						M400TB/G-P2	
				•						M430TBM-P2	
						•				M430TB 300SA	
						•	•			M400TB/G 400PBxx	
							•			M430TBM-P2 300SA	

Table 7.7.1.5 b: Selection of cable connectors, panel width 23.62 in, 38 kV, max. 600 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm²)]	Cables fitted: One cable	Two cables	Three cables	One cable + Surge arrester	Two cables + Surge arrester	Three cables + Surge arrester	Cable connector manufacturer / connector type: ABB Kabeldon	EUROMOLD	nkt cables GmbH	Südkabel GmbH	Tyco	Cellpack
38	600	AWG 1/0 - 500 (50 - 300)	•										RSTI-68xx	
				•									RSTI-68xx RSTI-CC-68xx	
						•							RSTI-68xx RSTI-CC-68SAxx	
							•						RSTI-68xx RSTI-CC-68xx RSTI-CC-68SAxx	
		AWG 1/0 - 750 (50 - 400)	•											CTS 630A 36kV
		AWG 1/0 - 1000 (50 - 630)	•							M484TB/G				
				•						M484TB/G M804PB/G				
					•					M484TB/G 2x M804PB/G				
						•				M484TB/G 800SA				
							•			M484TB/G M804PB/G 800SA				
								•		M484TB/G 2x M804PB/G 800SA				
		AWG 3/0 - 500 (70 - 300)	•									SET36		
						•						SET36 MUT33		
		AWG 4/0 - 500 (95 - 300)	•						CSE-A 36630-02					
		600 - 750 (300 - 500)	•									SEHDT33		
						•						SEHDT33 MUT33		
		1000 (400) 1000 (500) 1000 (630)	•								CB36-630(1250)			
						•					CB36-630(1250) CSA36-...			
		600 - 1000 (300 - 630)	•							M440TB/G				
				•						M440TB/G-P2				
						•				M440TB/G 400PBxx				
							•			M440TB/G-P2 400PBxx				
		1000 (400 - 630)	•						CSE-A 36630-03					

Table 7.7.1.6 a: Selection of cable connectors, panel width 23.62 in, 38 kV, max. 1200 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm²)]	Cables fitted						Cable connector manufacturer / connector type				
			One cable	Two cables	Three cables	One cable + Surge arrester	Two cables + Surge arrester	Three cables + Surge arrester	EUROMOLD	nkt cables GmbH	Südkabel GmbH	Tyco	Cellpack
38	1200	AWG 3 - 500 (25 - 300)		•						CB36-630 CC36-630			
					•					CB36-630 2 x CC36-630			
							•			CB36-630 CC36-630 CSA36-...			
								•		CB36-630 2 x CC36-630 CSA36-...			
		AWG 1 - 1000 (35 - 630)		•					M484TB/M-P2				
							•		M484TB/M-P2 800SA				
		AWG 1/0 - 400 (50 - 240)		•					M400TB/G-P2				CTS 630A 36kV
				•					M430TBM-P2				
							•		M400TB/G +400PBxx				
							•		M430TBM-P2 +300SA				
		AWG 1/0 - 500 (50 - 300)		•								RSTI-68xx RSTI-CC-68xx	
					•							RSTI-68xx 2x RSTI-CC-68xx	
							•					RSTI-68xx RSTI-CC-68xx RSTI-CC-68SA	
								•				RSTI-68xx 2x RSTI-CC-68xx RSTI-CC-68SA	
		AWG 1/0 - 1000 (50 - 630)		•					M484TB/G M804PB/G				
					•				M484TB/G 2x M804PB/G				
							•		M484TB/G M804PB/G 800SA				
								•	M484TB/G 2x M804PB/G 800SA				
		600 - 750 (300 - 500)	•								SEHDT33		
				•							2x SEHDT33		
						•					SEHDT33 MUT33		
		600 - 1000 (300 - 630)		•					M440TB/G-P2				
							•		M440TB/G-P2 400PBxx				

Table 7.7.1.6 b: Selection of cable connectors, panel width 23.62 in, 38 kV, max. 1200 A

Maximum operating voltage [kV]	Maximum operating current [A]	Cable cross-section [kcmil (mm²)]	Cables fitted: One cable	Two cables	Three cables	One cable + Surge arrester	Two cables + Surge arrester	Three cables + Surge arrester	Cable connector manufacturer / connector type: EUROMOLD	nkt cables GmbH	Tyco	Cellpack
38	1200	1000 (400) 1000 (500) 1000 (630)	•							CB36-630(1250)		
				•						CB36-630(1250) CC36-630(1250)		
					•					CB36-630(1250) 2x CC36-630(1250)		
						•				CB36-630(1250) CSA36-..		
							•			CB36-630(1250) CC36-630(1250) CSA36-..		
								•		CB36-630(1250) 2x CC36-630(1250) CSA36-..		
		1000 (400 - 630)	•									CTS 1250A 36kV
						•						CTS 1250A 36kV CTKSA
		1000 - 1500 (400 - 800)	•								RSTI-x95x	
				•							RSTI-x95x RSTI-CC-x95x	
					•						RSTI-x95x 2x RSTI-CC-x95x	
						•					RSTI-x95x RSTI-CC-68SAxx	
							•				RSTI-x95x RSTI-CC-x95x RSTI-CC-68SAxx	
		1250 - 1750 (630 - 1000)	•							CB42-1250/3		
						•				CB42-1250/3 CSA36		
		1750 - 2000 (800 - 1200)	•						M489TB/G			

7.8 Main grounding bar

The main grounding bar of the switchgear system runs through the cable termination compartments of the panels. The grounding bars in the individual panels are connected together during installation at site. The cross-section of the main ground bar is 789 kcmil (ECuF30 1,58 in x 0.394 in).

Details on grounding the switchgear can be found in section 11.8.

7.9 Test sockets

Panels with inner cone termination system

Outgoing cable panels and cable termination panels are equipped with test sockets (Figs. 7.9.1 and 7.9.2). The test sockets are accessible in the cable termination compartment, and are used to accommodate surge arresters (Fig. 7.9.6) for cable tests, for insulation testing of the panels, for testing of the protection systems by primary current injection and for maintenance grounding of the relevant outgoing feeder panel. Suitable testing and grounding and short-circuiting devices are available for these purposes (Figs. 7.9.3 to 7.9.5).

The test sockets must be closed off with blanking plugs of high dielectric strength during normal operation of the panel.

Panels with outer cone termination system

Testing and grounding sets are connected to the fitted cable plugs via special connection adapters. The connection adapters are to be selected to match the cable plugs used. Further information can be found in the manufacturer's documentation.

Fig. 7.9.1: View into the circuit-breaker compartment: test sockets

Fig. 7.9.2: View from the rear into the cable termination compartment: Test sockets (1) – access blocked by insulating blanking plugs; main grounding bar (transport condition) (2); cable blanking plug (3) for unused cable sockets, and wiring for capacitive indicator unit (4).

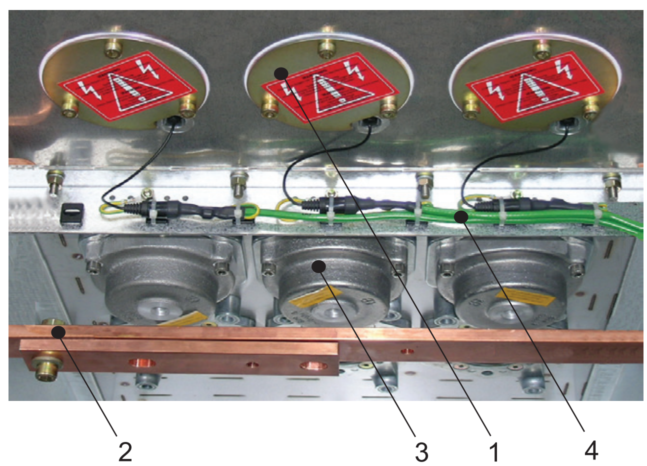


Fig. 7.9.3: Current test plug

Fig. 7.9.4: Voltage test plug

Fig. 7.9.5: Grounding or short-circuiting device for inner cone systems

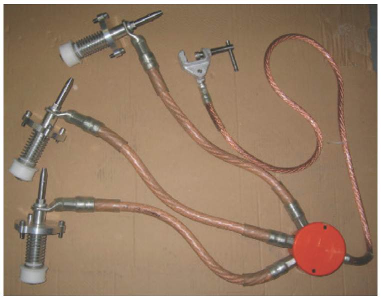


Fig. 7.9.6: Surge arrester

7.10 Capacitive voltage indicator systems

Two types of capacitive, low impedance voltage indicator systems are available for checking of the off-circuit condition of a feeder. The coupling electrode is integrated in the test sockets or in the sensors and – when an additional capacitive voltage indicator system is fitted in the panel door – in the cable sockets. The capacitive voltage indicator system is located at the rear of the panel. A further system in the low voltage compartment door can also be used.

Both systems used are voltage detection systems (VDS) according to IEC 61243-5.

The systems used allows phase comparison with the aid of an addition, compatible phase comparator.

System WEGA 1.2 C (Fig. 7.10.1)

- LC-Display
- Three phase
- No additional indicator unit required
- Auxiliary voltage not required
- Maintenance-free with integrated self-test in built-in condition
- Phase-selective overvoltage indication
- Three phase symbolic display:
  - Voltage present / no voltage present (Threshold value for voltage presence indication: 0.1 - 0.45 x U_N)
  - Integrated maintenence test passed
  - Voltage signal too high (Overvoltage indication)

System WEGA 2.2 C (Fig. 7.10.2)

As system WEGA 1.2 C, but:
- Two integrated relay contacts (changeover contacts) for signals/interlocks
- Auxiliary voltage for relay function required (LC-Display function via measuring signal)
- LED indication
  - green for U = 0
  - red for U ≠ 0

Fig. 7.10.1: System WEGA 1.2 C

Fig. 7.10.2: System WEGA 2.2 C

7.11 Current and voltage detection devices

The areas of application for current and voltage detection devices are

- Protection applications
- Measurement
- Billing metering

Current and voltage transformers comply with the ANSI - standard. Please consult ABB regarding current and voltage transformer data.

Current transformers

The inductive transmission principle of a current transformer is based on the use of a ferromagnetic core. Irrespective of its structure as a bushing-type, block-type transformer, bar-primary or wound-primary transformer, a current transformer is in principle subject to hysteresis and saturation. In the rated current range, the primary and secondary currents are proportional and in phase.

Voltage transformers

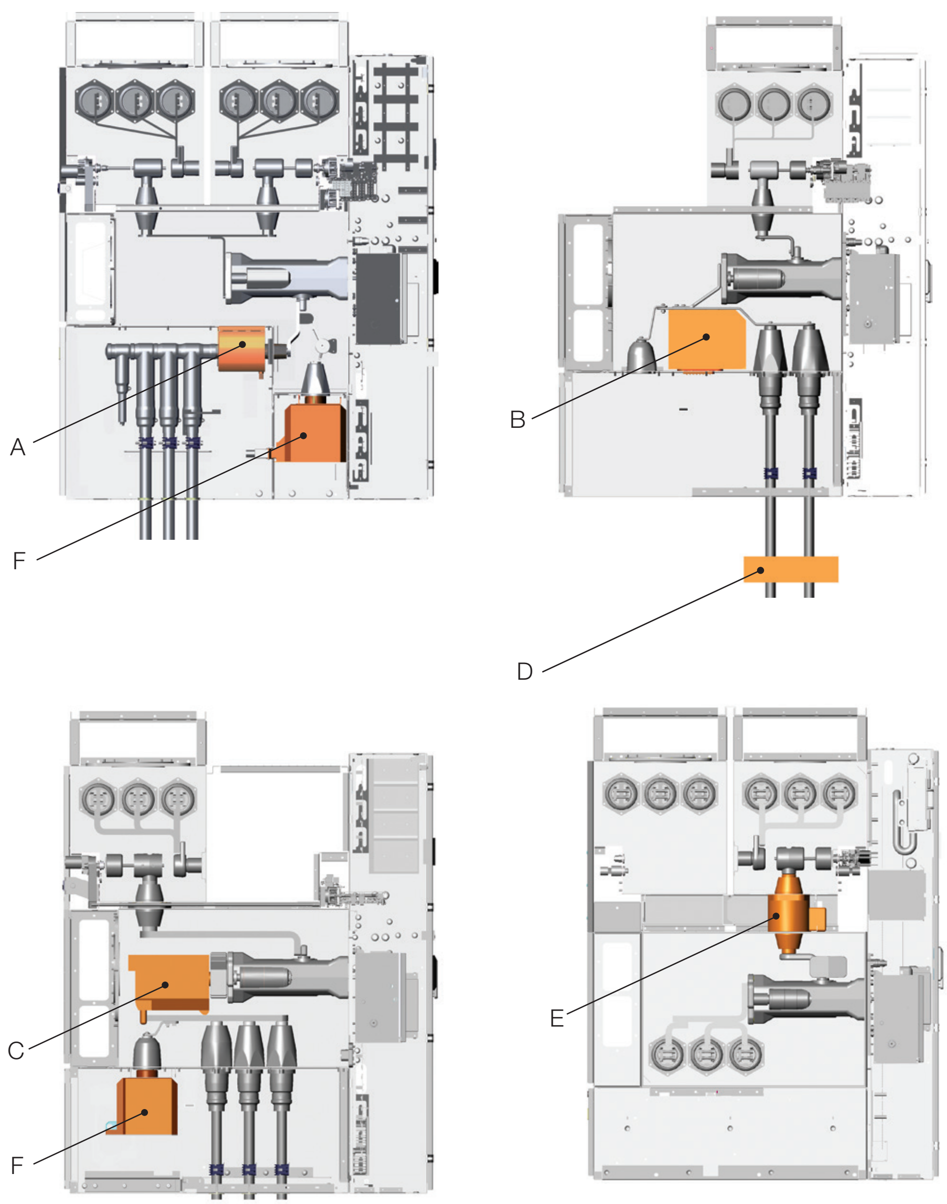
Inductive voltage transformers are low capacity transformers in which the primary and secondary voltage are proportional and in phase. The primary and secondary windings are electrically isolated from each other.

The following current and voltage detection devices can be used (see Fig. 7.11.3):

- Device A: Ring core current transformer for fitting to the outer cone bushing
- Device B: Block-type transformer in the circuit-breaker compartment
- Device C: Current transformer in the circuit breaker compartment
- Device D: Zero sequence ring core transformer for ground fault detection below the panel (in the cable basement)
- Device E: Optional bushing-type current transformer between the three position disconnect and circuit-breaker, located in a sectionalizer and riser panel
- Device F: Voltage transformer (outside the gas compartment only, plug-in type)

Current and voltage transformers are certifiable.

Fig. 7.11.3: Current and voltage detection devices



7.11.1 Ring core current transformer

Ring core current transformers (Fig. 7.11.1.1) are used in panels with outer cone connection systems. A distinction is made between two versions, depending on the rated current and the panel width. Only when the ring core current transformer has been slid onto a primary conductor - an outer cone bushing or a cable - has a functioning device created.

Ring core current transformers are located outside the gas compartment and comprise the iron core and the secondary winding. The cross-section of the connecting wires is AWG 13 (larger cross-sections on request).

Panels with only one cable per phase can also be fitted on request with ring core current transformers in the form of straight-through transformers for cables.

Fig. 7.11.1.1: Ring core current transformer

[1] Depending on rated primary current

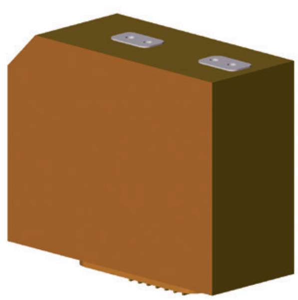
7.11.2 Block-type transformers

The block-type instrument transformer (Fig. 7.11.2.1) used in outgoing feeder panels with inner cone cable connection system for rated currents up to 1200 A [1] and in various bus tie panels for rated currents up to 2500 A.

The block-type transformer consists of cast resin in which the corresponding components are embedded. It is located in the gas compartment, and is therefore protected from external influences. The terminal board is easily accessible from the outside and lead-sealable. The cross-section of the connecting wires is AWG 13 (larger cross-sections on request).
At low primary currents, the block-type transformer provides the opportunity to lay the primary conductor around the iron core in several windings (wound-primary transformer). This can significantly increase the performance of the transformer.

When only current transformers are used, the device can contain up to three current transformer cores in a 23.62 in wide panel and up to five current transformer cores in an 31.50 in wide panel.

Fig. 7.11.2.1: Block-type transformer, device B

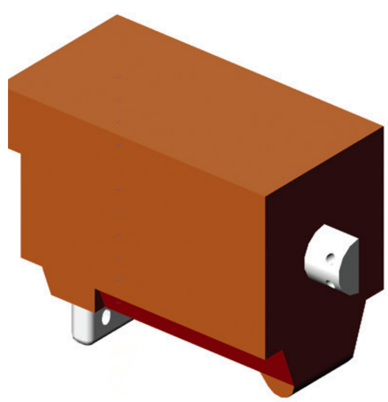


7.11.3 Current transformers

Outgoing feeder panels for currents > 1200 A are fitted with current transformers as shown in Fig. 7.11.3.1. These transformers are located in the gas compartment and can accommodate up to five cores.

The secondary wiring of the current transformer is routed out of the gas compartment into the low voltage compartment via secondary bushings below the circuit-breaker. The cross-section of the connecting wires is AWG 13 (larger cross-sections on request).

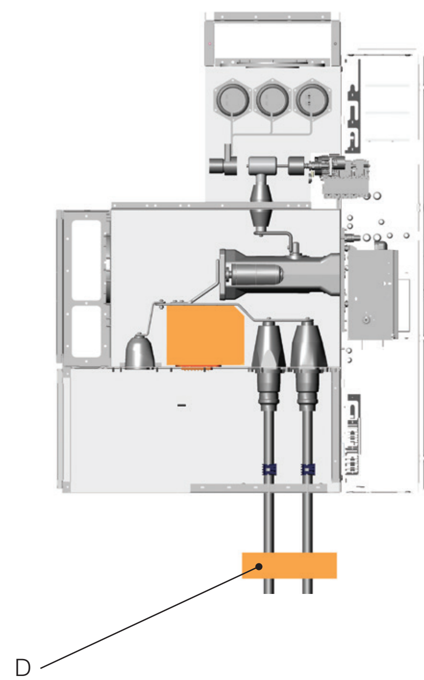
Fig. 7.11.3.1: Current transformer, device C



7.11.4 Zero sequence ground-fault transformers

Ground fault transformers (device D, Fig. 7.11.4.1) are special ring core transformers. As all the power cables in a panel are routed through the transformer, the opening in the transformer has to be correspondingly large. As a result of their size, ground fault transformers are installed in the cable basement below the panel.

Fig. 7.11.4.1: Zero sequence groundfault transformer, device D



7.11.5 Dimensioning of current transformers

The stipulations and recommendations of IEC 61936, section 6.2.4.1 "Current transformers", IEC / EN 60044-1 and IEC 60044-6 are to be observed in the design of current transformers. The rated overcurrent factor and burden of current transformer cores are to be selected in such a way that protection devices can function correctly and measuring systems are not damaged in the event of a shortcircuit.

Protection purposes

Protection cores are logically operated at above rated current. The function of the selected protection system is essentially determined by the connected current transformer. The requirements to be fulfilled by the current transformers for the selected protection or combination device can be found in the documentation from the protection equipment supplier. For an accurate switchgear proposal, these current transformer data are to be provided with the product inquiry and then finally agreed by the operator and manufacturer in the order.

The direct path to the right current transformers is via the technical documentation of the selected protection device. The current transformer requirements of the relay can be found there.

Measuring purposes

In order to protect measuring and metering devices from damage in the case of a fault, they should go into saturation as early as possible. The rated burden of the current transformer should be approximately the same as the operating burden consisting of the measuring instrument and cable. Further details and designations can be found in EN 60044-1.

Recommendations

In principle, we recommend a rated secondary current of 1 A. The current transformer ratings for ABB protection devices are known. The transformer data can be selected to suit the protection application and the network parameters. However, if a third party devices are to be connected, we recommend a review by our engineers at an early stage. Taking account of the burdens and overload capacities, our experts can examine the entire current transformer requirements of the third party protection devices on request.

Further information for different protection systems

If the current transformers to be used in the network concerned (e.g. on the opposite side of the network) have already been specified, early coordination of the switchgear configuration is advisable. This requires, but is not limited to, the provision of data on the ratio, rated capacity, accuracy class, and the resistance of the secondary winding and wiring. Further configurations for the particular application can then be requested.

7.11.6 Voltage transformers

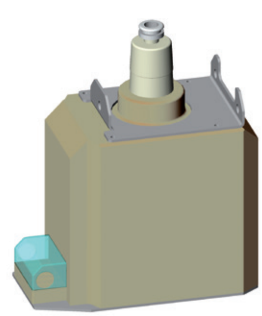
The voltage transformers are always located outside the gas compartments. They are of the plug-in type (plug size 2 to EN 50181 and DIN 47637). In feeder panels and in integrated meterings without isolating systems the voltage transformers can be dismantled for test purposes.

Voltage transformers in metering panels can be isolated. Integrated meterings can be equipped with an isolating device for the voltage transformers. Isolating devices include an earthing function for the isolated voltage transformers. In integrated meterings isolator devices for voltage transformers can be equipped with auxiliary switches.

Voltage transformers in outgoing feeder panels of 23.62 in width are suitable for rated voltages up to 34.5 kV (60 Hz).

Primary fused voltage transformers are available on request.

Fig. 7.11.6.1: Plug-in type voltage transformer, device G



[1] Depending on rated primary current

7.12 Protection and control units

ABB provides the right protection and automation solution for every application.

Table 7.12.1 below provides an overview of the most important protection devices with notes on their range of applications. Further information can be obtained in the Internet (http://www.abb.de/mediumvoltage) or from the responsible ABB contact for you.

Table 7.10.1: Application of protection and control units

		Application					Communication protocol			
	Unit designition	Feeder protection	Motor protection	Transformer protection	Voltage regulation	Bay control and measurement	IEC 61850	IEC 60870-5-103	Modbus	DNP 3.0
Main protection	REF620	•				• [1]	•	•	•	•
	REM620 [2]		•			• [1]	•	•	•	•
	RET620 [2]			•	•	• [1]	•	•	•	•
Backup protection	REF615	•								
	REM615		•							
	RET615			•						

[1] For panels with single bus bar
[2] On request

7.13 Sulphur hexafluoride

Sulphur hexafluoride (chemical symbol SF_6) is non-toxic, non-combustible, chemically inactive gas with a high dielectric strength.

Its unique electrical and thermal properties have made the design of new, more efficient switchgear possible. The change from conventional insulation to the non-flammable, chemically inactive and non-toxic, heavy gas sulphur hexafluoride has led to significant savings in space and materials, and to greater safety for the installations. Switchgear systems insulated with sulphur hexafluoride have become highly successful especially in applications where space is constricted and compact design is required. On account of their insensitivity to air-pollution, enclosed SF_6 systems are also used in the chemicals industry, in desert areas and at coastal locations.

SF_6 has been used in HV-switchgear since 1960.

7.14 Gas system in the panels

SF_6 is used as the insulating medium.

The gas compartments are designed as hermetically sealed pressure systems. As they are filled with SF_6, constant ambient conditions are permanently ensured for the entire high voltage area of the panel. It is not necessary to top up the insulating gas during the expected service life of the system. Under normal operating conditions, no inspections on the insulating gas are necessary. The insulating gas is maintenance-free.

The circuit-breaker compartment and the busbar compartment in each panel are separate gas compartments with their own gas filling connectors (Fig. 7.14.1). The gas compartments of the individual panels in a row are not connected together.

Each panel has gas filling connectors (Fig. 7.14.1 - see also section 6), through which the gas compartments can be filled with gas, for instance in the case of repairs.

The service pressure in the individual gas compartments is monitored by separate density sensors (temperature-compensated pressure sensors, Fig. 7.14.2). A shortfall below the insulation warning level (17.40 PSI) in a gas compartment is indicated on the protection and control unit or by a signal lamp. Temporary operation of the panel at atmospheric pressure (> 14.5 PSI) is in principle possible if the SF_6 content of the insulating gas is at least 95 % (exception: 17.40 PSI required for test voltages > 70/170 kV).

As an option, the thermal effects of an internal arc fault can be limited by an I_{th} protection function. For this purpose, the signal from an additional switching contact for all the gas density sensors (threshold 27.56 PSI) is logically linked to an overcurrent excitation system and used to trip defined circuit-breakers. The logic operation is performed by the combined protection and control unit, and reduces the breaking time to only approx. 100 ms.

Leakage testing of the gas compartments during manufacturing process

The leakage rate of the gas compartments is determined by integral leakage testing:
Inside a pressure test cabin, following evacuation of the gas compartments, the panel is filled with helium. The leakage rate of the gas compartments is determined by measurement of the proportion of helium in the test cabin. The helium is then recovered as the gas compartments in the panel are evacuated again. Thereafter, the gas compartments are filled with insulating gas at the rated filling pressure.
A successful leakage test is therefore the necessary condition for filling the systems with insulating gas.

Fig. 7.12.1: Gas filling connector

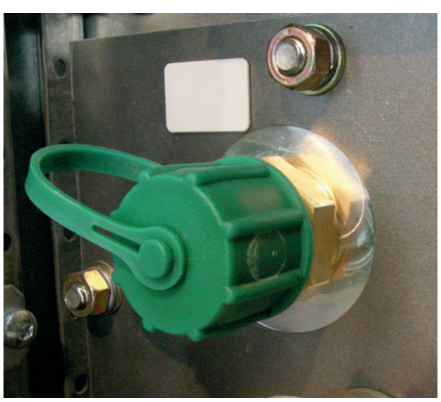


Fig. 7.12.2: Density sensor

7.15 SF_6 density sensor

Fig. 7.15.1 shows the function of the SF_6 density sensor. Between the measuring chamber and a reference chamber there is a moving mounting plate which operates electrical contacts.

Temperature compensation

The pressure in the monitored gas compartment rises with increasing temperature. However, the temperature in the reference chamber and thus the pressure of the reference volume, increases to the same extent. This does not lead to any movement of the mounting plate.

Self-supervision

A drop in pressure of the reference volume results in a movement of the mounting plate (to the right in Fig. 7.15.1). The self-supervision contact is operated. As the system is designed as a closed circuit, both, wire breakages and defective plug and terminal connections are signaled as faults.

Gas losses

A loss of gas in the monitored gas compartment results in a drop in pressure in the measuring volume and thus a movement of the mounting plate (to the left in Fig. 7.15.1). The contact for the pressure loss signal is operated.

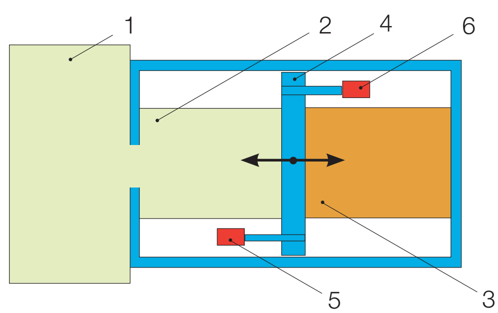
Two versions of SF_6 density sensors

Two versions of the density sensors (Figs. 7.15.2 and 7.15.3) are used.

1. A common indication for gas loss, wire breakage, defective plug connection and defective pressure sensor for the reference volume.

2. Separate indications for a) gas loss, wire breakage and defective plug connection, and b) defective pressure sensor for the reference volume, wire breakage and defective plug connection.

Fig. 7.15.1: Schematic diagram of the function of the SF_6 density sensor



1	Monitored gas compartment
2	Measuring volume
3	Enclosed volume for temperature compensation (reference volume)
4	Mounting plate moved by interaction of forces (pressure of measuring volume against pressure of reference volume)
5	Contact for self-supervision (p > 21.76 PSI)
6	Contact for gas loss (p < 17.40 PSI)

Fig. 7.15.2: Version 1 of the SF_6 density sensor

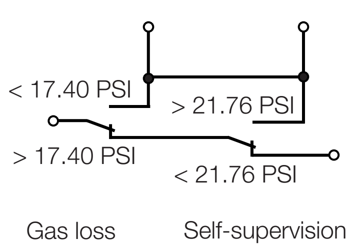
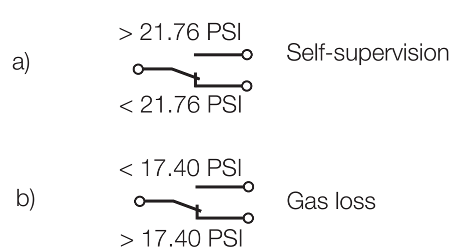


Fig. 7.15.3: Version 2 of the SF_6 density sensor



7.16 Plenum systems

In the unlikely event of an internal arc fault in a gas compartment, the relevant pressure relief disk opens.

There is an opportunity to discharge pressure via plenums; either via an absorber into the switchgear room or via extended plenums to the outside of the building.

Pressure relief via plenums and absorbers into the switch-room (Fig. 7.16.1)

Discharge of pressure from the circuit-breaker compartments and cable termination compartments is effected via the rear plenum, and then through a plenum designed as a broad end cover at the side of the switchgear block into the upper duct. Discharge of pressure from the busbar compartments is directed into the upper plenum. The pressure surge is cooled in the (plasma) absorber located above the upper duct and released into the switchgear room.

Pressure relief to the outside via plenums and absorbers (Fig. 7.16.2)

Discharge of the pressure takes place in principle in the same way as pressure relief via absorbers. The pressure is discharged into the open air by means of a customized plenum extension leading to an opening in the outside wall of the switchroom

The building wall through which the plenum is led to the outside must not contain any combustible materials. The area outside below the pressure relief discharge opening is to be fenced off and marked with warning signs. There must not be any accessible areas such as stairs or walkways above the pressure relief opening. Storage of combustible materials in the areas mentioned is prohibited. The dimensions of the hazardous area can be found in the section entitled "Hazardous area for pressure relief to the outside".

7.17 Surface treatment

The gas-tight enclosures of the panels consist of stainless steel sheets. The cable termination compartments, the low voltage compartments, the covered plenums at the rear and the plenums on the busbar compartments are manufactured from galvanised sheet steel; therefore surface treatment is not required in these cases.

The covers at the rear of the panels and the end covers at the sides of the switchgear system can be supplied galvanized or alternatively coated with a powder stove enamel in ANSI 61 (light grey).

Other colours for the painted components are available on request.

8 Range of panels

The following panel variants are available in single and double busbar versions:

- Incoming and outgoing feeder panels
- Cable termination panels
- Sectionalizer panels
- Metering panels
- Customized panel versions

Please note: The stated panel depths refer to a low voltage compartment depth of 19.69 in.

Fig. 7.16.1: Plenum (discharging into the switchroom)

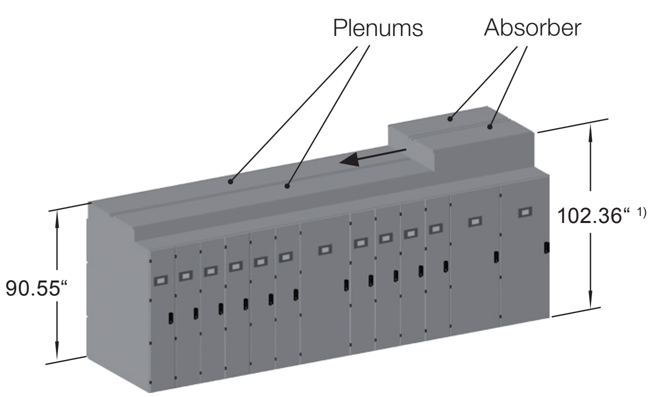
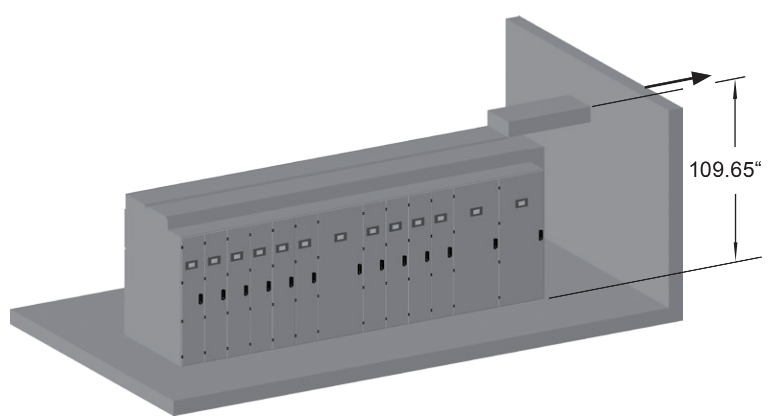


Fig. 7.16.2: Plenum (discharging to the outside)



1) Without taking account of voltage transformers or heat sinks on busbar compartments

8.1 Panels in single busbar design

8.1.1 Feeder panels

8.1.1.1 Incoming and outgoing feeder panels with inner cone cable plug system

Fig. 8.1.1.1.1: Feeder panel 1200 A with block-type transformer and two cable per phase

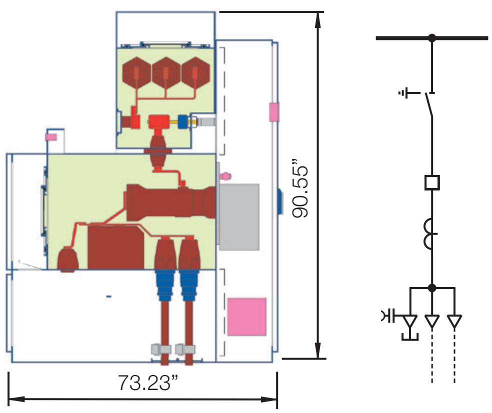


Fig. 8.1.1.1.2: Feeder panel 2000 A with current and voltage transformer and three cables per phase

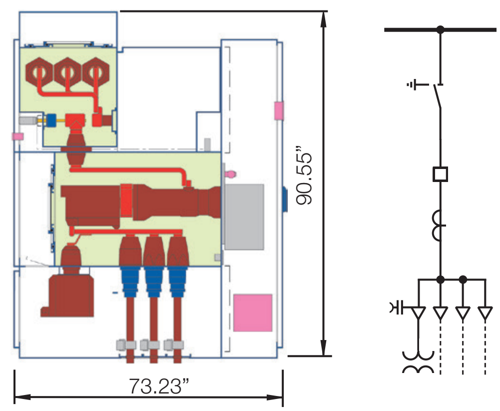


Fig. 8.1.1.1.3: Feeder panel 2500 A (width 33.07 in) with current and voltage transformer and four cables per phase

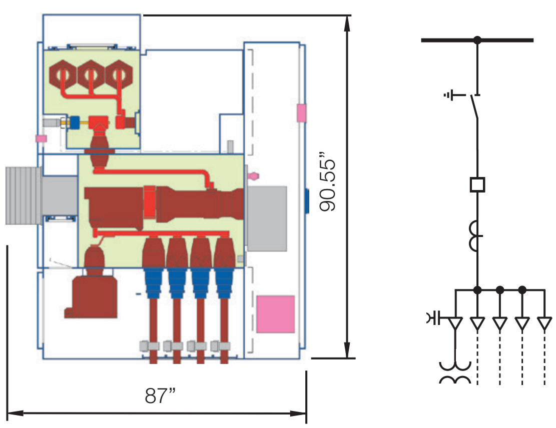
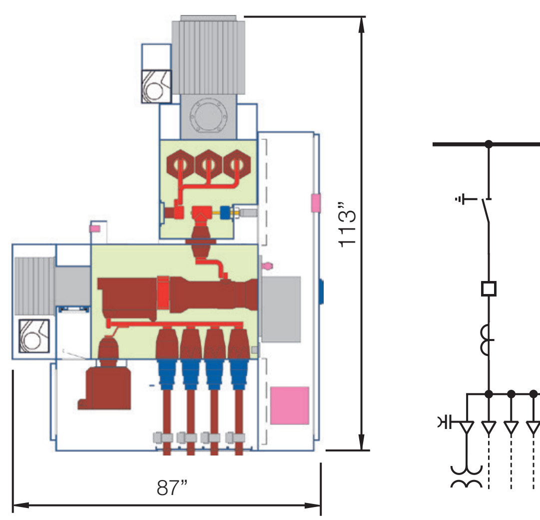


Fig. 8.1.1.1.4: Feeder panel 3000 A (width 33.07 in) with current and voltage transformer and four cables per phase



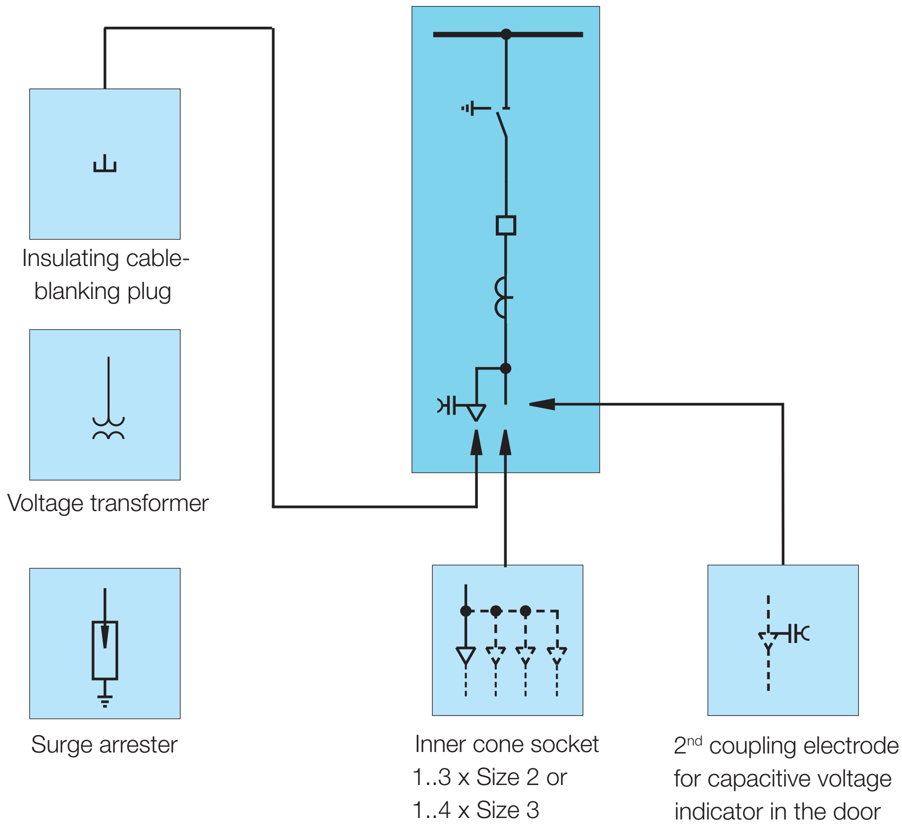


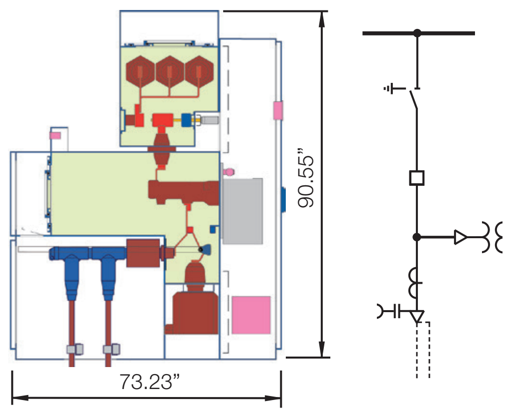
Table 8.1.1.1.1: Overview of variants of incoming and outgoing feeder panels with inner cone termination system

Panel width 23.62 in:	U_r:	... 38 kV (test voltages 70 kV / 150 kV)
	I_r:	... 800 A (1 x size 2)
	I_r:	... 1200 A (2 ... 3 x size 2 and 1 ... 2 x size 3) [1]
	I_p:	... 40 kA
Panel width 31.50 in:	U_r:	... 38 kV
	I_r:	... 1200 A (1 ... 3 x size 3) [1]
	I_r:	... 2000 A (3 ... 4 x size 3)
	I_p:	... 40 kA
Panel width 33.07 in:	U_r:	... 38 kV
	I_r:	... 3000 A (3 ... 4 x size 3)
	I_p:	... 40 kA

[1] Three sockets per phase only in conjunction with current transformers to Fig. 7.11.3.1

8.1.1.2 Incoming and outgoing feeder panels with outer cone cable plug system

Fig. 8.1.1.2.1: Feeder panel with outer cone, 1200 A



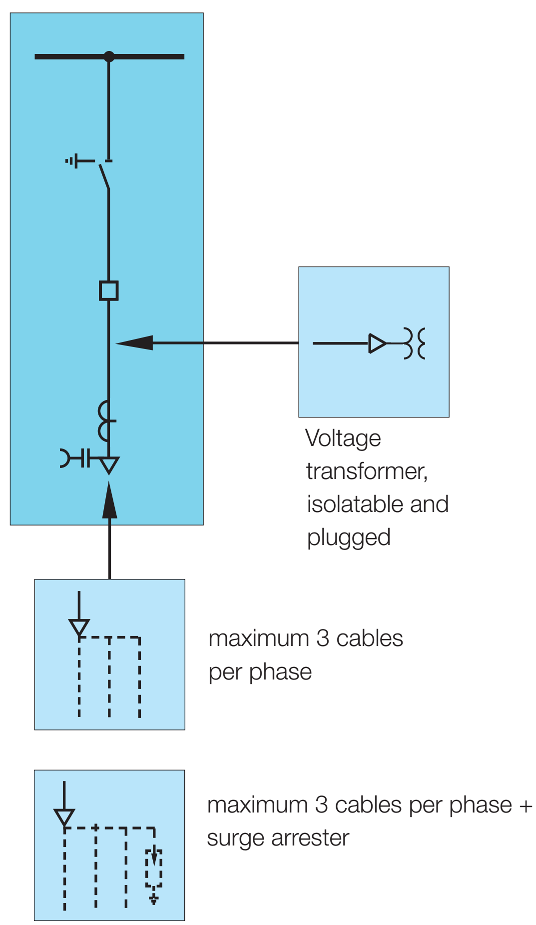


Table 8.1.1.2.1: Overview of variants of feeder panels with outer cone termination system

Panel width 23.62 in:	U_r:	... 38 kV (test voltages 70 kV / 150 kV)
	I_r:	... 1200 A
	I_p:	... 40 kA

8.1.1.3 Panels with operating currents over 3000 A and up to 4000 A

Incoming feeder panels (I_r up to 4000 A, Fig. 8.1.1.3.1)

In this version, the busbars of two double busbar panels of 31.75 in width each are connected in parallel by the disconnects. These two panels thus perform the function of a single busbar panel for currents up to 4000 A.

The operating current coming from the cable sockets is fed via the two circuit-breakers and the four disconnects in the two panels to the two parallel busbars.

Display of the switch positions and control of the switching devices are effected at the master control unit (only one of the two human-machine interfaces is used for display and control). The function of the two panels as a single busbar panel is shown on the display of this human-machine interface.

The two grounding switches are operated while the pure disconnects remain in the OFF position.

Outgoing feeder panels within a block with parallel busbars (I_r up to 2500 A, Fig. 8.1.1.3.2)

The feeder current coming from the two parallel busbars is fed via the two disconnects and the circuit-breaker to the cable sockets. This double busbar panel thus performs the function of a single busbar panel with one busbar for currents up to 4000 A.

Display of the switch positions and control of the switching devices are effected by the human-machine interface of the protection and control unit. The function of the panel as a single busbar panel is shown on the display of this human-machine interface.

The grounding switch is operated while the pure disconnect remains in the OFF position.

The variants for this panel version can be found in section 8.2.1.

Fig. 8.1.1.3.1: Example of an incoming feeder in single busbar design with I_r = 4000 A, consisting of two panels with a width of 31.75 in each.

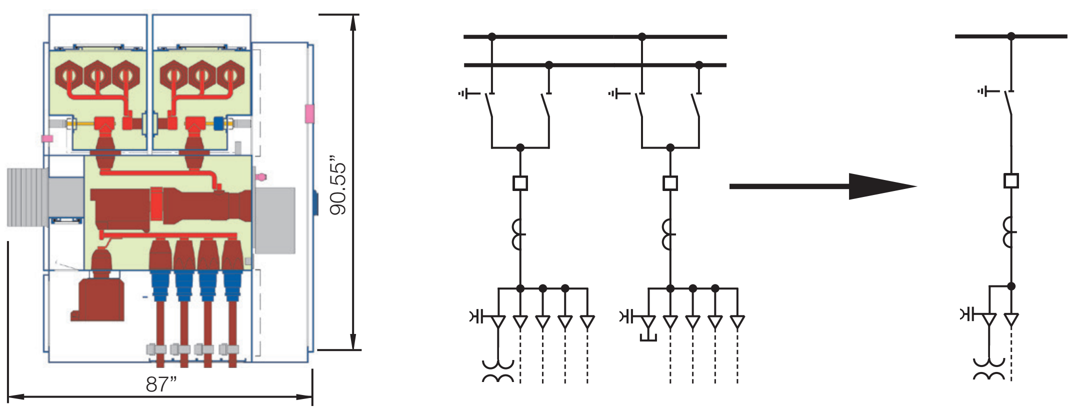
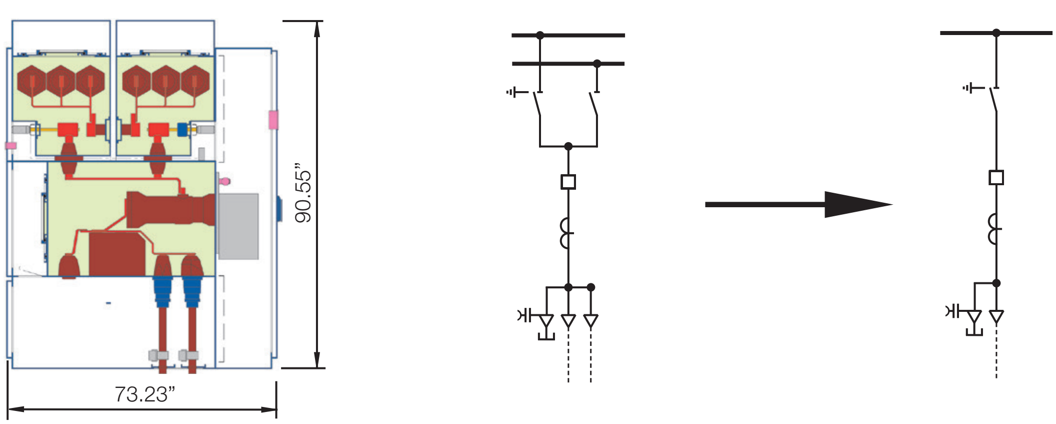


Fig. 8.1.1.3.2: Example of an outgoing feeder for parallel busbars



8.1.1.4 Cable termination panels

Fig. 8.1.1.4.1: Cable termination panel 2000 A

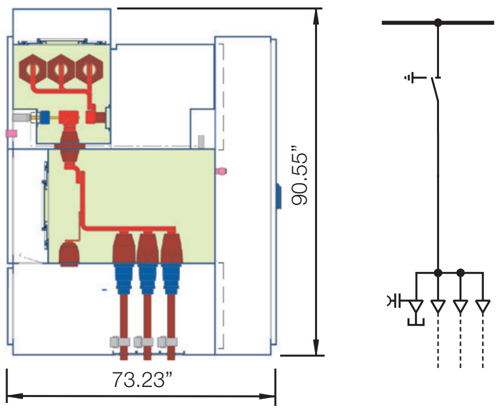
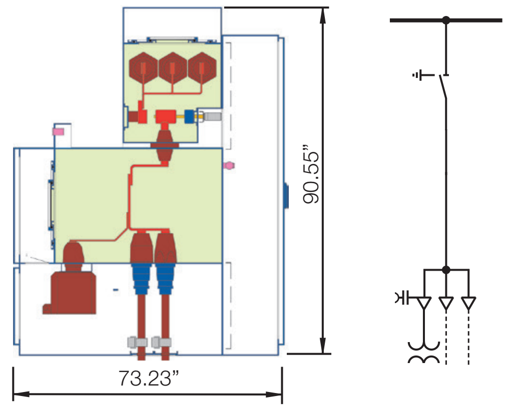


Fig. 8.1.1.4.2: Cable termination panel 1200 A with voltage transformer at the cable



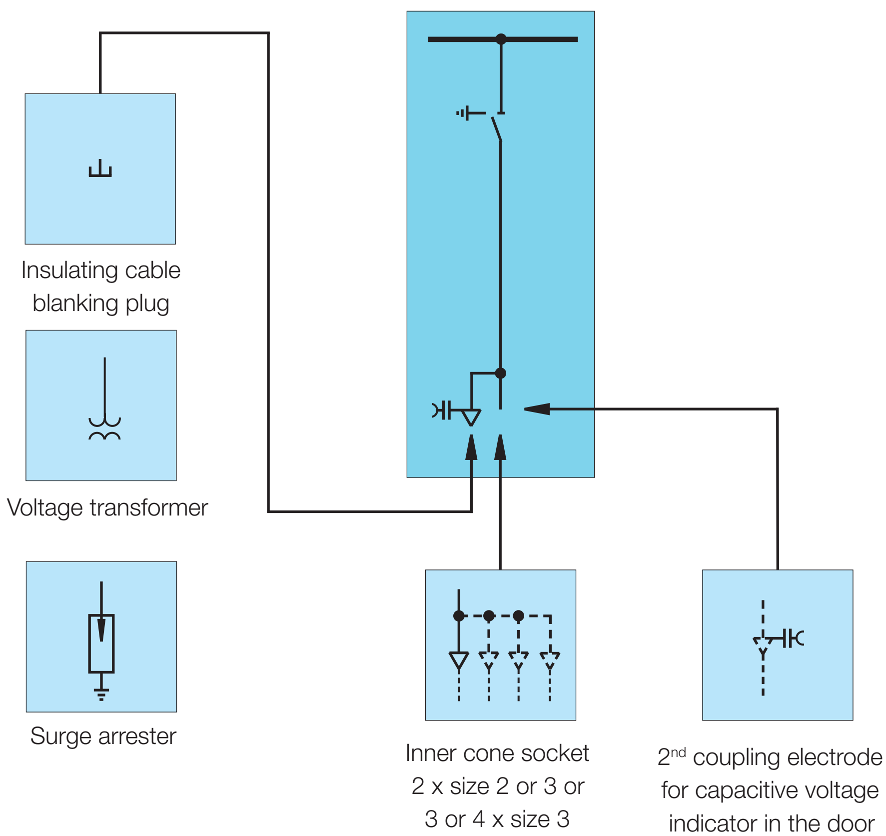


Table 8.1.1.4.1: Overview of variants for cable termination panels

Panel width 23.62 in:	U_r:	... 38 kV (test voltages 70 kV / 150 kV)
	I_r:	... 1200 A (2 x size 2 or 3)
	I_p:	... 40 kA
Panel width 31.50 in:	U_r:	... 38 kV
	I_r:	... 2000 A (3 or 4 x size 3)
	I_p:	... 40 kA
Panel width 33.07 in:	U_r:	... 38 kV
	I_r:	... 3000 A (3 or 4 x size 3)
	I_p:	... 40 kA

8.1.2 Busbar sectionalizer panels

8.1.2.1 Sectionalizer within a switchgear block

The sectionalizer panel contains the circuit-breaker, two three position disconnects and a block-type current transformer.

In addition, sectionalizers can be fitted with current transformers between the circuit-breaker and the three position disconnects. In the sectionalizer panel, the position of the busbar changes from front to rear or vice versa.

Fig. 8.1.2.1.1: Sectionalizer panel 1200 A with block-type CT

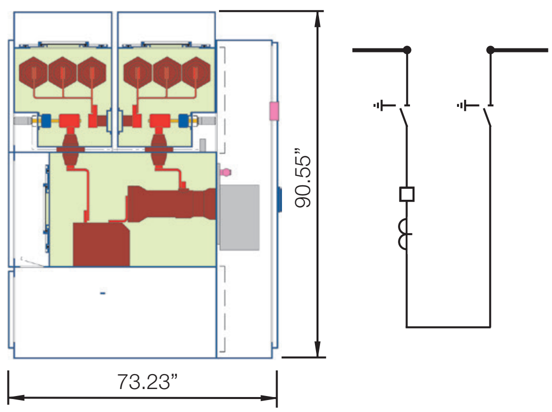


Fig. 8.1.2.1.2: Sectionalizer panel 2000 A with current transformers

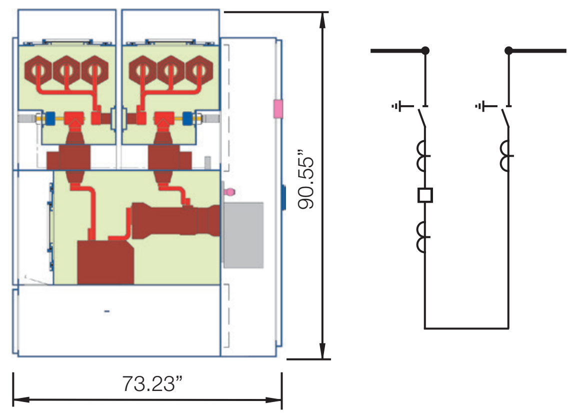


Fig. 8.1.2.1.1.3: Sectionaliser panel 2500 A (width 840 mm) with current transformers

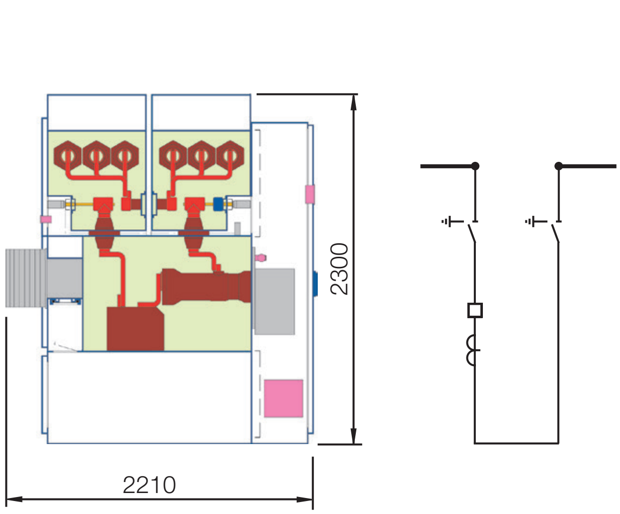
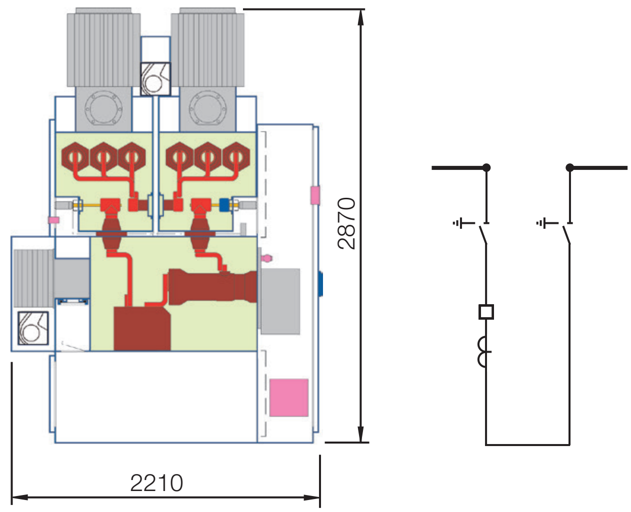


Fig. 8.1.2.1.1.3: Sectionaliser panel 3000 A (width 840 mm) with current transformers



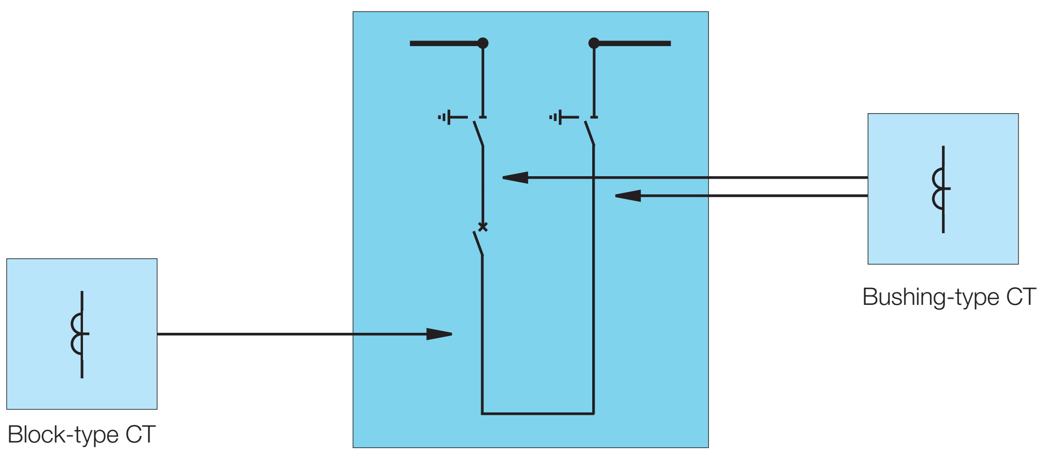
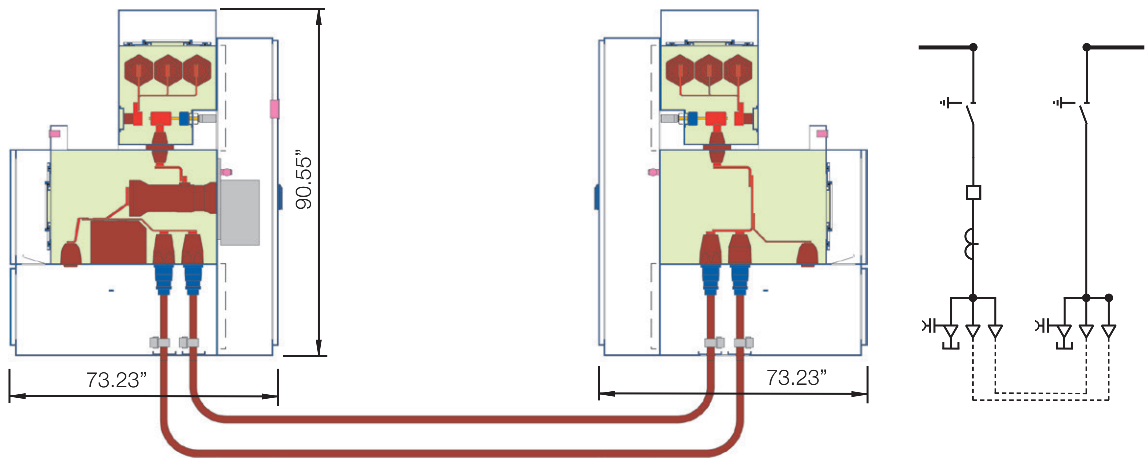


Table 8.1.2.1.1: Overview of variants for sectionalizer panels

Panel width 23.62 in:	U_r: I_r: I_p:	... 38 kV (test voltages 70 kV / 150 kV) ... 1200 A ... 40 kA	Two variants: - Without transformers - Block-type CT
Panel width 31.50 in:	U_r: I_r: I_p:	... 38 kV ... 1200 A or ..2000 A ... 40 kA	Four variants: - Without transformers - Block-type CT - Bushing-type CT - Block-type CT + Bushing-type CT
Panel width 33.07 in:	U_r: I_r: I_p:	... 38 kV ... 2500 A or ... 3000 A ... 40 kA	2 variants: - Block-type CT or sensor - Block-type CT or sensor + Bushing-type CT

8.1.2.2 Sectionalizer using cables (connection of two system blocks)

Fig. 8.1.2.2.1: Sectionalizer using cables (connection of two system blocks)



The overview of variants can be found in sections 8.1.1.1 (feeder panels) and 8.1.1.3 (cable termination panels).

8.1.3 Metering Panels

The following methods of busbar metering are available:

The metering panels

The metering panel contains a three position disconnect for isolating the voltage transformers.

Integrated metering with plugged-in voltage transformers

Sockets for plug-in voltage transformers are provided above the busbar compartment in outgoing feeder panels with integrated measurement. The following limitations to the use of integrated measurement must be taken into account at the planning stage:

- For 31.75 in wide panels.
- For panels without cooling systems.
- Integrated metering in sectionalizer panels is possible with pressure relief at both sides.
- The distance from the end of the system with plenum must be three panel widths.
- The ceiling height must be at least 118.11 in.
- The transport unit height is 90.55 in.

The integrated busbar metering system with plugged-in and isolatable voltage transformers

Above the busbar compartment of an outgoing feeder panel with integrated busbar metering, there are sockets for plug-in voltage transformers and a series isolating device with optional auxiliary switches. As a snap-action operating mechanism is used, operation of the isolating device is even possible when the busbar is live. The following limitations must be taken into account in the planning when an integrated busbar metering system with isolatable voltage transformers is used:

- For 31.75 in wide panels including.
- For panels without cooling systems.
- Integrated metering in sectionalizer panels is possible with pressure relief at both sides.
- The distance from the end of the system with plenum must be three panel widths.
- The ceiling height must be at least 137.80 in.
- The transport unit height is 91.73 in.
- Gas work at site is necessary.

Fig. 8.1.3.1: Metering panel (Example: Measurement of the front busbar), panel depth 31.50 in, with three-position disconnect

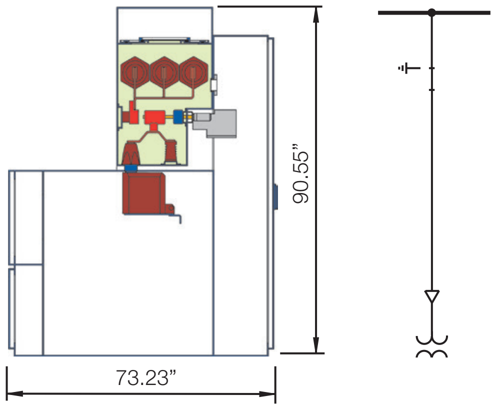


Fig. 8.1.3.2: Integrated busbar metering system with plug-in voltage transformers (example for measurement of the rear busbar)

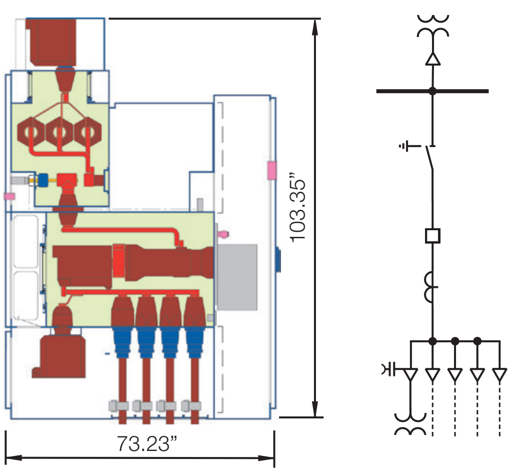


Fig. 8.1.3.3: Integrated busbar metering system with plug-in and isolatable voltage transformers for max. test voltages of 85 kV / 185 kV (example for measurement of the front busbar)

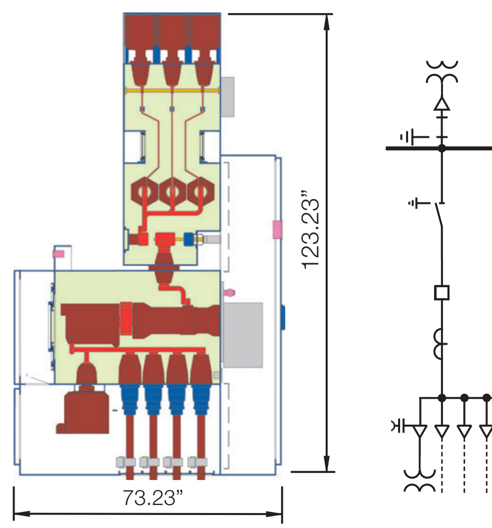


Table 8.1.3.1: Overview of variants of metering panels

Panel width 31.50 in:	U_r:	... 38 kV	Metering panel with three position disconnect Integrated busbar measurement - Voltage transformers plugged in (Fig. 8.1.3.2) - Voltage transformers plugged in and isolatable (Fig. 8.1.3.3) (test voltages 70 kV / 150 kV)

8.2 Panels in double busbar design

8.2.1 Feeder panels

8.2.1.1 Incoming and outgoing feeder panels with inner cone cable plug system

Fig. 8.2.1.1.1: Feeder panel 1200 A with block-type transformer or sensor and two cables per phase

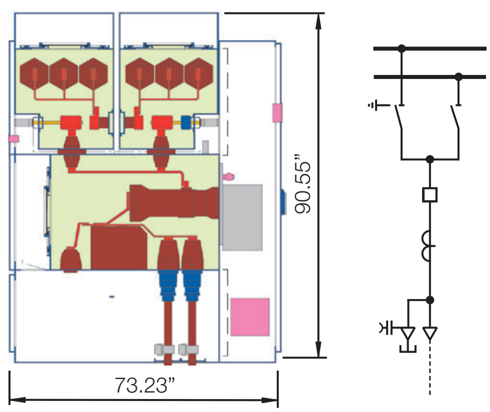


Fig. 8.2.1.1.2: Feeder panel 2500 A with current and voltage transformer and three cables per phase

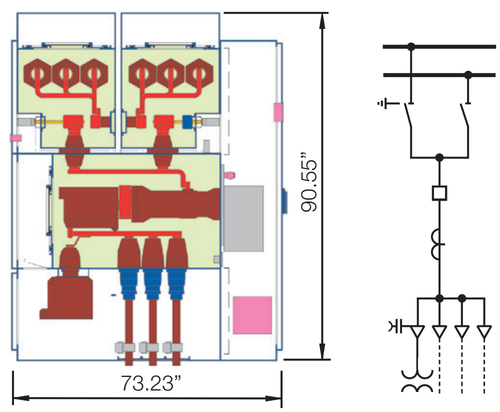


Fig. 8.2.1.1.3: Feeder panel 2500 A (width 33.07 in) with current and voltage transformer and four cables per phase

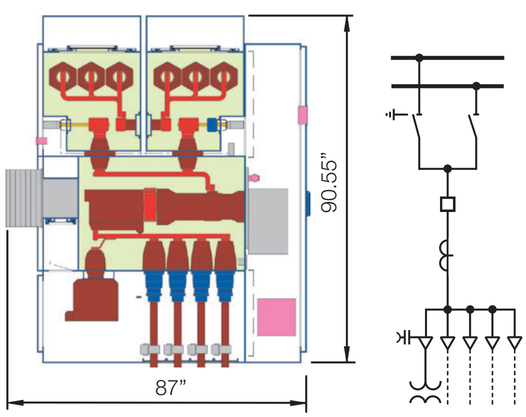
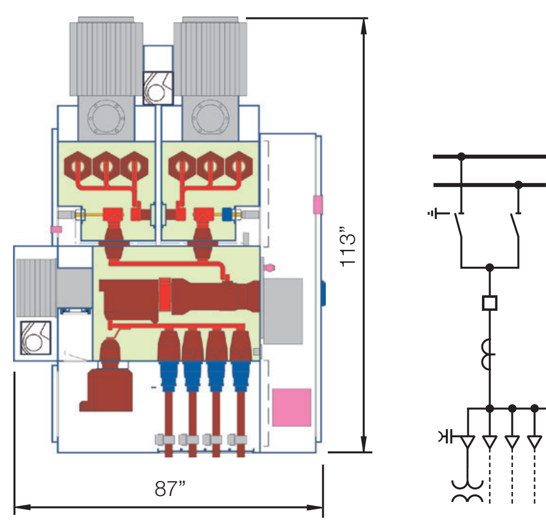


Fig. 8.2.1.1.4: Feeder panel 3000 A (width 33.07 in) with current and voltage transformer and four cables per phase



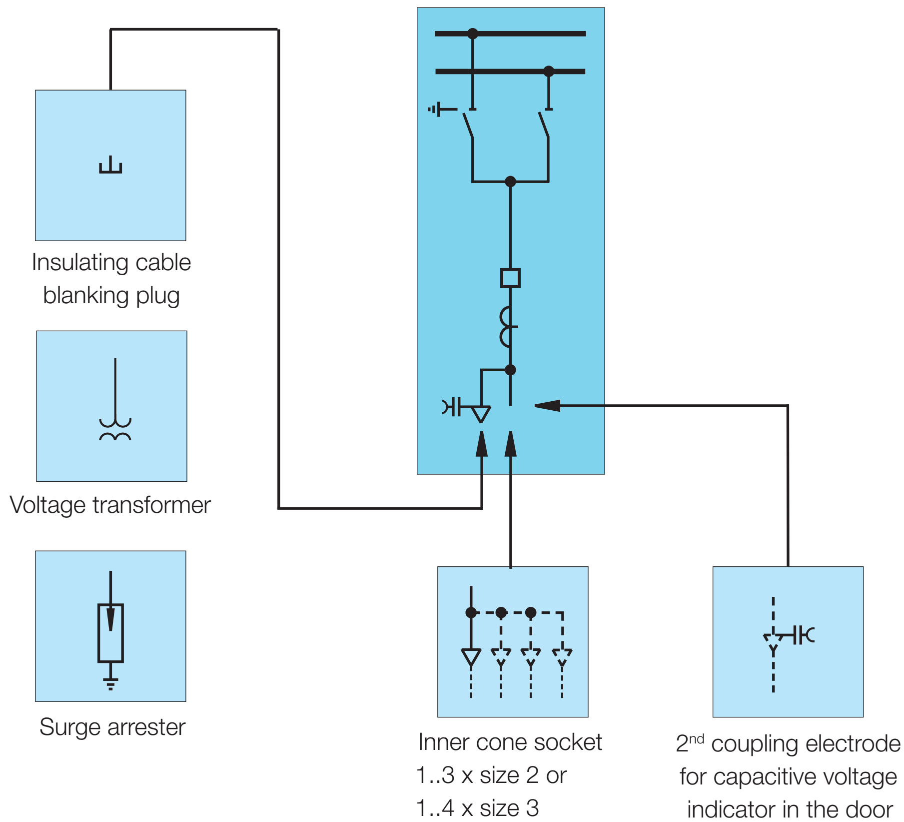


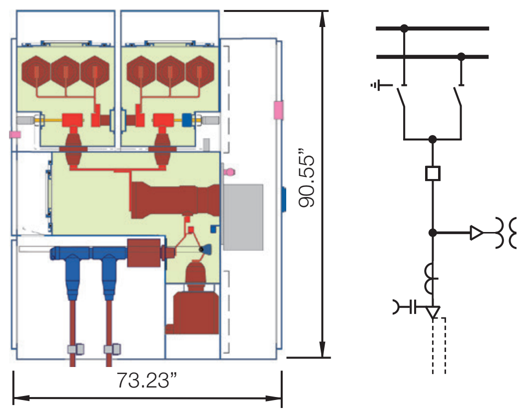
Table 8.1.1.1.1: Overview of variants of incoming and outgoing feeder panels with inner cone termination system

Panel width 23.62 in:	U_r:	... 38 kV (test voltages 70 kV / 150 kV)
	I_r:	... 800 A (1 x size 2)
	I_r:	... 1200 A (2 ... 3 x size 2 and 1 ... 2 x size 3) [1)]
	I_p:	... 40 kA
Panel width 31.50 in:	U_r:	... 38 kV
	I_r:	... 1200 A (1 ... 3 x size 3) [1)]
	I_r:	... 2000 A (3 ... 4 x size 3)
	I_p:	... 40 kA
Panel width 33.07 in:	U_r:	... 38 kV
	I_r:	... 2500 A, ... 3000 A (4 x size 3)
	I_p:	... 40 kA

[1)] Three sockets per phase only in conjunction with current transformers to Fig. 7.11.3.1

8.2.1.2 Incoming and outgoing feeder panels with outer cone cable plug system

Fig. 8.2.1.2.1: Feeder panel with outer cone, 1200 A



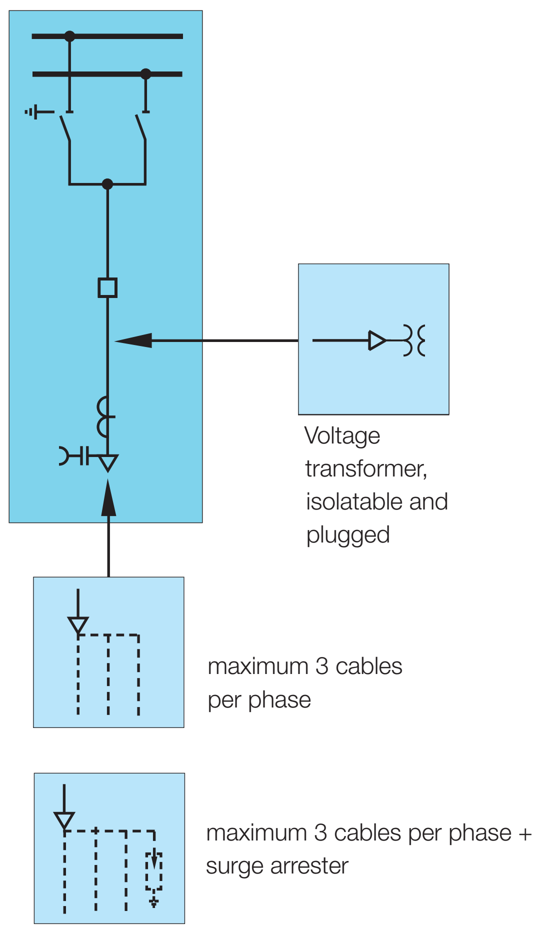


Table 8.2.1.2.1: Overview of variants of feeder panels with outer cone termination system

Panel width 23.62 in:	U_r:	... 38 kV
	I_r:	... 1200 A
	I_p:	... 40 kA

8.2.1.3 Cable termination panels

Fig. 8.2.1.3.1: Cable termination panel 1200 A (Example with continuous busbar at the front)

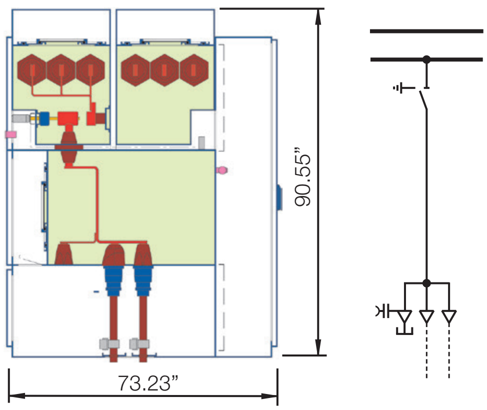
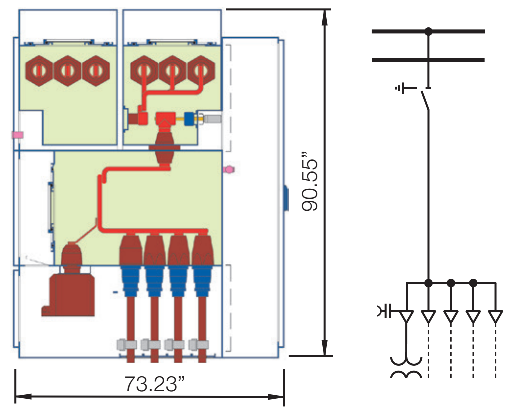


Fig. 8.2.1.3.2: Cable termination panel 2000 A (Example with continuous busbar at the rear and voltage transformer on the outgoing feeder)



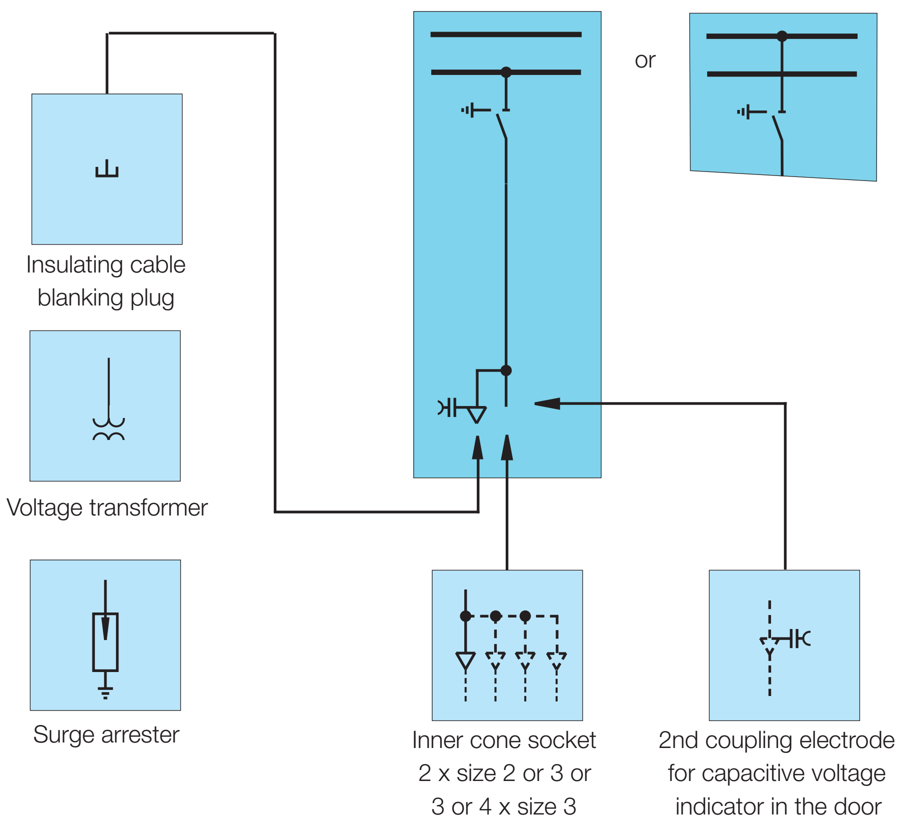


Table 8.2.1.3.1: Overview of variants for cable termination panels

Panel width 23.62 in:	U_r:	... 38 kV (test voltages 70 kV / 150 kV)
	I_r:	... 1200 A (2 x size 2 or 3)
	I_p:	... 40 kA
Panel width 31.50 in:	U_r:	... 38 kV
	I_r:	... 2000 A (3 or 4 x size 3)
	I_p:	... 40 kA
Panel width 33.07 in:	U_r:	... 38 kV
	I_r:	... 2500 A, ... 3000 A (4 x size 3)
	I_p:	... 40 kA

8.2.2 Coupling panels

8.2.2.1 Sectionalizer within a switchgear block

Two panels are required for a complete busbar sectionalizer. The sectionalizer panel contains the circuit-breaker and a three position disconnect. The riser panel contains only a three position disconnect. Installation variants “sectionalizer left – riser right” and vice versa are possible.

Fig. 8.2.2.1.1: Sectionalizer panel for the front busbar, 2000 A

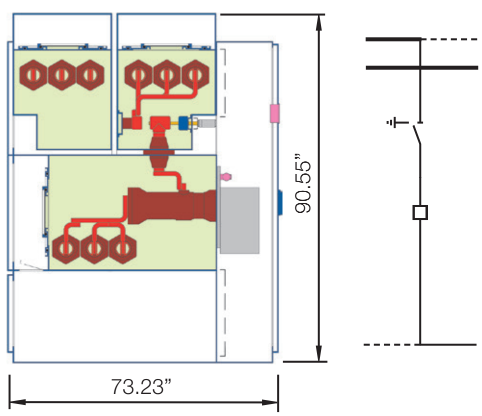
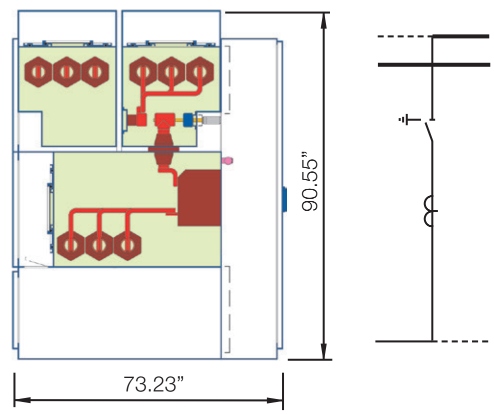


Fig. 8.2.2.1.2: Riser panel for the front busbar, 2000 A



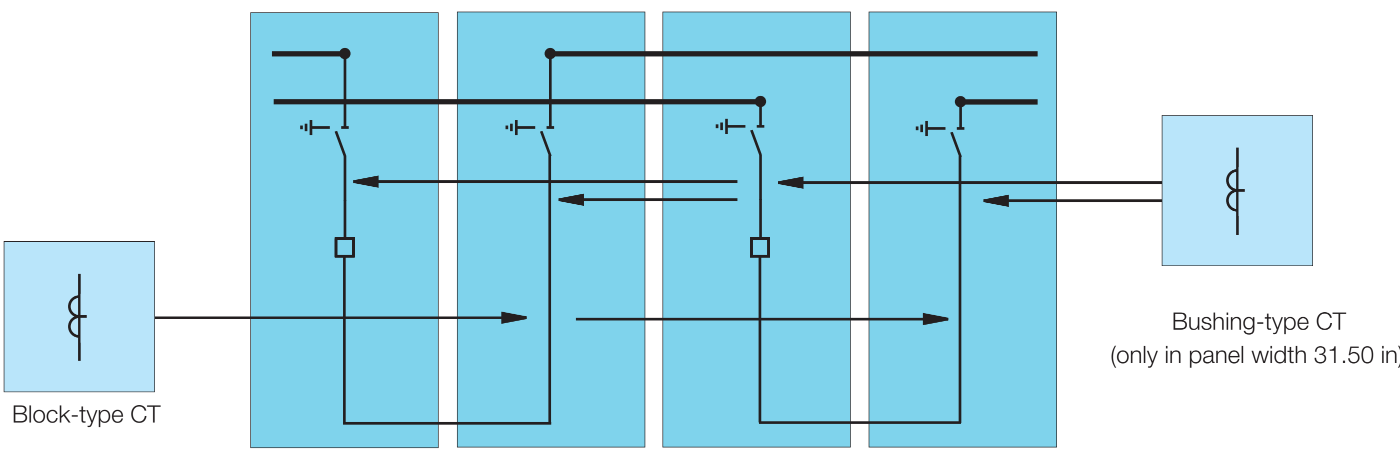


Table 8.2.2.1.1: Overview of variants for couplings within a switchgear block

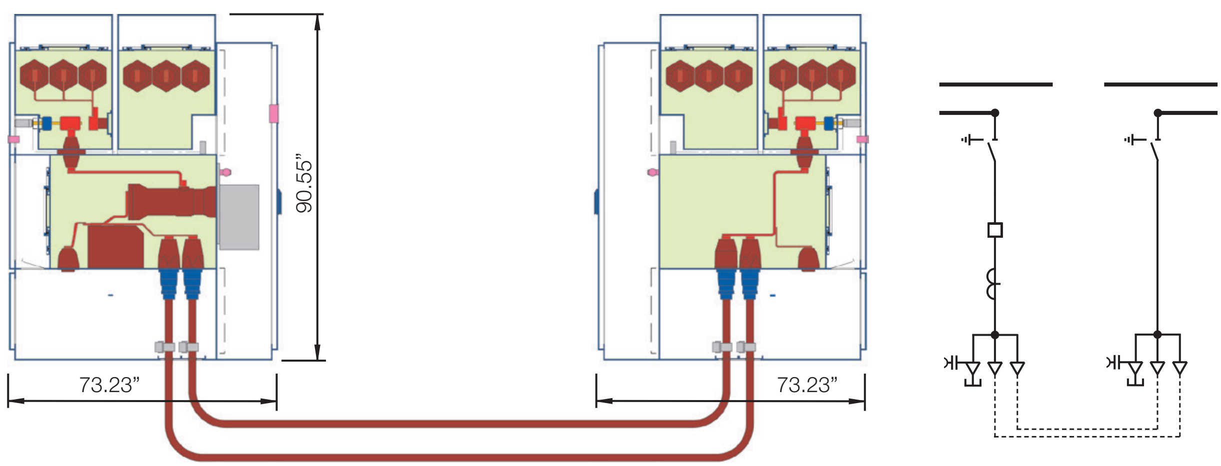
Panel width 23.62 in:	U_r: I_r: I_p:	... 38 kV (test voltages 70 kV / 150 kV) ... 1200 A ... 40 kA	Sectionalizer panel: without CTs Riser panel: with block-type CT
Panel width 31.50 in:	U_r: I_r: I_p:	... 38 kV ... 2000 A ... 40 kA	Sectionalizer panel: without CTs or with bushing-type CTs Riser panel: without CTs, with block-type CTor block-type CT+ bushing-type CT
Panel width 33.07 in:	U_r: I_r: I_p:	... 38 kV ... 2500 A ... 40 kA	Sectionaliser panel: without CTs Riser panel: with block-type CT/

8.2.2.2 Sectionalizer using cables (connection of two system blocks)

Two panels are required for a complete busbar sectionalizer. The sectionalizer panel contains the circuit-breaker and a three position disconnect. The riser panel contains only a three position disconnect.

The overview of variants can be found in sections 8.2.1.1 (feeder panels) and 8.2.1.2 (cable termination panels).

Fig. 8.2.2.2.1: Connection of two system blocks using cables (bus sectionalizer), 1200 A



8.2.2.3 Bus coupler

Fig. 8.2.2.3.1: Bus coupler, 1200 A with block-type CTs

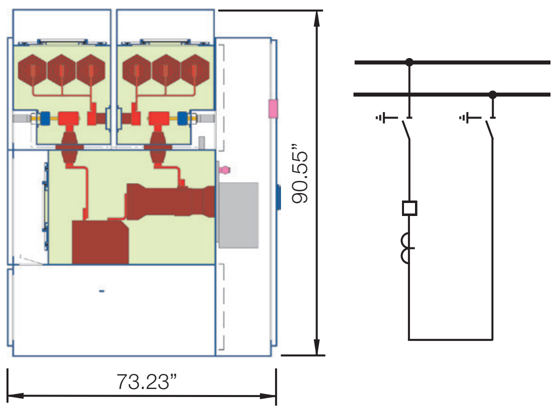


Fig. 8.2.2.3.2: Bus coupler, 2000 A, with CTs between the circuit-breaker and the three position disconnects

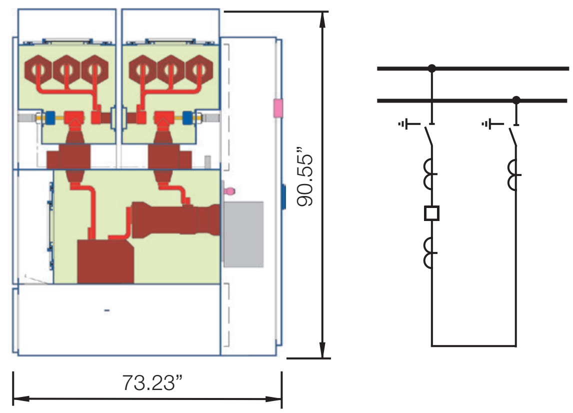


Fig. 8.2.2.3.3: Bus coupler, 2500 A (width 33.07 in) with block-type CTs or sensors

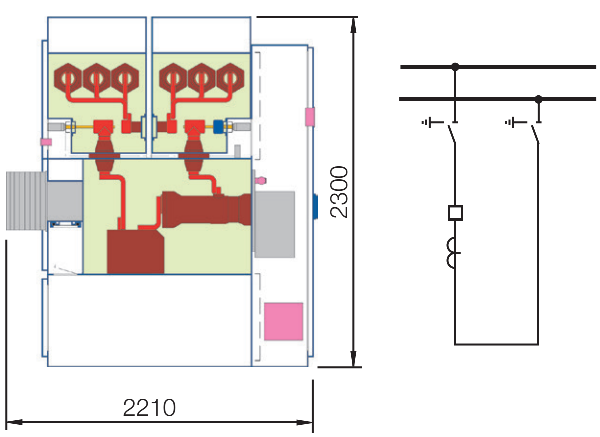
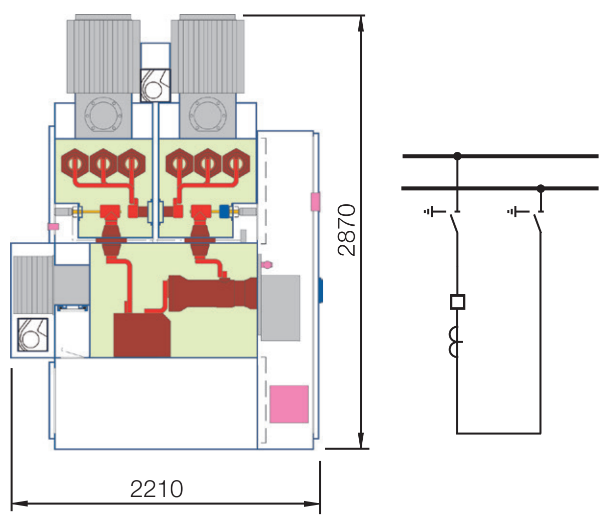


Fig. 8.2.2.3.4: Bus coupler, 3000 A (width 33.07 in) with block-type CTs or sensors



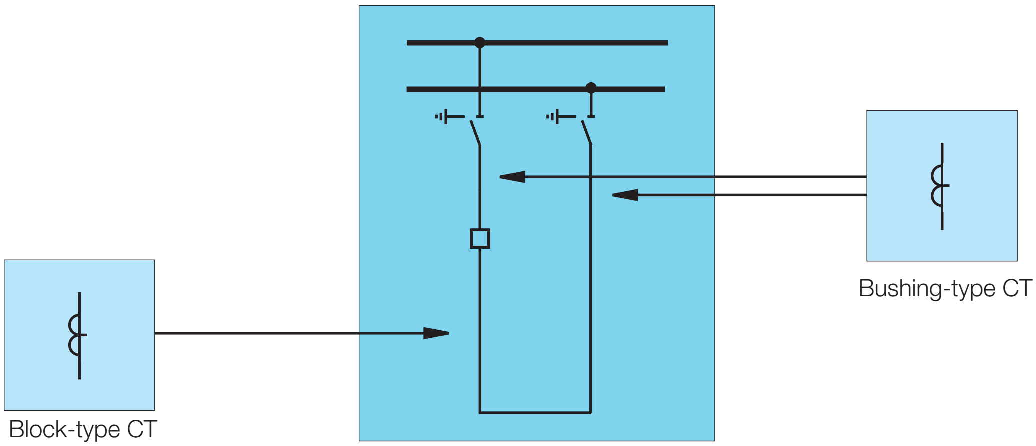


Table 8.2.2.3.1: Overview of variants for bus coupler panels			
Panel width 23.62 in:	U_r: I_r: I_p:	... 38 kV (test voltages 70 kV / 150 kV) ... 1200 A ... 40 kA	Two variants: - Without transformers - Block-type CT
Panel width 31.50 in:	U_r: I_r: I_p:	... 38 kV ... 1200 A or ...2000 A ... 40 kA	Four variants: - Without transformers - Block-type CT - Bushing-type CT - Block-type CT + Bushing-type CT
Panel width 840 mm:	U_r: I_r: I_p:	... 38 kV ... 2500 A or ... 3000 A ... 40 kA	2 variants: - Block-type CT or sensor - Block-type CT or sensor + Bushing-type CT

8.2.3 Bus sectionalizer

Fig. 8.2.3.1: Bus coupler without circuit-breaker 2000 A

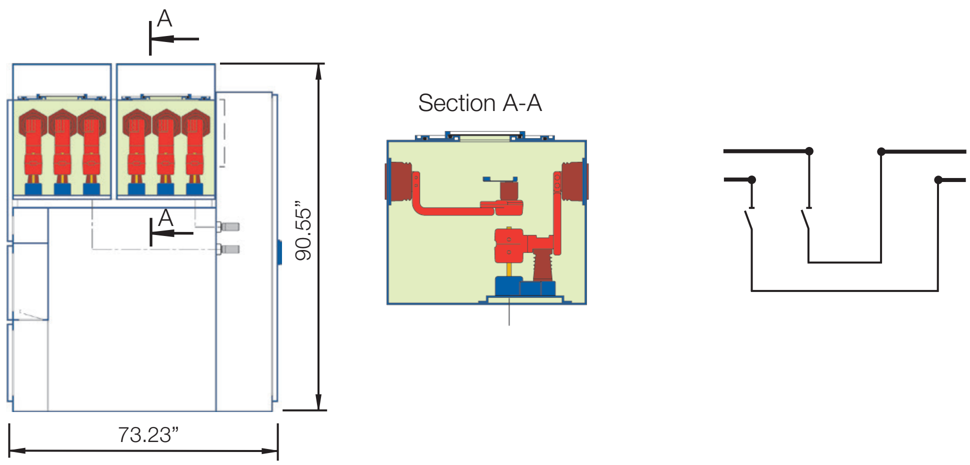


Table 8.2.3.1: Overview of variants for the bus coupler panels without circuit-breaker

Panel width 31.50 in:	U_r:	...38 kV
	I_r:	...2000 A or
	I_r:	...2500 A (cooling only with heat sinks)
	I_p:	...40 kA

8.2.4 Metering Panels

The following methods of busbar metering are available:

The metering panels

The metering panel contains three position disconnects for isolating the voltage transformers.

Integrated metering with plugged-in voltage transformers

Sockets for plug-in voltage transformers are provided above the busbar compartment in outgoing feeder panels with integrated measurement. The following limitations to the use of integrated measurement must be taken into account at the planning stage:

- For 31.50 in wide panels.
- For panels without cooling systems.
- The distance from the end of the system with plenum must be three panel widths.
- The ceiling height must be at least 118.11 in.
- The transport unit height is 90.55 in.

The integrated busbar metering system with plugged-in and isolatable voltage transformers

Above the busbar compartment of an outgoing feeder panel with integrated busbar metering, there are sockets for plug-in voltage transformers and a series isolating device with optional auxiliary switches. As a snap-action operating mechanism is used, operation of the isolating device is even possible when the busbar is live. The following limitations must be taken into account in the planning when an integrated busbar metering system with isolatable voltage transformers is used:

- For 31.50 in wide panels.
- For panels without cooling systems.
- The distance from the end of the system must be three panel widths to the side plenum.
- The ceiling height must be at least 137.80 in. The transport unit height is 91.73 in.
- Gas work at site is necessary.

Fig. 8.1.3.1: Metering panel, panel depth 31.50 in, with three-position disconnect

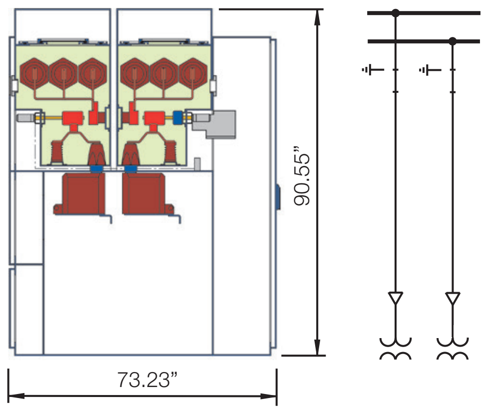


Fig. 8.2.4.2: : Integrated busbar metering system with plug-in voltage transformers (example for measurement of the rear busbar)

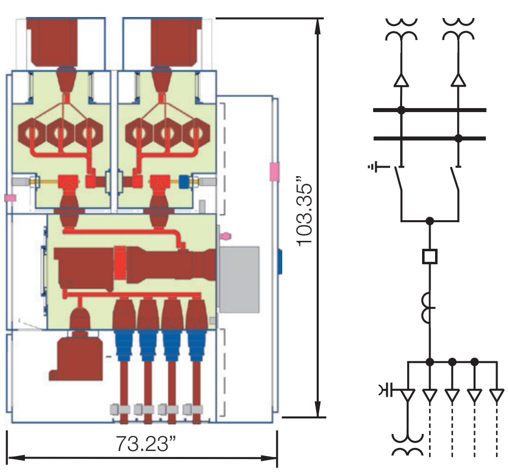


Fig. 8.2.4.3: Integrated busbar metering system with plug-in and isolatable voltage transformers for max. test voltages of 85 kV / 185 kV

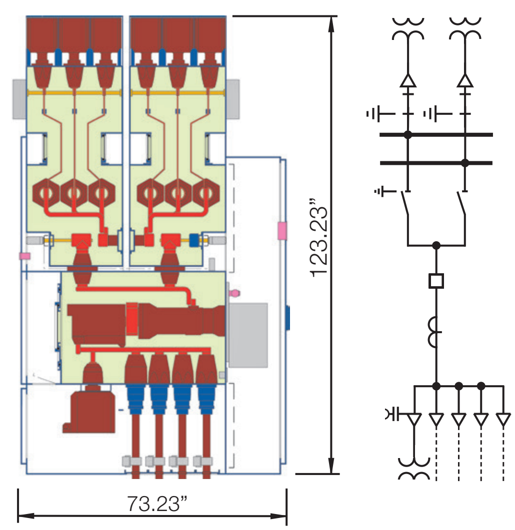


Table 8.1.4.1: Overview of variants of metering panels

Panel width 31.50 in:	U_r:	... 38 kV	Metering panel with three position disconnect Integrated busbar measurement - Voltage transformers plugged in (Fig. 8.1.3.2) - Voltage transformers plugged in and isolatable (Fig. 8.1.3.3) (test voltages 70 kV / 150 kV)

8.3 Design to order panels

The panel variants presented in sections 8.1 to 8.2 are standard panels. Should you require panel variants which are not listed there when planning your switchgear, please contact the ABB office responsible for your area. Our design team will be pleased to submit and implement technical proposals to fulfil your requirements. IAC qualification according to IEC 62271-200 of special panels may not be possible in all cases.

Fig. 8.3.1: Termination panels for fully insulated bars (Example: connection of two system blocks, 38 kV, 40 kA, 2000 A)

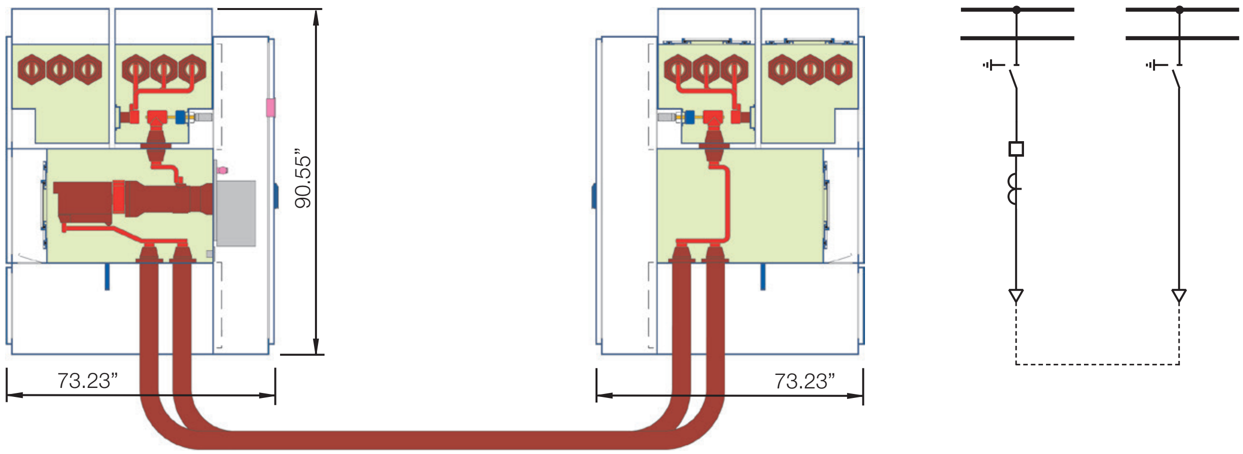


Fig. 8.3.2: Panel for capacitor switching (38 kV, 40 kA, 800 A)

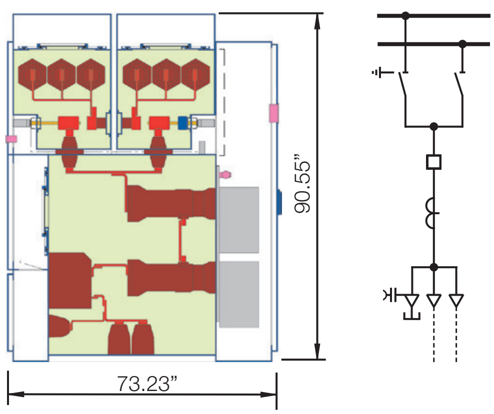


Fig. 8.3.3: Feeder panel 2000 A with current transformers at both sides of the circuit-breaker, bus bar at front or rear

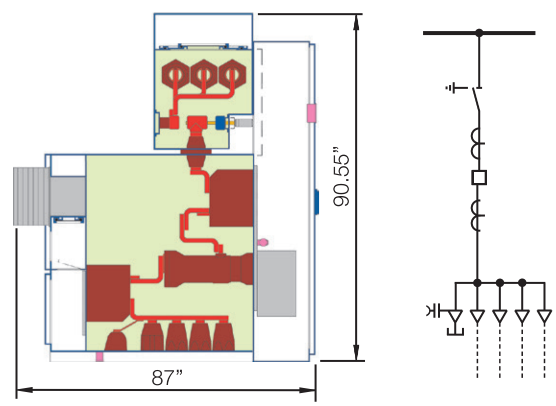


Fig. 8.3.4: Feeder panel 2500 A with current transformers at both sides of the circuit-breaker, cooling by heat sinks and forced cooling, bus bar at front or rear

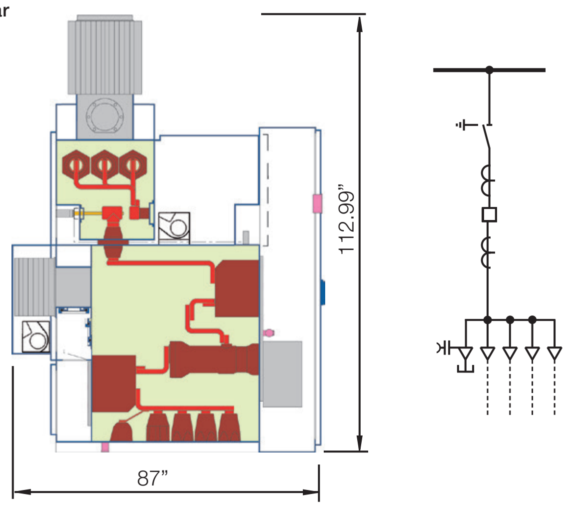
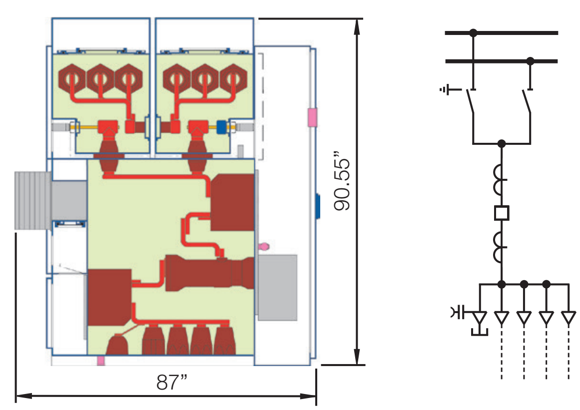


Fig. 8.3.5: Feeder panel 2000 A with current transformers at both sides of the circuit-breaker



8.4 Panels for rated currents > 2000 A

At a maximum ambient air temperature of 104 °F (40 °C), a maximum 24 hour average ambient air temperature of 95 °F (35 °C) and a rated frequency of 60 Hz (standard operating conditions), no cooling facilities are required for a rated current of up to 2000 A.

For higher rated currents, depending on the application, the following cooling measures are required:

B, C: Heat sink on the busbar compartment
B1, C1: Heat sink on the busbar compartment within the pressure relief duct
D: Heat sink at the circuit-breaker compartment
E: Radial flow fan below the heat sink D
F: Radial flow fan at the heat sink B and/or C

The cooling facilities required at

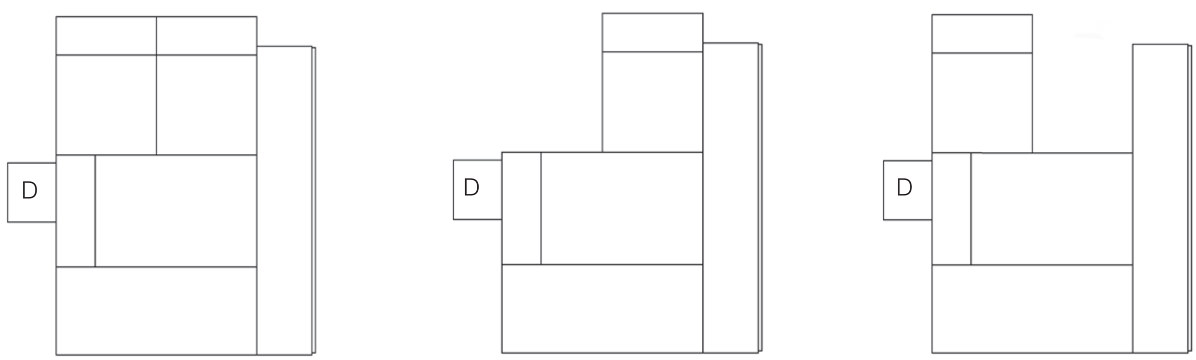
- higher ambient air temperatures and/or
- higher rated currents

may deviate from the cooling methods stated above. Such special cases can be investigated on request.

8.4.1 Feeder Panels for rated currents > 2000 A

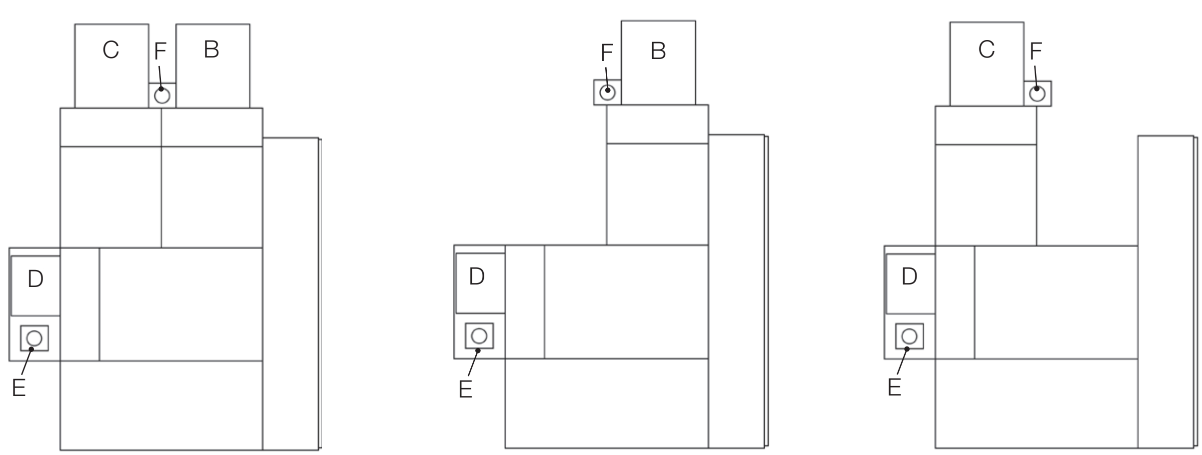
The panel width of feeder panels for a rated current > 2000 A is generally 33.07 in. For rated currents up to 2500 A (fig. 8.4.1.1), a heat sink is used at the circuit-breaker compartment. With a rated current of up to 3000 A (fig. 8.4.1.2) heat sinks on the busbar compartments and fans are also used.

Fig. 8.4.1.1: Cooling of feeder panels for a feeder current up to 2500 A



Double busbar | Single busbar at the front | Single busbar at the rear

Fig. 8.4.1.2: Cooling of feeder panels for a feeder current up to 3000 A



Double busbar | Single busbar at the front | Single busbar at the rear

8.4.2 Busbar current > 2500 A

With a busbar current of up to 3000 A, heat sinks on the busbar compartments are required on each panel (fig. 8.4.2.1). Up to a busbar current of maximum 2800 A, factory-installed heat sinks can be used on the busbar compartments. These heat sinks are located inside the pressure relief channels (figure 8.4.2.2).

Fig. 8.4.2.1: Cooling with a busbar current up to 3000 A

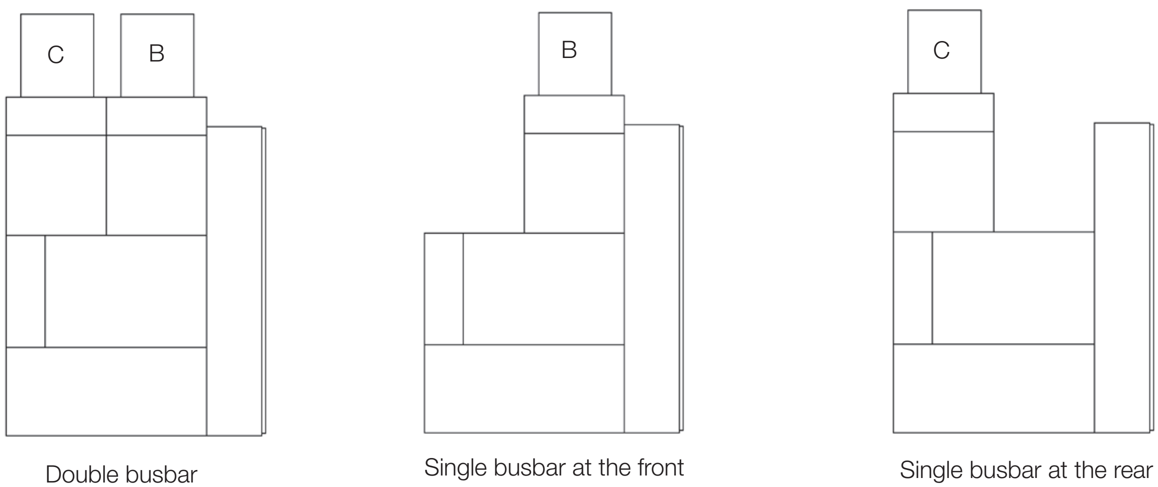
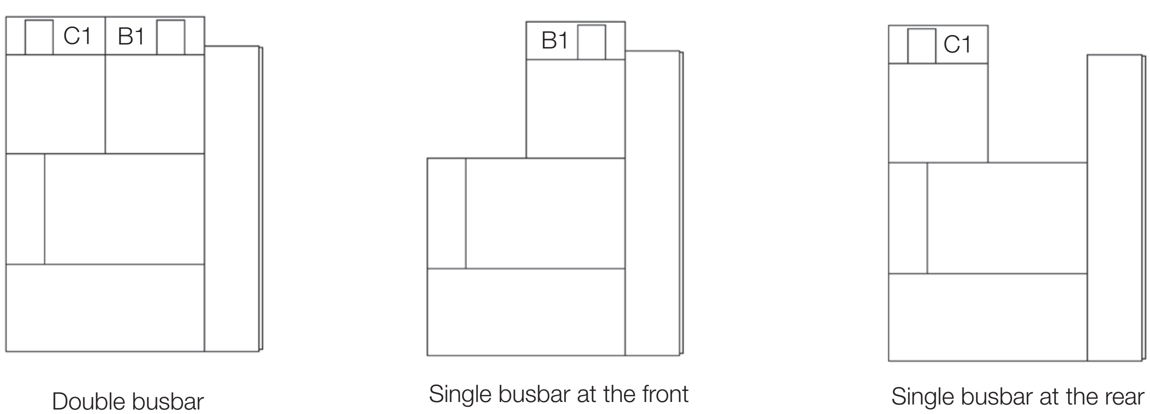


Fig. 8.4.2.2: Cooling with a busbar current up to 2800 A



8.4.3 Sectionalizers and bus couplers for a rated current > 2000 A

Coupling panels on double busbar systems up to 2500 A are equipped with a heat sink behind the circuit-breaker compartment as well as heat sinks C1 and B1 (fig. 8.4.3.1). For a rated current of a maximum of 3000 A, sectionalizers are available for single busbar systems and bus coupler panels for double busbar systems. Heat sinks behind the busbar compartment and fans are used (fig. 8.4.3.2).

Fig. 8.4.3.1: Cooling with sectionalizer or bus coupler panels with a busbar current up to 2500 A

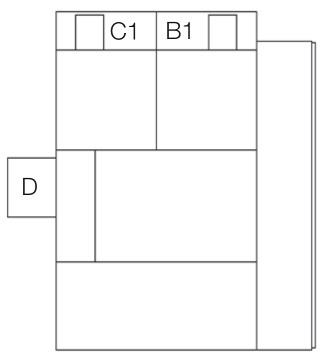
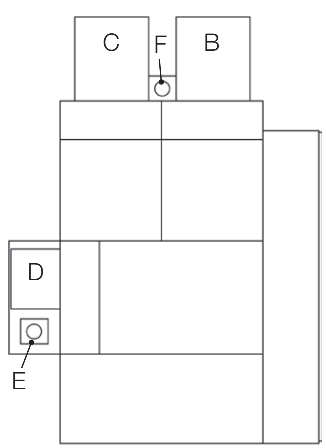


Fig. 8.4.3.2: Cooling with sectionalizer or bus coupler panels with a busbar current up to 3000 A



9 Arrangement of panels with cooling facilities and panels with integrated busbar measurement

The following is to be observed when installing panels with cooling facilities and panels with busbar measurement:

- Panels with heat sinks (B or C, section 8.4) or with busbar measurement can be positioned from the fourth panel at the absorber end onwards (section 7.16). (The distance from the absorber must be at least one panel width.)

- Coupling panels with a width of 840 mm which are not equipped with heat sinks can be positioned from the third panel onwards.

Further conditions for the use of integrated busbar measurement can be found in sections 8.1.3, 8.2.4.

10 Busbar grounding

This section outlines the ways in which the busbar can be grounded. The details of these operations can be found in the relevant instruction manuals.

10.1 Grounding the busbar by means of a grounding and short-circuiting device

Inner cone systems

With the outgoing feeder grounded, the test sockets or cable sockets can be fitted with a grounding and short circuiting device (Fig. 7.9.5 and Fig. 10.1.1) connected to the main grounding bar. Grounding of the busbar is affected via the closed feeder disconnect and subsequently closed circuit-breaker (Fig. 10.1.3).

Outer cone systems

The connection of a grounding and short circuiting device to the main grounding bar is effected via the rear side of the last cable connectors. In the case of a grounded feeder panel the voltage-proof terminations of the cable connector are exchanged with current-carrying terminations (Fig 10.1.2). Grounding of the busbar is affected via the closed feeder disconnect and subsequently closed circuit-breaker (Fig. 10.1.3).

10.2 Grounding the busbar by means of a sectionalizer and riser or bus coupler

Grounding is affected by the three position disconnect and the circuit-breaker in a bus coupler (see Fig. 10.2.1) or bus sectionalizer (see Fig. 10.2.2).

Fig. 10.1.1: Connecting a grounding and short-circuiting device to a feeder in case of an inner cone system (only one phase shown)

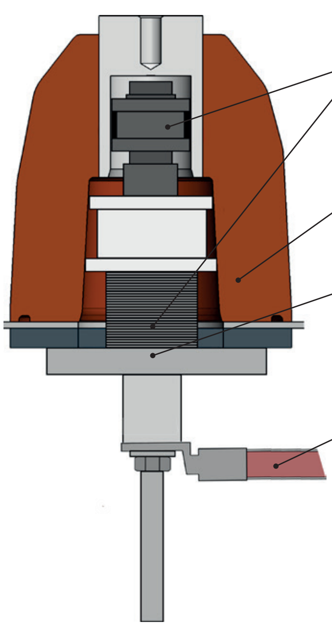


Fig. 10.1.2: Connecting a grounding and short-circuiting device to a feeder in case of an outer cone system (only one phase shown)

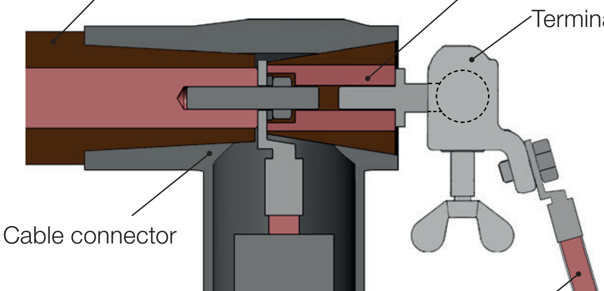


Fig. 10.1.3: Busbar grounding by grounding and short-circuiting device, double busbar

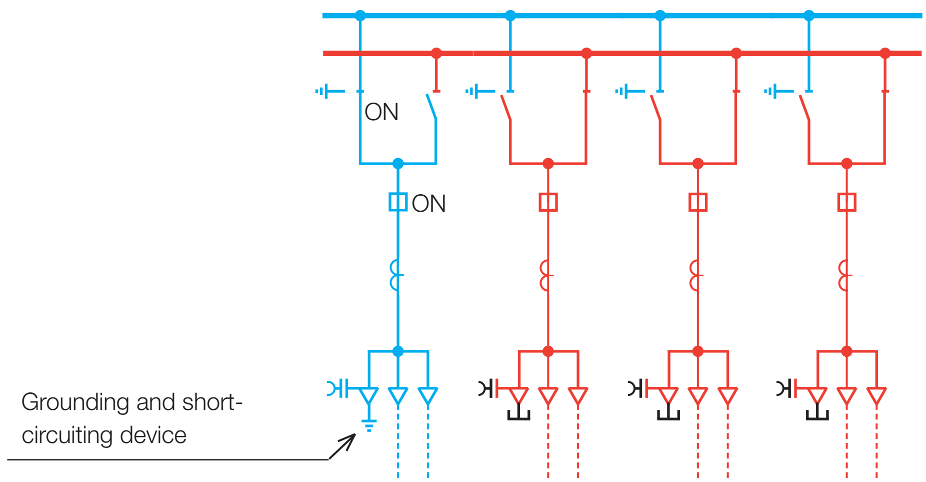


Fig. 10.2.1: Busbar grounding by bus coupler, double busbar

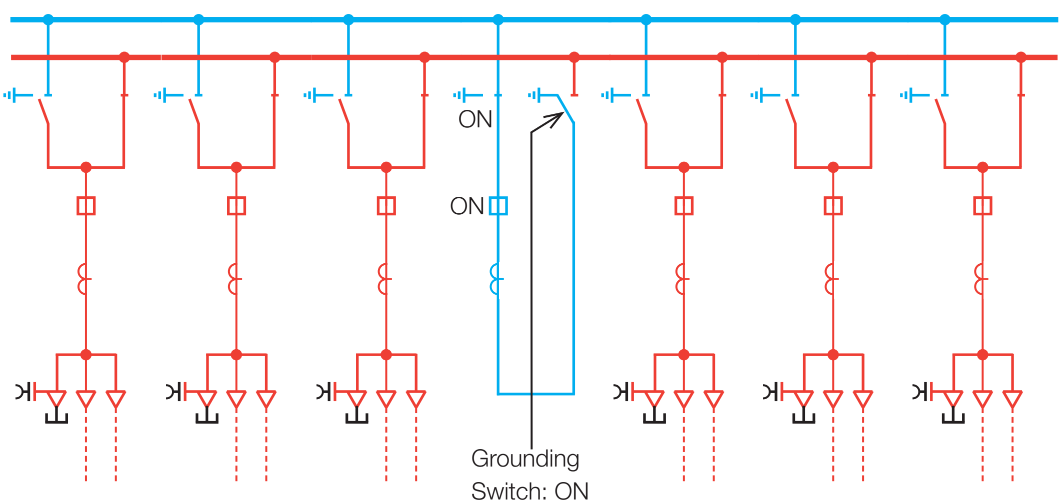
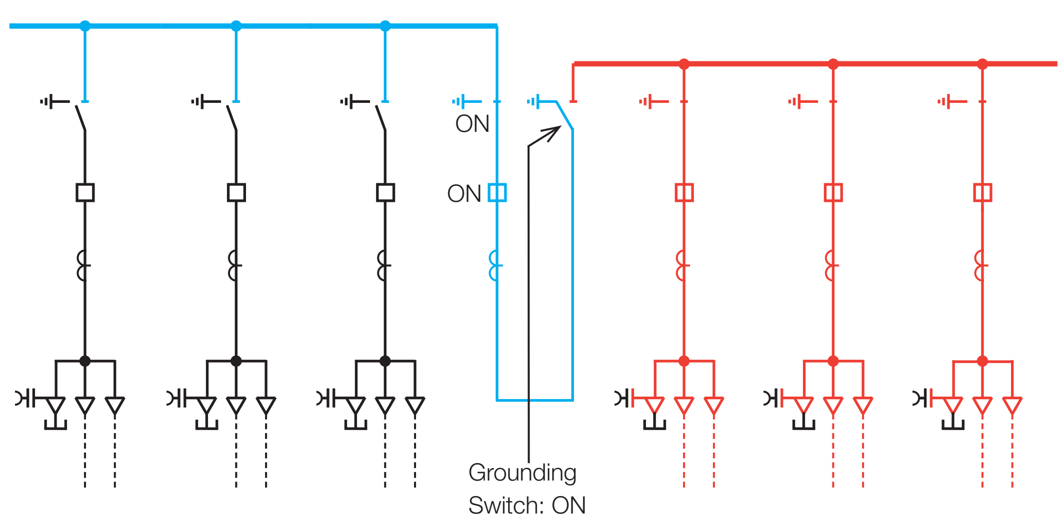


Fig. 10.2.2: Busbar grounding by sectionalizer, single busbar



11 Building planning

11.1 Site requirements

The switchgear can be installed

- on a concrete floor, or
- on a raised false floor.

Concrete floor

A concrete floor requires a foundation frame set into the floor topping. The evenness and straightness tolerances for the base of the switchgear system are ensured by the foundation frame. The foundation frame can be supplied by ABB.
Floor openings for power and control cables can be configured as cutouts for each panel, as continuous cutouts (one each for power and control cables) or as drill holes. The floor openings are to be free from eddy currents (drill holes for power cables three phase – without ridges in between).

False floor

Below the switchgear, the supporting sections of the raised false floor serve as a base for the panels. A foundation frame is not as a rule necessary.

Pressure stress on the switchroom

With pressure relief inside the switchroom, a pressure rise in the room can be expected in the highly unlikely event of an internal arc fault. This is to be taken into account when planning the building. The pressure rise can be calculated by ABB on request. Pressure relief openings in the switchroom may be necessary.

Ventilation of the switchroom

Lateral ventilation of the switchroom is recommended.

Service conditions

The service conditions according to IEC 62271-1 for indoor switchgear are to be ensured.

The ambient air is not significantly polluted by dust, smoke, corrosive and/or flammable gases, vapors or salt.

The conditions of humidity are as follows:

- the average value of the relative humidity, measures over a period of 24 hours, does not exceed 95 %:
- the average value of the water vapor pressure, over a period of 24 hours, does not exceed 0.32 PSI;
- the average value of the relative humidity, over a period of one month, does not exceed 90 %;
- the average value of the water vapor pressure, over a period of one month, does not exceed 0.26 PSI.

Heaters are to be fitted in the low voltage compartments to preclude condensation phenomena (outside the gas-tight enclosures) resulting from major rapid temperature fluctuations and corresponding humidity. The specified temperature conditions according to IEC 62271-1 (> 23 °F (-5 °C)) are also to be ensured by means of room heating.

11.2 Space required

Planning of the space required for the switchgear must take account of the
- escape routes,
- hazardous area in case of pressure relief to the outside,
- the possibility of inserting panels into an existing row,
- the boundary conditions for IAC qualification, and
- space required for dismantling and assembly of voltage transformers.

Fig. 11.2.1: Example of a single row installation (Top view, dimensions in inches)

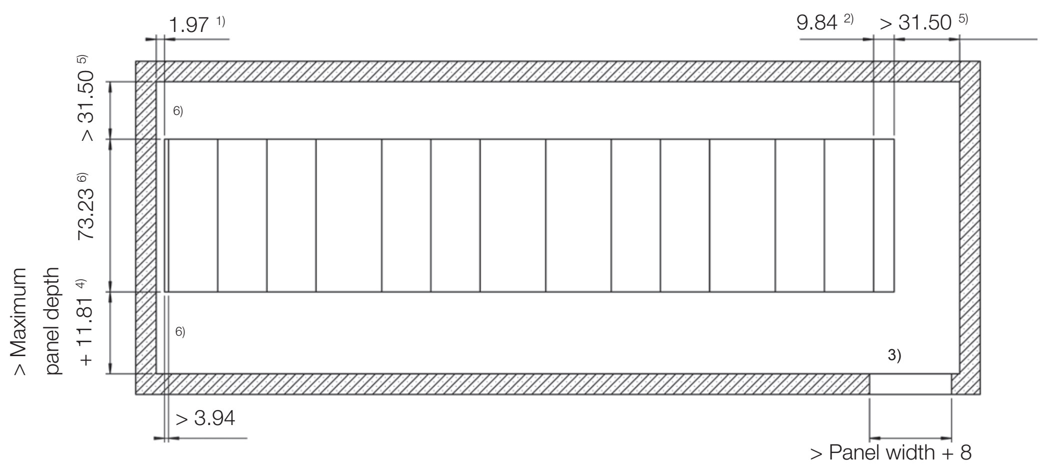
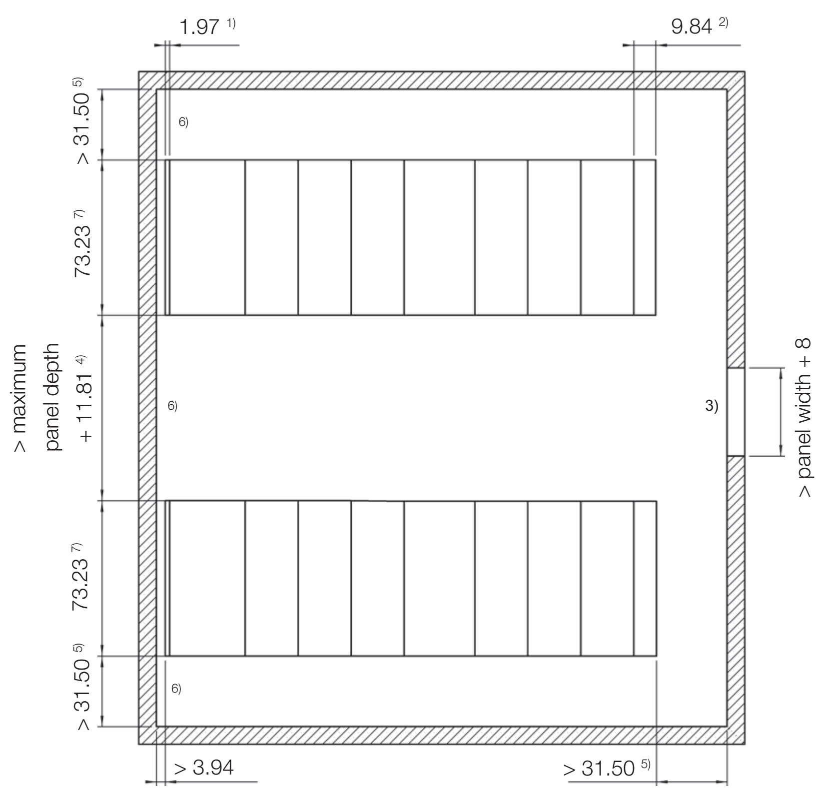


Fig. 11.2.2: Example of a double row installation (Top view, dimensions in inches)



1) End cover
2) Lateral plenum
3) Door height: > 90.55 in (with integrated measurement: > 98.43 in, with heat sinks mounted on a busbar compartment: 125.98 in).
4) Recommended dimension taking account of the insertion of panels into an existing row (can possibly be reduced as stated in section 11.3).
5) Recommended dimension; can be reduced under certain circumstances as stated in section 11.3.
6) Recommendable: 20 in, observe the notes on escape routes in section 11.3.
7) With heat sinks at the circuit-breaker compartment: 87 in.

11.3 Minimum aisle widths and emergency exits

The aisle width in front of the switchgear is to be planned with attention to the need to remove panels from or insert panels into existing rows, and to the requirements of the relevant standards (see IEC 61936 and IEC 62271-200). The minimum and recommended minimum aisle widths can be found in tables below.

“Aisles shall be at least 31.50 in wide. ... Space for evacuation shall always be at least 19.69 in, even when removable parts or open doors, which are blocked in the direction of escape, intrude into the escape routes. ... Exits shall be arranged so that the length of the escape route within the room ... does not exceed … 65.62 ft. ... If an operating aisle does not exceed 32.81 ft, one exit is enough. An exit or emergency possibilities shall be provided at both ends of the escape route if its length exceeds 32.81 ft. ... The minimum height of an emergency door [possibly the 2nd door] shall be 78.74 in [clear height] and the minimum clear opening 29.53 in.” [1)]

Table 11.3.1: Restrictive conditions on minimizing the aisle widths in front of the switchgear

		Minimum aisle width (Doors close in the direction of the escape route) [in]	Recommended aisle width taking no account of removal or insertion of panels [in]	Aisle width required for removal and insertion of panels [in]
Single row installation	Panel block consisting exclusively of panels of 23.62 in width	> 31.50	> 43.31	> maximum panel depth + 11.81
	Panel block with at least one panel of 31.50 in or 33.07 in width	> 39.37	> 51.18	
		Minimum aisle width [in]	Recommended aisle width taking no account of removal or insertion of panels [in]	Aisle width required for removal and insertion of panels [in]
Double row installation (with operator aisle between the system blocks)	Panel block consisting exclusively of panels of 23.62 in width	> 55.12	> 66.93	> maximum panel depth + 11.81
	Panel block with at least one panel of 31.50 in or 33.07 in width	> 70.87	> 82.68	

1) IEC 91936

Installation and maintenance areas behind and to the sides of the switchgear

Table 11.3.2 shows the required distances to walls behind and to the side of the switchgear.
Take notice of the downgrading of the internal arc classification if distances are minimized.

Table 11.3.2: IAC qualification on reduction of the wall distance behind the switchgear and the side wall distance

<table>
<tr><th>Wall distance behind the switchgear
[in]</th><th>Wall distance to the side of the switchgear (at one or both ends of the switchgear)
[in]</th><th>IAC qualification when a pressure relief duct discharging into the switchgear room is used</th><th>IAC qualification when a pressure relief duct discharging to the outside is used</th></tr>
<tr><td>> 31.50</td><td>> 31.50</td><td>AFLR</td><td rowspan="4">AFLR</td></tr>
<tr><td>> 23.62 [1]</td><td>> 31.50</td><td>AFL</td></tr>
<tr><td>> 31.50</td><td>> 19.69</td><td>AFR</td></tr>
<tr><td>> 23.62 [1]</td><td>> 19.69</td><td>AF</td></tr>
</table>

11.4 Minimum room heights

Table 11.4.1: Minimum room heights

<table>
<tr><th>Pressure relief into the switchgear room (absorber)
[in]</th><th>Pressure relief to the outside
[in]</th><th>Integrated metering on at least one panel
[in]</th><th>Integrated metering with plug-in, isolatable voltage transformers on at least one panel
[in]</th><th>Tall heat sink on at least one panel
[in]</th></tr>
<tr><td>> 110.24 [2]</td><td colspan="2">> 118.11</td><td>> 137.80</td><td>> 125.98</td></tr>
</table>

1) Reducing to at least 19.69 in on request
2) According to IEC 62271-200: IAC - qualification AFLR

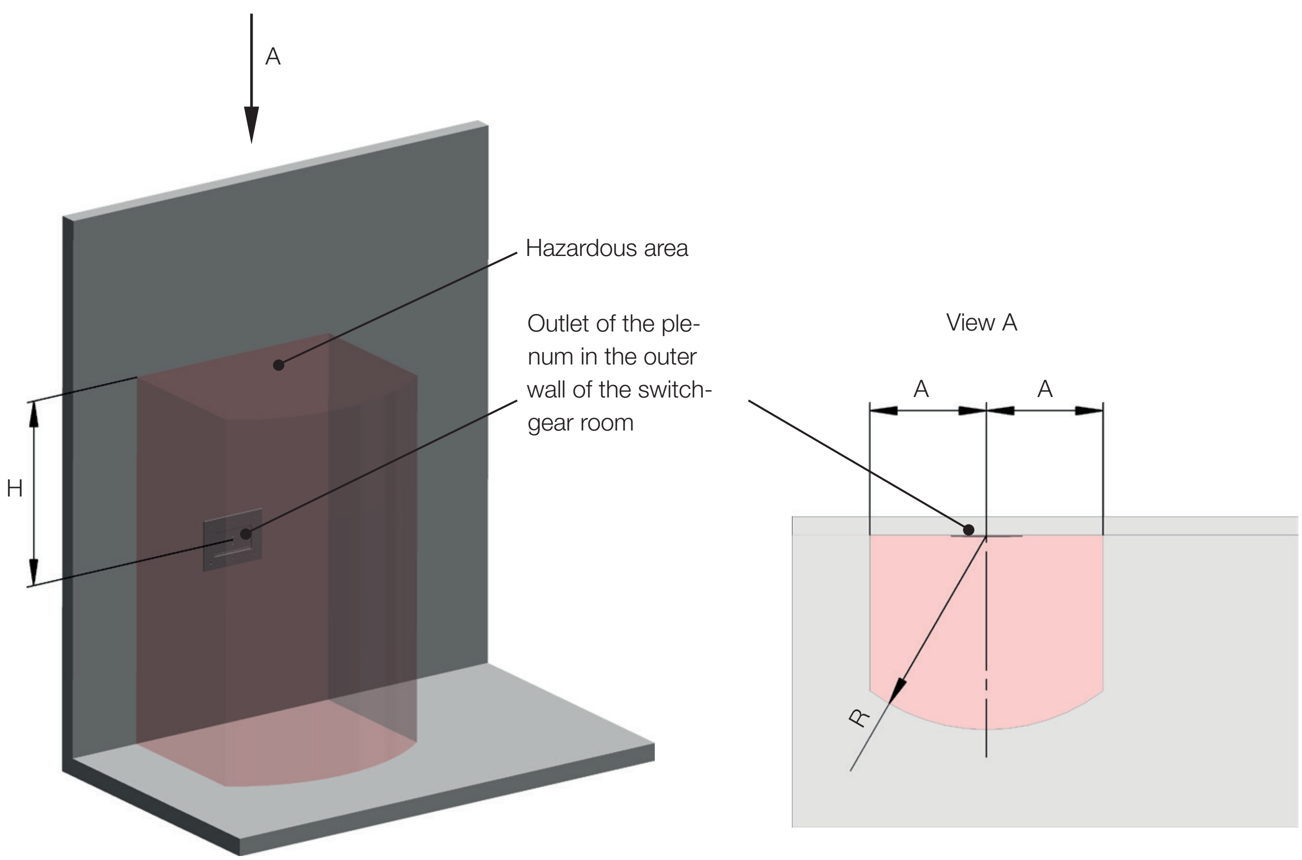
11.5 Hazardous area for pressure relief to the outside

In the case of an internal arc fault, hot gases can suddenly emerge from the outlet of the plenum. The area around the outlet of a plenum for relief to the outside constitutes a hazardous area which must be fenced off by the switchgear operator to prevent persons from entering that area.
The size of the hazardous area depends on the level of the expected short-circuit current. Please consult Fig. 11.5.1 and table 11.5.1 for the dimensions of the hazardous area.

Table 11.5.1: Dimensions of the hazardous area

Short-circuit current [kA]	A (distance to the side) [ft]	R (distance to the front) [ft]	H (distance to the top) [ft]
20 / 25	3.28	6.56	6.56
31.5 / 40	4.92	8.20	8.20

Fig. 11.5.1: Dimensions of the hazardous area for pressure relief to the outside



11.6 Floor openings and cable axes

Fig. 11.6.1: Feeder Panel with block-type CT, panel width 23.62 in, dimensions in inches

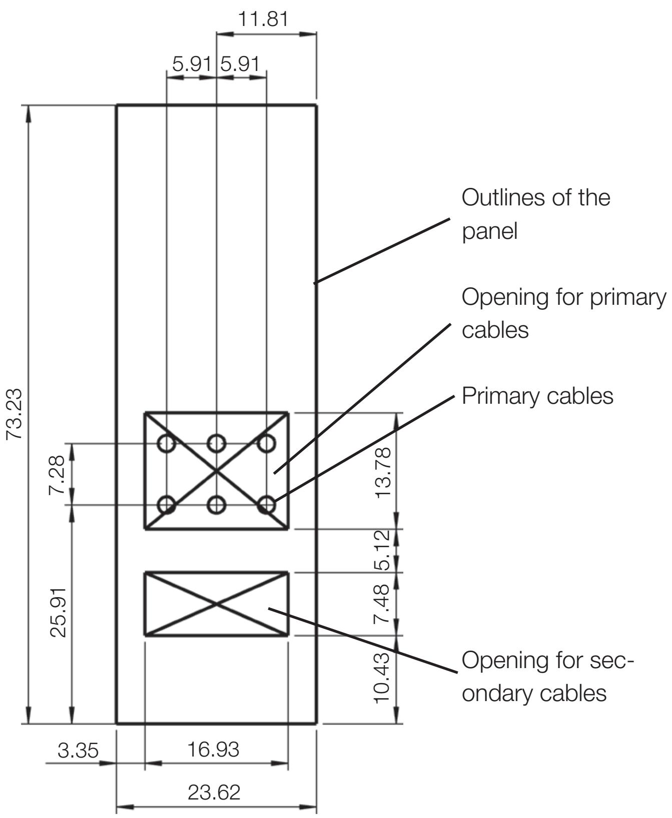


Fig. 11.6.2: Feeder Panel with block-type CT, panel width 31.50 in, dimensions in inches

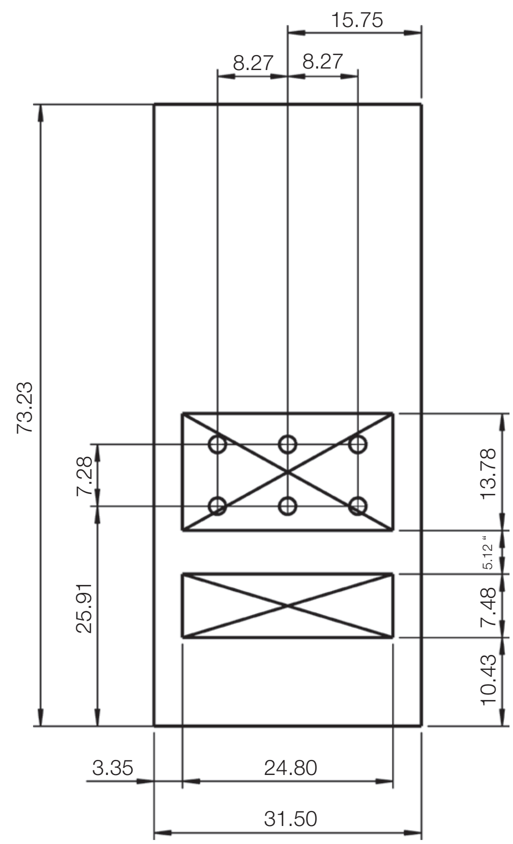


Fig. 11.6.3: Feeder panel, Panel width 31.50 in, dimensions in inches

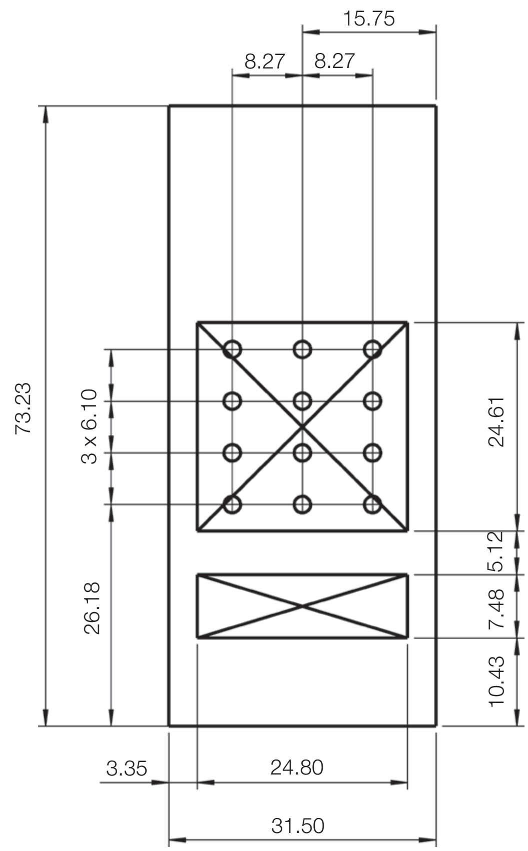


Fig 11.6.4: Feeder panel, panel width 33.07 in, dimensions in inches

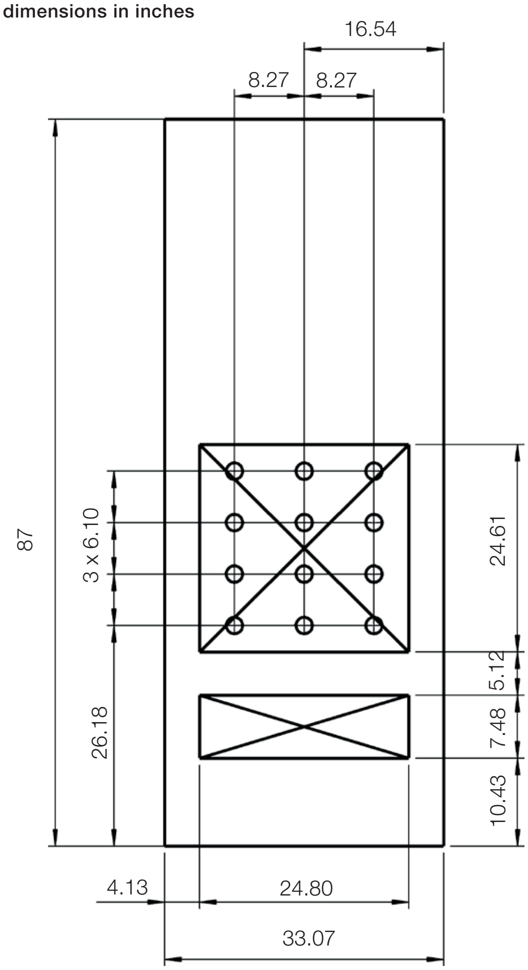


Fig. 11.6.5: Panel for capacitor switching ZX2-C, dimensions in inches

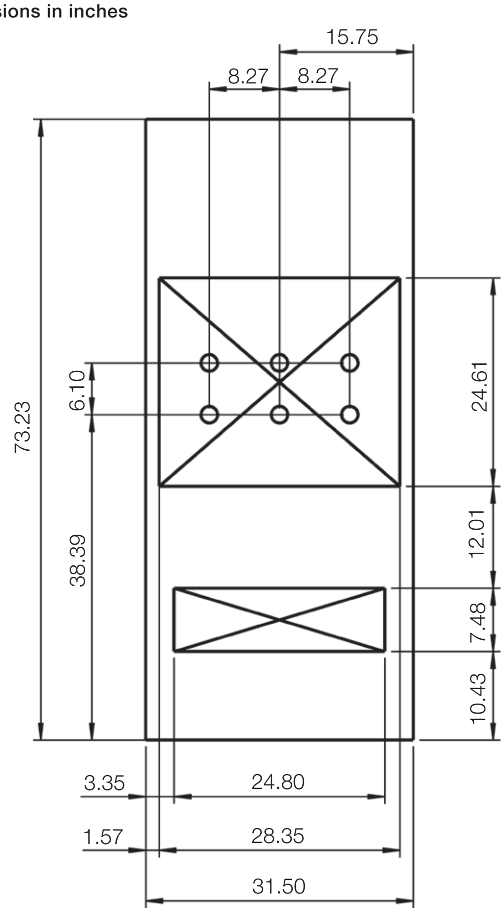


Fig. 11.6.6: Panel with outer cone cable plug system, panel width 23.62 in, dimensions in inches

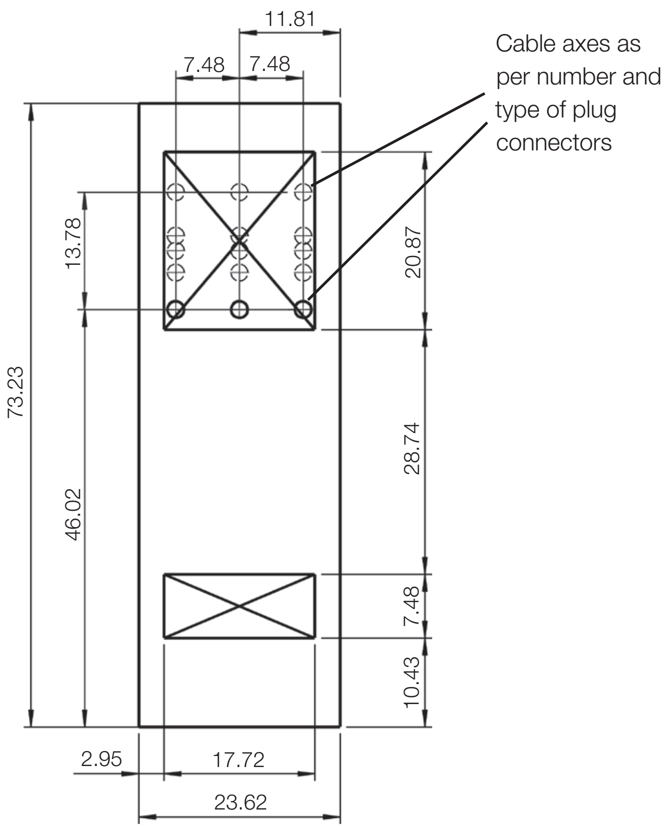
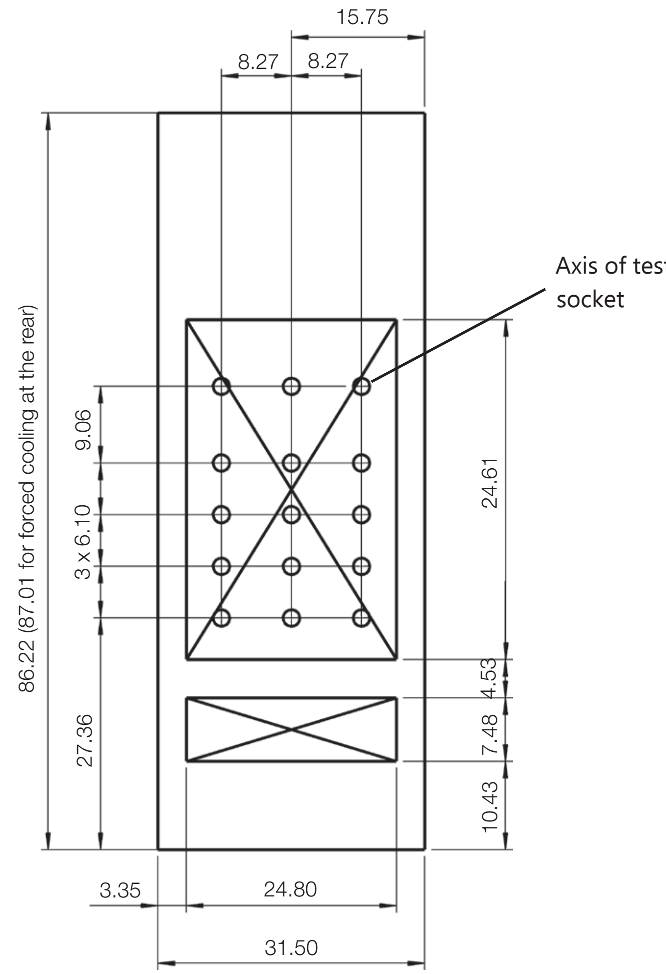


Fig. 11.6.7: Panel with current transformers at both sides of the circuit-breaker, dimensions in inches



For the following panels, only the openings for secondary cables in the concrete floor are required:

- Sectionalizer and riser panels [1)]
- Bus coupler [1)]
- Sectionalizer panels without circuit breaker
- Metering panels (not integrated metering)

1) Within a switchgear block

11.7 Foundation frames

The optional foundation frames consist of aluminium sections. They are supplied pre-assembled for one panel each. Foundation frames of 23.62 in, 31.50 in width are used, depending on the panel width.

The foundation frames are fastened to the concrete floor and embedded in the floor topping.

When installing the foundation frame at site, observe the form and position tolerances stated in the order documents.

Fig. 11.7.1: Foundation frame and outlines of the panel, panel width 31.50 in, dimensions in inches

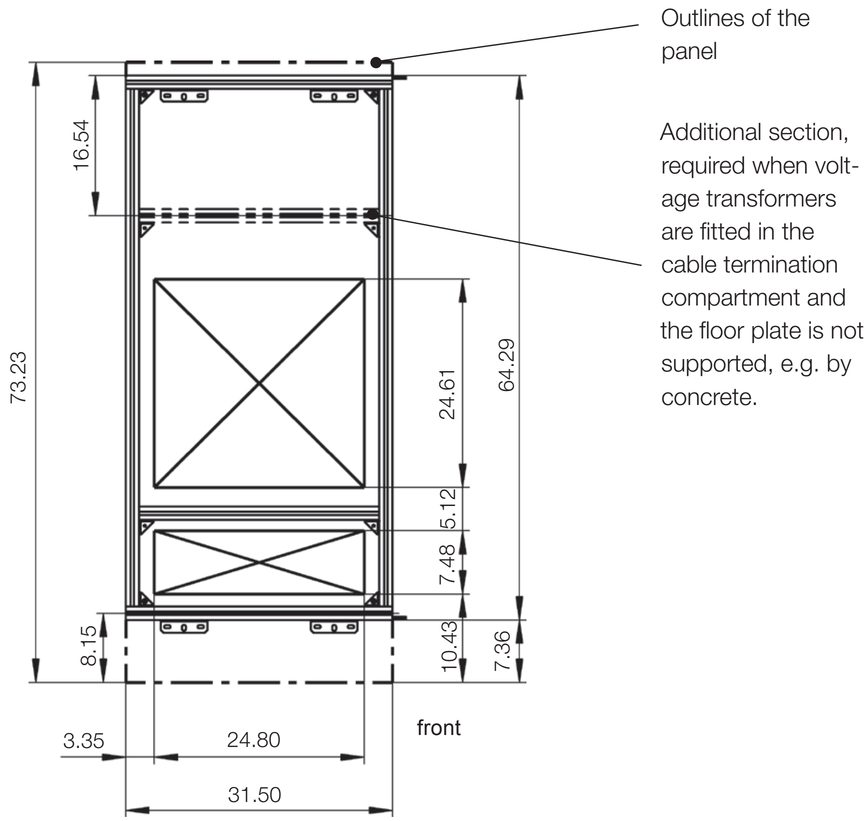


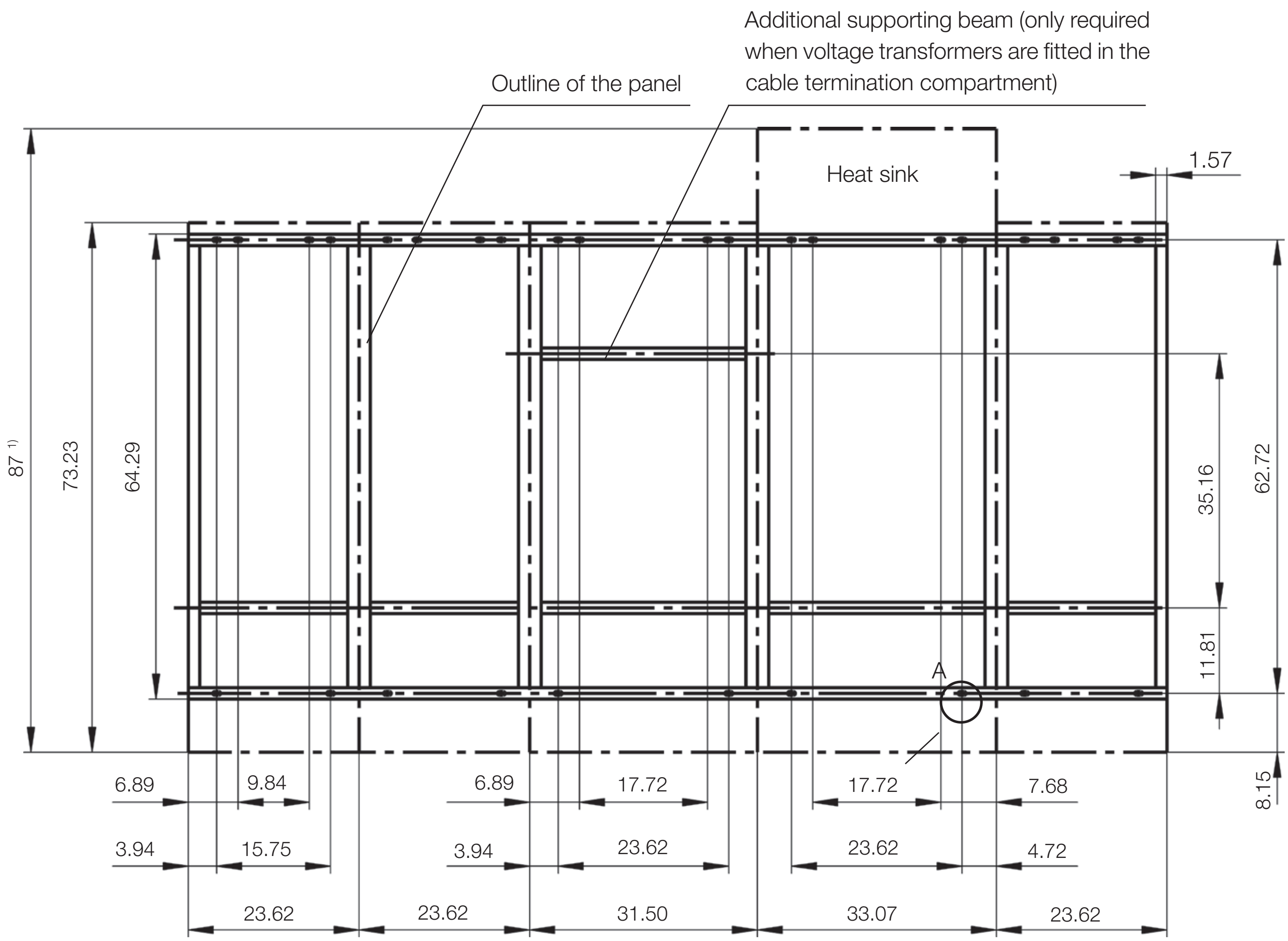
Fig. 11.7.2: Foundation frame for the panel width 31.50 in

11.8 False floor

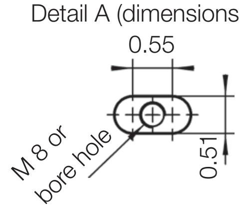
Fig. 11.8.1 is an aid to planning of the false floor.

The floor plates of the panels have L13 x 14 (mm) slots for fastening the panels to the frame sections. Provide M 8 threads or bore holes for screws M 8 in the frame sections at the positions of the slots.

Fig. 11.8.1: Example of a false floor in the area of a five-panel ZX2 switchgear system as an aid to planning (plan view, dimensions in inches).



Detail A (dimensions in inches)



- 0.51 in x 0.55 in slot in the floor plate of the panel
- M 8 thread or bore hole for screw M 8 in the frame section of the false floor

11.9 Grounding of the switchgear

11.9.1 Design of grounding systems with regard to touch voltage and thermal stress

The grounding system for the station building and the grounding system for the switchgear are to be designed in accordance with IEC 61936.

The switchgear system is to be fitted with a continuous copper grounding bar with a cross-section of 789.4 kcmil (ECuF30, 1.57 in x 0.39 in). The connection of this grounding bar to the station grounding system is to be effected in accordance with the above standards.

11.9.2 EMC-compliant grounding of the switchgear

Observe IEC 61000-5-2 and IEC 61000-6-5 to project the grounding system for the station building and the design, laying and connection of external control cables.

Establish the switchgear grounding due to the guidelines in the following section.

11.9.3 Recommendations on configuration of the switchgear grounding

We recommend that the switchgear be grounded as shown in Figs. 11.9.3.1 and 11.9.3.2.
A ring consisting of 3.15 in x 0.20 in copper strip is to be located beneath the switchgear and connected at several points with a maximum spacing of 16.4 ft to the grounding system of the building.
The foundation frame, the main grounding bar in the panels and the grounding bar in the low voltage compartments are to be connected at multiple points to the ring located beneath the switchgear. Details on the use of materials and the number of connections can be found in Figs. 11.9.3.1 and 11.9.3.2.

Fig. 11.9.3.1: Grounding recommendation, shown schematically as a sectional elevation of the lower part of a panel including the concrete floor

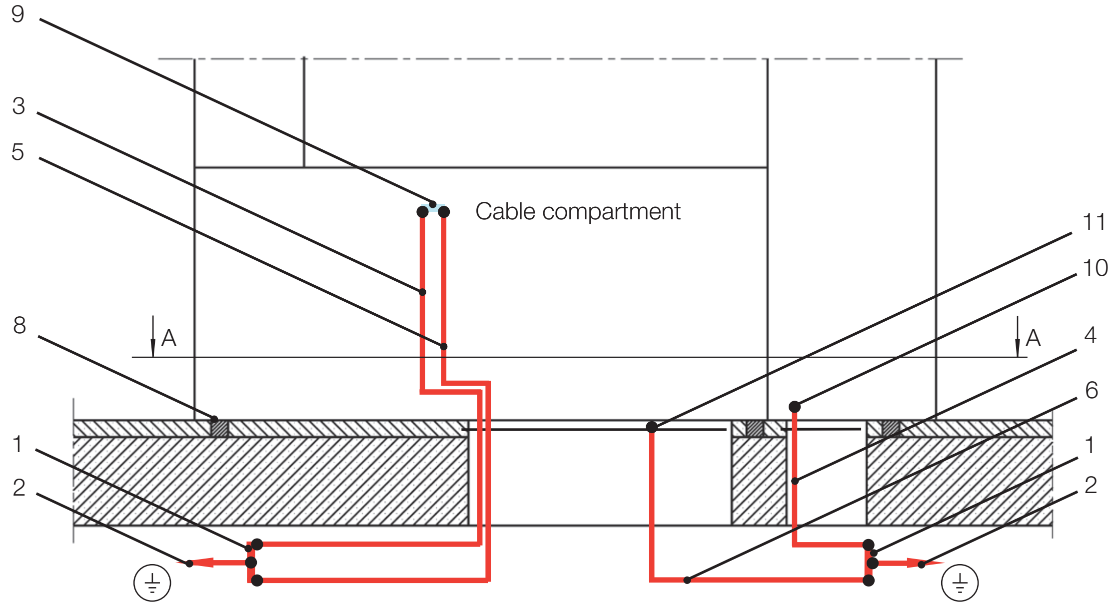
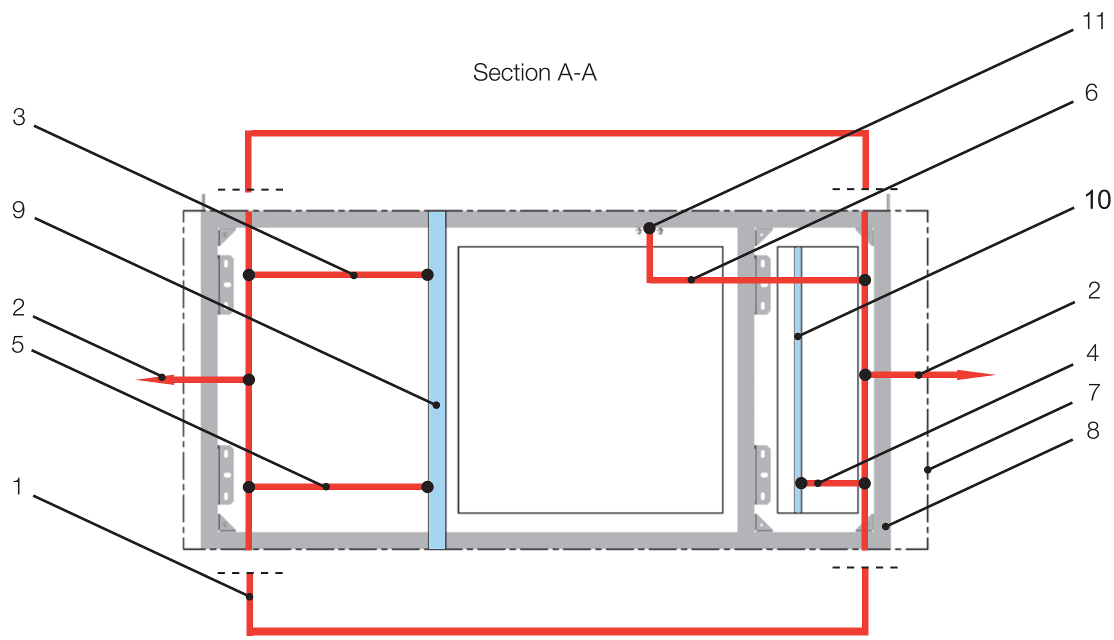


Fig. 11.9.3.2: Grounding recommendation, plan view (section A-A of Fig. 11.9.3.1)



1	Ring below the switchgear, material ECuF30, cross-section 3.15 in x 0.20 in
2	Several connections from (1) to the building ground at distances of max. 16.4 ft material ECuF30, cross-section 3.15 in x 0.20 in
3	Short-circuit proof grounding of the switchgear in both end panels and at least every third panel, material: ECuF30, cross-section: 1.57 in x 0.39 in
4	Low impedance grounding of the grounding bar in the low voltage compartment of each panel, material: tinned copper braid, cross-section: 0.79 in x 0.12 in
5	Low impedance grounding of the switchgear in each panel, material: tinned copper braid, cross-section: 0.79 in x 0.12 in
6	Grounding of the foundation frame, at least every third foundation frame, material: galvanised steel strip, cross-section: 1.18 in x 0.14 in
7	Outline of the panel
8	Foundation frame
9	Main grounding bar
10	Grounding bar in the low voltage compartment
11	Grounding point on the foundation frame

11.10 Panel weights

Table 11.10.1: Panel weights

Panel type	Panel width [in]	Weight, max. [lb]	Weight, max. [kg]
Single busbar	23.62	3086	1400
	31.50	4409	2000
Double busbar	23.62	3527	1600
	31.50	5291	2400
Side plenum (increase in weight of the relevant end panel)		551	250

12 Non-standard operating conditions

Non-standard operating conditions may require special action. A number of non-standard requirements and the measures which may be necessary are listed below. Over and above this, our design team will be pleased to make a technical proposal to meet your specific requirements.

Seismic withstand capability

Panels are tested to IEEE Std. 693 Draft 6; 1997. [1)]

Climate

With high humidity and/or major rapid temperature fluctuations, electrical heaters must be fitted in the low voltage compartments.

Site altitudes > 3281 ft above sea level

The panels are suitable for site altitudes > 3281 ft above sea level with the following exceptions.

- All panels with test voltages > 70/170kV
- Outer cone panels with a voltage transformer isolating device and test voltages > 50/125kV
- C-panels with a load current > 800 A
- C-panels with an ambient temperature > 86 ° F

- At site altitudes > 3281 ft, a reduction of the permissible operating current and/or the ambient temperature may be necessary. An individual examination can be made on request.

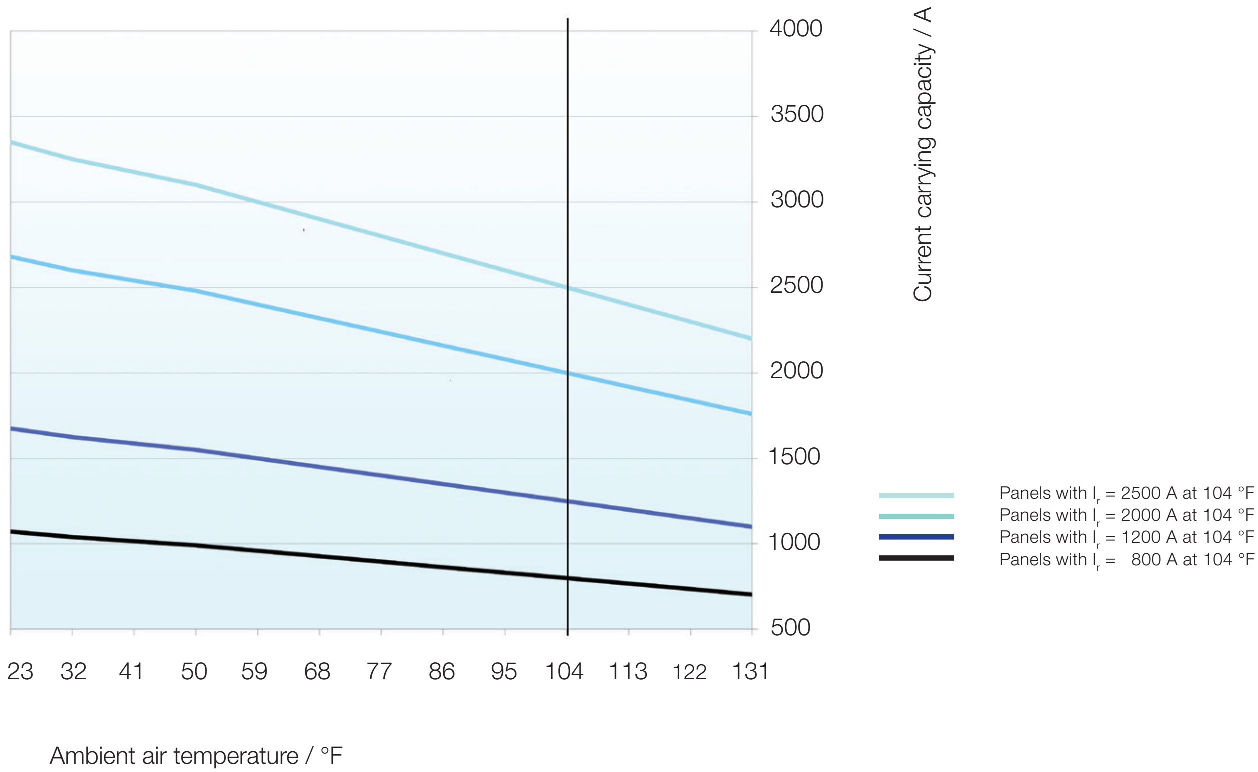
The non-standard operating conditions include in particular

- Higher ambient air temperature (maximum > 104 °F and maximum 24 hour average > 95 °F) see Fig. 12.1

- Ambient air contaminated by dust, smoke, corrosive or flammable gases or salt.

[1)] Additional measures required (on request)

Fig. 12.1: Relationship between ambient air temperature and current carrying capacity



For your notes

ABB AG
Oberhausener Str. 33
D-40472 Ratingen
Germany

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