Catalog
HB1 and VB1 ·
Edition 2017

HB1 and VB1 Generator Circuit-Breaker Switchgear

Medium-Voltage Switchgear

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Application

Typical uses

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R-HB1VB1-001.tif

Application:
- Gas-fired, gas-turbine-driven power plants
- Coal- and oil-fired steam turbine-driven power plants
- Concentrated solar steam turbine-driven power plants
- Hydro turbine-driven power plants
- Geothermal power plants
- Main distribution switchgear for heavy duty application

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MANAGEMENT SYSTEM CERTIFICATION
DNV·GL
ISO 9001 = ISO 14001
OHSAS 18001

The products and systems described in this catalog are manufactured and sold according to a certified management system (acc. to ISO 9001, ISO 14001 and BS OHSAS 18001).

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Fig. 1 Example of an HB1 switchgear

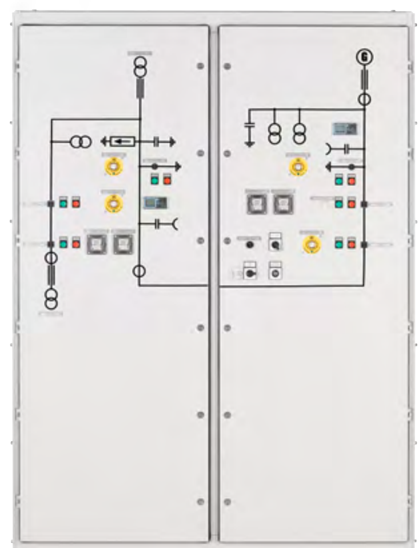

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Fig. 2 Example of a control panel

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Fig. 3 Example of a VB1 switchgear

Independent of the type of power plant, the use of a generator circuit-breaker switchgear provides numerous advantages. The implementation of this equipment in the system increases the profitability, availability and security of the power plant, minimizing losses of production and earnings due to maintenance or high investments in unexpected reparations.

Some of the advantages of using generator circuit-breaker switchgear:

Reliable synchronization and power plant optimization

- One switching operation on the generation side of the GSUT only
- Half-sized generator configuration (2 generators feed 1 GSUT)
- Pump storage: fast switch-over between generation and pumping.

Highest security of supply

- Uninterrupted auxiliary service supply if generator is switched off in case of internal faults of maintenance.

Improved protection

- The GSUT and auxiliary transformer against generator-fed faults
- The generator against system-fed faults.

Switching of generators means switching under special conditions, such as:

- Very high rated currents
- Very high short-circuit currents
- High DC components
- High rates-of-rise of recovery voltage.

Circuit-breakers used for generator switching applications are subject to conditions quite different from those of normal distribution circuit-breakers used in industrial, commercial and utility systems.

In a distribution application, the DC component is nearly completely decayed after just a few cycles. However, the basis of rating for a generator circuit-breaker is a system X/R ratio of 50 (at 60 Hz), which provides a time constant of DC decay, and hence the DC component decays only very slowly.

This means that the DC component of the current at the instant of interruption is much larger for a generator application than it would be for a distribution application.

The AC component is no longer a constant rms value, but, in fact, decays. In the case the time constant of decay of the AC component is faster than the corresponding DC decay, the superposition of the DC component on the AC component will result in a potentially long period in which the actual fault current does not pass through zero. This is a problem, because circuit-breakers actually interrupt when the current passes through a normal current zero.

This phenomenon is referred to in the standard IEEE C37.013, IEC/IEEE 62271-37-013 as "delayed current zeroes" and is a condition for which the performance of the generator circuit-breaker "must" be determined by testing and verified by calculation.

Another aspect of a generator circuit-breaker application is that the transient recovery voltage (TRV) across the contacts, as the interrupter opens, is much greater than for a distribution circuit-breaker. The rate of recovery voltage (RRRV) values can be up to 10 times higher in the standard IEEE C37.013, IEC/IEEE 62271-37-013 than in IEC.

This is just a brief overview of the conditions that make a generator circuit-breaker application quite different from the standard distribution application.

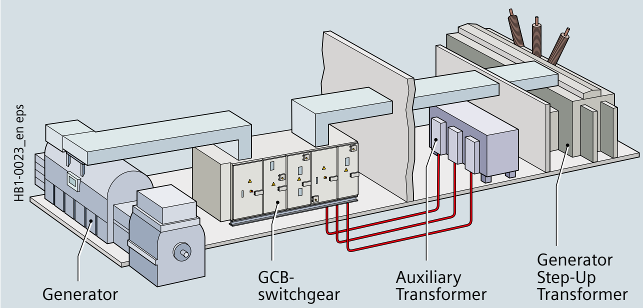


Fig. 4 Typical location of the GCB switchgear in the power plant

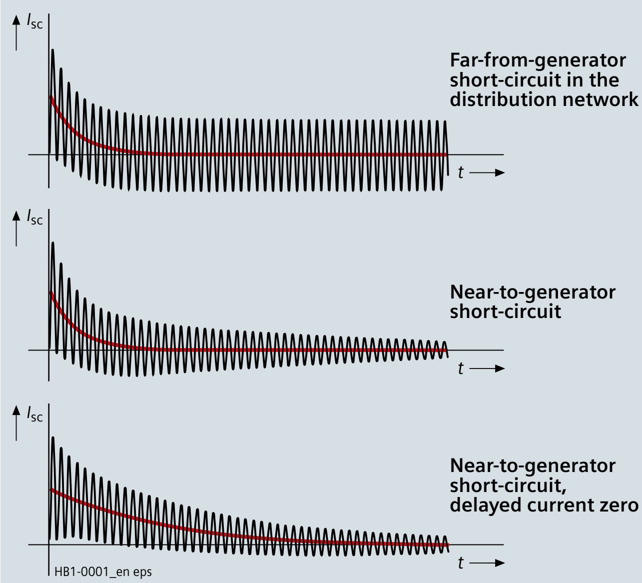


Fig. 5 Short-circuit current profiles

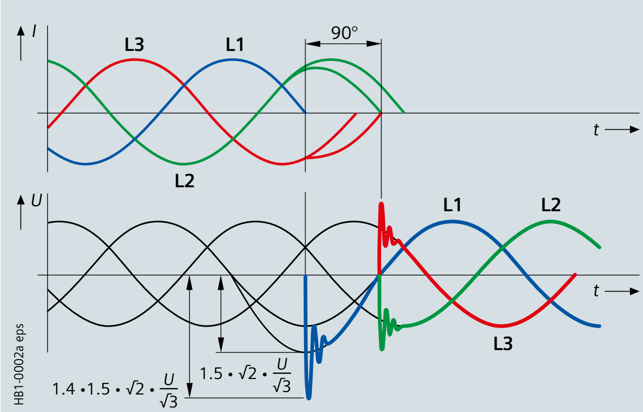


Fig. 6 Transient recovery voltage in generator applications

Application

Typical uses, classification

Siemens generator circuit-breaker switchgear types HB1 and VB1 are factory-assembled, air-insulated, metal-enclosed, non-phase segregated switchgear for indoor and outdoor installation and they are designed according to the standards IEC 61271-1 and IEC 61936-1 (VDE 0101). The type tests of the HB1 and VB1 have been carried out according to the standard IEC 62271-200.

Siemens is one of the leading manufacturers in the field of vacuum circuit-breaker and switchgear technology, providing solutions to the most demanding clients all over the world.

The HB1 and VB1 circuit-breaker switchgear provide a compact solution which can be customized to the individual needs of our clients. The application of the HB1 and VB1 switchgear is done both in power plants and as high-current-/furnace switchgear.

For current interruption capabilities, Siemens vacuum generator circuit-breaker types 3AH37 and 3AH38 are used, which are type tested and compliant with the generator circuit-breaker standard IEEE C37.013, IEEE/IEC 62271-37-013.

For severe ambient conditions, like e.g. in deserts or very corrosive atmospheres with chemical content in the air, the HB1 and VB1 switchgear can be installed in container modules equipped with its own auxiliary devices and be delivered to the site completely tested.

Direct connection to the generator terminals is also possible due to the modular design of the HB1, providing cost savings and avoiding additional connection from the generator to the generator circuit-breaker switchgear.

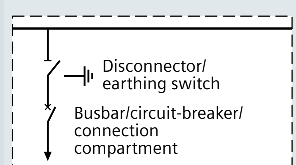
The HB1 and VB1 generator circuit-breaker switchgear is designed for generators up to 240 MVA for connection between the generator(s) and the step-up transformer(s) and, if applicable, also for auxiliary supply transformers and excitation transformers. They can be used, for example, in:

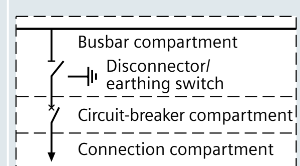
- Gas-fired, gas-turbine-driven power plants (simple cycle and combined cycle)
- Coal- and oil-fired steam turbine-driven power plants
- Concentrated solar steam turbine-driven power plants
- Hydro turbine-driven power plants
- Geothermal power plants
- Main distribution switchgear for heavy duty application up to 24 kV, 5.000 A, ≥ 50 kA.

The generator circuit-breaker switchgear types HB1 and VB1 correspond to the following classifications:

	HB1	VB1
Loss of service continuity category and partition class		
Loss of service continuity category	LSC 1	LSC 1 LSC 2A on request
Partition class	None	None PI on request PM on request
Internal arc classifications		
Internal arc classifications	A FLR 72 kA/0.1 s A FLR 63 kA/0.1 s A FLR 63 kA/1 s	A FL 50 kA/0.5 s A FL 72 kA/0.1 s
A	= 300 mm distance of indicators for test (installation in closed electrical service location)	
F	= Front arrangement of indicators for test	
L	= Lateral arrangement of indicators for test	
R	= Rear arrangement of indicators for test	
I_{sc}	= Test current 50 kA, 63 kA, 72 kA	
t	= Arc duration 0.1 s, 0.5 s, 1 s	

LSC 1	LSC 2A
Definition: Entire shut-down required for access to any compartment of the siwtchgear (busbar, circuit-breaker, earthing switch, disconnector in one common compartment)	Definition: Access to aux.-feeder or connection compartment permitted due to disconnection from grid in segregated compartment





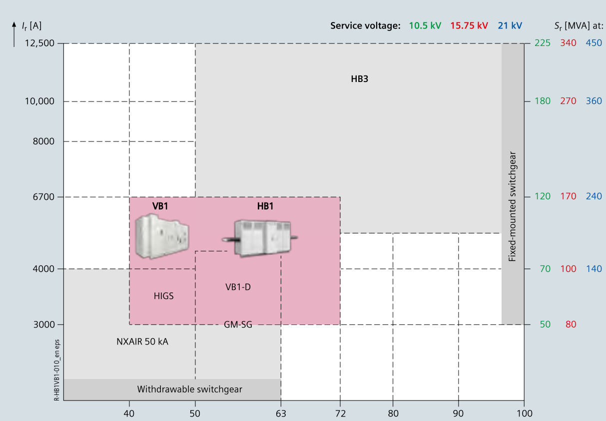


Fig. 7 Portfolio

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Based on years of experience and customer orientation as a pioneer in development of vacuum switchgear technology for reliable transmission and distribution of electrical power in medium voltage, Siemens has gained the competence and solutions for the unique switching duties of generator circuits.

Siemens has optimized its portfolio of high-current and generator circuit-breaker switchgear in order to meet the high demands of the merging market for power generation sets up to 450 MVA.

Customer benefits	Design features
• **Peace of mind**	• No handling of insulating gas and therefore no low and high-pressure monitoring required • As insulating medium, air is always available • Use of standard components available worldwide • More than 450,000 air-insulated switchgear panels and systems with vacuum switching technology operating worldwide • Use of maintenance-free vacuum circuit-breakers • Quality assurance in accordance with DIN EN ISO 9001 • Computer-aided calculation and simulation of short-time withstand current and peak current in accordance with IEC 60909 • Dimensioning of enclosure and current path to withstand dynamic and thermal impact of continuous and short-circuit currents • Verification of breaker interruption capabilities under consideration of delayed current zero • High reliability of vacuum circuit-breakers due to the low number of moving parts inside the arcing chamber • Extremely high mean-time-to-failure (MTTF) values of the vacuum interrupters • No leakage due to the welded connections of the vacuum interrupter. This sealed for live technology does not require any gas monitoring.
• **Optimum safety**	• Design and construction according to IEC 62271-1 and IEC 61936-1, type tests according to IEC 62271-200 • Internal arc classification (IAC) is available for switchgear enclosures • All switching devices can be operated locally by means of electrical commands with all doors and covers closed • In case of loss of electrical control power, the switchgear can be operated manually by means of emergency operating crank handles or levers, also with all doors and covers closed • The positions of the switching devices are visible through inspection windows • No explosion in the unlikely event of a fault in the vacuum interrupter of the generator circuit-breaker • Switching devices are electrically interlocked • In the extremely unlikely case of a loss of vacuum in the circuit-breaker, only an arc develops, as the current is interrupted inside a ceramic-metal housing
• **Increases productivity**	• Loss of service continuity category LSC 2A on request • Partition class PI and PM on request • Maximum degree of protection IP55 possible • Use of maintenance-free vacuum circuit-breakers for 10,000 operating cycles at rated current • Frequent-operation circuit-breakers for up to 120,000 operating cycles available • High reliability of vacuum circuit-breakers due to the low number of moving parts inside the arcing chamber • Extremely high mean-time-to-failure (MTTF) values of the vacuum interrupters

Requirements

Customer benefits, design features

Customer benefits	Design features
• **Saves money**	• Use of maintenance-free vacuum circuit-breakers • Due to its compact design the necessary space for installation is minimized thanks to a modular enclosure concept • Factory-assembled, thus reducing installation works on site • Significant lower life-cycle costs in terms of inspection intervals and maintenance costs compared to other switching medium technologies
• **Preserves the environment**	• Long lifetime of the switchgear and all components (more than 20 years) • Vacuum switching technology, no gas filling every few years • The materials used are fully recyclable without special knowledge • Easy disposal, no toxic decomposition of products by the arc quenching medium
• **Experience**	With over 40 years of experience in vacuum switching technology, Siemens has perfected its vacuum circuit-breakers for generator switching applications in particular, where they are subjected to high thermal and mechanical stress.

• **Vacuum circuit-breaker**	• Special contact material for minimum contact wear and low chopping currents • Specifically developed contact system • Optimized design for efficient cooling • Post insulator construction for highest mechanical stability • Safe breaking operations by controlling long arcing times even in case of delayed zero crossings • Transient recovery voltages with high rates-of-rise, typical for generators, are controlled without additional capacitor circuits.

Rated values for HB1

Rated								
voltage		kV	**12**		**17.5**		**24**	
frequency		Hz	50 / 60		50 / 60		50 / 60	
short-duration power-frequency withstand voltage		kV	28		38		60	
lightning Impulse withstand voltage		kV	75		95		125	
short-time withstand current		kA / s	50 / 3 63 / 1 72 / 1		50 / 3 63 / 1 72 / 1		50 / 3 63 / 1 72 / 1	
peak withstand current		kA	125 / 130 [1)] 160 / 164 [1)] 180 / 188 [1)] 200 [2)]		125 / 130 [1)] 160 / 164 [1)] 180 / 188 [1)] 200 [2)]		125 / 130 [1)] 160 / 164 [1)] 180 / 188 [1)] 200 [2)]	
normal current of feeders:			**IP4X** [3)]	**IP54** [4)]	**IP4X** [3)]	**IP54** [4)]	**IP4X** [3)]	**IP54** [4)]
Generator feeder	3150 A VGCB	A	2900	2300	2900	2300	2900	2300
Generator feeder	4000 A VGCB	A	4200	3300	4200	3300	4200	3300
Generator feeder	5000 A VGCB	A	5200	3700	5200	3700	5200	3700
Generator feeder	6300 A VGCB	A	6700	4700	6700	4700	6700	4700
Auxiliary transformer feeder [6)]	for transformers ≤ 1250 kVA with FLBS [5)]	A	< 125		< 125		< 125	
Auxiliary transformer feeder [6)]	for transformers > 1250 kVA with 1250 A VCB or 3150 A VGCB	A	< 1250		< 1250		< 1250	
Auxiliary transformer feeder [6)]	with disconnector	A	< 1250		< 1250		< 1250	
Auxiliary transformer feeder [6)]	without switching devices	A	< 1250		< 1250		< 1250	
Auxiliary transformer feeder [6)]	with fuse link	A	< 200		< 200		< 200	

Example:

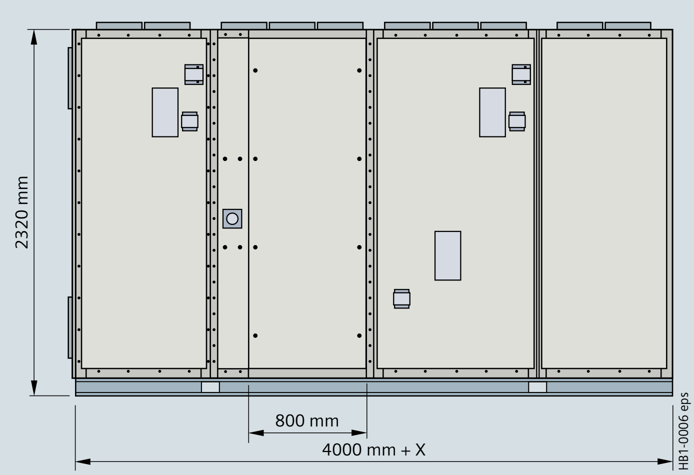


Fig. 8 Front view

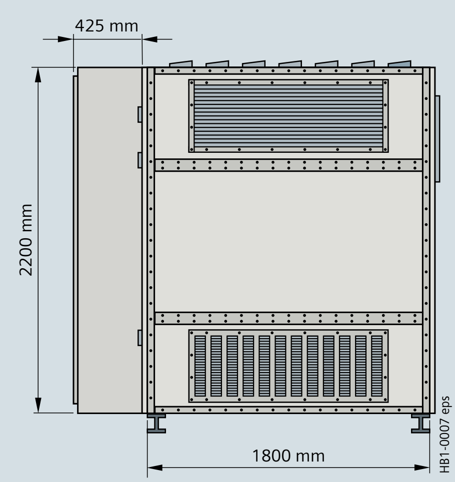


Fig. 9 Side view

X is defined depending on the type of connection

1) Values for 60 Hz
2) Values on request
3) Also with IP41, IP42
4) Also with IP55 for outdoor use
5) Fused load break switch
6) Optional feature, available on request

Rated values for VB1

Rated								
voltage		kV	**12**		**17.5**		**24**	
frequency		Hz	50/60		50/60		50/60	
short-duration power-frequency withstand voltage		kV	28		38		60	
lightning Impulse withstand voltage		kV	75		95		125	
short-time withstand current		kA/s	50/3 63/1 72/1		50/3 63/1 72/1		50/3 63/1 72/1	
peak withstand current		kA	125/130 1) 160/164 1) 180/188 1) 200 2)		125/130 1) 160/164 1) 180/188 1) 200 2)		125/130 1) 160/164 1) 180/188 1) 200 2)	
normal current of feeders:			**IP4X** 3)	**IP54** 4)	**IP4X** 3)	**IP54** 4)	**IP4X** 3)	**IP54** 4)
Generator/Transformer feeder	3150 A VGCB	A	2830	2680	2830	2680	2680	2680
Generator/Transformer feeder	4000 A VGCB	A	4200	3000	4200	3000	4200	3000
Generator/Transformer feeder	5000 A VGCB	A	4400	3150	4400	3150	4400	3150
Generator/Transformer feeder	6300 A VGCB	A	5800	4000	5800	4000	5800	4000
Auxiliary transformer feeder	for transformers ≤ 1250 kVA with FLBS 5)	A	< 125		< 125		< 125	
Auxiliary transformer feeder	for transformers > 1250 kVA with 1250 A VCB or 3150 A VGCB	A	< 1250		< 1250		< 1250	
Auxiliary transformer feeder	with disconnector	A	< 1250		< 1250		< 1250	
Auxiliary transformer feeder	without switching devices	A	< 1250		< 1250		< 1250	
Auxiliary transformer feeder	with fuse link	A	< 200		< 200		< 200	

Example:

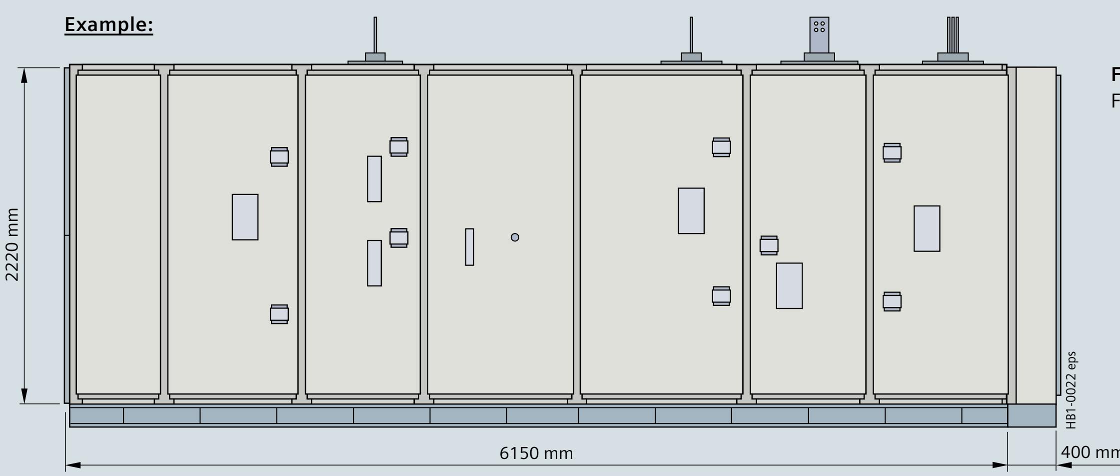


Fig. 10
Front view VB1

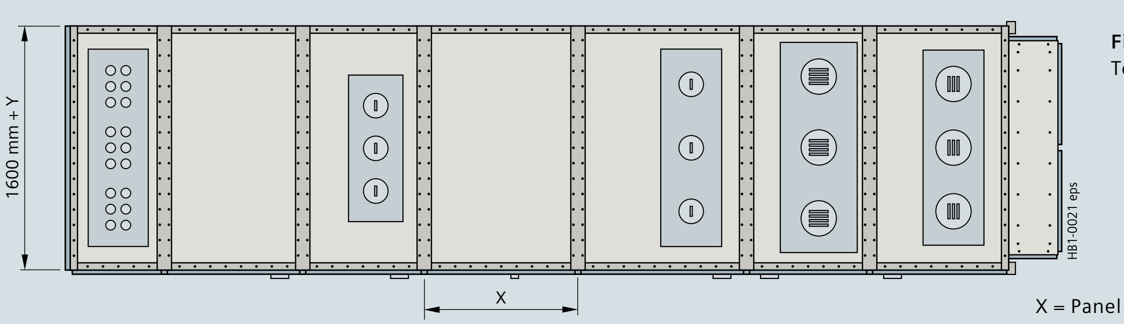


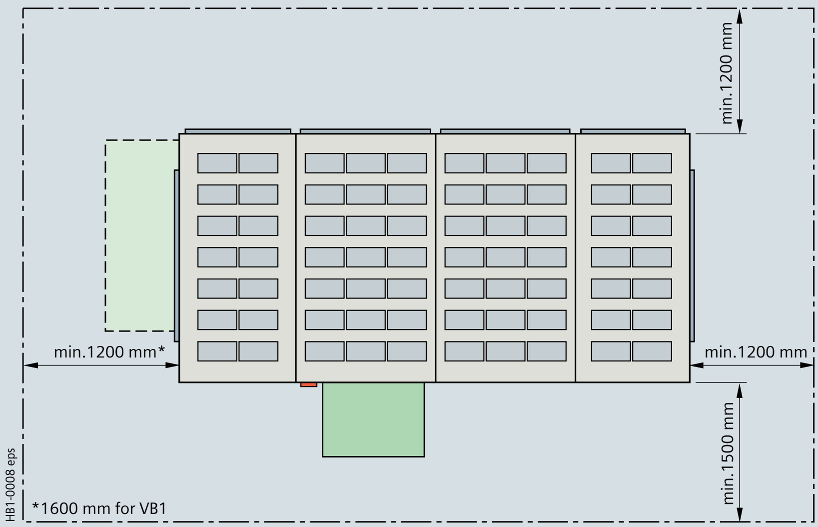
Fig. 11
Top view VB1

X = Panel width from 600 mm to 1300 mm,
Y = is defined depending on the panel functionality

1) Values for 60 Hz
2) Values on request
3) Also with IP41, IP42
4) Also with IP55 for outdoor use
5) Fused load break switch

Room planning for HB1 and VB1

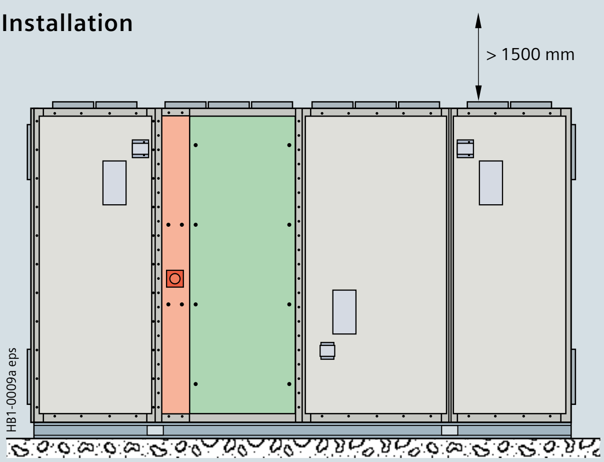
Plan view



Recommended minimum distances for maintenance

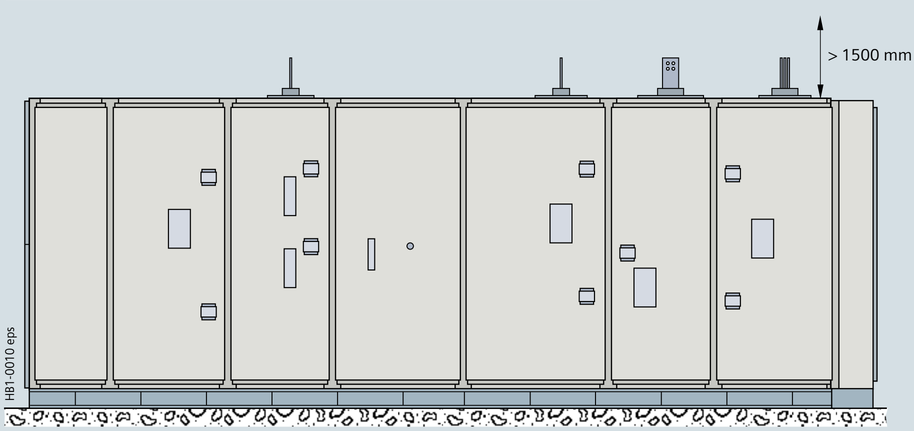
Fig. 12
Top view HB1

Installation



In case of a room height of above 4000 mm, pressure relief is adequate from the top. Otherwise, the pressure relief system must be evaluated according to the room conditions.

Fig. 13 Front view HB1



In case of a room height of above 4000 mm, pressure relief is adequate from the top. Otherwise, the pressure relief system must be evaluated according to the room conditions.

Fig. 14 Front view VB1

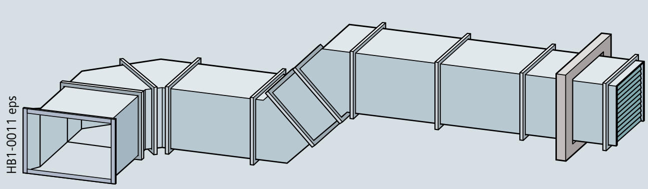


Fig. 15 Example of pressure relief duct

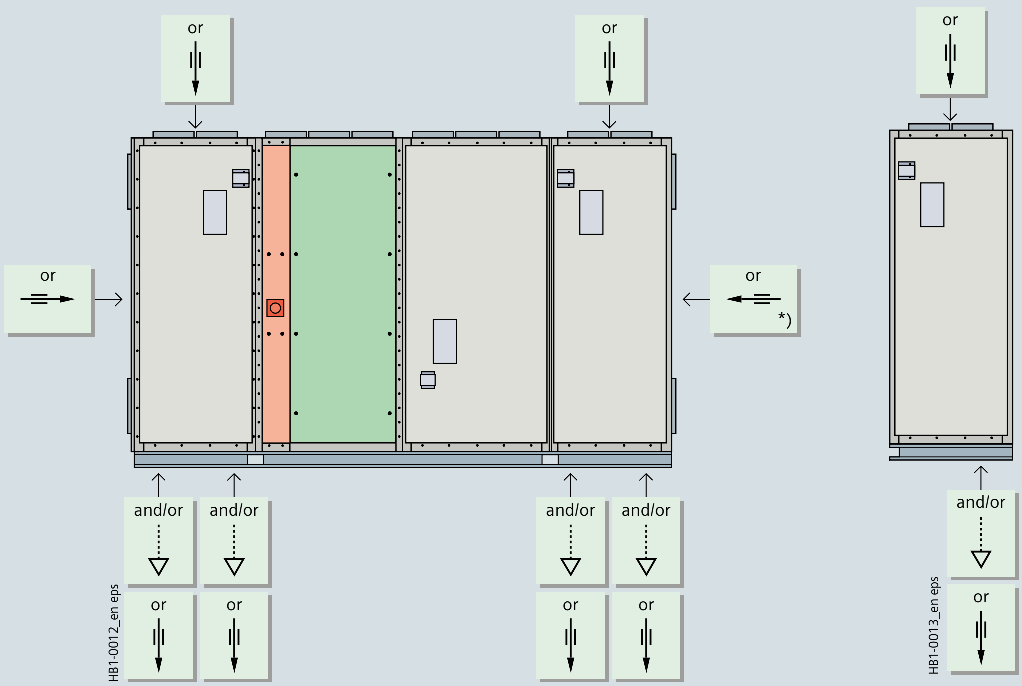
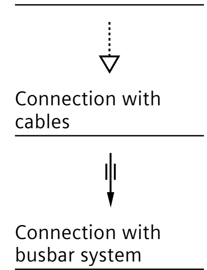


Fig. 16 Possibilities for connection of an HB1 switchgear



The connection to the generator and the transformer can be done by means of either cables, fully-insulated busbars or non-phase segregated bus ducts. The connection to the terminals can be either from top, bottom or horizontally from the left and right side.

Similar connection types are available for VB1 switchgear. The location is to be defined according to the project requirements.

*) Only without auxiliary feeder

Connection types

The connection to the generator and transformer can be done by means of either cables, fully-insulated busbars (e.g. make Moser Glaser, Preissinger, Ritz) or non-phase segregated bus ducts. The connection to the terminals can be either from top, bottom or horizontally from the left and right side. Additionally, an isolated phase bus duct with a phase-centre distance < 510 mm can be connected from the side.

The access to the connection terminals is covered with non-magnetic sheet metal which is cut out according to the number of cables and respectively the diameter of busbars. Cable glands or flanges are not included in the scope of supply.

Connection of the HB1 to the IPB system: Connection to an isolated phase bus duct system (IPB) is available as an option. However, conditions for segregation of the switchgear from pressurized IPB enclosures, earthing systems and details of the flange connection, phase-centre distance, etc. have to be evaluated individually.

Transport

The HB1 switchgear is delivered in one factory-assembled transport unit. The VB1 switchgear can be delivered either in one factory-assembled transport unit or in form of sections/ individual panels. Please observe the following:

- Transport facilities on site
- Transport dimensions and transport weights
- Size of door openings in building.

Packing

Means of transport: Truck

– Open packing with PE protective foil.

Means of transport: Ship

– In closed crates with sealed upper and lower PE protective foil
– With desiccant bags
– With sealed wooden base
– Max. storage time: 12 months.

Transport dimensions, transport weight

Unit dimension	Transport dimensions			Transport weight	
	Width	Height	Depth	with packing	without packing
mm	mm	mm	mm	approx. kg	approx. kg
Transport of HB1 with truck					
4000 × 2320 × 2300	4000	2700	2400	5750	5500
up to 6000 × 2500 × 2300	up to 6000	2700	2400	8000	7750
Transport of HB1 with ship					
4000 × 2320 × 2300	4500	3000	2800	6750	5500
up to 6000 × 2500 × 2300	up to 6000	3000	2800	9250	7750
Transport of VB1 with truck					
4500 × 2320 x up to 1800	4500	2700	up to 1800	6750	6500
up to 6500 × 2500 × up to 1800	up to 6500	2700	up to 1800	9500	9000
Transport of VB1 with ship					
4500 × 2320 x up to 1800	5000	3000	2200	7750	6500
up to 6500 × 2500 × up to 1800	up to 7000	3000	2200	10500	9000

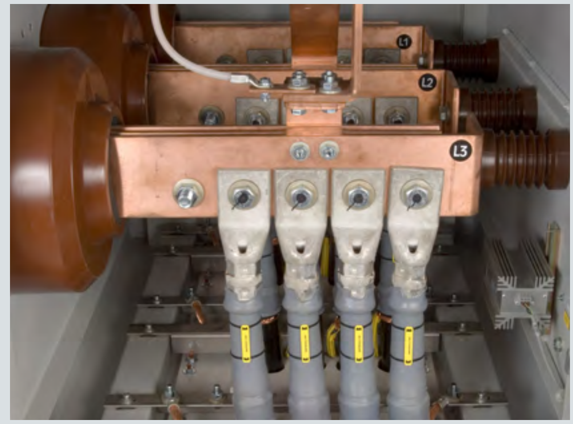

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Fig. 17 Cable connection from bottom


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Fig. 18 Fully-insulated busbars – horizontal connection

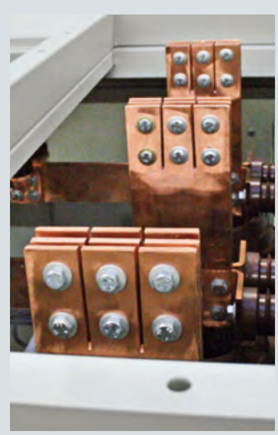
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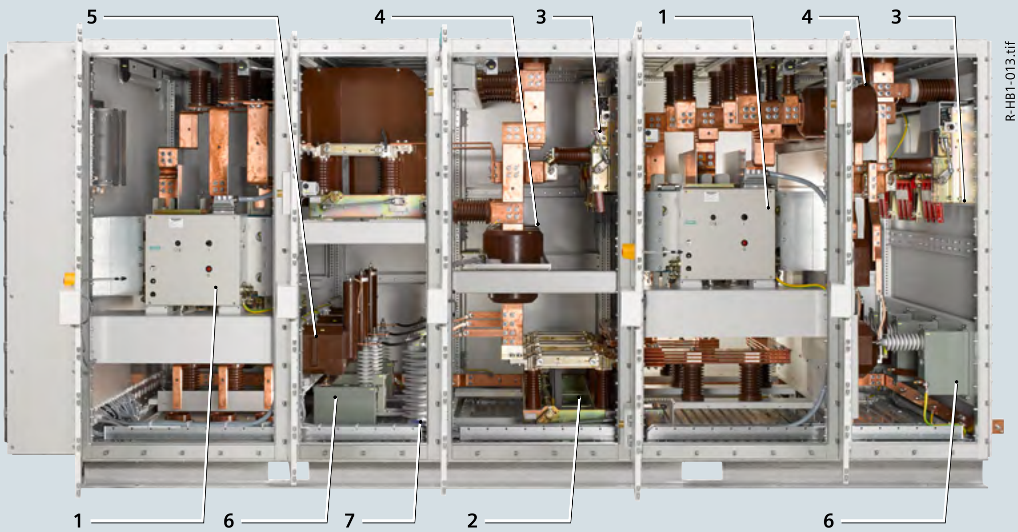
Fig. 19 Bus duct connection from top

Fig. 20 Fully-insulated busbars – bottom connection



1 Generator circuit-breaker
2 Disconnector
3 Earthing switch
4 Current transformer
5 Voltage transformer
6 Surge capacitor
7 Surge arrester

Fig. 21 Interior view of the VB1 generator circuit-breaker switchgear

Enclosure for HB1 and VB1

The modular designed switchgear comprises a welded framework construction and bolted sheet-metal enclosure walls.

The doors at the operating side are bolted with hinges. Inspection windows and access holes for the emergency operating tools are provided for all switching devices to allow visual inspection of the switching position and manual operation with all covers closed.

Pressure relief is provided as standard on the roof to release gases in case of internal faults. These can also be provided at the rear side depending on the on-site conditions.

The enclosure is available with degrees of protection IP20, IP21, IP40, IP41, IP42 and IP54 for indoor installation.

The degrees of protection IP54 and IP55 with a roof are available for outdoor installation.

The standard enclosure including all internal surfaces is epoxy powder-coated with color RAL 7035. Other RAL colors are also available on request. Internal structure parts can be manufactured using stainless steel, aluminium and sensimized steel without further surface coating.

Switchgear enclosure of the main current path (generator feeder)

The switchgear is an air-insulated, three-phase system in one common enclosure (non-phase segregation) with all components necessary for the main current path between generator and main transformer.

A phase-centre distance of up to 470 mm (up to 345 mm for earthing circuits) provides sufficient clearance for safe isolation between the live parts and live parts to earth under all operating conditions. This large clearance helps to reduce the usage of insulation material to a minimum.

All switching devices are fixed-mounted and the interconnections are done by flat busbars made of electrolytic copper with standard dimensions of 100 × 10 mm up to 200 × 10 mm.

Switchgear enclosure of the auxiliary current path (auxiliary feeder)

In the case that auxiliary and / or excitation transformer feeders shall be incorporated in the switchgear, additional auxiliary panels can be added.

These feeders are also air-insulated, three-phase systems which are mounted to the longitudinal sides of the enclosure construction site.

The main enclosure and auxiliary panels can be separated by metal partitions. Connection to the main current path is done by pre-fabricated busbars.

A phase-centre distance of up to 345 mm provides sufficient clearance for safe isolation between the live parts and live parts to earth under all operating conditions.

All switching devices are fixed-mounted and the interconnections are done by flat busbars made of electrolytic copper with standard dimensions of 100 × 10 mm up to 120 × 10 mm.

Interlocks

All switching devices are equipped with a motor operating mechanism which is incorporated in the electrical interlock scheme.

In case of emergency (e.g. loss of auxiliary power), the switching devices can be operated manually. However, there are no interlocks in case of manual operation. The access to the manual operation of the switching devices may be protected by means of padlocks.

Operator safety is ensured since all operations are done with the doors closed. The position of the disconnector and earthing switches can be observed through inspection windows.

An optional interlocking system with electromagnetic keys for additional interlocking features can be provided.

Interlocks to external components of the system can be considered in the interlocking concept (electrical or by means of key systems).

Minimum standard interlocking conditions for the generator feeder	
Generator circuit-breaker CLOSE:	Associated disconnector in CLOSED position and associated earthing switches on both sides in OPEN position
Generator circuit-breaker OPEN:	An emergency/local manual OFF pushbutton or the remote command always cause direct opening of the circuit-breaker
Disconnector CLOSE / OPEN:	Associated generator circuit-breaker in OPEN position and associated earthing switches on both sides in OPEN position
Earthing switch generator side CLOSE / OPEN:	Associated generator circuit-breaker in OPEN position and associated disconnector in OPEN position and associated generator stopped
Earthing switch transformer side CLOSE / OPEN:	Associated generator circuit-breaker in OPEN position and associated disconnector in OPEN position (and in case of auxiliary feeder) auxiliary feeder disconnector in OPEN position.

Minimum standard interlocking conditions for the auxiliary feeder	
Auxiliary feeder for auxiliary transformers > 1250 kVA	
Auxiliary circuit-breaker CLOSE:	Associated disconnector in CLOSED position and associated earthing switch in OPEN position
Auxiliary circuit-breaker OPEN:	An emergency/local manual OFF pushbutton or the remote command always cause direct opening of the circuit-breaker
Disconnector CLOSE / OPEN:	Associated circuit-breaker in OPEN position and associated earthing switch in OPEN position
Auxiliary feeder for auxiliary transformers ≤ 1250 kVA	
Auxiliary fused load break switch OPEN:	Associated earthing switch in OPEN position
Auxiliary fused load break switch OPEN:	Always operates the opening of the fused load break switch (local / remote)
Option	
Earthing switch CLOSE / OPEN (if applicable):	Associated circuit-breaker or fused load break switch in OPEN position and associated disconnector in OPEN position (only for feeder with circuit-breaker)

Operation, control panel

The operation of the generator switchgear can be done locally via the control panel as well as remotely. In case of the absence of the auxiliary control voltage, hand levers are provided for manual operation of the switching devices.
The standard control panel is fixed-mounted to the enclosure. It includes the electrical control and electrical interlocks of the switching devices. Optionally, metering and protection devices can be mounted into the control panel.
A separate control panel may be provided on request in case the local operation is required from another location.

Features

- Bottom or top entry for external control cables by means of a gland plates slotted opening is provided with (optional) or without cut-outs. Glands for external cables are optional on request
- Standard wiring: black, PVC, 2.5 mm² for instrument transformers, 1.0 mm² for control, signals, power supply, with ferrules. Colored wiring and larger cable cross-sections are available on request
- Mimic diagrams with pushbuttons (optional with additional LEDs) for ON / OFF operation of switching devices and position indication (optionally with LED position indicators) of switching devices
- Selector switch for LOCAL / REMOTE (optionally key-operated).
- Voltage detecting system CAPDIS-S1+ standard / CAPDIS-S2+ on request
- Terminals: Screw terminals for control, signal and power supply circuits, disconnect terminals for potential transformer circuits, short-circuit terminals for current transformers
- Auxiliary power: 110 V, 125 V, 220 V DC and 220 – 240 V AC, to be provided by the customer
- Standard interface for signals: Termination strips within the control panel
- External signals: By means of potential-free contacts and relays. Communication protocols (e.g. IEC 61850, PROFIBUS, etc. can be provided on request in case of numerical control devices or digital protection devices)
- Key interlocks available on request
- Numerical control with generator and transformer protection available on request.

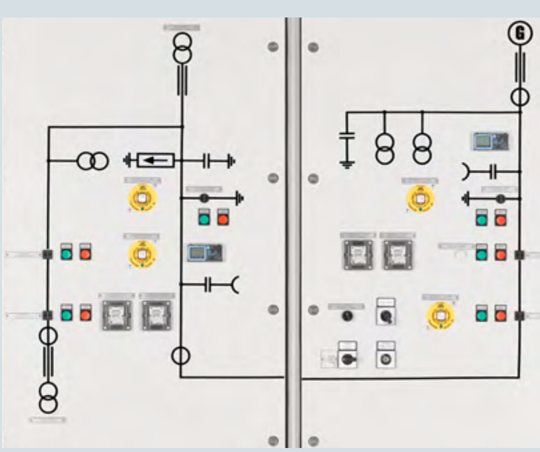

R-HB1-025.tif

Fig. 22 Example of mimic diagram with optional devices


R-HB1-014.tif


R-HB1-015.tif


R-HB1-016.tif


R-HB1-017.tif

Fig. 23
Pushbutton

Fig. 24 **Fig. 25**
LED Lamp indicators (optional)

Fig. 26
Illuminated pushbutton (optional)


R-HB1-018.tif

Fig. 27
Standard position indicator


R-HB1-019.tif

Fig. 28
LED position indicators (optional)


R-HB1-020.tif

Fig. 29
Standard local / remote switch


R-HB1-021.tif

Fig. 30
Key-operated local / remote switch (optional)


R-HA35-154.tif R-HA35-155.tif

Fig. 31
Voltage detecting systems CAPDIS-S1, -S2 (optional)

R-HB1-024.tif

Fig. 32
Key interlocks (optional)


R-HB1-022.tif

Fig. 33
Door locking device with solenoid (optional)


R-HHA-102.eps

Fig. 34 SIPROTEC Protection device (optional)

R-HB1-023.tif

Fig. 35 7PA30 relay trip supervision (optional)

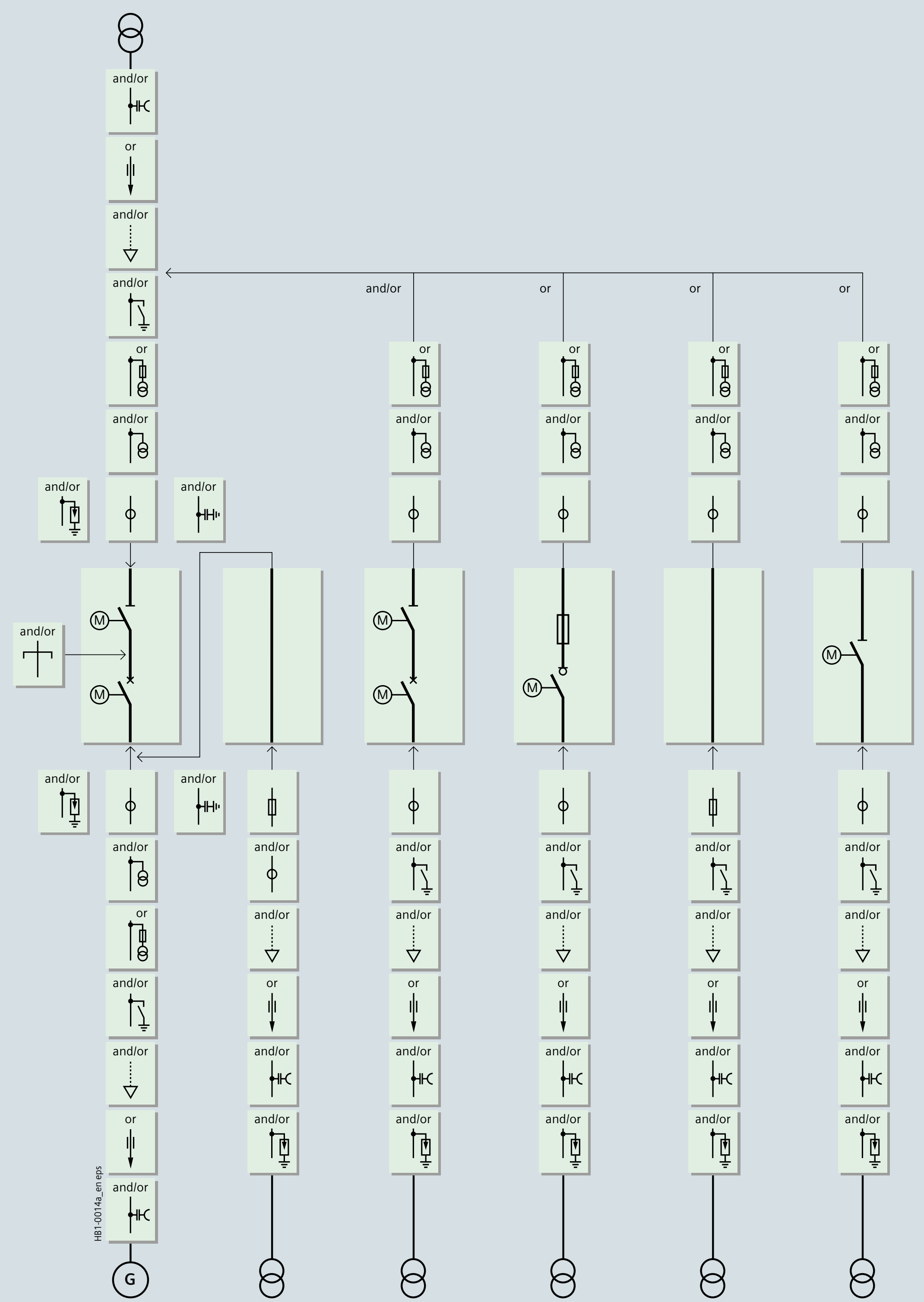
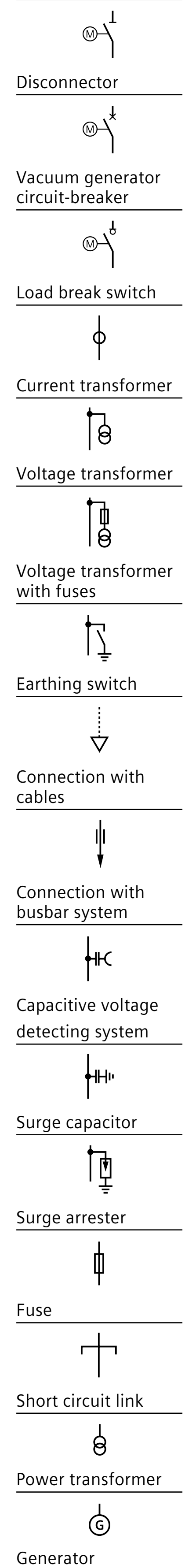


Fig. 36 HB1 switchgear product range



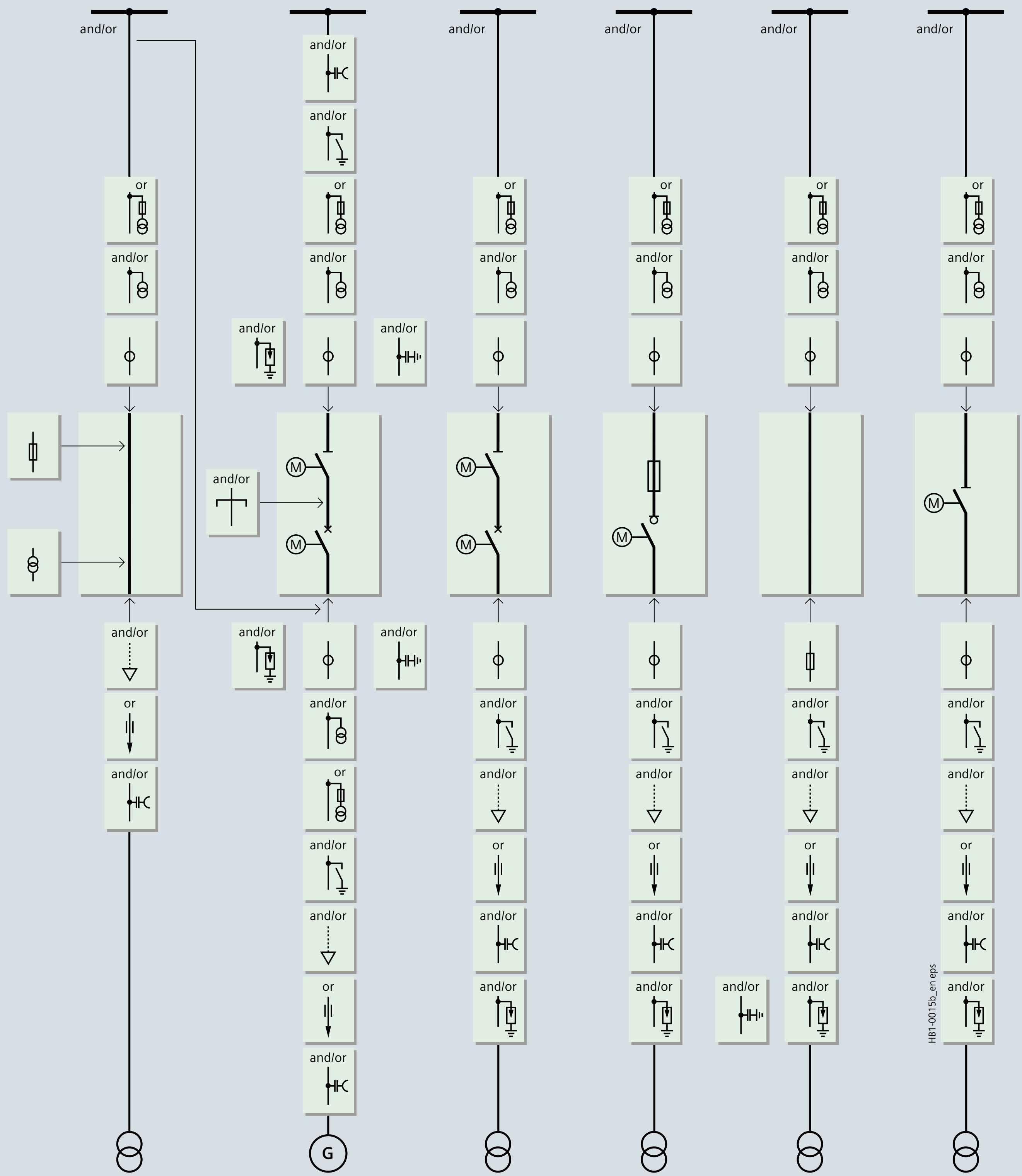
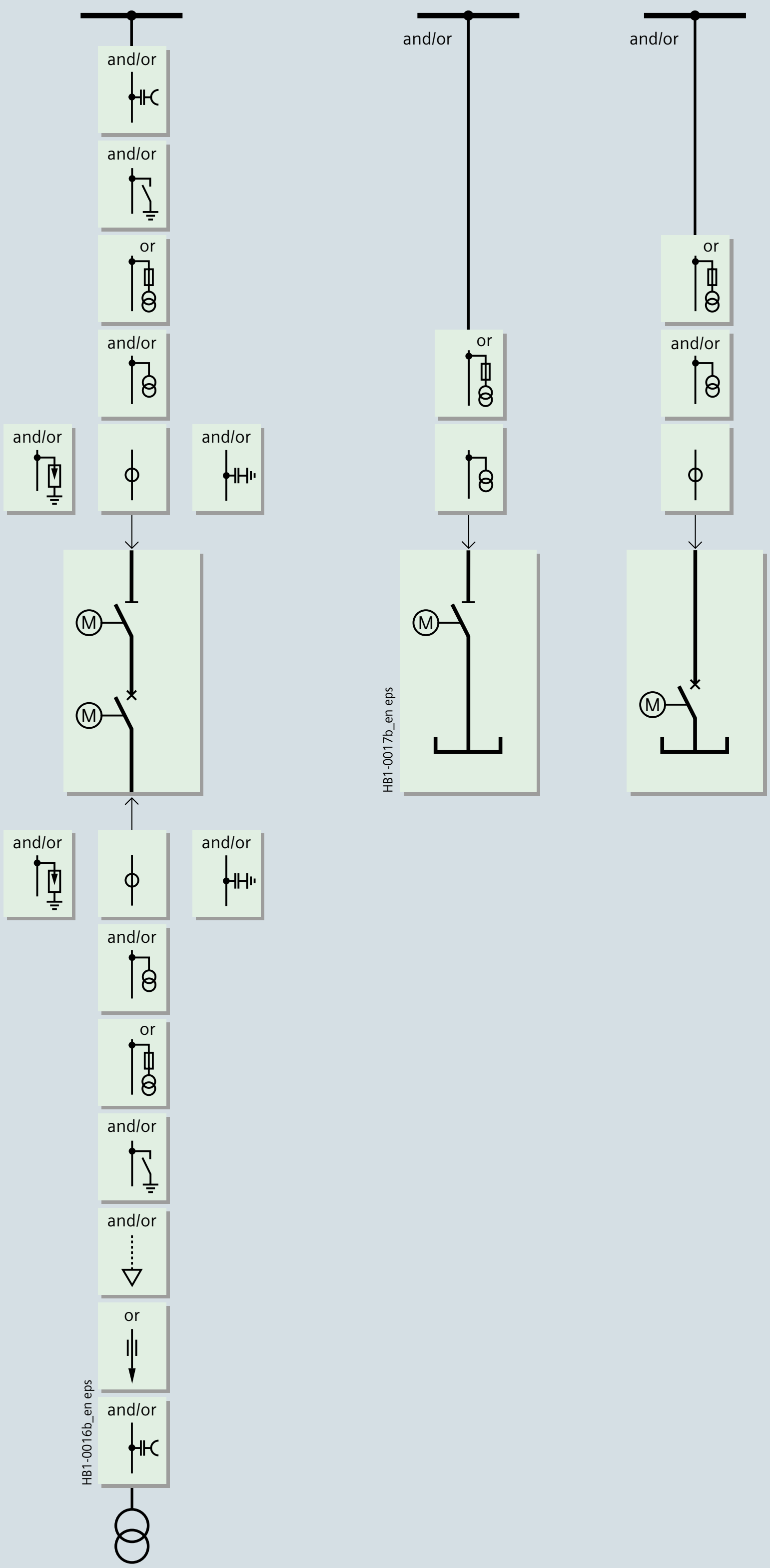
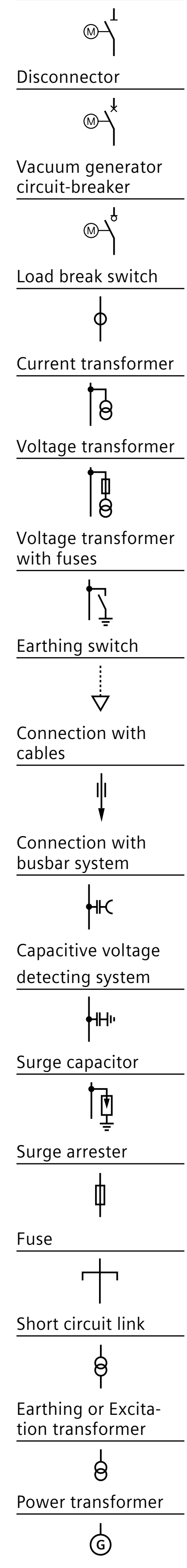


Fig. 37 HB1 switchgear product range


and/or
or
and/or
M
HB1-0016b_en eps
HB1-0017b_en eps


M
Disconnector
Vacuum generator circuit-breaker
Load break switch
Current transformer
Voltage transformer
Voltage transformer with fuses
Earthing switch
Connection with cables
Connection with busbar system
Capacitive voltage detecting system
Surge capacitor
Surge arrester
Fuse
Short circuit link
Earthing or Excitation transformer
Power transformer
G
Generator

Vacuum circuit-breaker

The vacuum circuit-breaker consists of the pole assemblies and the operating mechanism box. The pole assemblies are fixed to the operating mechanism box via post insulators. The switching movement is transferred by means of operating rods and levers.

Switching medium

The vacuum switching technology, proven and fully developed for more than 40 years, serves as arc-quenching principle by using vacuum interrupters.

Pole assemblies

The pole assemblies consist of the vacuum interrupters and the interrupter supports. The vacuum interrupters are air-insulated and freely accessible. This makes it possible to clean the insulating parts easily in adverse ambient conditions. The vacuum interrupter is mounted rigidly to the upper interrupter support. The lower part of the interrupter is guided in the lower interrupter support, allowing axial movement. The braces absorb the external forces resulting from switching operations and the contact pressure.

Operating mechanism box

The whole operating mechanism with releases, auxiliary switches, indicators and actuating devices is accommodated in the operating mechanism box. The extent of the secondary equipment depends on the case of application and offers a multiple variety of options in order to meet almost every requirement.

Operating mechanism

The operating mechanism is a stored-energy mechanism. The closing spring is charged either electrically or manually. It latches tight at the end of the charging process and serves as an energy store. The force is transmitted from the operating mechanism to the pole assemblies via operating rods.

To close the breaker, the closing spring can be unlatched either mechanically by means of the local “ON” pushbutton or electrically by remote control. The closing spring charges the opening or contact pressure springs as the breaker closes. The now discharged closing spring will be charged again automatically by the mechanism motor or manually.

Then the operating sequence OPEN-CLOSE-OPEN is stored in the springs. The charging state of the closing spring can be checked electrically by means of a position switch.

Trip-free mechanism

3AH3 vacuum circuit-breakers have a trip-free mechanism according to IEC 62271-100. In the event of an opening command being given after a closing operation has been initiated, the moving contacts return to the open position and remain there even if the closing command is sustained. This means that the contacts of the vacuum circuit-breakers are momentarily in the closed position, which is permissible according to IEC 62271-100.

Releases

A release is a device which transfers electrical commands from an external source, such as a control room, to the latching mechanism of the vacuum circuit-breaker so that it can be opened or closed. Apart from the closing solenoid, the maximum possible equipment is one shunt release and two other releases.

- The closing solenoid unlatches the charged closing spring of the vacuum circuit-breaker, closing it by electrical means. It is suitable for DC or AC voltage.
- Shunt releases are used for automatic tripping of vacuum circuit-breakers by suitable protection relays and for deliberate tripping by electrical means. They are intended for connection to an external power supply (DC or AC voltage) but, in special cases, may also be connected to a voltage transformer for manual operation.
- Current-transformer operated releases comprise a stored energy mechanism, an unlatching mechanism and an electro-magnetic system. They are used when there is no external source of auxiliary power (e.g. a battery). Tripping is effected by means of a protection relay (e.g. overcurrent-time protection) acting on the current-transformer operated release.

When the tripping current is exceeded (= 90 % of the rated normal current of the c.t.-operated release), the latch of the energy store, and thus opening of the circuit-breaker, is released.

- Undervoltage releases comprise a stored-energy mechanism, an unlatching mechanism and an electromagnetic system which is permanently connected to the secondary or auxiliary voltage while the vacuum circuit-breaker is closed. If the voltage falls below a predetermined value, unlatching of the release is enabled and the circuit-breaker is opened via the stored-energy mechanism. The deliberate tripping of the undervoltage release generally takes place via an NC contact in the tripping circuit or via an NO contact by short-circuiting the magnet coil. With this type of tripping, the short-circuit current is limited by the built-in resistors. Undervoltage releases can also be connected to voltage transformers. When the operating voltage drops to impermissibly low levels, the circuit-breaker is tripped automatically. For delayed tripping, the undervoltage release can be combined with energy stores.

Closing

In the standard version, 3AH3 vacuum circuit-breakers can be remote closed electrically. They can also be closed locally by mechanical unlatching of the closing spring via pushbutton. Instead of this “manual mechanical closing”, “manual electrical closing” is also available. In this version, the closing circuit of the circuit-breaker is controlled electrically by a pushbutton instead of the mechanical button. In this way, switchgear-related interlocks can also be considered for local operation in order to prevent involuntary closing.

If constant CLOSE and OPEN commands are present at the circuit-breaker at the same time, the circuit-breaker will return to the open position after closing. It remains in this position until a new CLOSE command is given. In this manner, continuous closing and opening (= “pumping”) is prevented.

Circuit-breaker tripping signal

The NO contact makes brief contact while the vacuum circuit-breaker is opening, and this is often used to operate a hazard-warning system which, however, is only allowed to respond to automatic tripping of the circuit-breaker. Therefore, the signal from the NO contact must be interrupted when the circuit-breaker is being opened intentionally. This is accomplished under local control with the cut-out switch that is connected in series with the NO contact.

Fig. 38 3AH38 / 37 generator vacuum circuit-breaker, side view

Fig. 39 3AH38 / 37 generator vacuum circuit-breaker, front view

Due to the modular design of the circuit-breakers, the best materials can be used each for the current path, electric flux and cooling. Thus, the 3AH37/38 circuit-breakers combine low resistance of the main circuit with high mechanical stability and ideal cooling performance.

Moreover, the modular design enables even horizontal installation of the circuit-breaker, if required. To do this, cooling elements can be installed which are provided especially for this mounting position. Thus, the 3AH37/38 can be operated continuously in any position without additional fans, reliably excluding any overheating.

Features of the 3AH38/37 generator vacuum circuit-breakers:

- Type tested according to IEEE standard C37.013
- High DC components > 65 %
- Maintenance-free for 10,000 operating cycles
- MTTF (mean-time-to-failure) > 50,000 years (Values of the vacuum interrupters)
- No toxic decomposition products of the arc quenching medium.

Electrical data

Rated short-circuit breaking current I_{SC} (3 s)	kA	**50**		**63**		**72**	
DC component of the rated short-circuit breaking current	%	75		65		65	
Asymmetrical breaking current	kA	73		86		98	
Rated short-circuit making current	kA	137		173		197	
Generator short-circuit breaking current $I_{SC\ gen}$	kA	**25**		**31.5**		**36**	
DC component of the short-circuit breaking current	%	110	130	130		110	
Asymmetrical breaking current	kA	46	52	66		67	
Rated currents	A	**3150, 4000, 5000, 6300, 8000** (with forced cooling)					
Rated voltages							
17.5 kV (IEC 62271); **15.5 kV** (IEEE C37.013a) 50 / 60 Hz; U_p = 110 kV; U_d = 50 kV		**3AH3817** (≤ 4000 A)	**3AH3712** (> 4000 A)	**3AH3818** (≤ 4000 A)	**3AH3713** (> 4000 A)	**3AH3819** (≤ 4000 A)	**3AH3714** (> 4000 A)
24 kV (IEC 62271; IEEE C37.013a) 50 / 60 Hz; U_p = 125 kV; U_d = 60 kV		**3AH3722** (≤ 4000 A)	**3AH3722** (> 4000 A)	**3AH3723**		**3AH3724**	
Rated operating sequence							
– at short-circuit breaking current		CO – 30 min – CO, up to 30 short-circuit breaking operations Further operating sequences possible: O – 3 min – CO – 3 min – CO					
– at normal current		O – 3 min – CO – 3 min – CO, up to 10,000 operating cycles					

U_p = Rated lightning impulse withstand voltage

Disconnectors, fused load break switches and earthing switches

Disconnectors are used to electrically isolate the switchgear or the associated equipment (e.g. generator, main transformer, etc.) from the network, in order to guarantee safe maintenance or repair work where it is required.

For each fixed-mounted vacuum circuit-breaker, an associated disconnector is provided. Switching of the disconnectors must take place under no-load conditions.

Fused load break switches are used to protect and switch transformers < 1250 kVA.

Earthing switches are used to connect the switchgear's busbar or the associated equipment (e.g. generator, main transformer, etc.) to earth, in order to guarantee safe maintenance or repair work where it is required.

Disconnectors, fused load break switches and earthing switches are designed in accordance with the requirements of EN 62271-102. A motor operating mechanism attachment enables actuation independent of the operator, with a switching angle of 90°.

One isolating blade is inserted into the impact contact per pole for the disconnector.

One earthing blade is inserted into the earth terminal per earthing pole for the earthing switch.

The switch positions OPEN or CLOSED are available as potential-free switch signals for each pole via an auxiliary switch and wired to the terminals in the control panel.

The operation can be done electrically (local and remote) or manually by means of a hand crank for operating the motor operating mechanism from outside the switchgear.

Mechanical class (in accordance with EN 62271-102) for the disconnector:
Class M1 = 2000 mechanical switching operations.

Mechanical class (in accordance with EN 62271-102) for the fused load break switch:
Class M1 = 2000 mechanical switching operations.

Mechanical class (in accordance with EN 62271-102) for the earthing switch:
Class M0 = 1000 mechanical switching operations.

Electrical class (in accordance with EN 62271-102) for the earthing switch:
Class E0 = no short-circuit making capacity
Class E1 = short-circuit making capacity (optional).

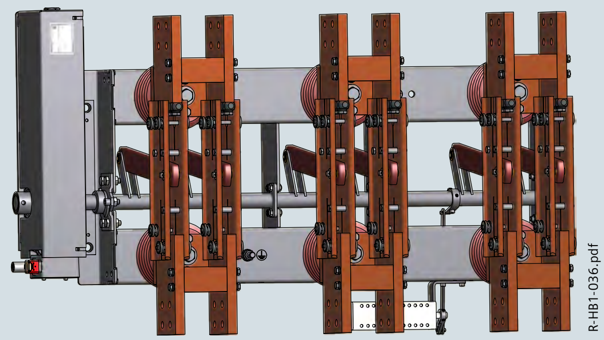


Fig. 40 Disconnector

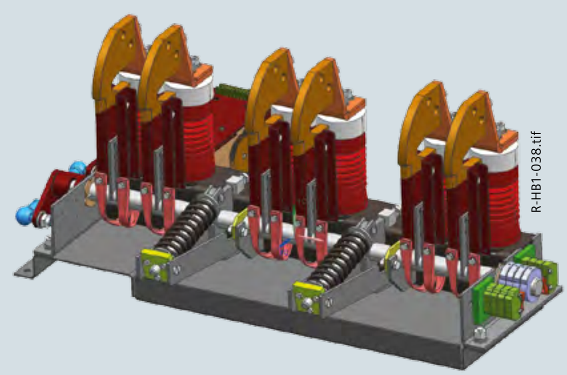


Fig. 41 Earthing switch

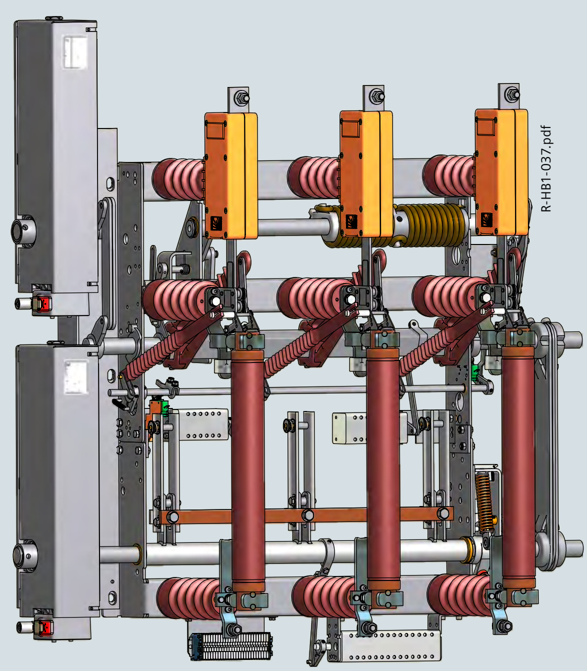


Fig. 42 Fused load break switch

Surge arresters, capacitors

Generator vacuum circuit-breakers do not require additional capacitors or surge arresters to withstand the system inherent rate-of-rise of recovery voltage.

For other system phenomena, such as overvoltages transferred via the step-up transformer or transmission of zero-sequence voltages via the step-up transformer, it is recommended to install surge arresters and surge capacitors on the step-up transformer side terminals of the generator breaker. The system designer is responsible to ensure that these stresses are limited to permissible values because such phenomena must be taken into account for all the electrical equipment primarily thinking of the step-up transformer itself and finally of the generator which are the most expensive electrical devices of the system.

The vacuum generator circuit-breaker will not be negatively influenced or will not change its proper switching behavior if surge capacitors and surge arresters are installed on the line side terminals of the switchgear. Additional surge capacitors and arresters can be provided on the generator side terminals, too. Surge arresters with line discharge class 1 to 4 are available (3.5 kJ / kV to 10 kJ / kV).

Independent of the size of the generator or transformer, surge capacitors with capacitances of 250 nF up to 300 nF per phase, may be considered appropriate to ensure safe limitation of the possible stresses without proving this by detailed calculations.

Current transformers

Features:
- Cast-resin insulated
- Max. operating voltage up to 24 kV
- Max. rated primary current up to 8000 A
- Max. rated short-time thermal current up to 72 kA, 1 s
- Max. rated peak withstand current up to 180 kA
- Max. 4 secondary cores
- Very large range of accuracy class combinations
- Secondary multiratio possible
- Current transformer certifiable
- Block type up to 4000 A and window type up to 8000 A.

Voltage transformers

Features:
- Cast-resin insulated, single-pole
- Primary operating voltage up to 24 kV
- Max. secondary operating voltage up to 120 V or divided by $\sqrt{3}$
- Very large range of accuracy class combinations
- Rating up to 200 VA
- Earth-fault winding optional with damping resistor.

Fuses

Features:
- Made with porcelain tubes
- Used in voltage transformers or to protect power transformers
- Silver melting elements and terminals
- For load break switch application, there is a striker pin, which activates the trip mechanism with a release force of 80 N.

Fig. 43 Surge arrester type 3EK7

Fig. 44 Surge capacitor

Fig. 45 Surge arrester type 3EL2

Fig. 46 Block-type current transformer up to 4000 A

Fig. 47 Window-type current transformer

Fig. 48 Voltage transformer, fixed-mounted

Fig. 49 Voltage transformer, fixed-mounted with primary fuses

Fig. 50 Fuses for transformer protection

Fig. 51 Fuse holder

Type of service location

The switchgear can be used as indoor installation according to IEC 61936 (Power installations exceeding AC 1 kV) and VDE 0101

- Outside lockable electrical service locations at places which are not accessible to the public. Enclosures of switchgear can only be removed with tools
- In lockable electrical service locations. A lockable electrical service location is a place outdoors or indoors that is reserved exclusively for housing electrical equipment and which is kept under lock and key. Access is restricted to authorized personnel and persons who have been properly instructed in electrical engineering. Untrained or unskilled persons may only enter under the supervision of authorized personnel or properly instructed persons.

Dielectric strength

- The dielectric strength is verified by testing the switchgear with rated values of short-duration power-frequency withstand voltage and lightning impulse withstand voltage according to IEC 62271-1 / VDE 0671-1 (see table "Dielectric strength")
- The rated values are referred to sea level and to normal atmospheric conditions (1013 hPa, 20 °C, 11 g/m^3 humidity according to IEC 60071 and VDE 0111)
- The dielectric strength decreases with increasing altitude. For site altitudes above 1000 m (above sea level) the standards do not provide any guidelines for the insulation rating, but leave this to the scope of special agreements
- Site altitude

– The dielectric strength of air insulation decreases with increasing altitude due to low air density. This reduction is permitted up to a site altitude of 1000 m according to IEC and VDE

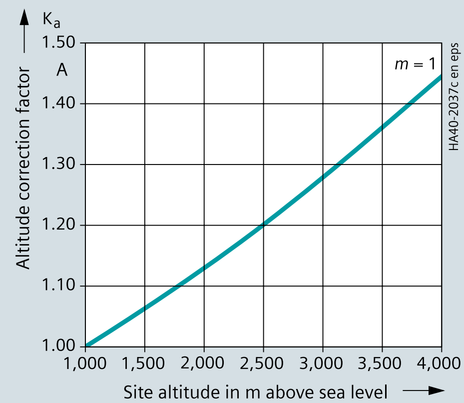
– For site altitudes above 1000 m, a higher insulation level must be selected. It results from the multiplication of the rated insulation level for 0 to 1000 m with the altitude correction factor K_a.

Table – dielectric strength

Rated voltage (r.m.s. value)	kV	12	17.5	24
Rated short-duration power-frequency withstand voltage (r.m.s. value)				
– Between phases and to earth	kV	28	38	50
– Across isolating distances	kV	32	45	60
Rated lightning impulse withstand voltage (peak value)				
– Between phases and to earth	kV	75	95	125
– Across isolating distances	kV	85	110	145

Altitude correction factor K_a

For site altitudes above 1000 m, the altitude correction factor K_a is recommended, depending on the site altitude above sea level.



Rated short-duration power-frequency withstand voltage to be selected for site altitudes > 1000 m	
≥ Rated short-duration power-frequency withstand voltage up to ≤ 1000 m · K_a	
Rated lightning impulse withstand voltage to be selected for site altitudes > 1000 m	
≥ Rated lightning impulse withstand voltage up to ≤ 1000 m · K_a	

Example:
3000 m site altitude above sea level
17.5 kV switchgear rated voltage
95 kV rated lightning impulse withstand voltage
Rated lightning impulse withstand voltage to be selected =
95 kV · 1.28 = 122 kV

Result: According to the above table, a switchgear for a rated voltage of 24 kV with a rated lightning impulse withstand voltage of 125 kV is to be selected.

Overview of standards

Switchgear, enclosure

VDE 0101	IEC 61936-1	Power installations exceeding 1 kV AC – Part 1: Common rules
VDE 0470-1	IEC 60529	Degree of protection provided by enclosures (IP-code)
VDE 0671-1	IEC 62271-1	Common specifications for high-voltage switchgear and controlgear standards
VDE 0671-200	IEC 62271-200	AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to including 52 kV (according to list of performed tests)

Components

	IEC 61869-2	Instrument transformers Part 2: Additional requirements for current transformers
	IEC 61869-3	Instrument transformers Part 3: Additional requirement for inductive voltage transformers
VDE 0671-100	IEC 62271-100	High-voltage alternating-current circuit-breakers
VDE 0671-102	IEC 62271-102	Alternating current disconnectors and earthing switches
VDE 0675-4	IEC 60099-4	Surge arresters: Metal-oxide surge arresters without gaps for AC systems
VDE 0682-415	IEC 61243-5	Voltage detecting systems

Generator circuit-breaker

	IEEE C37.013	IEEE standard for AC high-voltage generator circuit-breakers rated on a symmetrical current basis. Amendment 1: Supplement for use with generators rated 10 – 100 MVA
	IEEE/IEC 62271-37-013	Alternating-current generator circuit-breakers

Standards

The switchgear complies with the relevant standards and specifications applicable at the time of type tests. In accordance with the harmonization agreement reached by the countries of the European Union, their national specifications conform to the IEC standard.

Current carrying capacity

- According to IEC 62271-1 / VDE 0671-1 and IEC 62271-200 / VDE 0671-200, the rated normal current refers to the following ambient air temperatures:

– Maximum of 24-hour mean + 40 °C
– Maximum + 45 °C

- The rated normal current of the panels and busbars depends on the ambient air temperature outside the enclosure.

Protection against solid foreign objects, electric shock and water

HB1 and VB1 switchgear fulfill according to the standards

– IEC 62271-200
– IEC 60529
– VDE 0470-1
– VDE 0671-200

the following degrees of protection:

Switchgear panel	HB1	VB1
Degree of protection for the enclosure optionally	IP4X IP41, IP42, IP54, IP55	IP4X IP41, IP42, IP54, IP55
Degree of protection for the partitions	N. A.	IP2X
Degree of protection for the control panel optionally	IP4X IP54, IP55	IP4X IP54, IP55

Climate and environmental influences

HB1 and VB1 switchgear are suitable for application in indoor installations under normal operating conditions as defined in the standard IEC 62271-1 as follows:

- Max. value of ambient air temperature: + 45 °C,
  Average value over a period of 24 h: + 40 °C
- Minimum ambient air temperature: – 5 °C
- Altitude of installation ≤ 1000 m
- Average value of relative humidity
  over a period of 24 h: ≤ 95 %,
  over a period of one month: ≤ 90 %
- Ambient air not significantly polluted by dust, corrosive gases, vapours or salt.

The switchgear may be used, subject to possible additional measures, under the following environmental influences:

– Natural foreign materials
– Chemically active pollutants
– Small animals

and the climate classes:

– 3K3
– 3K5.

The climate classes are defined according to IEC 60721-3-3.

Aseismic capacity

VB1 switchgear has been tested in accordance with the following internationally accepted requirements: IEEE 693, UBC Division IV.

Internal arc classification

- Protection of operating personnel by means of tests for verifying the internal arc classification
- Internal arc tests must be performed in accordance with IEC 62271-200 / VDE 0671-200
- The switchgear complies with all criteria specified in the standards (see page 25) for the basic version up to 72 kA
- HB1 complies with the internal arc classification: IAC A FLR up to 63 kA, 1 s
- VB1 complies with the internal arc classification: IAC A FLR up to 72 kA, 0.1 s.

This provides maximum personal safety of the switchgear accessible from all sides

- Definition of criteria:

– Criterion 1
Correctly secured doors and covers do not open, limited deformations are accepted

– Criterion 2
No fragmentation of the enclosure, no projection of small parts above 60 g

– Criterion 3
No holes in accessible sides up to a height of 2 m

– Criterion 4
No ignition of indicators due to hot gases

– Criterion 5
The enclosure remains connected to its earthing point

- In addition to the internal arc tests, Siemens performs a pressure simulation.

Fig. 52 Personnel safety and reliability

Fig. 53 Seismic test at an independent laboratory

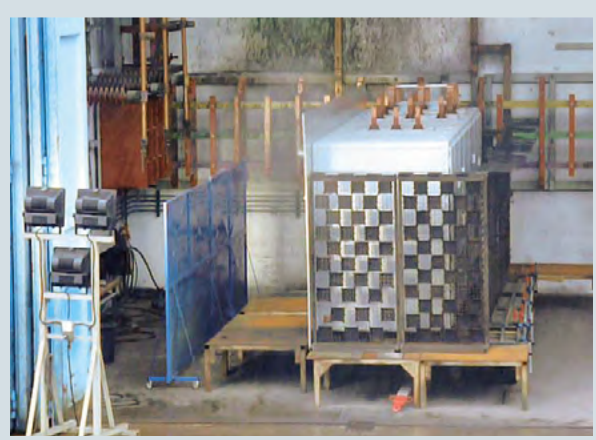


Fig. 54 Internal arc test at an independent laboratory

Guidelines

You know your application. And we know the behavior and features of our switching devices. Together we work out the perfect solution for your application.

For this purpose, we kindly ask you to submit the following data:

- Data sheets of:
- – Generator
- – Transformer
- – Auxiliary transformer and motors, if applicable
- Single-line diagram
- Information on equipment operation, e.g. interconnected circuits.

Based on the information concerning your application, our experts select a circuit-breaker which reliably controls all service conditions, including tripping in the case of a fault. Among other things, the results of the calculations contain a graphical representation of the current characteristics, as shown below.

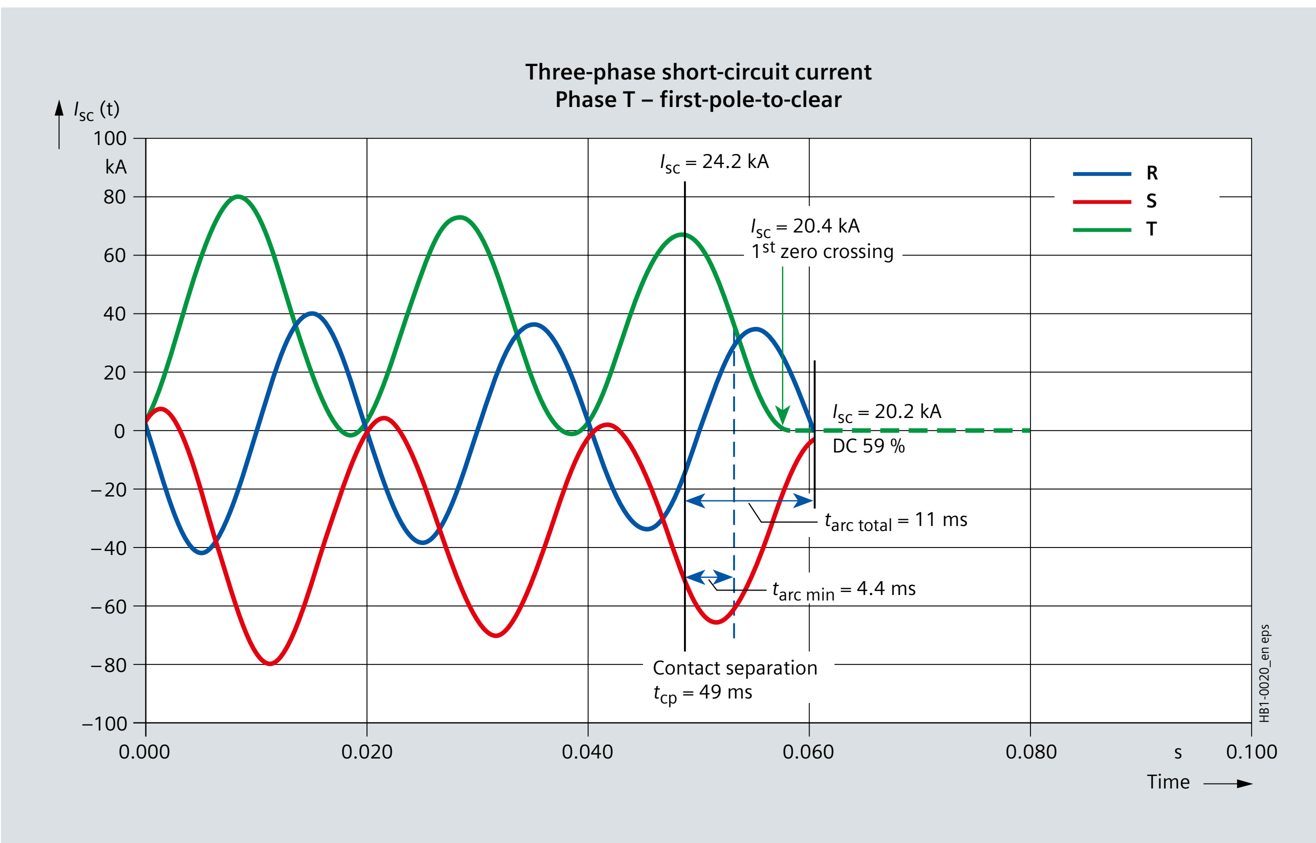


Fig. 55 Example of a short-circuit simulation for the breaking capability confirmation

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