Gas-insulated ring main units FB

up to 36 kV

System Configuration

ALSTOM

T&D
Power Distribution

Terms of delivery
The General Terms of Delivery, as amended, shall apply.

Illustrations
The illustrations are not binding for delivery.

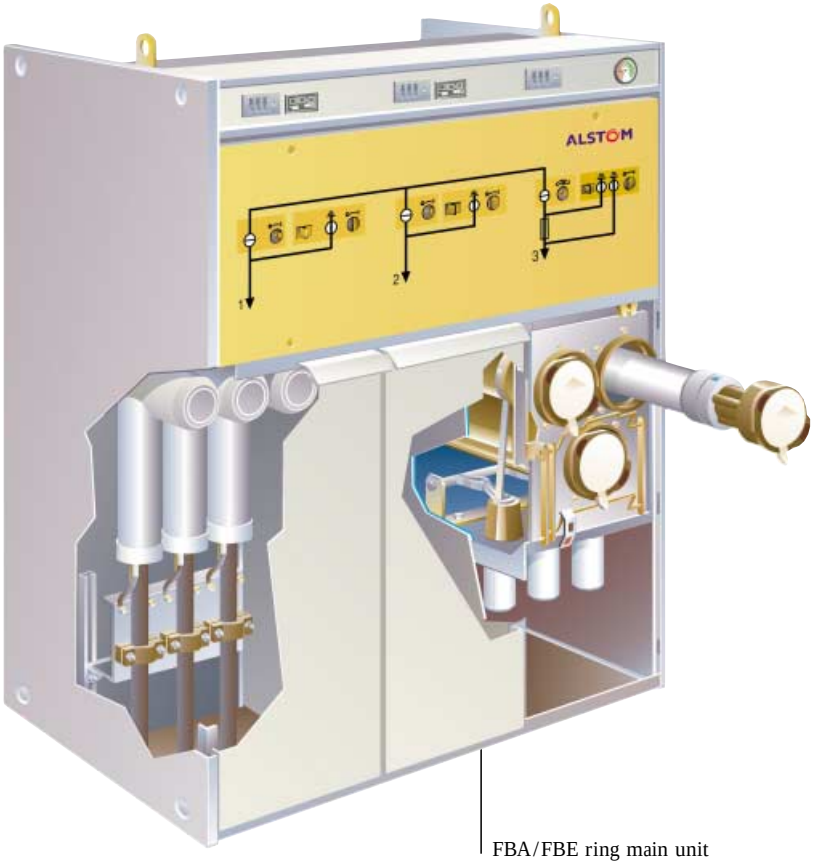
Introduction

Introduction

Features

Straightforward planning

The FBA, FBE ring main units and the FBT transformer switching blocks are three-pole enclosed switch-disconnector units. SF6 gas is used as insulating and switching medium. The gas-insulated switchgear units are insensitive to environmental influences, e.g. to humidity, dust and aggressive gases, and afford maximum personnel protection. The clear overall design ensures easy, straightforward operation. The spacious cable connection area permits selection of various cable connection systems.
The FB ring main units have been designed for rated voltages of up to 36 kV and rated currents up to 630 A; they feature a particularly compact design.

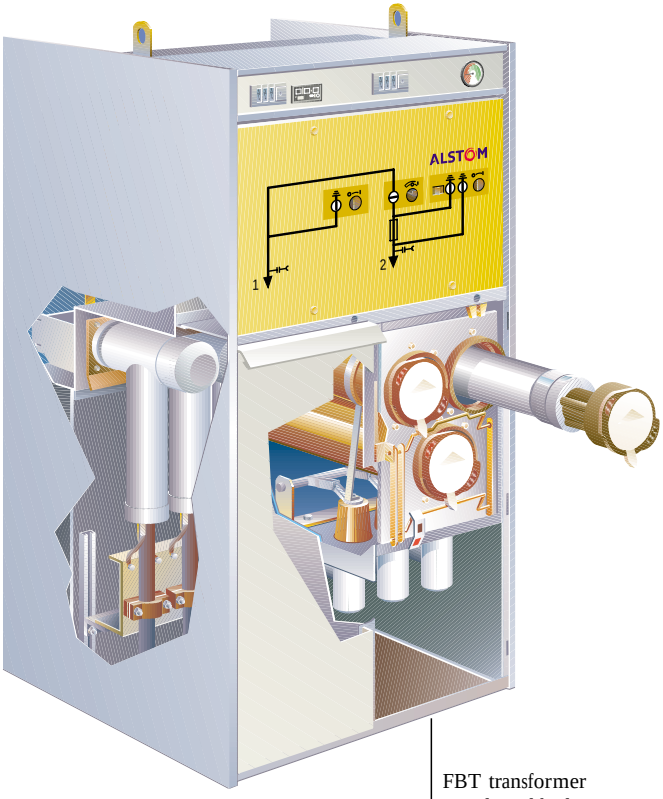


FBA/FBE ring main unit

Safe operation

This switchgear station warrants safe operation: thanks to its high personnel and operating safety, extremely reduced space requirements and independence of environmental influences.

The result is a particularly economical solution with an extremely high safety standard, especially due to:
- separate switching devices for load disconnectors and earthing switches
- fuse/load disconnector combinations
- one separate earthing switch each upstream and downstream of the fuse receivers



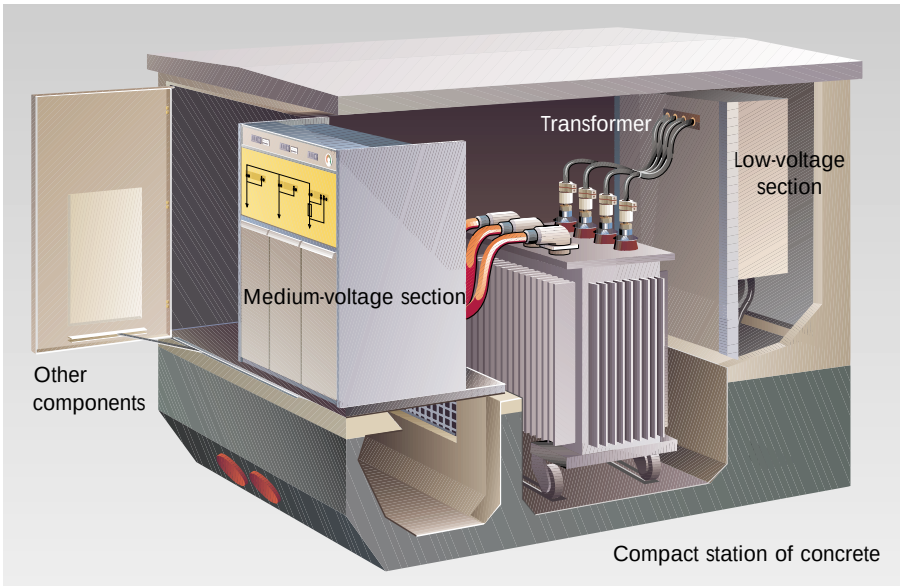
FBT transformer switching block

The advantages of our gas-insulated ring main units

- All components conducting medium voltage are insensitive to
  – air humidity
  – aggressive atmosphere
  – dirt
  – dust
  – vermin and rodents
- SF_6 – an insulating gas featuring extremely favourable properties
  – extremely high insulating capacity
  – incombustible
  – no contact oxidation
- Maximum operating safety due to
  – low gas pressurization
  – excellent gas-proofing
  – high inductive breaking capacity
- Minimum floor space / room requirements due to
  – insulating medium SF_6
  – compact design
- Maximum personnel safety
  – straightforward and safe operation
  – comprehensive, powerless interlocking system
  – tested and approved for behaviour in case of an internal fault (PEHLA tested)
- Zero maintenance for life-time (approx. 30 years)

Particular features of our series FB A/E/T

- Continuity up to 36 kV
- Enhanced personnel protection due to separate switching devices for load disconnectors and earthing switches
- Straightforward exchange of cable phases due to horizontal arrangement of the outside-cone cable bushings (i.e. 3 bushings side-by-side at the same level)
- Extremely easy replacement of fuses
- No bridging of the isolating distance by insulating material, i.e. the condition of the electrical isolating distance is maintained for the entire service life
- Spacious cable connection compartment, suited for connection of parallel cables or cable connection with additional surge arresters - possible within the switchgear boundaries
- Particularly clearly arranged operating panel with operator guidance and switchgear interlocking



Compact station of concrete

Mechanical design

Technical description

The FBA/E ring main unit and the FBT transformer switching block are mounted on a rugged, hot-galvanized supporting structure. The switching units are housed in a shared tank made of corrosion-resistant and non-magnetic chromium-nickel steel.
The tank is designed as a "sealed pressure system". Given the climatic conditions which are normally assumed to exist in substations, it has a service life of approx. 30 years.
The service pressure of the insulating gas SF_6 is 0.3 bar.
The tank bottom is equipped with pressure relief devices which ensure, in case of excess pressure, that gases which escape are diverted to the bottom or to the rear.

Switching units

The current circuits of the three-pole switching units are arranged side by side; load disconnectors and the make-proof earthing switches are separate switching devices with separate drives. The load disconnectors are designed as twist switches and arranged so that the isolating distances are not bridged by insulating material when the unit is switched off.

Drives

The drives for the switching units are located on the front end, in a separate metal-enclosed chamber, outside of the gas-filled switching compartment.
To enhance personnel and operating safety, separate switching devices (each switching device has a drive of its own) are used on principle for load disconnectors and earthing switches.
All switching devices are equipped with snap-action drives. As a rule, the load disconnectors of the transformer unit are equipped with an additional breaking stored-energy mechanism.
In our ring main units, we use technical lubricants which do not require any maintenance under normal climatic conditions according to IEC 60298 or DIN/VDE 0670, part 6.
A shutter is installed above the operating panel; it can be used to accommodate short-circuit indicators, voltage detection systems or – on request – DSA2 and pressure gauges.

Spacious cable connection compartment

The cable connection compartments are amply designed. All commercially available systems can be installed in the ring main units: fully insulated, metal-enclosed terminal systems, partially insulated terminal systems, parallel cables, cables and surge arresters or ground cables.

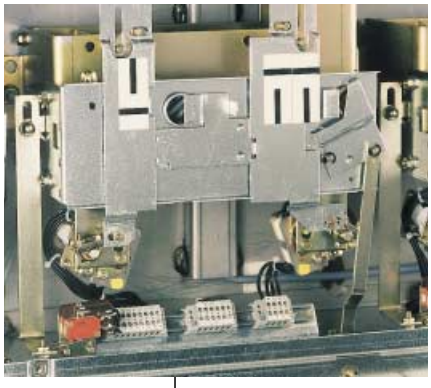
Pressure relief

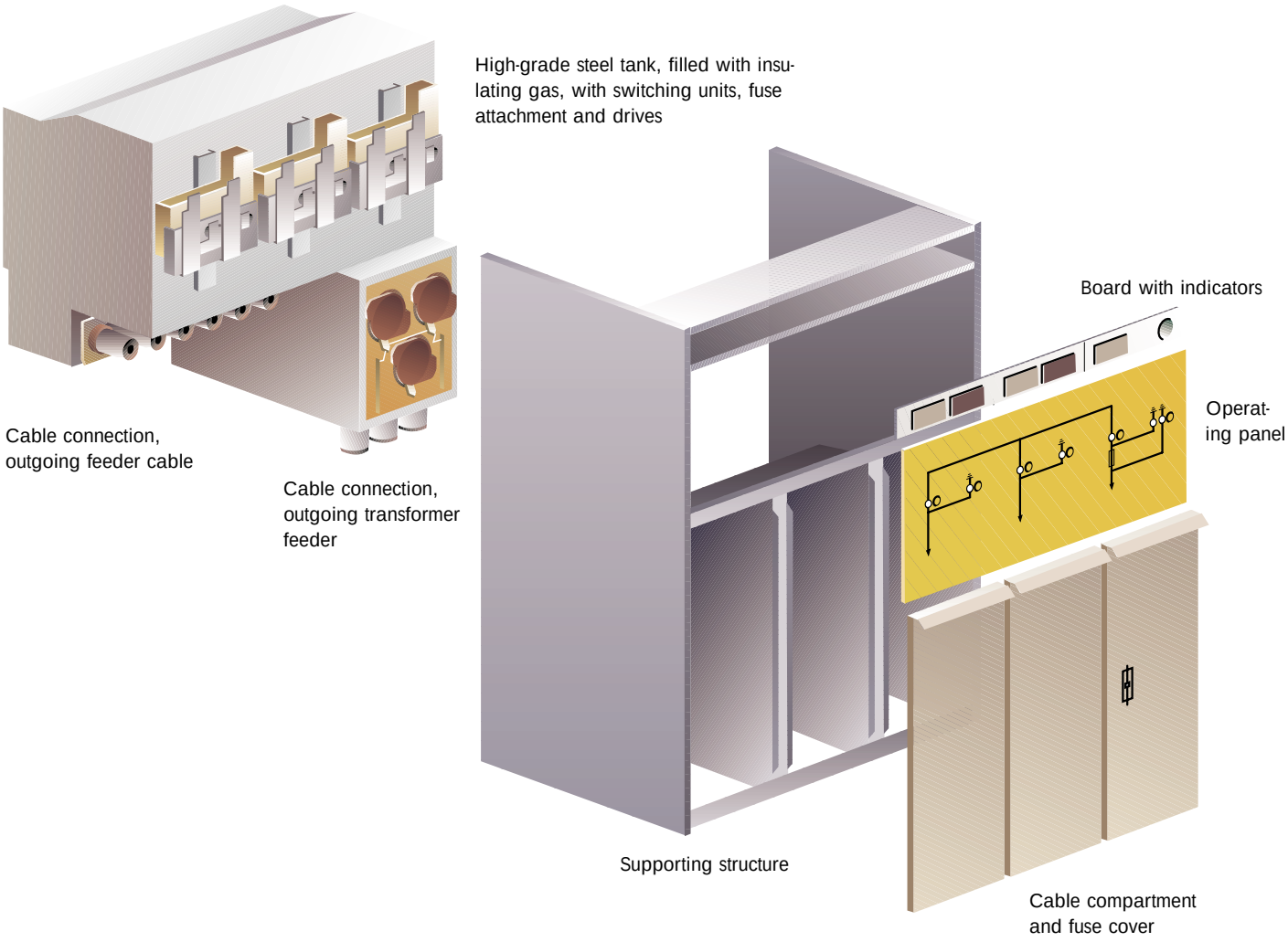
The pressure relief devices which are metallically separated from the cable connection act as rupture joints for the case of internal excess pressure of the gas-filled cladded compartment.

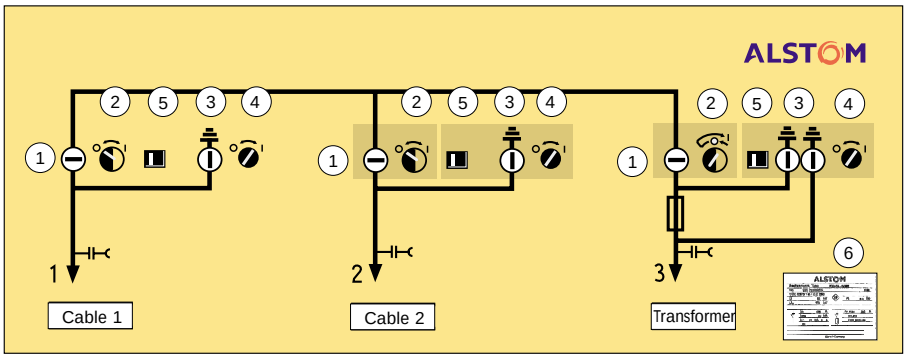
Operation


Pressure relief device


Cable connecting sockets according to DIN 47636


Drive unit FBA





Operating panel FBA / FBE

1 Position indicator, load disconnector "ON"-"OFF"

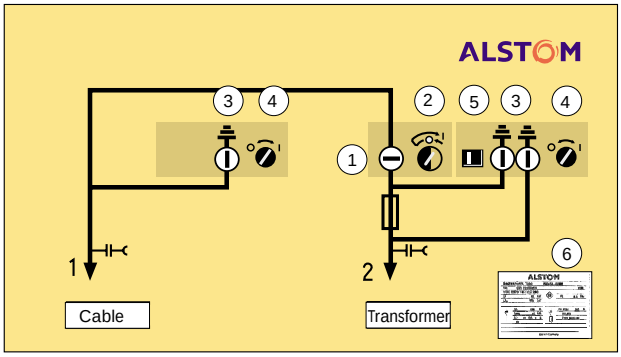
2 Insertion opening for detachable lever Load disconnector

3 Position indicator, earthing switch

4 Insertion opening for detachable lever Earthing switch

5 Slide switch for powerless interrogator lock
Earthing switch / load disconnector

6 Rating plate



Operating panel FBT

Standardized cable terminal components

The cables are connected via standardized outer cone-type components according to DIN 47636.
Ring main cable connection: Tee screw-type plugs or cable terminal systems for outside-cone cable bushings according to DIN 47 636, part 6, AS36 630 with internal thread M16x2 must be provided to this effect.
Connection of transformer cables: The use of right-angle or straight connectors according to DIN, part 3, ASL24 250, is recommended for this purpose. As an alternative, outside-cone cable bushings AS36 630 according to DIN 47 636, part 6, with internal thread M16x2 can be provided to this effect.
For a precise list, please refer to page 27.
Variable adjustable cable irons permit connection of different cable terminal systems. Additional horizontally and vertically adjustable supporting plates for parallel cable boxes or surge arresters can be supplied with the switchgear as optional equipment.

Interrogator interlock system

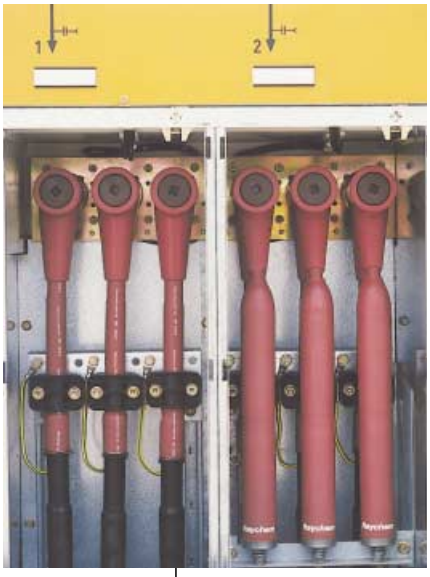
At ALSTOM Sachsenwerk, personnel and operator safety is of maximum priority in the development of switchgear. A continuous interrogator interlock system has been designed to prevent any unauthorized operation and to enable access to the cable compartment only after it has been grounded as specified.
The following mutual interlocks have been implemented:
- Load disconnector - earthing switch
- Earthing switch - cable compartment cover
- Earthing switch - fuse cover

Replacement of the fuse links

An essential advantage of the FB ring main unit is straightforward replacement of its fuse links. The fuse links are installed in insulating conduits which are integrated into the hermetically sealed, gas-filled cladded compartment as required by the system; this has the following advantages:
- the electrical field is essentially arranged within the SF_6 atmosphere
- the fuse handle with its sealing set is placed in the "shadow" of the field intensity
- no conductive layers (e.g. industrial or sea atmosphere) can settle on the insulating surface of the fuse attachment
- the area within the gas-filled cladded compartment is completely protected
- the area of the fuse handle is insensitive - there is especially no need to establish "electrical sealing" conditions (arrangement of insulation) with the handle closed.

The stored-energy mechanism and the rugged tripping linkage ensure that all three phases are switched off on fuse tripping, as provided by IEC 60 420. Maximum personnel protection is ensured by the interrogator interlock which only enables opening of the fuse cover if the system is correctly grounded. Two earthing switches arranged upstream and downstream of the fuse links enable fuse replacement without insulating tools. Vice versa, the earthing can only be cancelled after the fuse cover has been closed.
Both earthing switches are make-proof and are switched simultaneously via a snap-action drive.

Interrogator lock



Cable connection


Fuse handle and all-pole tripping

Fuse replacement

For selection of the fuse links, we recommend to adhere to page 18 and to insert standard fuses with thermal protection.

Connecting external control lines

External control lines can be connected to terminal strips by branches following the standardized wiring diagram.

Auxiliary switches

Multi-pole (up to 10) auxiliary switches can be installed on/in load disconnectors.
Earthing switches can be equipped with 2-pole auxiliary switches. The auxiliary switches can also be adjusted subsequently as break and make contacts by adjustable cams.

Tested and approved switchgear

Our ring main units have satisfied the requirements of DIN VDE 0670, part 6, PEHLA 1-6 or IEC 60298 in the type tests and in several tests during development, thus proving their safety. The tests were conducted in internal high-capacity test bays and in neutral institutions, as e.g. IPH Berlin, KEMA, L.C.O.E. Spain, LABORATORIUM LISTRIK Jakarta etc.

Climatic conditions

The switchgear is suited for temperatures between -25 and +60°C as well as for the operating conditions according to DIN VDE 0670, part 6 (see operating conditions on page 15). The medium-voltage section located in the gas-filled cladded compartment and a fully insulated cable connection conforming with the system is protected against environmental influences, such as humidity, dust, aggressive gases etc. The gas-filled cladded compartments made of chromium-nickel steel, the SF_6 gas insulation and the high switching capacity warrant trouble-free operation and a long service life.

Surface protection

The ring main unit fairings are hot-galvanized to protect them against corrosion. The switchgear front is visually enhanced by painting.
Standard paint:
- Operating panel RAL 1003 (signal yellow)
- Covers painted according to RAL 7044 (silk grey)
- Side panels and supporting structure hot-galvanized

Locations for installation

The switchgear is suited for installation in confined electrical operating areas.

Optional equipment

Zero voltage detection

The electronic voltage detection system IVIS with integrated indicator (three lightning flash symbols) indicates zero voltage in a branch and fully satisfies the requirements of VDE 0682, part 415, or of the IEC publication 61243-5, part 5E.

In the presence of full rated voltage, IVIS indicates continuous, uninterrupted lightning flash symbols.

The lightning flash symbols feature an integrated malfunction indication showing interrupted lightning flash symbols in case of a malfunction. In this case, the switchgear may remain operative, but remedies must be co-ordinated with the manufacturer.

The IVIS measuring sockets meet the operating conditions for a phase monitor with N.O. interface.

Optionally, zero voltage of the branch may also be determined via a constant-voltage indicator. In this case, the sockets for the constant-voltage indicator (HO system) are installed in the appliance recess.

Phase comparison

Phase comparison is possible by means of the phase monitor MS 100.

Short-circuit indicator

The switchgear can be equipped with short-circuit indicators. On principle, short-circuit indicators can be used in two ways:
1. Short-circuit indicators within the switchgear front. The conductors L1, L2 and L3 are displayed separately. The short-circuit indicators can be equipped as follows, on request:
– with manual reset
– with automatic reset
– with remote alarm contact
– with earth-fault indicator
2. Short-circuit indicators which are directly mounted to the grounded single-conductor cables. To this effect, the cable compartment covers must feature inspection ports (optional equipment).
The indications of the short-circuit indicator manufacturers must be complied with.

Cable compartment cover

The cable compartment covers serve as a shock-hazard protection of the cable connection systems and are designed to be arc-resistant. The covers are also available with inspection ports on request.

Additional interlock

An auxiliary interlock can be provided for cable testing; it prevents the load disconnector from being switched on while the earthing switch is "OFF" and the cable connection compartment is open.

Pressure indication

The pressure is indicated via a pressure gauge which is screwed onto the filler valve. A pressure gauge can be retrofitted without requiring gas work and without interrupting the operating condition.

Mimic diagram

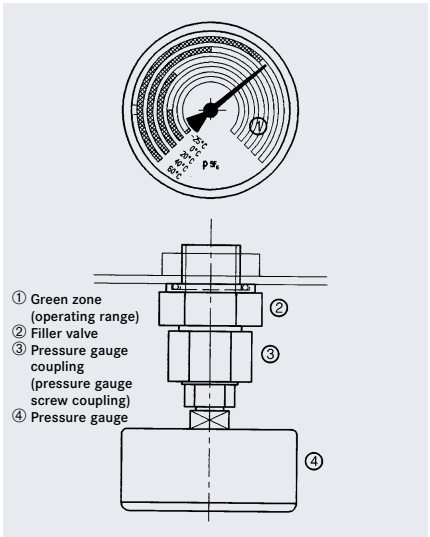
One of the characteristic features of the FB ring main units is the operating panel of exemplary design.

Motor-drive mechanisms

The load disconnectors and earthing switches are actuated manually via detachable levers. Motor-drive mechanisms for remote control can be provided for the load disconnectors behind the operating panel.

– IVIS – the integrated voltage detection system
– short-circuit indicator

Removable cable compartment covers

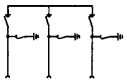
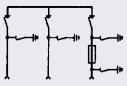
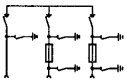
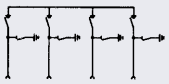
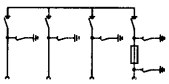
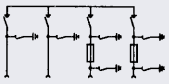
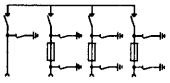
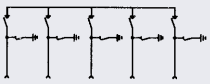
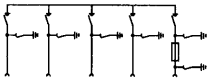
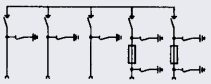
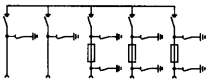
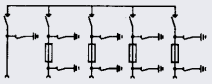


Gas pressure gauge

Ring main units, type FBA, FBE, FBT, FBM

The type designations of the type-tested ring main units and of the transformer switching block inform about the design, the rated voltage, the insulation level and the components fitted.

	Type designation	Explanation		
Series	**FB . . . / . . - . / . . .**	Switch disconnector units with load disconnector		
Model	**A, E**	Gas-insulated ring-main unit for substations		
	T	Gas-insulated transformer switching block for mast base stations and wind converter plants		
	M	Metering panel		
Rated peak current	4	Rated peak current	40	kA
	5		50	kA
	6		63	kA
Rated voltage				
	/ 12-2 /	Rated voltage	12	kV
	/ 17-2 /		17.5	kV
	/ 24-2 /		24	kV
	/ 36-2 /		36	kV

Variants	Model code		Rated voltage kV				Types		
			12	17.5	24	36	FBT	FBA	FBE
	**2011**	KT	●	●	●	●	●		
	**3000**	KKK	●	●	●	●		●	●
	**3001**	KKT	●	●	●	●		●	●
	**3002**	KTT	●	●	●			●	
	**4000**	KKKK	●	●	●	●		●	●
	**4001**	KKKT	●	●	●	●		●	●
	**4002**	KKTT	●	●	●	●		●	●
	**4003**	KTTT	●	●	●			●	
	**5000**	KKKKK	●	●	●	●		●	●
	**5001**	KKKKT	●	●	●	●		●	●
	**5002**	KKKTT	●	●	●	●		●	●
	**5003**	KKTTT	●	●	●	●		●	●
	**5004**	KTTTT		●	●			●	
		Metering panel	○[1]		●			●	

[1] on request

K=Cable, T=Transformer

Performance characteristics of FBT ring main units (transformer switching block)
Outgoing feeder cable
Outgoing transformer feeder

Performance characteristics of the switching units								
Rated voltage			kV		12	17.5	24	36
Service voltage			max. kV		12	17.5	24	36
Rated frequency			Hz		50/60	50/60	50/60	50
Rated lightning impulse	to ground		kV		75	95	125	170
withstand voltage	across isolating distance		kV		85	105	145	195
Rated power	to ground		kV		28	38	50	70
frequency	across isolating distance		kV		32	45	60	80
Cable testing voltage	(direct voltage) 15 min.		kV		48	60	96	108
	Rated current			A	200	200	200	200
Outgoing feeder cable	Rated short-time current	1 s		kA	16	16	16	16
with earthing switch		3 s		kA	–	–	–	–
	Rated peak current			kA	40	40	40	40
	Rated making current (earthing switch)			kA	40	40	40	40
	Number of operations with rated making current				5	5	5	5
Outgoing transformer	Rated current			A	200	200	200	200
feeder	Rated short-time current	1 s		kA	5	5	5	5
	(Earthing switch)	3 s		kA	–	–	–	–
	Rated peak current			kA	16	16	16	16
	Rated making current			kA	16	16	16	16
	Number of operations with rated making current				5	5	5	5
	Rated take-over current according to IEC 60420			A	3000	800	800	800
Dielectric strength	Lightning impulse withstand voltage			kV	75	95	125	170
	Power frequency withstand voltage			kV	28	38	50	70
Dielectric strength at balanced	Lightning impulse withstand voltage			kV	75	95	95	145
pressure of 0.0 bar SF_6	Power frequency withstand voltage			kV	28	38	50	70
Rated filling pressure SF_6 at 20 °C				bar	0.3	0.3	0.3	0.3
Pickup pressure of pressure relief device				bar	<2	<2	<2	<2
Wall thickness of stainless steel tank				mm	3	3	3	3

Performance characteristics of
FBA, FBE ring main units
Outgoing feeder cable
Outgoing transformer feeder

Performance characteristics of the switching units							
Rated voltage			kV	12	17.5	24	36
Service voltage			max. kV	12	17.5	24	36
Rated frequency			Hz	50/60[1]	50/60[1]	50/60[1]	50
Rated lightning impulse	to ground		kV	75	95	125	170
withstand voltage	across isolating distance		kV	85	105	145	195
Rated power frequency	to ground		kV	28	38	50	70
withstand voltage	across isolating distance		kV	32	45	60	80
Cable testing voltage	(direct voltage) 15 min.		kV	48	60	96	108
Outgoing feeder	Rated current		A	400/630	400/630	400/630	630
cable	Rated short-time current	1 s	kA	16/20/25	16/20/25	16/20/25	16
		3 s	kA	16/20/25	16/20/25	16/20/25	16
	Rated peak current		kA	40/50/63	40/50/63	40/50/63	40
	Rated making current		kA	40/50/63	40/50/63	40/50/63	40
	Number of operations with rated making current			5	5	5	5
	Rated closed-loop breaking current		A	400/630	400/630	400/630	630
	Rated load breaking current		A	400/630	400/630	400/630	630
	Number of operations with rated load breaking current			100	100	100	100
	Number of mechanical operating cycles			1000	1000	1000	1000
	Rated cable-charging and line-charging breaking current		A	160	160	160	80
	Inductive breaking current[2]						
	Rated cable-charging breaking current under						
	earth-fault conditions		A	160	160	160	160
	Rated breaking current under						
	earth-fault conditions		A	600	600	600	300
Outgoing transformer	Rated current		A	200	200	200	200
feeder with fuses	Rated short-time current	1 s	kA	5	5	5	5
	(Earthing switch)	3 s	kA	3	3	3	3
	Rated peak current		kA	16/20	16/20	16	16
	Rated making current		kA	16/20	16/20	16	16
	Number of operations with rated making current			5/2	5/2	5	5
	Rated take-over current						
	according to IEC 60420		A	3000	800	800	800
Dielectric strength	Lightning impulse withstand voltage		kV	75	95	125	170
	Power frequency withstand voltage		kV	28	38	50	70
Dielectric strength at balanced	Lightning impulse withstand voltage		kV	75	95	95	145
pressure of 0.0 bar SF_6	Power frequency withstand voltage		kV	28	38	50	70
Rated filling pressure SF_6 at 20 °C			bar	0.3	0.3	0.3	0.3
Pickup pressure of pressure relief device			bar	<2	<2	<2	<2
Wall thickness of stainless steel tank			mm	3	3	3	3

[1] Rated making current 63 kA at 60 Hz on request
[2] No-load current of transformers up to 1250 kVA

Performance characteristics
Regulations and directives
Degrees of protection
Standard operating conditions

Regulations and directives	VDE	IEC
Design and execution Type testing, routine testing	VDE 0670, part 6; VDE 0670, part 1000	IEC 60298; IEC 60694
Load disconnector – switching units	VDE 0670, part 301	IEC 60265-1
Fuse/load disconnector combination	VDE 0670, part 303	IEC 60420
Earthing switch	VDE 0670, part 2	IEC 60129
Behaviour in case of an internal fault	VDE 0670, part 6 Appendix AA criteria 1-6, 1s	IEC 60298 with Appendix AA
Operation, operator control and work in the vicinity of live components	VDE 0105, part 1000	
Installations, building dimensions, room type	Indoor switchgear, utilization according to VDE 0101 in confined electrical operating areas: rooms or locations which are exclusively used for the operation of electrical equipment, which are kept closed and which are only accessible to persons having undergone electrotechnical training. Access by untrained persons is only permitted in the presence of specialist electricians or persons having undergone electrotechnical training.	

Degree of protection	VDE 0470, part 1	IEC 60529
for the main circuits	IP 64	
for the drive mechanisms	IP 2X	
for the cable connection compartment (operator side with cable compartment cover, side panels)	IP 3X	

Standard operating conditions		Indoor conditions according to VDE 0670, part 1000	IEC 60694
			Options
Temperature of ambient air	Maximum value	40 °C	50 °C to 60 °C[1]
	Average value over 24 h	35 °C	45 °C to 55 °C[1]
	Minimum "indoor" value	minus 5 °C	minus 25 °C
Installation altitude		up to 1000 m above sea level	higher installation altitudes on request
Rated filling pressure (gas pressure) at 20 °C			

[1] at reduced rated current – refer to diagram, page 16

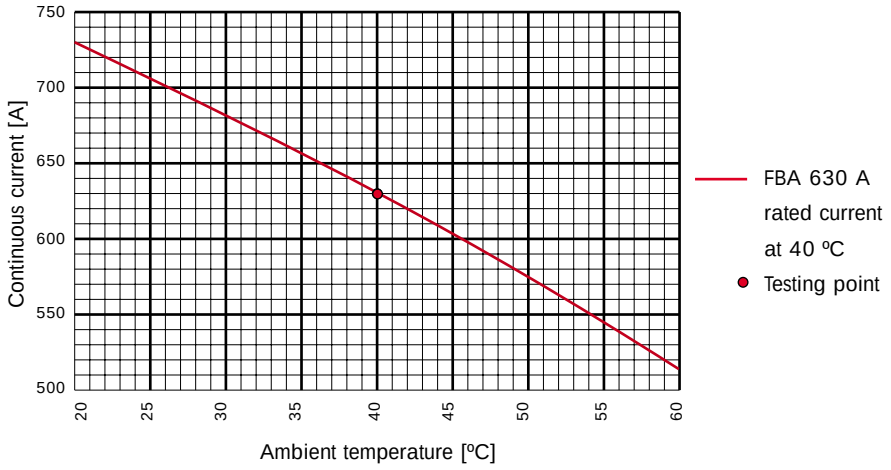
Admissible number of operations of the load disconnectors

Type FBA, FBE and FBT switchgear units are maintenance-free for their entire service life.

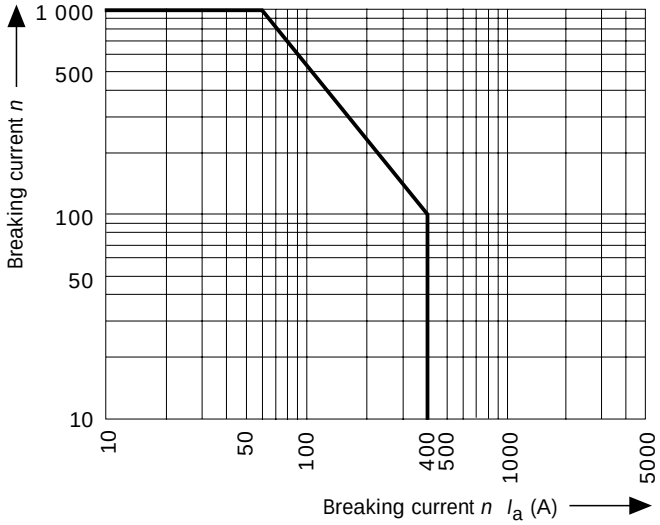
The admissible number of operations is so ample that it is normally not reached within the service lives.

Should, however, the admissible number of operations be reached in exceptional cases, please contact the manufacturer.

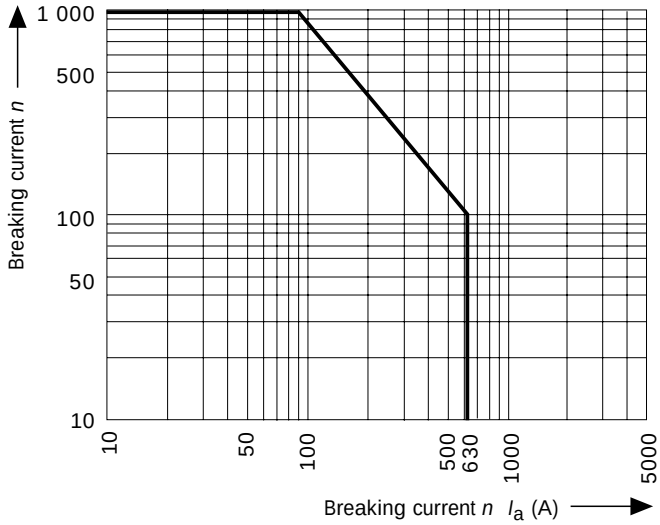
Continuous current carrying capacity as a function of the ambient temperature for FBA



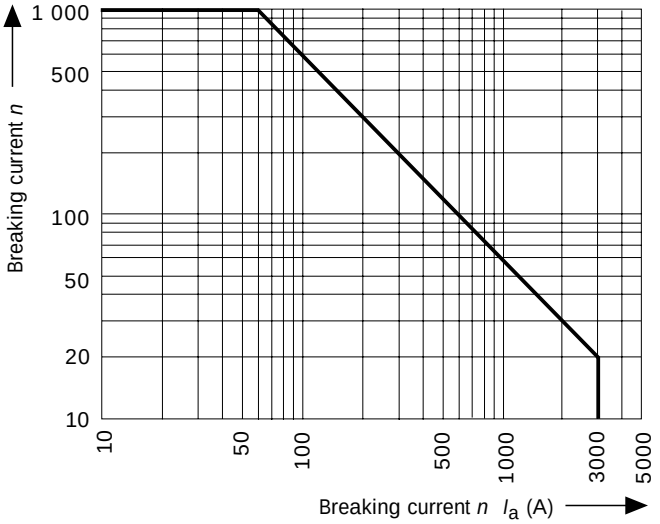
Mains cable outgoing feeder
Rated current 400 A



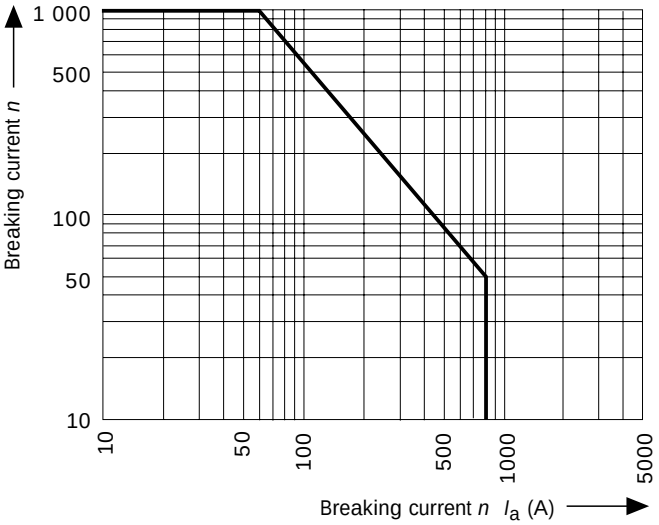
Mains cable outgoing feeder
Rated current 630 A



Outgoing transformer feeder
Series FBA, FBT 12 kV
Take-over current 3000 A



Outgoing transformer feeder
Series FBA, FBT 24 kV
Take-over current 800 A



Diagrams indicating the admissible number of operations

Control and operating devices

Technical data for motor-drive mechanism

Drive mechanism type		Outgoing transformer feeder Stored-energy mechanism SF				Mains cable outgoing feeder Snap-action drive SFU			
Rated voltage	[kV]	12	17.5	24	36	12	17.5	24	36
Closing time (for motor actuation)	[s]	≤ 6				≤ 3			
Opening time (for motor actuation)	[s]	≤ 0.7				≤ 3			
Opening time for release 160 W	[ms]	≤ 34			≤ 45	–			
Minimum command time "OFF" for release 160 W	[ms]	≤ 20				–			
Arcing time (max. value)	[ms]	18				15			
Opening time T_o	[ms]	38				–			
Motor charging time "ON"	[s]	≤ 6				≤ 3			
Motor charging time "OFF"	[s]	–				≤ 3			
Motor (power consumption)	[W/VA]	150			170	150			170

Power consumption for motor drive in case of SF and SFU drive mechanisms

Rated voltage		[VDC]						[VAC]	
		24	48	60	110	125	220	120	230
Starting current	[A]	13.3	12.1	8.4	4.7	4.1	2.5	6.8	3.7
Rated current	[A]	5.5	2.8	2.2	1.2	1.1	0.6	2.2	1.2

Technical data for shunt opening release

Power consumption of solenoid (160 W) of shunt opening release (SF drive)

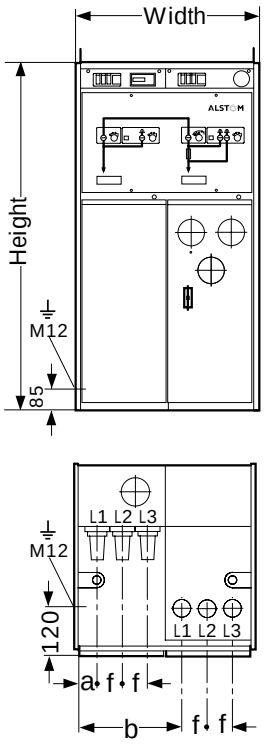
Rated voltage		[VDC]						[VAC]	
		24	48	60	110	125	220	120	230
Coil current	[A]	6.3	3.2	2.6	1.3	1.2	0.7	0.9	0.5

Technical data for auxiliary switch

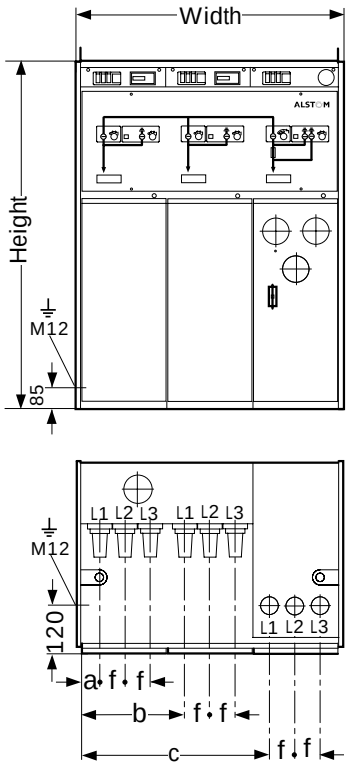
	DC voltage [V]					Alternating voltage [V]	
	24	48	60	110	220	120	220
Switching capacity in [A]	8	4	3	2	1	10	10
Rated short-time current	100 A up to 30 ms						
Time constant T = L/R	≤ 20 ms					–	

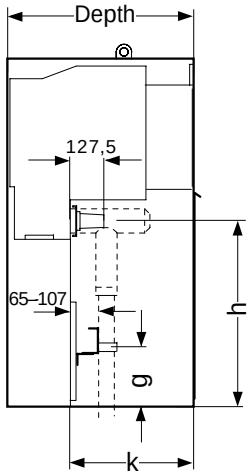
Dimensions, weights and SF_6 filling

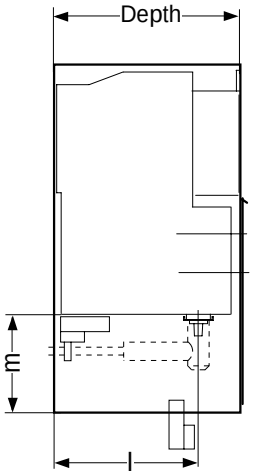
FBT 2011



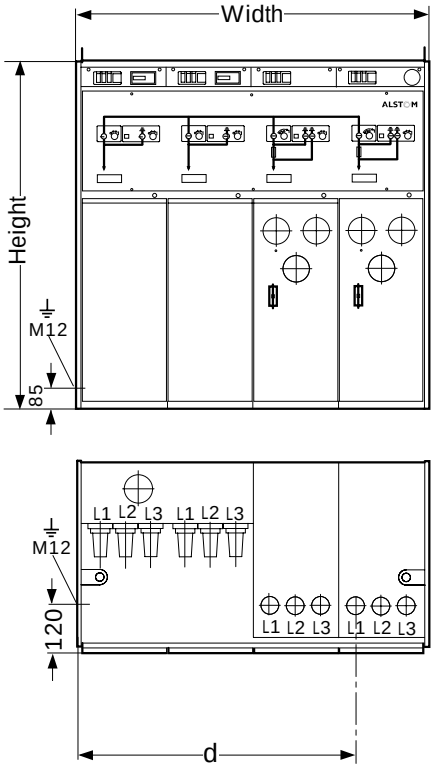
FB 3001



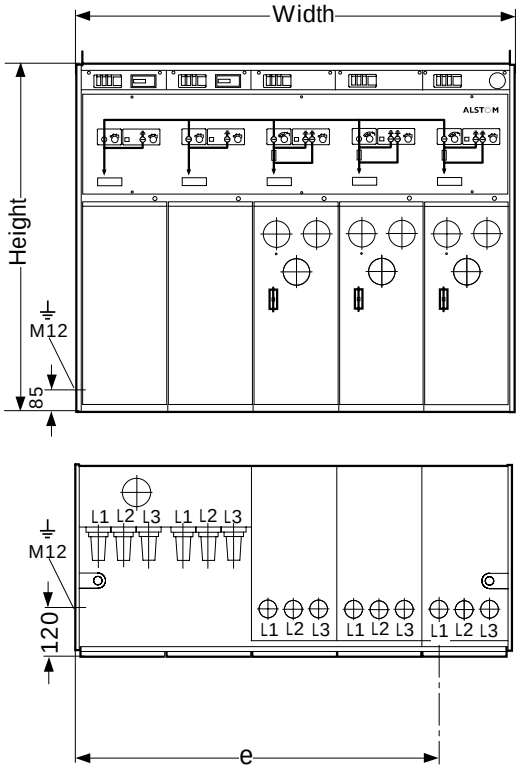




FB 4002



FB 5003



Model	Up kV	Width	Height	Depth	a	b	c	d	e	f	g	h	k	l	m	Weight kg
FBT 2011	12/17.5/24	690					–									220 to 235
FBA 3000	12/17.5/24															
FBA 3001	12/17.5/24	1010						–								300 to 350
FBA 3002 2)	12/17.5/24								–							
FBA 4000	12/17.5/24															
FBA 4001	12/17.5/24															400 to 465
FBA 4002	12/17.5/24	1330	1315	725	90	410	730			95	75 – 435	700	470	541.5	373	
FBA 4003 2)	12/17.5/24		(1045) 1)								(60 –170)1)	(430)1)			(103)1)	
FBA 5000	12/17.5/24							1050			–					480
FBA 5001	12/17.5/24															510
FBA 5002	12/17.5/24	1650							1370							530
FBA 5003	12/17.5/24															555
FBA 5004 2)	12/17.5/24															580

1) optional

Dimensions in mm

2) this model not available in optional switchgear height 1045

Model	Up kV	Width	Height	Depth	a	b	c	d	e	f	g	h	k	l	m	Weight kg
FBT 2011	36	990	1700 (1400)1)				–				75 – 665 (25 –465)1)	975 (675)1)			698 (398)1)	460
FBE 3000	36	1460														510
FBE 3001	36		1700					–			75–665	975			698	560
FBE 4000	36	1930							–							600
FBE 4001	36		1700 (1400)1)	865	135	605	1075				75 – 665 (25 –465)1)	975 (675)1)	475	646.5	698 (398)1)	650
FBE 4002	36									125						700
FBE 5000	36	2400						1545								700
FBE 5001	36								2015		75–665	975			698	750
FBE 5002	36															800
FBE 5003	36															850

1) optional

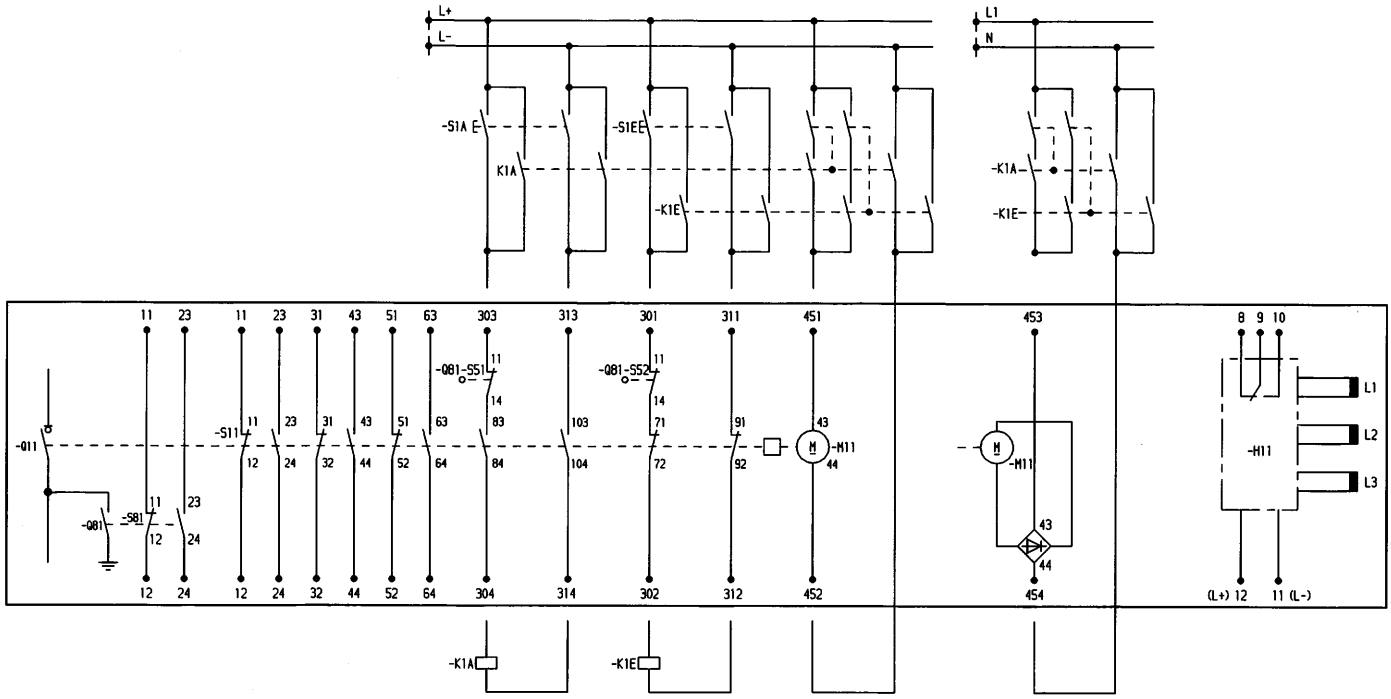
Dimensions in mm

SF_6 filling

Rated voltage	12 kV	17.5 kV	24 kV	36 kV
Type	Volume of SF_6 gas tank			
2011	230 l; 1.8 kg			510 l; 4.0 kg
3000	250 l; 1.9 kg			530 l; 4.2 kg
3001	310 l; 2.4 kg			650 l; 5.1 kg
3002	370 l; 2.9 kg			–
4000	330 l; 2.6 kg			680 l; 5.3 kg
4001	390 l; 3.0 kg			790 l; 6.2 kg
4002	450 l; 3.5 kg			900 l; 7.0 kg
4003	510 l; 4.0 kg			–
5000	410 l; 3.2 kg			820 l; 6.4 kg
5001	470 l; 3.7 kg			–
5002	530 l; 4.1 kg			1060 l; 8.3 kg
5003	590 l; 4.6 kg			1180 l; 9.2 kg
5004	650 l; 5.1 kg			–

Auxiliary circuits

Wiring diagram – Mains cable outgoing feeder

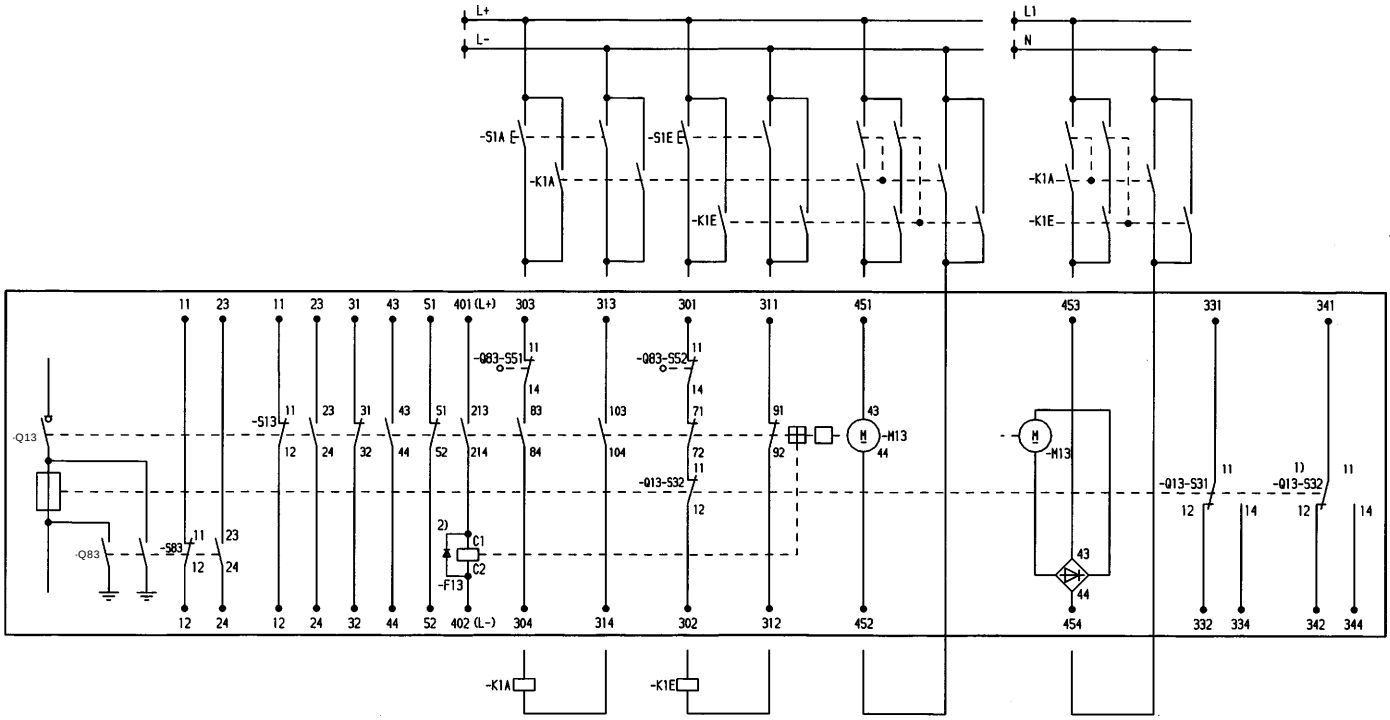


Item of apparatus

1st branch	2nd branch	3rd branch	4th branch	5th branch	Function
–H11	–H12	–H13	–H14	–H15	Short-circuit indicators (terminals 8-12: optional equipment)
–M11	–M12	–M13	–M14	–M15	Motor on load disconnector
–Q11	–Q12	–Q13	–Q14	–Q15	Load disconnector
–Q81 S51/52	–Q82 S51/52	–Q83 S51/52	–Q84 S51/52	–Q85 S51/52	Auxiliary contact on earthing switch control element
–Q81	–Q82	–Q83	–Q84	–Q85	Earthing switch
–S11	–S12	–S13	–S14	–S15	Auxiliary switch on load disconnector
–S81	–S82	–S83	–S84	–S85	Auxiliary switch on earthing switch

The devices appearing in the boxed-in area are installed in the switchgear unit, depending on the order, and are wired up to the terminal strip.
Devices outside of the boxed-in areas are not included in the scope of supplies. The free contact elements of the auxiliary switch (S11) have been factory-set as shown in the circuit diagram. However, independently of the factory setting, each contact element of the auxiliary switch can be adjusted as break contact, make contact or passing contact.

Wiring diagram – Outgoing transformer feeder with integrated fuse installation



Item of apparatus

1st branch	2nd branch	3rd branch	4th branch	5th branch	Function
	–F12	–F13	–F14	–F15	Shunt opening release
	–M12	–M13	–M14	–M15	Motor on load disconnector
	–Q12	–Q13	–Q14	–Q15	Load disconnector with fuse attachment
	–Q12 S31/32	–Q13 S31/32	–Q14 S31/32	–Q15 S31/32	Initiator on fuse attachment
	–Q82 S51/52	–Q83 S51/52	–Q84 S51/52	–Q85 S51/52	Auxiliary contact on earthing switch control element
	–Q82	–Q83	–Q84	–Q85	Earthing switch
	–S12	–S13	–S14	–S15	Auxiliary switch on load disconnector
	–S82	–S83	–S84	–S85	Auxiliary switch on earthing switch

The devices appearing in the boxed-in area are installed in the switchgear unit, depending on the order, and are wired up to the terminal strip.
Devices outside of the boxed-in areas are not included in the scope of supplies. The free contact elements of the auxiliary switch (S13) have been factory-set as shown in the circuit diagram. However, independently of the factory setting, each contact element of the auxiliary switch can be adjusted as break contact, make contact or passing contact.

1. HVHBC fuse links

Selection and supply by
ALSTOM Sachsenwerk GmbH

These projecting notes represent recommendations by the manufacturer in accordance with the requirements of the appropriate standards. The user is enabled to select ALSTOM HVHBC fuse links or – on his own responsibility – fuse links of other types and from other manufacturers based on the specified data.

Switchgear types / HVHBC fuse links

For utilization in the FBA, FBE, FBT gas-insulated ring main units, for the protection of distribution transformers, we recommend ALSTOM HVHBC back-up fuse links with integrated thermal cut-outs according to the fusing table on page 23.
In case of overload of the HVHBC fuses, the thermal cut-outs cause the load disconnectors to switch off the unit in case of
– overload currents,
– fuse links which had been damaged previously due to transients.

This avoids thermal overload of the switchgear.

Ordering data

The following ordering data must be specified in the order:
– Transformer rated capacity
– Transformer service voltage
– Rated current of the selected HVHBC fuses

Fusing table and standards

The fusing table on page 23 has been designed for normal application of the switchgear units and taking account of all appropriate standards.

These standards are:
– Protection of distribution transformers according to IEC 60787, VDE 0670, part 402, transformer connection group Dy5
– Fuse links according to IEC 60282-1, VDE 0670, part 4, model I, or DIN 43625
– Specificiations in IEC 60420, VDE 0670, part 303
– Max. ambient temperature for switchgear 40°C according to IEC 60694, VDE 0670, part 1000, identical to max. ambient temperature for the switchgear within the housing of a packaged substation according to IEC 61330, VDE 0670, part 611
– No transformer operation under overload conditions
– The LVHBC fuse links gTr according to VDE 0630, part 22, are selective vis-à-vis the HVHBC fuse links
– The LVHBC fuse links can handle 1.3 times the rated transformer current for min. 10 hours
In the case of 1.5 times the rated transformer current, the unit is switched off within two hours.

High ambient temperature

The fusing table also applies to a max. ambient temperature of 50 °C, e.g. for the switchgear within the housing of a packaged substation according to IEC 61330, VDE 0670, part 611, for very hot climate conditions.

Temperature-rise limit

The fusing table takes account of the temperature rise limits in the enclosure of the switchgear.

HVHBC fuse links

Fusing table
ALSTOM Sachsenwerk GmbH

Service voltage of transformer	Rated voltage range of HVHBC fuse link	Dimension D ("e") of HVHBC fuse link	Type of switchgear	Transformer rated capacity in kVA							Remarks
				250	315	400	500	630	800	1000	–
				u_k = 4 %					u_k = 5 %		–
				Max. admissible short-circuit duration = 2 s							
kV	kV	mm		Rated current in A of the HVHBC fuse links							
6	6/12	292	FBA, 12 kV FBT, 12 kV	50	63	80	100	125	160	[1]	[1]
10	6/12	292	FBA, 12 kV FBT, 12 kV	31.5	40	50	63	80	100	125	[1]
15	10/24	442	FBA, 24 kV FBT, 24 kV	25	31.5	31.5	40	50	63	[1]	[1]
20	10/24	442	FBA, 24 kV FBT, 24 kV	16	25	25	31.5	40	63	63	[1]
30	20/36	537	FBE, 36 kV FBT, 36 kV	16	20	25	25	31.5	40	40	[2]
		HVHBC fuse link	Rated capacity in kVA (of the transformer to be protected)								
0.4	0.4/0.5 kV	NH-gTr	kVA (A)	250 (361)	315 (455)	400 (577)	500 (722)	630 (909)	800 (1155)	1000 (1443)	– –

Rated short-circuit voltage u_k and maximum admissible short-circuit duration according to VDE 0532, part 5/05.84 (= IEC 6076-5:1976)
This selection table must be used in case of ambient temperatures ≤ +50°C without overload.

(...) = Rated current in A

[1] In the case of relatively high transformer rated voltages, project engineering is to follow section 2.

[2] In the case of a transformer rated capacity of 1250 kVA at 30 kV, a fuse rated current of 50 A is possible.
In the case of a transformer rated capacity of 1600 kVA at 30 kV, a fuse rated current of 63 A is possible.
Circuit-breakers must be used on the low-voltage end.
The selectivity between the high voltage and the low voltage end must be checked by the user.

2. HVHBC fuse links, selection data

„ – unless selection is based on section 1”

Fuse links

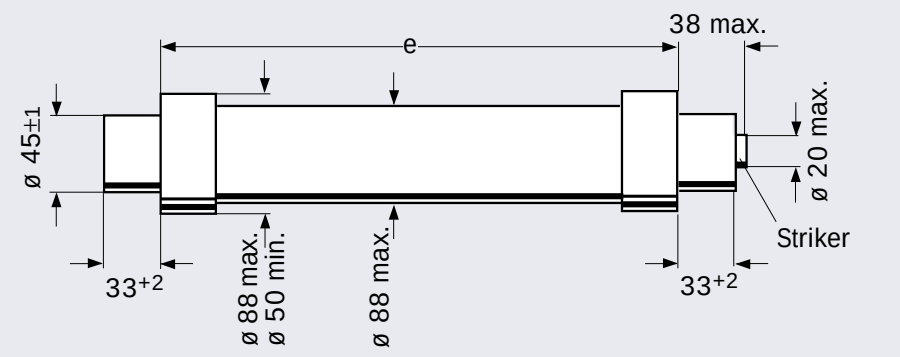
Fuse links must correspond to:
– VDE 0670, part 4, or IEC-60 publication 282-1 with dimensions according to the data sheet I (model I) or DIN 43 625.
– Striker type "medium" with initial tripping force of max. 80 N.

Dimensions for fuse links

Switchgear for the following dimensions "D" or "e" of the fuse links:

Type designation	Fuse gauge „D” or „e” in mm
FBA./12-2/...	292
FBA./17-2/...	442
FBA./24-2/...	442
FBE./36-2/...	537
FBT./12-2/...	292
FBT./17-2/...	442
FBT./24-2/...	442
FBT./36-2/...	537

Refer also to the operating instructions, chapter "Replacement of fuses" (replacing short fuse links in the case of switchgear with fuse gauge "D" or "e" = 442 mm)



Dimensions in mm

Back-up fuses

When using back-up fuses without integrated, temperature-limiting striker tripping, the following standard requirements must be satisfied:
– at overload currents, the unit is switched off by the LVHBC fuse links, as specified on page 22;
– in case of switchgear in exposed locations, in which fuse links may have suffered previous damage due to transients (e.g. lighting impulse currents), all fuse links must be replaced at regular servicing intervals.

If these requirements are not satisfied, only HVHBC back-up fuse links with integrated, thermal cut-out-type striker tripping may be used in the gas-insulated switchgear FBA, FBE and FBT to protect them against thermal overload.
The following series of the suppliers of HVHBC fuse links with integrated, thermal cut-out-type striker tripping are admitted:

Series	Supplier
HVHBC fuse links with thermal cut-out	ALSTOM Sachsenwerk GmbH
HVHBC fuse links with thermal cut-out	SIBA
HVHBC back-up fuses with overload release (thermal protection)	EFEN
HVHBC fuse links, type IKUS, with thermo-striker	JEAN MÜLLER
HVHBC fuse links, type H220 or 221 Sta. with thermal protection ”FGS”	Driescher-Moosburg

HVHBC fuse links

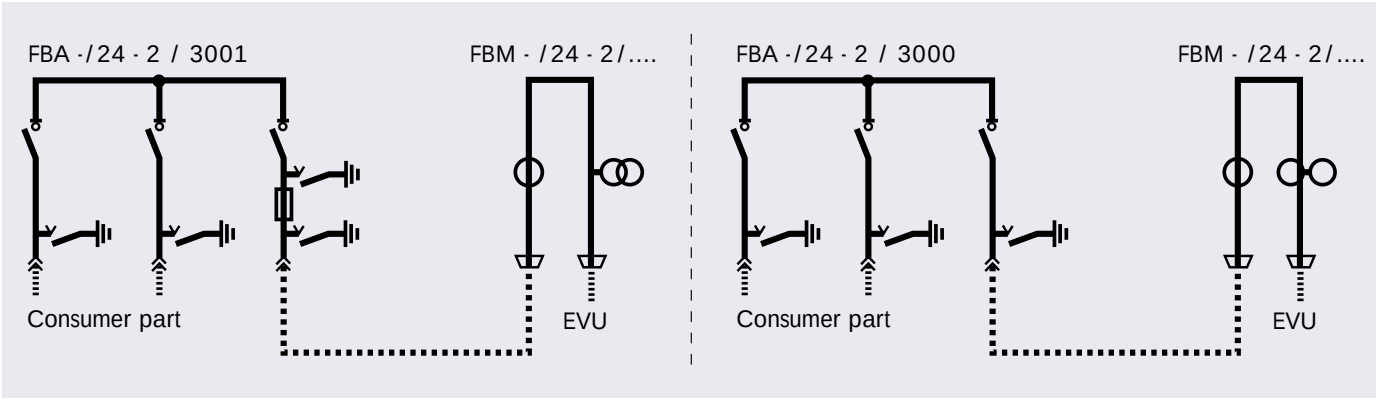
Selection data

General-purpose fuses

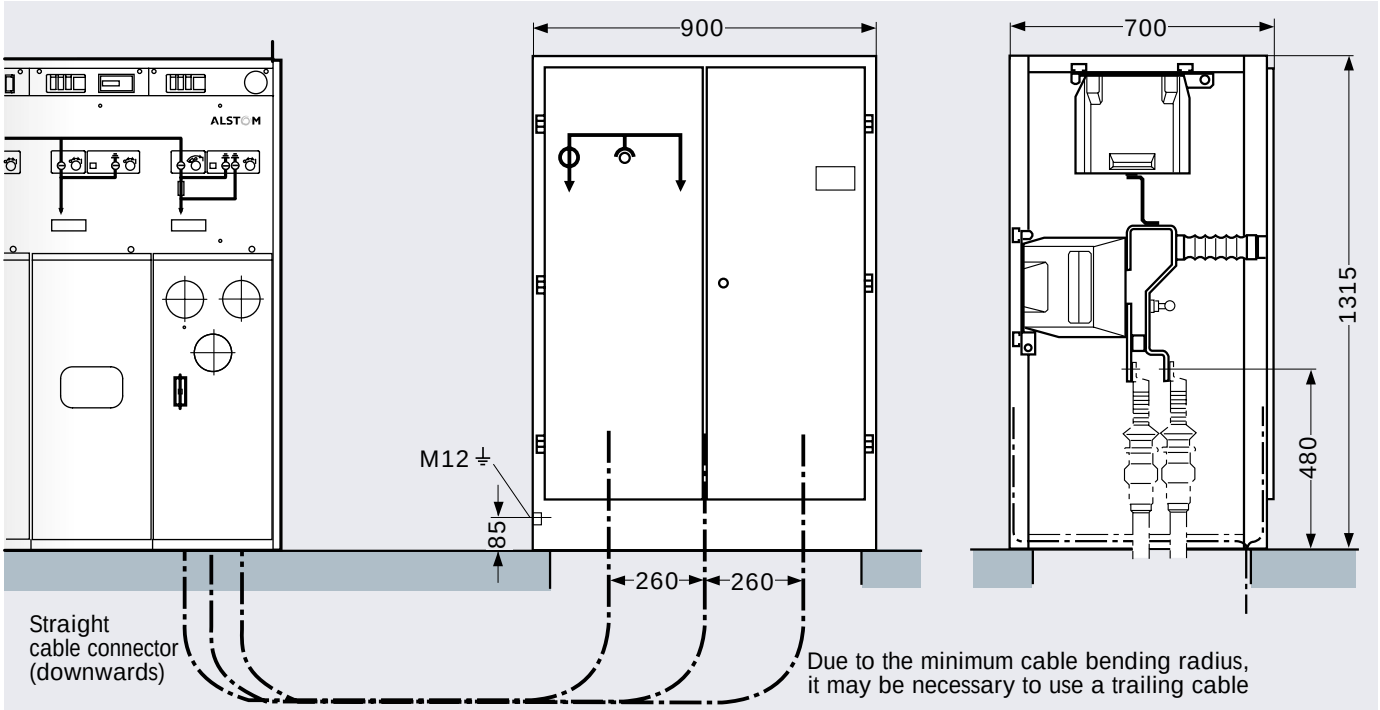
General-purpose fuses are recommended in the exceptional cases when load disconnectors are to be designed with snap-action drive SFU (instead of stored-energy mechanism SF), meaning that no all-pole fuse tripping is possible.

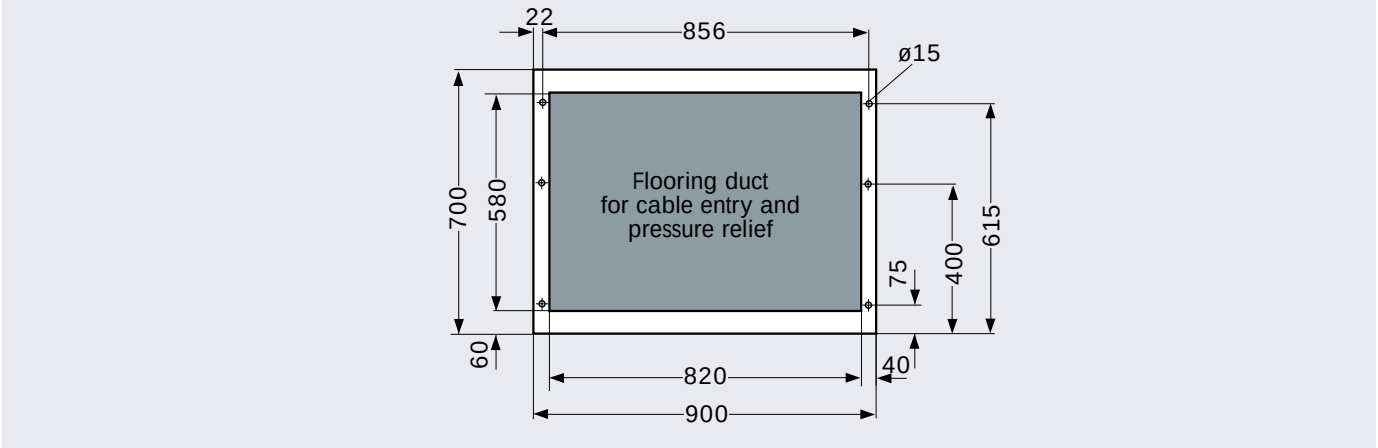
For detailed information on selection of the fuse links, refer to the brochure:
Selection of HVHBC fuse links for distribution transformers
no. 531 400

Metering panel, FBM 24 kV [1)]



Combination examples





Possible configuration of switchgear

[1)] Metering panel, FBM 12 kV available on request

Selection tables for cable fittings

Cable connection

The cable connection compartment is so designed that it enables connection of
– fully insulated
– metal-enclosed
or
– partially insulated
connection systems or ground cables.

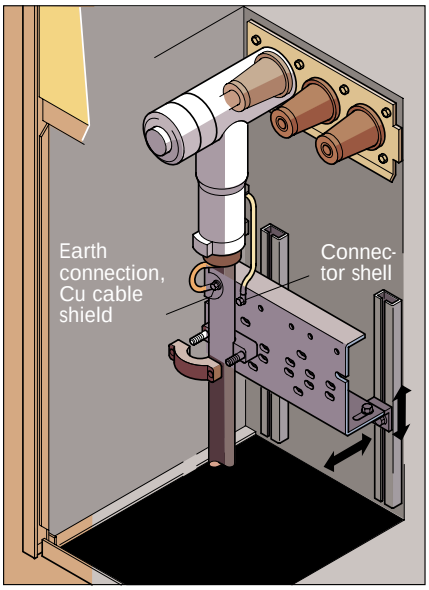
The standard switchgear model is equipped with outer cone-type appliance couplers:

- Mains cable outgoing feeder for FBA up to 24 KV:
  FBE 36 kV:
  FBT up to 36 kV:
  Appliance coupler
  DIN EN 50181 for 630 A
  female-thread screw-type contact M16
- Outgoing transformer feeder for FBA/FBT up to 24 kV:
  Appliance coupler
  DIN EN 50181 for 250 A
  (plug-in contact 7.9 + $^{0.02}/_{0.05}$ mm)
- Outgoing transformer feeder for FBA/FBT 36 kV:
  Appliance coupler
  DIN EN 50181 for 400 A
  (plug-in contact 14 + $^{0}/_{-0.04}$ mm)

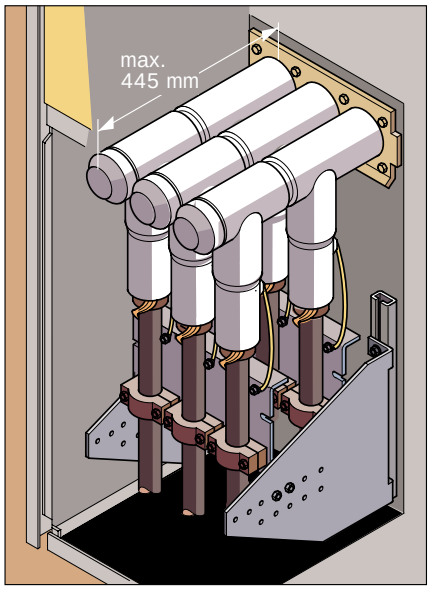
Other variants are available from the manufacturer on request.

The selection table on page 28 and 29 contains a number of common connection systems.

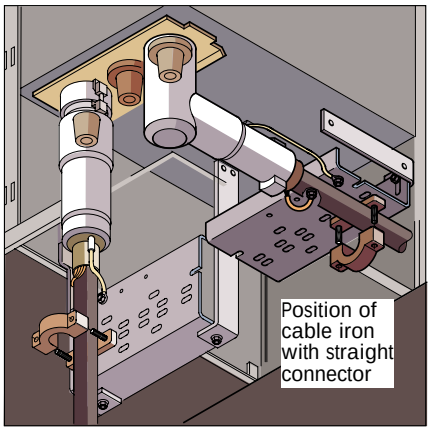
The use of Tee plugs is recommended for connection of the ring mains, and the use of straight or right-angle connectors is recommended for the connection of transformer cables.



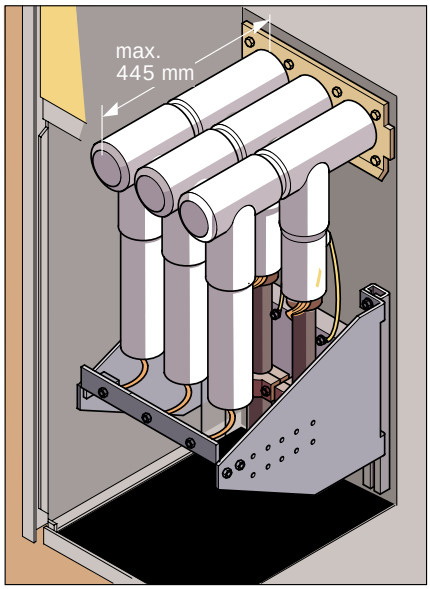
Mains cable connection*



Double connection*



Outgoing transformer feeder with right-angle connector (cable iron replaceable)



Surge arrester with separate earthing bar *

* for FBE/36 kV available on request

Selection table I: Outgoing transformer feeder (Subject to modifications. Updated 03/96)

Examples of cable fittings (right-angle or straight connectors) for outgoing transformer cable, **plug-in contact**

Cable type	Connector type	Manufacturer	Rated current A	12 kV Connector type	12 kV for cross-section mm²	24 kV Connector type	24 kV for cross-section mm²	36 kV Connector type	36 kV for cross-section mm²
Plastic cable, fully insulated system	Right-angle connector	KABEL RHEYDT	250	AGW 10/250	25...95	AGW 20/250 AGWL 20/250	35...95 35...95		
		EURO-MOLD	250 400	158 LR	16...120	K158 LR	16...120	M 400 LR	35...185
		F & G	250	ASW 10/250	25...120	ASW 20/250	25...120		
		ABB Kabel & Draht	250 400	SEHDW 11.1	25...70	SEHDW 21.1	25...70	SEHDT 32	70...500
		RAYCHEM	250	RSES..R	25...120	RSES..R	16...120		
		PIRELLI	250 400	FMCE-250	16...120	FMCE-250	25...120	FMCE-400	25...240
	Straight connector	KABEL-RHEYDT	250	AGG 10/250	25...95	ASG 20/250 AGGL 20/250	35...95 35...95		
		EURO-MOLD	250	151 SR 152 SR	16...120 16...120	K 151 SR K 152 SR	25...120 25...120		
		ABB Kabel & Draht	250	SEHDG 11.1	25...70	SEHDG 21.1	25...70		
		PIRELLI	250 400	FMCS-250	16...120	FMCS-250	25...120	FMCS-400	25...300
		RAYCHEM	250	RSSS...R	25...120	RSSS...R	16...120		

Selection table II: Cable branch line (Subject to modifications. Updated 03/96)

Examples of cable fittings (Tee plugs) for mains cables, **screw-type contact**

Cable type		Manufacturer	Rated current A	12 kV		24 kV		36 kV	
				Connector type	for cross-section mm²	Connector type	for cross-section mm²	Connector type	for cross-section mm²
Plastic cable	Fully insulated system	KABEL RHEYDT	400	AGT 10/400	25...240	AGT 20/400 AGTL 20/400	35...240 35...240		
		EURO-MOLD	400	400 TBS	70...300	K 400 TBS	35...300	M 400 TBS	35...185
		F & G	400 630	AST 10/400 ASTS 10/630 AST 10/630	25...240 25...240 240...500	AST 20/400 ASTS 20/630 AST 20/630	25...240 25...240 240...500	 AST 30/630	 240...500
		ABB Kabel & Draht	630	SEHDT 13.1 SEHDT 13	70...240 50...500	SEHDT 23.1 SEHDT 23	25...240 25...500	 SEHDT 33	 70...500
		PIRELLI	630	FMCTs-400	95...300	FMCTs-400	35...300	FMCTs-400	25...300
		RAYCHEM	630	RSTI...	25...300	RSTI...	25...300		
	Partially insulated system	F & G	630	AWK 10/630[1)] AWKS 10/630[1)]	25...240 25...240	 AWKS 20/630[1)]	 25...240		
		RAYCHEM	400/630	RICS...with cable box IXSU-F...for single-conductor cables	25...300	RICS...with cable box IXSU-F...for single-conductor cables	25...300		
				RICS...with cable box IXSU-F...for three-conductor cables	25...300	RICS...with cable box IXSU-F...for three-conductor cables	25...300		
Ground cable	Partially insulated system	KABEL-RHEYDT	400	ESEK 20 W single-conductor and three-conductor cables	25...300Cu 25...240Al	ESEK 20 W single-conductor and three-conductor cables	25...300Cu 25...240Al		
		F & G	400	AWM 10/400[1)] with cable box SKV 10	50...240	AWM 20/400[1)] with cable box GKV 20	25...150		
		ABB Kabel & Draht	400			MEHW 22 single-conductor and three-core separately sheathed cables	25...150		
		RAYCHEM	400/630	RICS...with cable box UHGK...for quality cables	16...300				
				RICS...with cable box IDST...for paper insulated single conductor and three-core separately sheathed cables	50...300	RICS...with cable box IDST...for paper insulated single conductor and three-core separately sheathed cables	35...240		

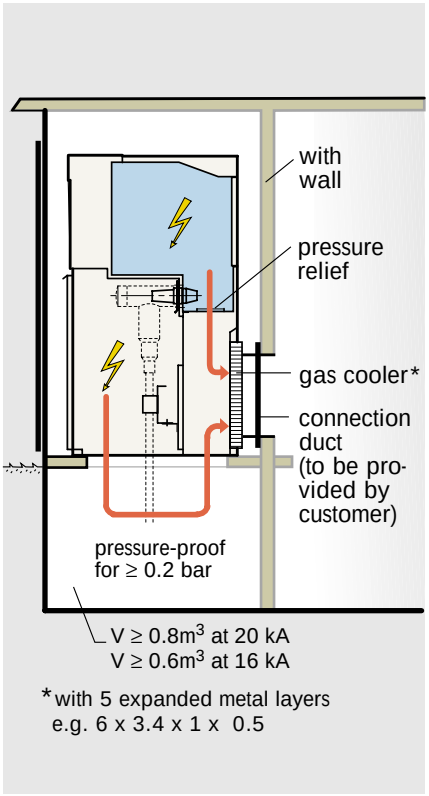
[1)] Right-angle connector

Constructional data

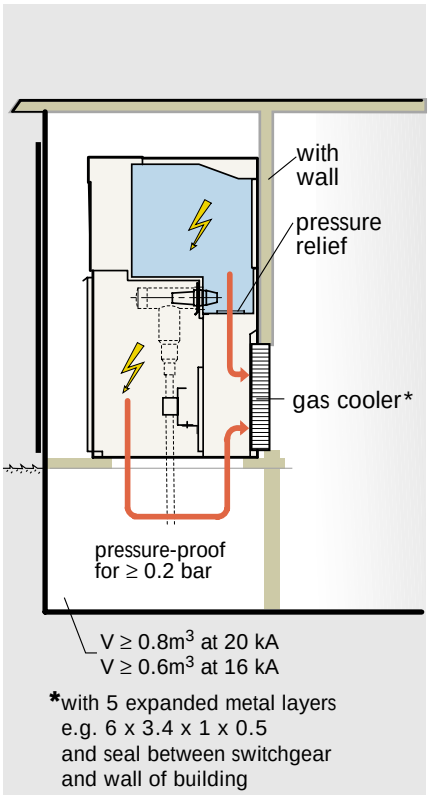
Pressure relief (in case of an internal fault)

1. Pressure relief into pressure relief compartment and via rear side of switchgear (the data and illustrations are also applicable for stations with control aisle).

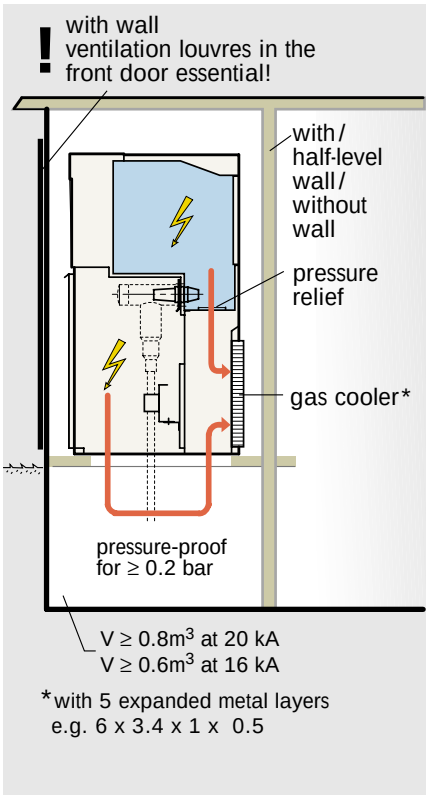
The rear panel and the gas cooler are necessary if the conditions according to criteria 1 to 6 are met. Criteria 1 to 6 refer to the operator's side.



Installation example with wall clearance (with connection duct)

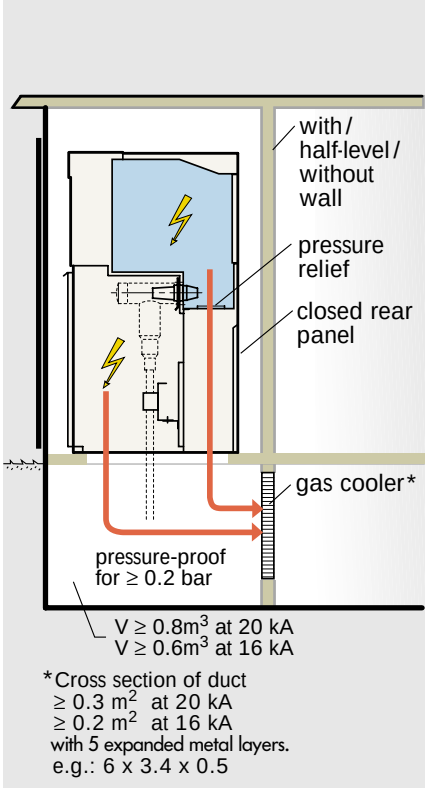


Installation example without wall clearance (cable branch line)



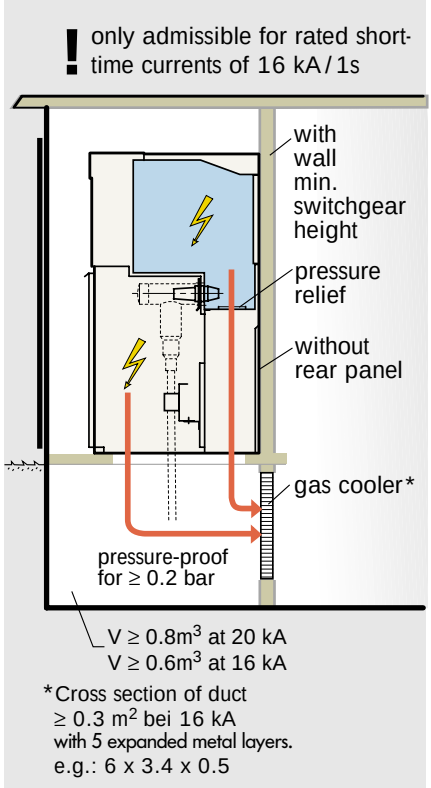
Installation example with clearance to wall and ceiling ≥ 150 mm (cable branch line)
(Pressure relief completely or partially into the switchgear room)

2. Pressure relief into pressure relief compartment / false floor only



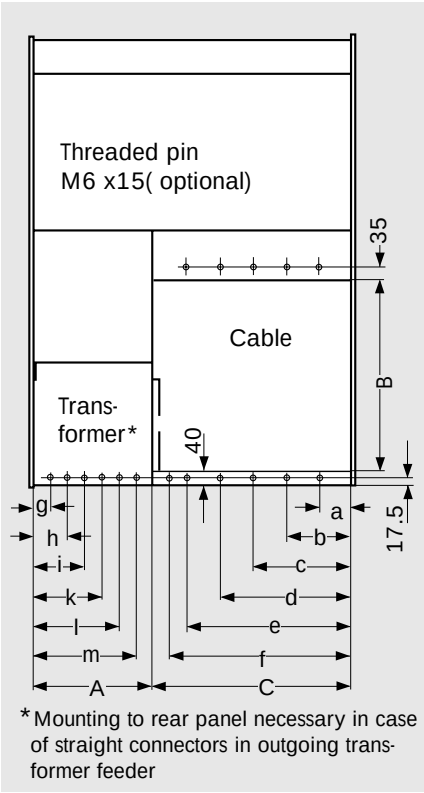
Installation example with wall clearance (cable branch line)

(the data and illustrations are also applicable for stations with control aisle)



Installation example without wall clearance (cable branch line)

Points of attachment of gas coolers to rear wall of switchgear



Rear side of switchgear (for dimensions, refer to table)

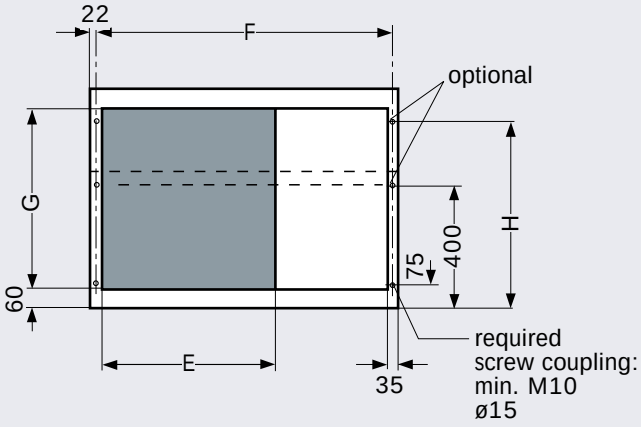
Dimension table for gas cooler attachment

Model	Dim. A	Dim. B for switchgear height of				Dim. C	Dim. a	Dim. b	Dim. c	Dim. d	Dim. e	Dim. f	Dim. g[1]	Dim. h[1]	Dim. i[1]	Dim. k[1]	Dim. l[1]	Dim. m[1]
		1315	1045	1700	1400													
FBA 2011	316		319			314	81	221	–	–	–	–	51	251	–	–	–	–
FBA 3000	–		319			950	81	471	861	–	–	–	51	251	–	–	–	–
FBA 3001	316		319			634	81	541	–	–	–	–	51	251	–	–	–	–
FBA 3002	636		–			314	81	221	–	–	–	–	51	571	–	–	–	–
FBA 4000	–		319			1270	81	541	721	1181	–	–	–	–	–	–	–	–
FBA 4001	316		319			954	81	471	861	–	–		51	251	–	–	–	–
FBA 4002	636	589	319	–	–	634	81	541	–	–	–	–	51	571	–	–	–	–
FBA 4003	956		–			314	81	221	–	–	–	–	51	438	891	–	–	–
FBA 5000	–		319			1590	81	438	795	1152	1509	–	–	–	–	–	–	–
FBA 5001	316		319			1274	81	447	813	1179	–	–	51	251	–	–	–	–
FBA 5002	636		319			954	81	471	861	–	–	–	51	571	–	–	–	–
FBA 5003	956		319			634	81	541	–	–	–	–	51	438	891	–	–	–
FBA 5004	1276		–			314	81	221	–	–	–	–	51	438	795	1152	–	–

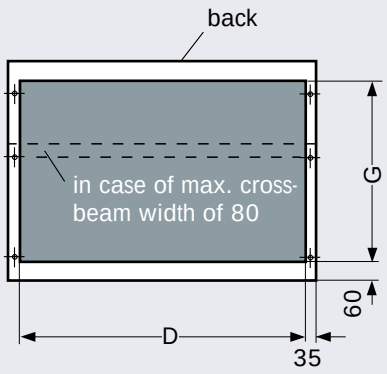
FBE 2011	467				537	462	96	370	–	–	–	–	96	370	–	–	–	–
FBE 3000	–				–	1400	96	337.6	579.2	820.8	1062.4	1304	–	–	–	–	–	–
FBE 3001	467				537	932	96	344	593	841	–	–	96	370	–	–	–	–
FBE 4000	–				–	1870	96	336	576	816	1056	1296	94	334	–	–	–	–
FBE 4001	467	–	–	837	537	1402	96	339	582	825	1068	1311	96	370	–	–	–	–
FBE 4002	937				–	932	96	344	593	841	–	–	96	344	592	840	–	–
FBE 5000	–				–	2340	96	334.6	573.2	811.8	1050.4	1289	96.6	335.2	573.8	812.4	–	–
FBE 5001	467				–	1872	96	344	593	841	1035	1289	96	370	–	–	–	–
FBE 5002	937				–	1402	96	339	582	825	1068	1311	96	344	592	840	–	–
FBE 5003	1407				–	932	96	314	593	841	–	–	96	338.8	581.6	824.4	1068.2	1310

[1] Dimensions not valid for switchgear height of 1045 (fastening not possible)

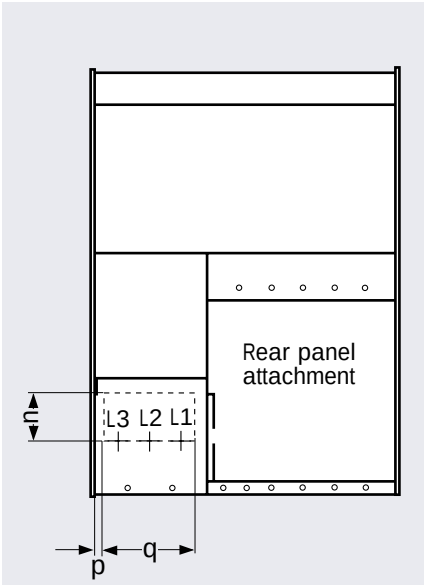
for right-angle connectors
in the outgoing transformer feeder



for right-angle connectors
in the outgoing transformer feeder



Required wall cutout in case of right-angle connectors



Back of switchgear

Required wall cutout in case of right-angle

–	FBA/T	FBE/T
U (kV)	12/17.5/24	36
Dim. n	120	170
Dim. p	30	75
Dim. q	310	370

Model	U kV	Dim. D	Dim. E	Dim. F	Dim. G	Dim. H
FBT 2011	12 to 24	620	300	646	590	615
FBA 3000	12 to 24	940	940	966	590	615
FBA 3001	12 to 24	940	620	966	590	615
FBA 3002	12 to 24	940	320	966	590	615
FBA 4000	12 to 24	1260	1260	1286	590	615
FBA 4001	12 to 24	1260	940	1286	590	615
FBA 4002	12 to 24	1260	620	1286	590	615
FBA 4003	12 to 24	1260	320	1286	590	615
FBA 5000	12 to 24	1580	1580	1606	590	615
FBA 5001	12 to 24	1580	1260	1606	590	615
FBA 5002	12 to 24	1580	940	1606	590	615
FBA 5003	12 to 24	1580	620	1606	590	615
FBA 5004	12 to 24	1580	320	1606	590	615
FBT 2011	36	920	520	946	745	745
FBE 3000	36	1390	1390	1416	745	770
FBE 3001	36	1390	955	1416	745	770
FBE 4000	36	1860	1860	1886	745	770
FBE 4001	36	1860	1425	1886	745	770
FBE 4002	36	1860	955	1886	745	770
FBE 5000	36	2330	2330	2365	745	770
FBE 5001	36	2330	1895	2356	745	770
FBE 5002	36	2330	1425	2356	745	770
FBE 5003	36	2330	955	2356	745	770

Dimensions in mm

Transport of switchgear

When transporting the switchgear, make sure that the transport unit does not slip or tip over (if necessary, nail transport pallet to loading platform). Leave transport unit packed as far as possible. Parts which have been unpacked for inspection must be re-packed for further storage. Use the original packaging material.

Packing the switchgear unit

- In the case of truck-worthy packing, the switchgear is delivered on a pallet with PE protective film. Two plastic belts serve to fasten the switchgear.
- In the case of sea-worthy export, the switchgear is packed in sealed aluminium film with desiccant and a closed crate with sealed wooden bottom.
- In the case of air freight, the switchgear is packed in a wooden crate with closed wooden bottom and with bubble-pack-type plastic packaging film as dust protection, or in a wooden crate, also with closed wooden bottom.

Transport to the site of installation

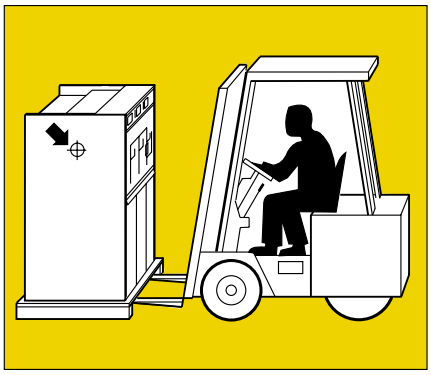
The switchgear must be stored at the conditions admissible for operation.
Condensation must be avoided.

For transport, lateral parallel displacement of the switchgear must be ruled out (if necessary, by using stabilisers).

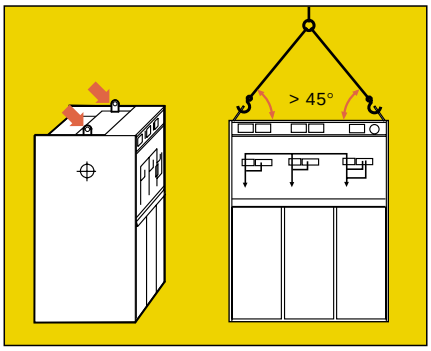
For transport to the site of installation, it is important to remember that the main weight is in the top area of the switchgear. The centre of gravity is marked with a label on the side face of the switchgear.

Transport using a forklift truck:
The switchgear may only be transported on pallets.

Transport without pallet:
Attach crane suspension gear into transport eyelet of switchgear.
Angle of crane suspension gear:
> 45°.



Transport of switchgear with pallet



Transport of switchgear without pallet

Fax query to submit an offer

To

ALSTOM Sachsenwerk GmbH
Rathenaustraße 2
Dept. SW V6

D-93055 Regensburg

Our FB team:

Phone:	**+49 (0)9 41/46 20-186**	**V61**	**Mr. Hillinger**
	-122	**V61**	**Mr. Ettinger**
	-481	**V61**	**Mr. Kiesewetter**
	-371	**V61**	**Mr. Cavus**
	-275	**V61**	**Ms. Schmidt**
	-530	**V61**	**Ms. Kopf**

Telefax: +49 (0)9 41/46 20-227

Sender

Company: .....
Address: .....
Postal Code/City: .....
Contact: .....
Name/first name: .....
Department: .....
Phone: .....
Telefax: .....

Please submit to us your offer regarding the items ticked off herebelow:
Please call us back for clarification of details
Number of following pages

☐ FBA/E/T . / . . –2 / . . . .

☐ Rated current . . . A

☐ Rated short-time current . . kA

Attachments:

☐ Auxiliary switch on switch-disconnector, 4-pole

☐ Auxiliary switch on switch-disconnector, 6-pole

☐ Auxiliary switch on earthing switch, 2-pole

☐ PEHLA 1-6 / 1 sec.

☐ Short-circuit indicator

☐ Motor drive on switch-disconnector

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