



FBX

Gas- Insulated Medium-Voltage Switchgear up to 24 kV



for secondary distribution
- compact or extensible

System configuration

Delivery Conditions

The General Delivery Conditions as amended shall apply.

Illustrations

The illustrations are not binding.





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Overview

FBX - compact and extensible

FEATURES

Gas-insulated ring main units

- > Ring main units up to 24 kV, 20 kA, 630 A
- > FBX-C - compact (non-extensible) design
- > FBX-E - extensible design
- > available with switch disconnectors, switch fuse combinations or vacuum circuit-breakers
- > for non-accessible or walk-in stations
- > available in single-panel designs and extensible designs especially suited to installation in windpower stations
- > complies with IEC, EN, GOST and China National Standards (CNS)

Advantages

- > Economic, space-saving design
- > Extensible or non-extensible, to suit your requirements
- > Straightforward installation without gas handling
- > Independent of environmental influences
- > Very long service life and low life cycle costs
- > Eco-friendly

Automated stations

With its modular concept and options including motorized switching devices and remote control modules, FBX is especially well-suited for the increasing automation of secondary distribution networks.

To enable communication with power system control centres, FBX provides various project stages with solutions integrated in the switchgear. All versions - from remote-signalling only to remote control and re-transmission of additional signals from the substation – are possible.

For automated power system operation, FBX can be managed from the remote control station by motor control and electrically via the micro remote control module.

Modern communication techniques, including modem solutions for telephone lines, radio or GSM can be incorporated.

Fields of application

The FBX ring main units are used in non-accessible or in walk-in stations belonging to the public power supply companies, of industry, infrastructure and windpower stations.



Example of an extensible FBX-E switchgear:

Ring main panels and the tie breakers – designed as switch disconnectors – are located at the left-hand and right-hand ends of the switchgear. The six outgoing feeder panels T2 for the transformer outgoing feeders with vacuum circuit-breakers are supplied via two air-insulated FBX-M metering panels for billing metering.

FBX – Straightforward planning

The FBX is a gas-insulated three-pole enclosed switchgear system for secondary distribution. SF₆ gas is used as the insulating medium. The gas-filled, clad compartments of FBX are insensitive to environmental influences such as humidity, dust, dirt and vermin, and afford maximum operator safety.

FBX-C switchgear is available as classical non-extensible ring main units, with 2 to 4 switching units. FBX-E is the extensible version, with 1 to 4 switching units, which are arranged in a common gas-filled, clad compartment. The functional units of FBX-E can be arranged in any order, without gas handling, to form the required multi-panel switchgear arrangement.



FBX-C, compact, no-extensible

FBX-E in-line technology offers the following advantages:

- > Very cost-effective solution for secondary distribution applications.
- > Can be installed from the outside through very small access openings and hatches, e.g. for installation in cellars or on upper floors, or inside windpower stations.
- > FBX-E modules can be aligned in any order.
- > Subsequent expansion is possible on both sides of the switchgear.
- > Installation at the construction site with no gas handling.



FBX-E, extensible

Both FBX-C (non-extensible) and FBX-E (extensible) versions can be equipped with

- circuit-breakers (C),
- switch fuse combinations (T1),
- Transformer outgoing feeders with vacuum circuit-breakers (T2) for high-capacity distribution transformers or outgoing feeders up to 400/630A
- busbar risers (R)
- busbar risers with earth switches (RE), help provide a very cost-effective solution to the requirements of secondary distribution network engineering.

FBX-M air-insulated metering panels with conventional current and voltage transformers for medium-voltage billing metering complete this range of products.

The clear overall design of the FBX switchgear range ensures straightforward, reliable operation. A continuous zero-force interlocking concept prevents operator errors.

The generous space in the cable connection compartments allows the use of various cable connection systems for outer cone-type appliance couplers to EN 50181.

Up to 2x3 cable Tee screw-type plugs or 3 cable Tee screw-type plugs plus 3 surge arresters per outgoing feeder can be installed within the standard switchgear profile.

OVERVIEW OF FBX-C VERSIONS

Compact (non-extensible) two to four panel units

Examples



FBX-C/C-C-C-T1



FBX-C/C-C-T1



FBX-C/C-T1

Functional units:

- C = Outgoing feeder cable with switch disconnector
- T1 = Transformer outgoing feeder with switch fuse combination
- T2 = Transformer outgoing feeder with vacuum circuit-breaker
- R = Busbar riser without earth switch
- RE = Busbar riser with earth switch

Complete range of FBX-C versions with two, three and four switching functions, see page 14.

BASIC ELEMENTS OF FBX-E VERSIONS

FBX-E (extensible on both sides) single-panel units

Examples



FBX-E/C



FBX-E/T1



FBX-E/T2

Functional units:

- C = Outgoing feeder cable with switch disconnecter
- T1 = Transformer outgoing feeder with switch fuse combination
- T2 = Transformer outgoing feeder with vacuum circuit-breaker
- R = Busbar riser without earth switch
- RE = Busbar riser with earth switch

OVERVIEW OF FBX-E VERSIONS

FBX-E (extensible on both sides) two to four-panel units

Examples



FBX-E/C-C-C-T1



FBX-E/C-C-T1



FBX-E/C-T1

Functional units:

- C = Outgoing feeder cable with switch disconnecter
- T1 = Transformer outgoing feeder with switch fuse combination
- T2 = Transformer outgoing feeder with vacuum circuit-breaker
- R = Busbar riser without earth switch
- RE = Busbar riser with earth switch.

For the complete FBX-E range, with one to four panel functions, see page 15.



Standards

Regulations, provisions and standards

FBX switchgear units are

- > metal-enclosed
- > SF₆ insulated
- > pre-fabricated and type-tested
- > arc resistant

DEGREE OF PROTECTION AGAINST ACCIDENTAL CONTACT AND INGRESS OF FOREIGN OBJECTS

Main electric circuits	IP65
Drive mechanisms and secondary systems recess	IP2X IP5X ¹⁾
Cable connection compartment (Operator's side with cable compartment cover and sides)	IP3X ¹⁾ IP5X ¹⁾

1) Optional

ENVIRONMENTAL AND OPERATING CONDITIONS

FBX switchgear units must be installed and operated in normal conditions as specified in EN 60694 or IEC 60694.

Operation under conditions other than these is only permissible after consultation with the manufacturer and obtaining written consent.

Ambient conditions		
Temperature class		"minus 5 indoors" ¹⁾
Min./max. ambient temperature	°C	-5 ¹⁾ / 40
Average value over 24 hours (max.)	°C	35 ²⁾
Maximum installation altitude above sea level	m	1000 ³⁾
Insulating gas		
Type		Sulphur hexafluoride (SF ₆)
Rated pressure p _{re} at 20 °C	MPa	0,03
Relative leakage rate F _{rel}	%	< 0,1 p.a.

1) Optional: "minus 25 indoors"

2) Optional up to 55° at reduced normal currents

3) Higher altitudes possible on request, especially for the air-insulated metering panels FBX-M and for the HV HRC fuse carriers operating in normal atmosphere.

APPLICABLE STANDARDS

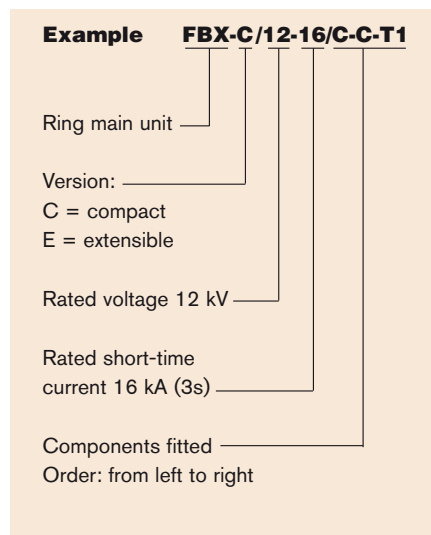
FBX switchgear units meet the requirements of the following standards and regulations:

Designation	IEC standard	IEC classes	EN standard
Switchgear	IEC 62271-200 IEC 60694	Partition class PM Loss of service continuity category (LSC) of cable connection compartments and locating tubes for HV HRC fuse links: LSC 2A ¹⁾	EN 62271-200 EN 60694
Behaviour in the event of internal faults	IEC 62271-200		EN 62271-200
Earth switch (in C, T1, T2, RE)	IEC 62271-102	E2	EN 62271-102
Disconnecter (in T2)	IEC 62271-102	M1	EN 62271-102
Multi-purpose switch disconnector (C)	IEC 60265-1	M1, E3	
Switch fuse combination (T1)	IEC 62271-105	M1, E1	
Circuit-breaker (T2)		E1, C1	EN 62271-100
Current transformer	IEC 60044-1		EN 60044-1
Voltage transformer	IEC 60044-2		EN 60044-2
Voltage detection systems	IEC 61243-5		EN 61243-5
Protection against accidental contact, foreign objects and water	IEC 60529		N 60529
Installation			HD 637 S1
Operation of electrical equipment			EN 50110

¹⁾ If FBX-M air-insulated metering panels are used, operating availability may be restricted, depending on the entire switchgear configuration, below LSC 2A. However, if the FBX-M1 metering panel can be isolated to the left or right (live operation of switchgear section on the left and right can be maintained), the operating availability with LSC 2A is guaranteed for the entire switchgear.

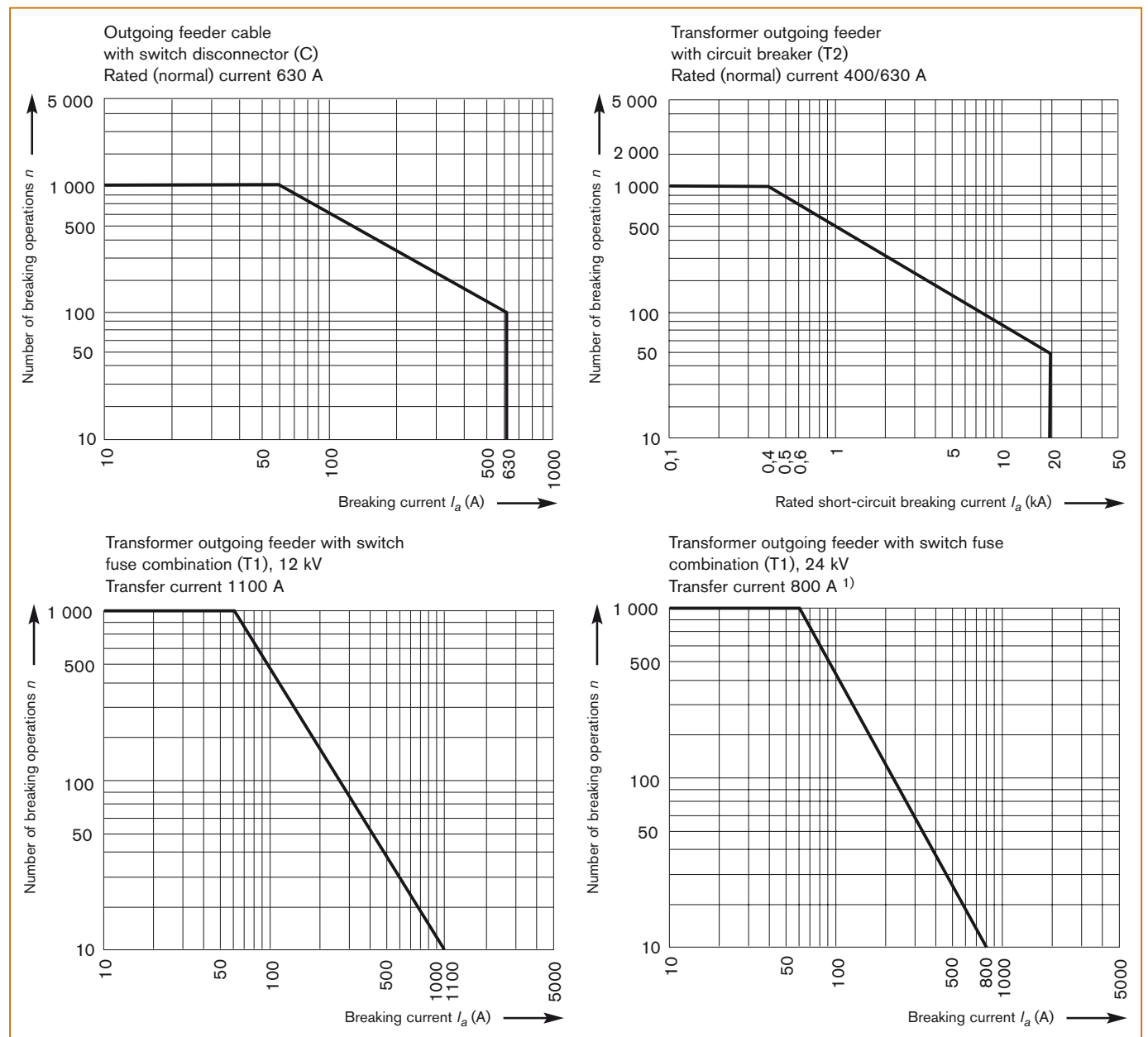
TYPE DESIGNATION

The designation of the type-tested switch disconnector unit defines its design, rated short-time current, rated voltage and components fitted.



- C = Outgoing feeder cable with switch disconnector
- T1 = Transformer outgoing feeder with switch fuse combination
- T2 = Transformer outgoing feeder with vacuum circuit-breaker
- R = Busbar riser
- RE = Busbar riser with earth switch

MAXIMUM NUMBER OF OPERATIONS



Diagrams showing the maximum numbers of operations

¹⁾ higher values on request

FBX WITH SWITCH DISCONNECTOR C

Rated voltage	kV	12		17.5		24	
Rated frequency	Hz	50/60		50/60		50/60	
Rated lightning impulse withstand voltage							
to earth	kV	75		95		125	
over the isolating distance	kV	85		105		145	
Rated power frequency withstand voltage							
to earth	kV	28		38		50	
over the isolating distance	kV	32		45		60	
Insulating level for SF ₆ pressure Pre = 0.00 MPa							
Rated lightning impulse withstand voltage	kV	75		95		95	
Rated power frequency withstand voltage	kV	28		38		50	
Insulating level of isolating distance for cable test							
at busbar	U _r kV	12		17.5		24	
at outgoing feeder	Power-frequency test voltage kV 0.1 Hz	18		26		35	
at outgoing feeder	DC test voltage kV	48		60		96	
Rated normal current							
Busbar	A	630		630		630	
Outgoing feeder	A	630		630		630	
Rated peak withstand current, rated short-circuit making current	kA 50 Hz	40	52.5	40	52.5	40	50
	kA 60 Hz	40	52	40	52	40	–
Rated short-time current, main power circuit	1s kA 50 Hz	16	21	16	21	16	20
	kA 60 Hz	16	20	16	20	16	–
Rated short-time current, main power circuit	3s kA 50 Hz	16	20	16	20	16	20
	kA 60 Hz	16	20	16	20	16	–
Rated short-time current, earthing circuit	1s kA	16	21	16	21	16	20
	3s kA	16	0.85x20	16	0.85x20	16	0.85x20
Network load and closed-loop breaking current	A	630		630		630	
Rated cable-charging breaking current	A	160		160		160	
Breaking current under earth-fault conditions	A	600		600		600	
Cable breaking current under earth-fault conditions	A	277		277		277	
Number of operating cycles without inspection							
mechanically with:							
switch disconnecter / earth switch M1/-		1000		1000		1000	
electrically with:							
rated normal current E3		100		100		100	
short-circuit making operations							
switch disconnecter E3		5		5		5	
earth switch E2		5		5		5	

FBX WITH SWITCH FUSE COMBINATION T1

Rated voltage		kV	12		17.5		24	
Rated frequency		Hz	50/60		50/60		50/60	
Rated lightning impulse withstand voltage								
to earth		kV	75		95		125	
over the isolating distance		kV	85		105		145	
Rated power frequency withstand voltage								
to earth		kV	28		38		50	
over the isolating distance		kV	32		45		60	
Insulating level for SF ₆ pressure Pre = 0.00 MPa								
Rated lightning impulse withstand voltage		kV	75		95		95	
Rated power frequency withstand voltage		kV	28		38		50	
Rated normal current								
Busbar		A	630		630		630	
Outgoing feeder		A	1)		1)		1)	
Rated short-time current		1s kA	5		5		5	
		3s kA	3		3		3	
Rated peak withstand current		kA	13		13		13	
Rated short-circuit making current		kA	13		13		13	
Rated short-time current, earthing circuit		1s kA	16	21	16	21	16	20
		3s kA	16	0.85x20	16	0.85x20	16	0.85x20
Rated cable-charging breaking current		A	60		60		60	
Rated breaking current								
under earth-fault conditions		A	200		200		200	
Rated cable-charging breaking current								
under earth-fault conditions		A	87		87		87	
Rated transient current to IEC 62271-105		A	1100		800 ³⁾		800 ³⁾	
Opening time in case of striker actuation T _o		ms	34		34		34	
Number of operating cycles without inspection								
mechanically with:								
switch disconnecter / earth switch M1/-			1000		1000		1000	
electrically with:								
rated normal current E1 ²⁾			10		10		10	
short-circuit making operations								
switch disconnecter E3			5		5		5	
earth switch E2			5		5		5	

¹⁾ see Table for fuse selection on page 33

²⁾ E3 (100x rated normal current) on request

³⁾ higher ratings available on request, with optional time delay for switching OFF the switch disconnecter

FBX WITH VACUUM CIRCUIT-BREAKER T2

Rated voltage			kV		12		17.5		24							
Rated frequency			Hz		50/60		50/60		50/60							
Rated lightning impulse withstand voltage																
to earth			kV		75		95		125							
over the isolating distance			kV		85		105		145							
Rated power frequency withstand voltage																
to earth			kV		28		38		50							
over the isolating distance			kV		32		45		60							
Insulating level for SF ₆ pressure Pre = 0.00 MPa																
Rated lightning impulse withstand voltage			kV								75		95		95	
Rated power frequency withstand voltage			kV								28		38		50	
Insulating level of isolating distance for cable test																
at busbar			U _r	kV	12		17.5		24							
at outgoing feeder			Power-frequency test voltage	kV 0.1 Hz	18		26		35							
at outgoing feeder			DC test voltage	kV	48		60		96							
Rated normal current																
Busbar			A		630		630		630							
Outgoing feeder			A		400/630 ¹⁾		400/630 ¹⁾		400/630 ¹⁾							
Rated peak withstand current, rated short-circuit making current					kA 50 Hz		40	52,5	40	52,5	40	50				
					kA 60 Hz		40	52	40	52	40	–				
Rated short-time current, main power circuit					1s kA 50 Hz		16	21	16	21	16	20				
					kA 60 Hz		16	20	16	20	16	–				
Rated short-time current, main power circuit					3s kA 50 Hz		16	20	16	20	16	20				
					kA 60 Hz		16	20	16	20	16	–				
Rated short-time current, earthing circuit					1s kA		16	21	16	21	16	20				
					3s kA		16	0.85x20	16	0.85x20	16	0.85x20				
Rated short-circuit breaking current					kA		16	20	16	20	16	20				
Percentage value of the DC component					%		28		28		28					
Rated operating sequence ²⁾					0-3 min-CO											
Rated cable-charging breaking current					A		25		31.5		31.5					
Number of operating cycles without inspection mechanically with:																
vacuum circuit-breaker							1000		1000		1000					
disconnector/earth switch M0/–							1000		1000		1000					
electrically with:																
disconnector/earth switch																
short-circuit making operations																
earth switch E2							5		5		5					
vacuum circuit-breaker																
rated normal current E2							1000		1000		1000					
rated short-circuit breaking current E1							50		50		50					

¹⁾ 630 A on request

²⁾ Making snap-action mechanism and breaking stored-energy mechanism with motor

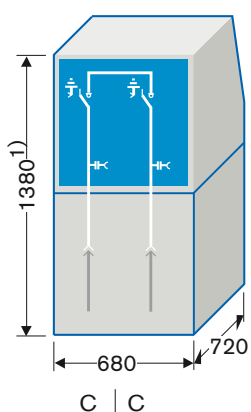


Dimensions and weights

FBX-C, COMPACT (NON EXTENSIBLE)

Dimensions and weights: Type FBX-C, compact (non extensible)

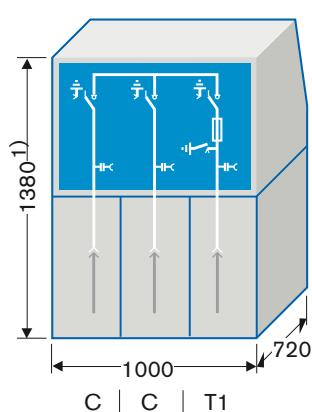
Function	Number of panels	Height [mm]	Depth [mm]	Width [mm]	Weights approx. [kg]
RE-T1	2-panel unit	1380 (optional 1040)	720	680	210
RE-T2	2-panel unit	1380			240
C-C	2-panel unit	1380 (optional 1040)			200
C-T1	2-panel unit	1380 (optional 1040)			200
C-T2	2-panel unit	1380			200
C-C-T1	3-panel unit	1380 (optional 1040)	720	1000	330
C-C-T2	3-panel unit	1380			360
C-RE-T1	3-panel unit	1380 (optional 1040)			320
C-RE-T2	3-panel unit	1380			360
R-RE-T1	3-panel unit	1380 (optional 1040)			320
R-RE-T2	3-panel unit	1380			350
C-C-C	3-panel unit	1380 (optional 1040)			320
C-C-C-T1	4-panel unit	1380 (optional 1040)	720	1320	450
C-C-C-T2	4-panel unit	1380			480
C-T1-C-T1	4-panel unit	1380 (optional 1040)			470
C-T2-C-T2	4-panel unit	1380			500
C-C-C-C	4-panel unit	1380 (optional 1040)			440



2-panel functional units

Variants

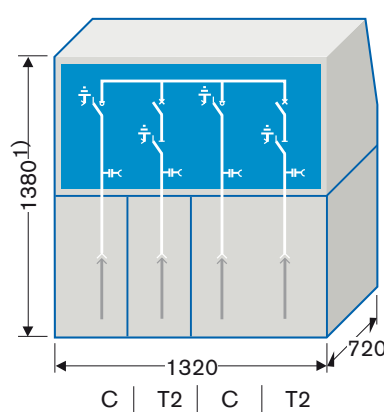
RE-T1
RE-T2
C-C
C-T1
C-T2



3-panel functional units

Variants

C-C-T1
C-C-T2
C-RE-T1
C-RE-T2
R-RE-T1
R-RE-T2
C-C-C



4-panel functional units

Variants

C-C-C-T1
C-C-C-T2
C-T1-C-T1
C-T2-C-T2
C-C-C-C

¹⁾ optional: 1040 mm,
Refer to components fitted
according to Table above

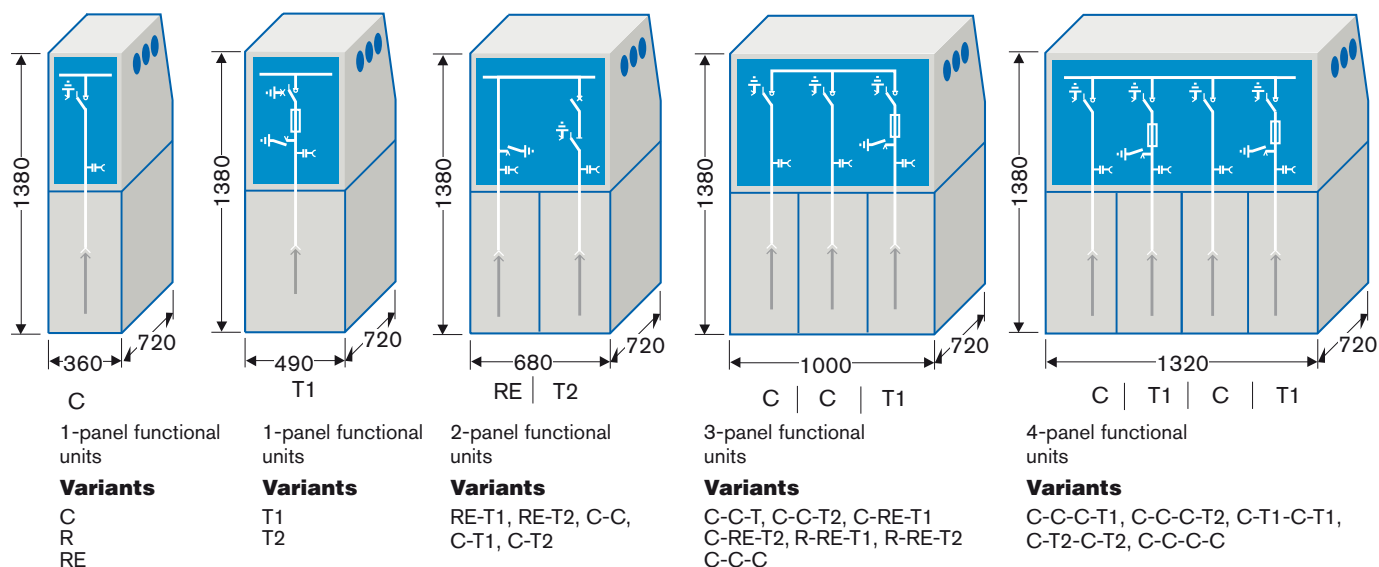
FBX-E (EXTENSIBLE)

Dimensions and weights: Type FBX-E (extensible)

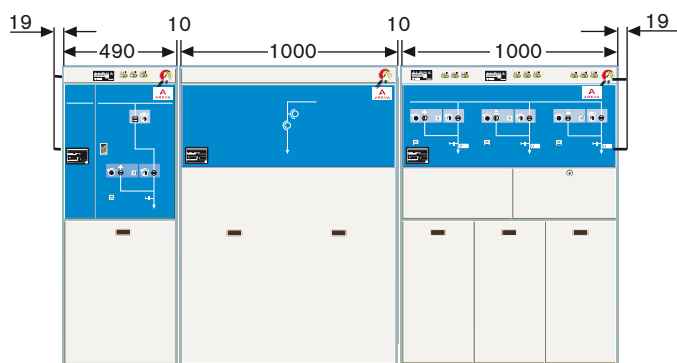
Function	Number of panels	Height [mm]	Depth [mm]	Width [mm]	Weights approx. [kg]
C	Single panel	1380	720	360 ²⁾	135
R	Single panel				125
RE	Single panel				135
T1	Single panel	1380	720	490 ²⁾	160
T2	Single panel				190
RE-T1	2-panel unit	1380	720	680 ²⁾	220
RE-T2	2-panel unit				250
C-C	2-panel unit				210
C-T1	2-panel unit				210
C-T2	2-panel unit				210
C-C-T1	3-panel unit	1380	720	1000 ²⁾	340
C-C-T2	3-panel unit				370
C-RE-T1	3-panel unit				330
C-RE-T2	3-panel unit				330
R-RE-T1	3-panel unit				330
R-RE-T2	3-panel unit				330
C-C-C	3-panel unit				330
C-C-C-T1	4-panel unit	1380	720	1320 ²⁾	460
C-C-C-T2	4-panel unit				490
C-T1-C-T1	4-panel unit				480
C-T2-C-T2	4-panel unit				510
C-C-C-C	4-panel unit				450

1) plus 19 mm for the busbar covers (left- and right-hand) at the end of the switchgear

2) Dimensions plus 10 mm width for in-line arrangement, refer to list



Installation



Switchgear example FBX-E



Product description

Basic equipment, operation

Gas-insulated FBX switchgear units satisfy the most demanding service requirements

- > operating reliability
- > operator safety
- > availability
- > flexibility
- > economic efficiency
- > ecological considerations

BASIC EQUIPMENT

- > manually actuated switching devices
- > gas-filled, clad compartments with stainless-steel tanks
- > cable compartment covers, arc-proof
- > mechanical interlocks for each outgoing feeder

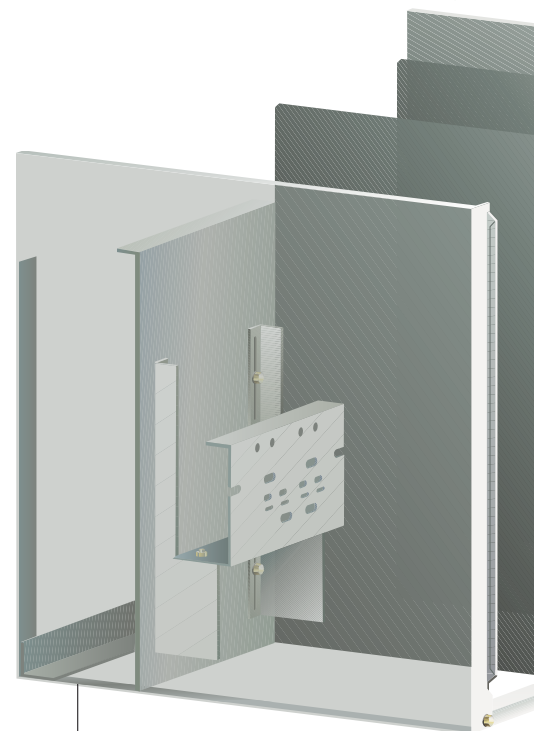
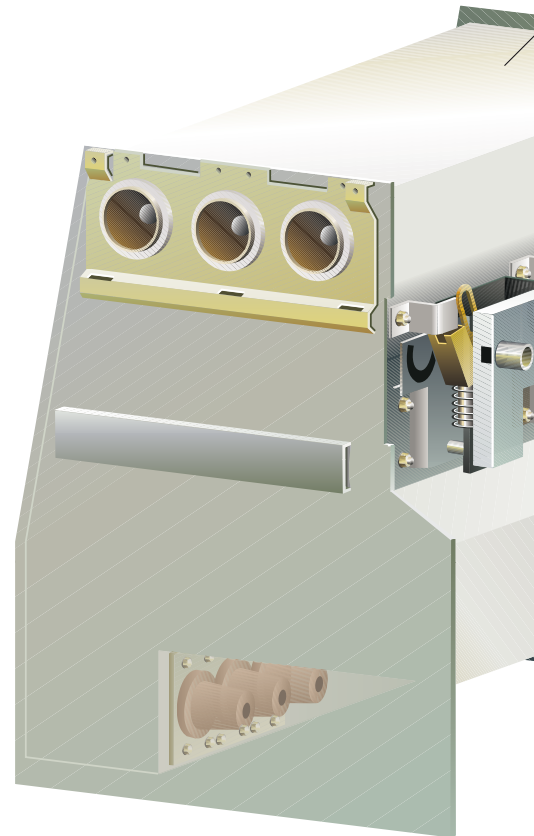
options available include

- > fuse attachment featuring all-pole tripping or
- > vacuum switches with protection equipment
- > pressure gauge with green/red indicator:

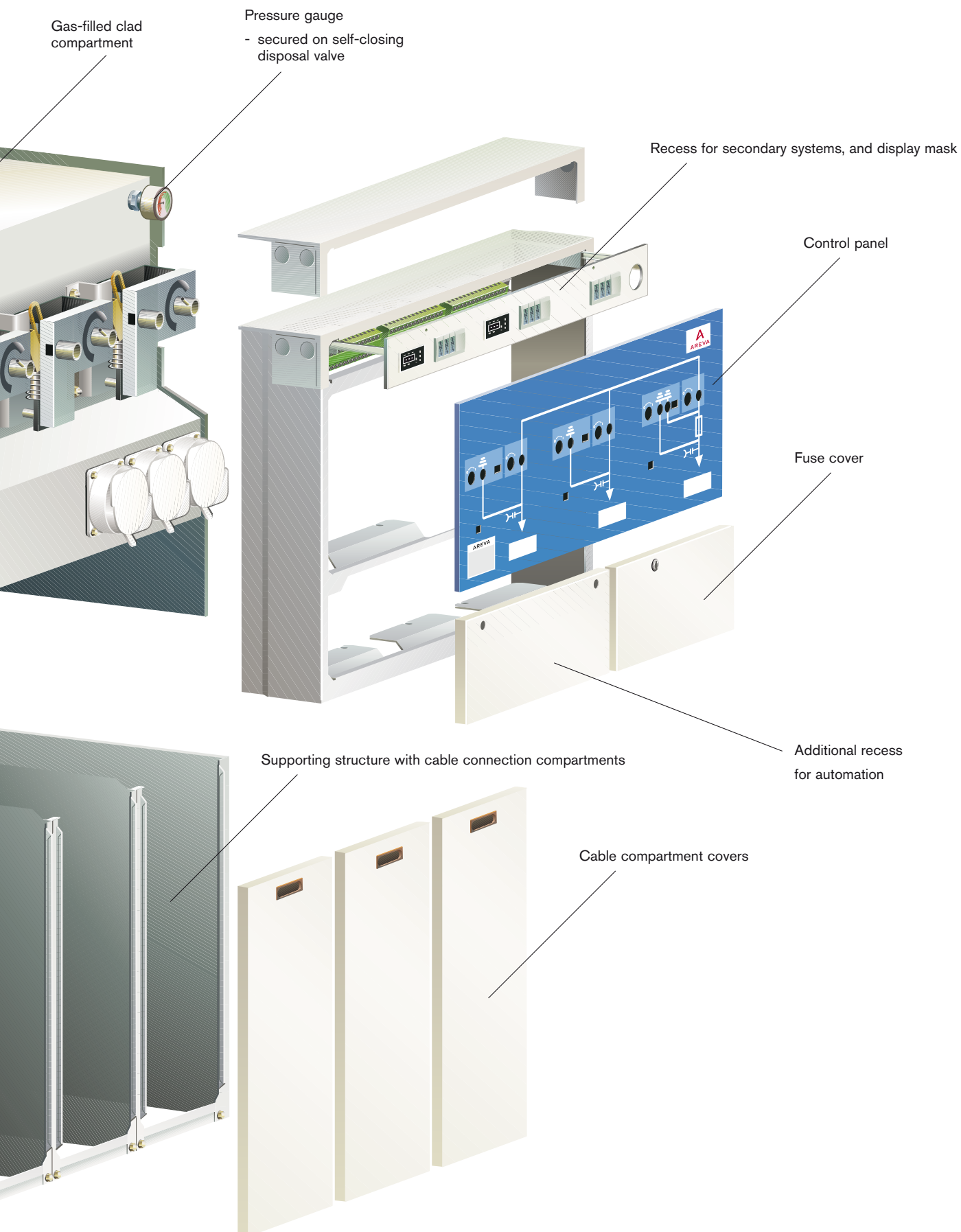
Gas monitoring is effected for each gas-filled, clad compartment via a pressure gauge with clear indicator areas:

- green - gas pressure OK
- red - gas pressure low.

The check for zero voltage is performed via the (non-integrated) voltage detection system to IEC 61243-5 part 5 system HR.



Illustrated: FBX-E



Outgoing feeder cable with switch disconnecter, version C

The three-pole switching units are located in the gas-filled, clad compartment. The power from the external drive mechanisms is transmitted directly to the switching devices.

The three-position switch features a make-break snap-action mechanism for the switch disconnecter function and a separate snap-action making mechanism for the earth switch function.

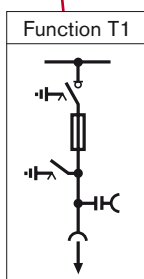
Transformer outgoing feeder with switch fuse combination, version T1

Switch fuse combinations comply with IEC 62271-105. The combination consists of a three-position switch disconnecter, gas-proof locating tubes for the HV HRC fuse links and additional earth switches on the cable connection end to ensure maximum operator safety.

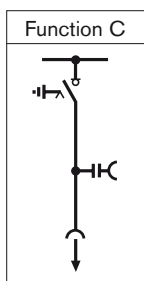
To facilitate replacement of the HV HRC fuses, earthing is always provided upstream and downstream of the fuses. The two earth switches are mechanically coupled and are operated via a single drive.

The switch disconnecter is equipped with a snap-action mechanism for making operations, and a stored-energy mechanism for breaking operations. The stored-energy mechanism is mechanically pre-charged to prepare for a breaking operation. If the striker of an HV HRC fuse link operates, the switch disconnecter is switched-off mechanically on all three poles. In addition, a breaking operation triggered by the tripping of any of the HV HRC fuse link strikers is displayed mechanically on the front operating panel. Breaking via a magnetic trip is also possible.

The Earth ON function is achieved via a separate drive with a snap-action making mechanism.



T1
Transformer outgoing feeder switch disconnecter fuse combination



C
Outgoing feeder cable with switch disconnecter



T1



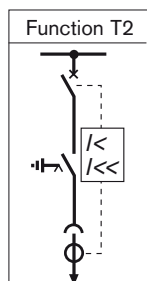
C

Illustrated: FBX-E

Transformer outgoing feeder with vacuum circuit-breaker, version T2

The transformer outgoing feeder with a vacuum circuit-breaker, version T2, can be used on applications where the load current is too high to use a switch fuse combination.

A typical application is the protection of distribution transformers and windpower stations up to $S = \sqrt{3} \times 400 \text{ A} \times 20 \text{ kV} = 13.8 \text{ MVA}$, or 6000 kVA (for 20 kV) when using a vacuum circuit breaker and a combination of three current transformers and a current transformer operated protection relay. Operation and tripping on faults does not require an additional auxiliary supply. The vacuum circuit-breaker, version T2, is also a cost-effective solution for the selective transfer at the medium-voltage point between a regional operating agency and a customer's switchgear.



T2
Transformer outgoing feeder with vacuum circuit-breaker (400/630 A)

The T2 transformer outgoing feeder consists of the three-pole switching units, a vacuum circuit-breaker located upstream of the three-position switch, and an integrated outgoing feeder switch on the cable end. The disconnecter is operated via the snap-action make/break mechanism. The make-proof earth switch is operated via a snap-action making mechanism.

Currents is detected via three toroidal-core current transformers. In the event of an external fault, the vacuum circuit-breaker is switched off via the current transformer actuated protection relay.

The drive functions of the vacuum circuit-breaker outgoing feeder T2 are identical in design to those of the switch fuse combination T1. The operating sequence when a motor-operated drive mechanism is provided is: 0 - 3 min - CO.

The vacuum circuit-breaker outgoing feeder has been designed with ratings of 400 A and 630 A. It is designed to switch 1000 times the rated normal current. 50 short-circuit breaking operations are possible up to a maximum fault rating of 20 kA.

The vacuum circuit-breaker features a snap-action making mechanism and a stored-energy breaking mechanism.

The stored-energy mechanism is mechanically pre-charged to ensure it is always ready for a breaking operation. Electrical breaking when tripped by a protection relay is effected via a dedicated transformer-operated release. The toroidal-core current transformer, the three-phase transformer-operated WIC1 protection relay¹⁾ and the magnetic trip for switching off the vacuum circuit-breaker all have matching functions.

For further details regarding the WIC1-2P protection relay, please refer to the separate documents for this relay.

¹⁾ standard equipment



Illustrated: FBX-E

Breaking due to tripping of a protection relay is indicated on the front operating panel.

For the transfer stations and outgoing cable feeders, units rated at 630 A and with a network master relay actuated by external voltage (UMZ [definite-time overcurrent protection] and AMZ [inverse-time overcurrent protection] characteristics) can be supplied on request.

Overview of adjustment ranges and functions

	Adjustment range	Steps	Function
I>	0.9 x - 2,5 x Is	0.05 x Is	
tI>	0.04 - 300 s	0.01 s	UMZ / DEFT
	0.05 - 10	0.05	NINV, VINV, EINV, RIINV, LINV, HV-Fuse, FR-Fuse
I>>	1 x - 20 x Is	0.1 x Is	UMZ / DEFT
tI>>	0.04 - 3 s	0.01 s	
IE>	0.2 - 2.5 x Is	0.05 x Is	
tIE>	0.1 - 300 s	0.01 s	UMZ / DEFT

WIC1 PROTECTION RELAY

Combining a compact protection relay and a toroidal-core current transformer, the WIC1 system was specifically developed for compact medium-voltage switchgear with integrated circuit-breakers.

The following protection functions are incorporated in the WIC1:

- > 3-phase definite-time overcurrent and short-circuit protection with variable tripping times
- > 3-phase overcurrent protection with selectable inverse time characteristics and definite-time short-circuit current element
- > Earth-fault protection
- > ANSI codes
 - 50/51
 - 50N/51N

In WIC1, the phase current is mapped by forming the arithmetic mean. The earth current is calculated from the three phase currents.

Protection characteristic of the WIC1-2P

- > Independent low and high set overcurrent element (DEFT)
- > IMT characteristics with independent short-circuit current element.
 - Normal Inverse (NINV)
 - Very Inverse (VINV)
 - Extremely Inverse (EINV)
 - Long Time Inverse (LINV)
 - RI-Inverse (RIINV)
 - Fuse characteristic of a HV HRC fuse (HV fuse)



Toroidal-core current transformer on outer cone-type cable bushings

- Fuse characteristic of a full range fuse (FR fuse)

With the protection system, a tripping time of just 40 ms can be achieved.

The minimum tripping time when switched on a fault varies with the fault current level.

With the type WIC 1-2P, setting of parameters is effected via DIP switches. The appropriate toroidal-core current transformers are wide-range current transformers whose data is matched to the protection relay WIC1 which is actuated by the transformer current. These wide-range current transformers are available in four versions.

Wide-range current transformer

WIC1-W2AR	WIC1-W3AR	WIC1-W4AR	WIC1-W5AR
16-56 A	32-112 A	64-224 A	128-448 A

OPERATION

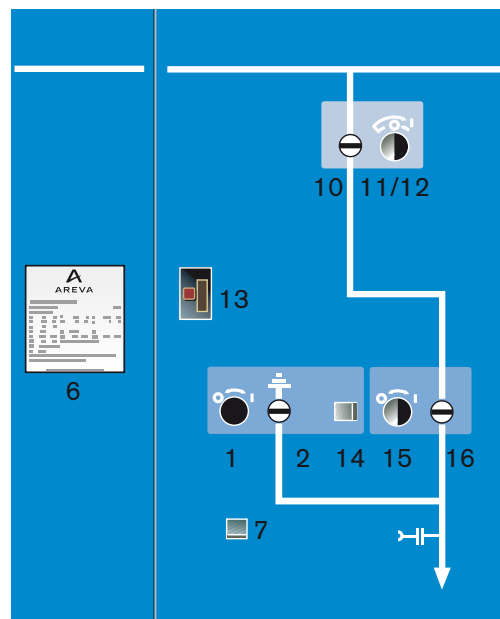
Operator interfaces

With its well-structured layout and clear integrated functional diagram, the operator interface is designed to ensure safe operation.

Each switching device is equipped with an access point for the operating lever and a mechanical position indicator. The two earth switches, located upstream and downstream of the HV HRC fuse carriers on the switch fuse combination T1, are actuated simultaneously via a common drive.

All actuator access points can be provided with a locking facility as an option.

As an option, both switch disconnectors and vacuum circuit-breakers can be fitted with a motor-drive. In this case, emergency manual mechanical actuation can be provided for the switching device drives.

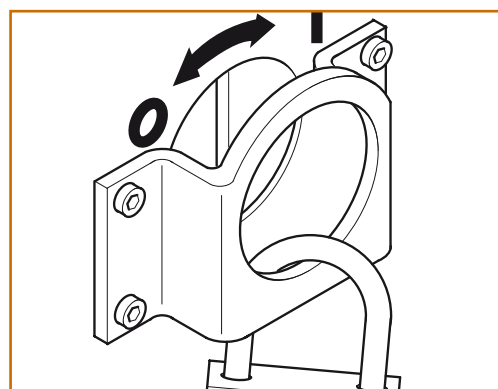


Transformer outgoing feeder with vacuum circuit-breaker T2

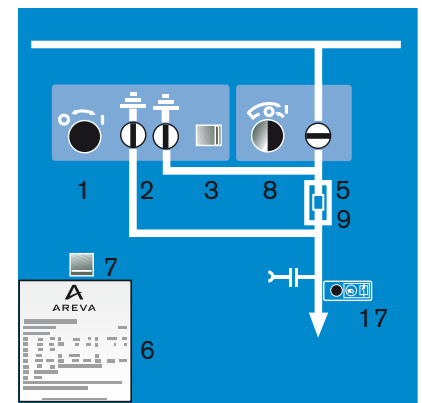
- 1 Opening for actuation of earth switch in outgoing feeder cable
- 2 Earth switch position indicator
- 3 Slide for interlocking lock, switch disconnector and earth switch
- 4 Opening for actuation of switch disconnector in outgoing feeder cable
- 5 Switch disconnector position indicator
- 6 Rating plate
- 7 Slide for interlocking lock, cable compartment cover
- 8 Opening for actuation of switch disconnector in transformer outgoing feeder
- 9 Fuse tripping indication
- 10 Vacuum circuit-breaker position indication
- 11 Opening for actuation of vacuum circuit-breaker in transformer outgoing feeder
- 12 Interlocking interlock, vacuum circuit-breaker and disconnector
- 13 Display for tripping of protection relay
- 14 Slide for interlocking lock, disconnector and earthing switch
- 15 Opening for actuation of disconnector in transformer outgoing feeder
- 16 Disconnector position indicator
- 17 Optional: Opening for manual emergency actuation of the motor drive for the switch disconnector (in this case, the actuating opening 8 or 4 is closed by the factory).

Closure of actuator access points

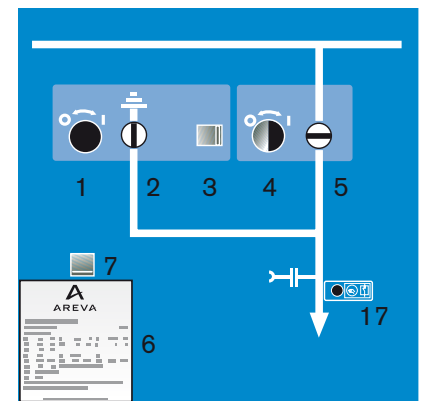
The access points for the detachable actuator operating levers can be closed and locked to prevent unauthorized operation (optional).



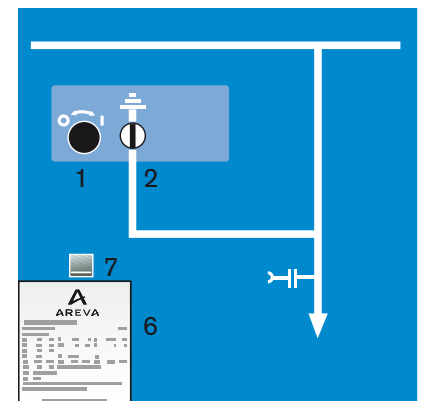
Closure of operating lever insertion opening



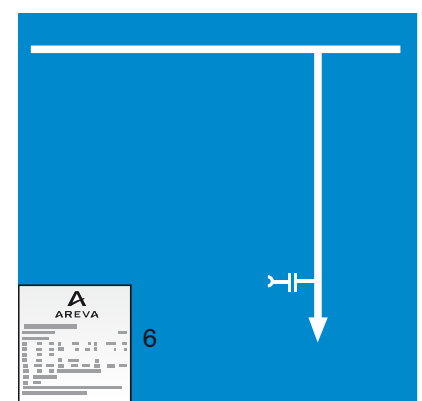
Switch fuse combination T1



Outgoing feeder with switch disconnector C



Busbar riser with earth switch RE



Busbar riser R

INTERLOCKING SYSTEM

In developing the FBX switchgear, operator safety and operating reliability were given top priority. A continuous interlocking system prevents incorrect operation. Thus, it is only possible to insert operating levers for the switching devices if the instantaneous operating state so permits. Access to the cable connection compartments and to the fuse links is only possible if the appropriate outgoing feeder is earthed.

Mechanical interlocks

Interrogator lock

The following interlocks are installed in the ring main units as a standard feature:

Functional unit with switch disconnecter and earth switch or with switch fuse combination

Switching device	Operating state	Interlock state versus...		
		Switch disconnecter	Earth switch	Cable compartment or fuse cover
Switch disconnecter	ON	–	locked	locked
	OFF	–	unlocked	locked if earth switch OFF
Earth switch	ON	locked	–	unlocked
	OFF	unlocked	–	locked
Cable compartment or fuse cover	removed	locked	locked	–
	inserted	unlocked if earth switch OFF	unlocked if switch disconnecter OFF	–

optional:

Switch disconnecter – cable compartment cover interlock, e.g. for cable testing (refer to operating instructions!).

Functional unit with vacuum circuit-breaker, disconnecter and earth switch

Switching device	Operating state	Interlock state versus...			
		Circuit-breaker	Disconnecter	Earth switch	Cable compartment or fuse cover
Circuit-breaker	ON	–	locked	unlocked	unlocked
				locked if disconnecter ON	locked
	OFF	–	locked if earth switch ON	unlocked if disconnecter OFF	unlocked if earth switch ON
			unlocked if earth switch OFF	locked if disconnecter ON	locked
Disconnecter	ON	unlocked	–	locked	locked
	OFF	unlocked	–	unlocked	locked if earth switch OFF
Earth switch	ON	unlocked	locked	–	unlocked
	OFF	unlocked	unlocked	–	locked
Cable compartment cover	removed	unlocked	locked	locked	–
	inserted	unlocked	locked	unlocked	–

MOTOR DRIVE FOR SWITCH DISCONNECTOR AND VACUUM CIRCUIT-BREAKER

Motor drive for switch disconnecter and vacuum circuit-breaker

The "switch disconnecter ON-OFF" function in the outgoing cable feeder, C, and in the switch fuse combination, T1, can be fitted with a motor drive as an option. The vacuum circuit-breaker in the transformer outgoing feeder, T2, can also be designed with motor-actuation on request. The snap-action make-break

mechanism (SFU) or the snap-action make and stored-energy break mechanism (SF) are mechanically coupled directly to the motor drive. The motor drive is installed in the drive recess outside of the gas-filled, clad compartment, behind the operator interface.

The standard opening for manual operation of the actuator is closed if the switchgear features a motor drive. An operating handle is supplied for emergency manual opening of the actuator in the event of failure of the motor or the motor supply.

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

Rated supply voltage		VDC						VAC		
		24	48	60	110	125	220	100/110	120/125	230
Starting current	[A]	13.3	12.1	8.4	4.7	4.1	2.5	6.9	6.8	3.7
Normal current	[A]	5.5	2.8	2.2	1.2	1.1	0.6	2.3	2.2	1.2
Motor operating time in case of SFU drive for ON (making) and OFF (breaking) < 3 sec										

Magnetic shunt opening releases

To enable the outgoing transformer feeders with switch fuse combination, version T1, or with vacuum circuit-breaker, version T2, to be switched off electrically, an additional magnetic shunt opening release is

available. Independently of the existing manual or motor-actuation of the making snap-action mechanism/breaking stored-energy mechanism (SF), this magnetic release acts directly on the mechanically pre-charged breaking stored-energy mechanism.

When the WIC1-2P protection relay is used in the outgoing feeder T2, the magnetic release in the feeder can be tripped remotely via a separate pulse input of 230 VAC or 115 VDC within a maximum of 1 second. A second magnetic release on the outgoing feeder T2 available on request.

Power consumption for solenoid of the shunt opening release (SF drive mechanism)

Rated supply voltage		VDC						VAC		
		24	48	60	110	125	220	100/110	120/125	230
Coil current	[A]	6.3	3.2	2.6	1.3	1.2	0.7	1	0.9	0.5

Note:

The values specified for the current consumption are "mean values" which can be used for calculating the supply rating. The actual values may be higher or lower.

Auxiliary switch

All switching devices of the FBX switchgear can be equipped additionally with multi-pole auxiliary switches. 2- or 4-pole auxiliary switches are available on the switch discon-

nectors, vacuum circuit-breakers and disconnectors. The earthing switches can be equipped with 2-pole auxiliary switches. The auxiliary switches can be re-set subsequently as NC contacts, NO contacts or pulse contacts via adjustable cams.

The three-pole HV HRC fuse carrier in the switch fuse combination T1 can be equipped additionally with a two-pole push switch for electrical signalling of "fuse tripped".

Auxiliary switch

Rated supply voltage		VDC					VAC	
		24	48	60	110	120	120	230
Switching capacity	[A]	8	4	3	2	1	10	10
Rated short-time current		100 A for a duration of 30 ms						
Time factor T=L/R	[ms]	≤ 20					–	
Rated continuous current	[A]	10						

In the event of an order being placed, we will provide connection and wiring diagrams for motor-drive mechanisms, magnetic releases and auxiliary switches.

IN-LINE ARRANGEMENT FBX-E

FBX-E offers highly flexible in-line configurations of switchgear for secondary distribution applications. Functional units comprising up to four switching units can be lined up in any order. In-line connection is possible on both sides.

Local assembly and in-line connection of FBX-E does not require gas handling.

In-line connection is a very straightforward process due to

- the F-link busbar couplers on the medium-voltage end.

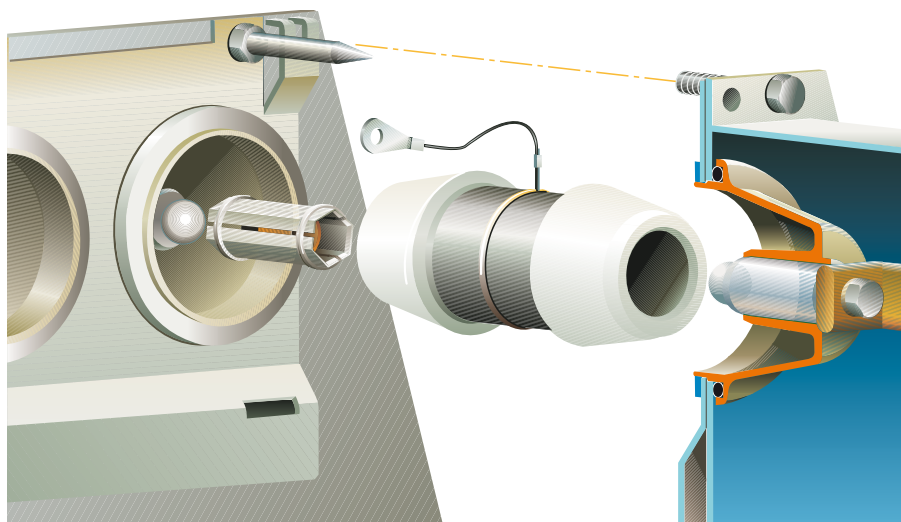
Variations between adjacent panels are compensated by spherical fixed contacts and movable couplers allowing adjustment in all axial directions;

- very safe dielectric seals with potential-controlled silicone deflectors externally earthed and adjustable to fit.

These are a press-fit on to the in-line assembly, using a specified force. Potential-controlled blanking plugs, with a design based on the the F-link silicon deflectors, are located at the switchgear ends.

These blanking plugs are held in position, at the press-fitting force, by a common metal cover:

- integrated guide pins for alignment of adjacent panels in a defined position;
- panel screw couplings with clearly fixed stoppers for the distances between adjacent panels;
- a wall clearance of at least 180 mm is required for replacement or alignment of one or more functional units.



In-line connection of FBX-E

Extensible design FBX-E: additional space required on either side > 180 mm required (as clearance to the building wall) for extension/s on the switchgear side/s.

VOLTAGE DETECTION SYSTEM

A high-resistance (HR) voltage detection system (not integrated) to IEC 61243-5 and EN 61243-5, is used to check zero voltage of the outgoing feeders. The multi-way connectors for the voltage indicators are located in the secondary systems recess. The indicators supplied as standard are VDS systems (Horstmann).

Optionally, the IVIS integrated Voltage Detecting System with integrated indicator can be used to check zero voltage. Logic flash arrow symbols on the indicators display if a mains voltage within the defined response thresholds is present. The IVIS system does not require the electrical repeat tests for voltage detection systems.

The IVIS system has been designed for maximum operating reliability. It does not require a supply from an external source. It features climate-proof encapsulated electronics and is maintenance-free, because of the permanent monitoring of indication thresholds.

Phase coincidence is established via integrated, hermetically shielded measuring bushings using a phase monitor.

IVIS satisfies the requirements of IEC 61243-5 and EN 61243-5 for integrated voltage detection system.

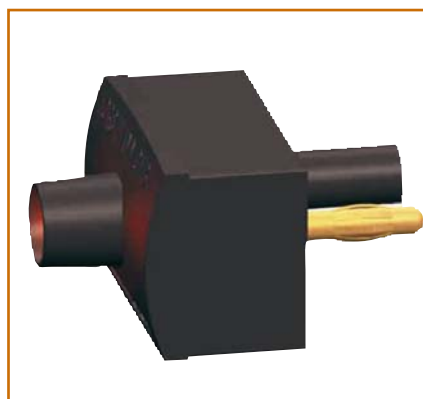
Short-circuit indicator

As an option, the outgoing cable feeders, C, can be equipped with short-circuit indicators, types Alpha M or E, optional F or Gamma manufactured by Dipl.-Ing. H. Horstmann GmbH. Other brands are available on request.

The short-circuit indicators can be set as follows, depending on the type concerned:

- > Response values:
400 / 600 / 800 / 1000 A
- > Manual reset
- > Automatic reset after 2 or 4 hours
- > Remote signalling contact
- > Earth-fault detection

The magnet yokes acting as sensors for the Horstmann short-circuit indicators are installed on the outer cone-type cable bushings. Retrofitting of short-circuit indicator units is possible at any time.



Horstmann indicator

GAS COMPARTMENT TECHNOLOGY

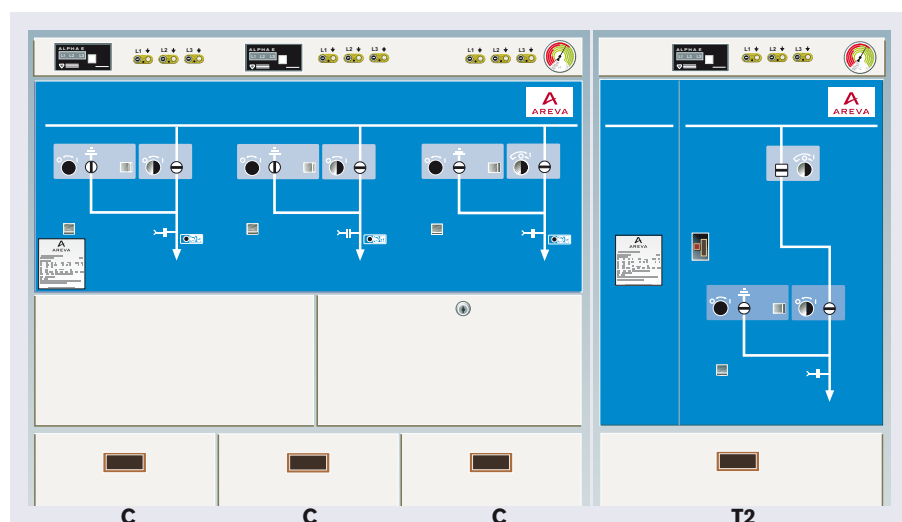
The switching units are installed in gas-filled tanks made of corrosion proof chromium-nickel steel. SF₆ is used as the insulating and quenching medium. FBX is a sealed pressure system to IEC 60694. During the service life of the switchgear, it is not necessary to replenish the SF₆ gas. The gas pressure is indicated via a pressure gauge.

In the event of excess pressure, the gas-filled, clad compartment discharges downwards via a pressure relief device, to prevent any hot gases from venting directly on to the cable end boxes.



Pressure gauge

Example: Secondary system display panel



Switchgear example FBX-E: C-C-C-T2

INTEGRATED PACKAGE SOLUTIONS FOR AUTO- MATION

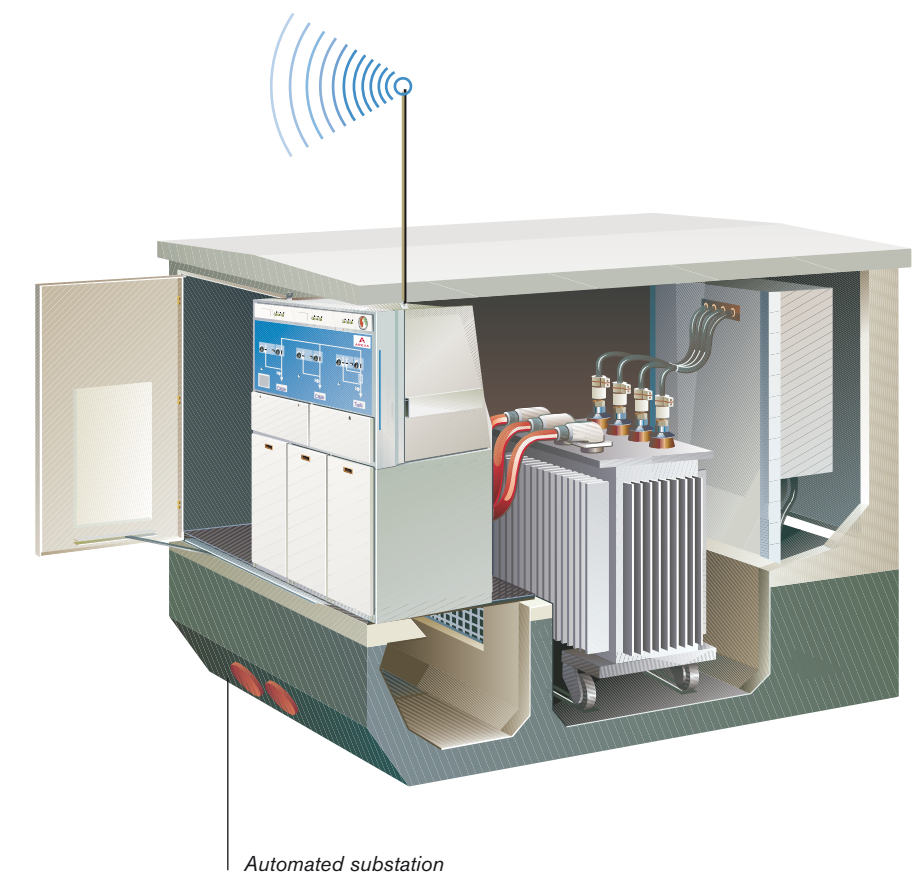
In the secondary distribution sector, automation of medium-voltage switchgear is becoming more common.

Transformer stations in the vicinity of major consumers, stations in remote locations and important switching substations benefit from remote signalling of information and remote control.

To satisfy these requirements, we can offer FBX, with automation solutions integrated in the standard size. Project stages 1 and 2 are basic variants. Project stage 3 includes coupling relays, control contactors, local/remote change-over switches and miniature circuit-breakers.

Further integrated project stages with a “mini RTU” are available on request. This tele-control system with modem allows the ring main unit to be controlled and monitored via communication systems such as telephone networks, fibre optics or a GSM network.

Further documents regarding the project stages for remote signalling (AB1), remote signalling plus remote control (AB2) and remote signalling plus remote control including the drive package (AB3) can be provided on request.



conventional		
remote signalling	remote signalling & remote control	remote signalling & remote control incl. drive package
AB 1	AB 2	AB 3

AB = project stage

CABLE CONNECTIONS

The amply designed cable connection area enables installation of different cable connection systems.

The cable connection compartment has been designed to accept

- > fully insulated
- > metal-enclosed
- or
- > partially insulated connection systems.

Installation of 2 x 3 cable screw-type plugs or 3 x cable screw-type plugs plus 3 surge arresters is possible for outgoing feeder cables, type C, and busbar risers types R and RE within the normal cable connection compartment.

The switchgear has been equipped as standard with outer cone-type appliance coupler systems:

Outgoing feeder cable with switch disconnector C, transformer outgoing feeder with vacuum circuit-breaker T2, busbar riser R and busbar risers with earth switch RE:

Appliance couplers 630A, connection type C, to EN 50181.

Transformer outgoing feeders with switch fuse combination T1:

Appliance couplers 250A, connection type A, to EN 50181. The Tables on pages 28/29 include a selection of common connection systems.

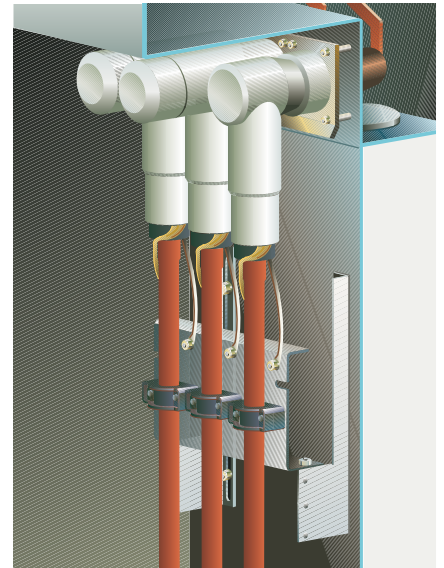
The installation depths in the cable connection compartment are intended for variants:

C, R, RE	450 mm
T2	300 mm.

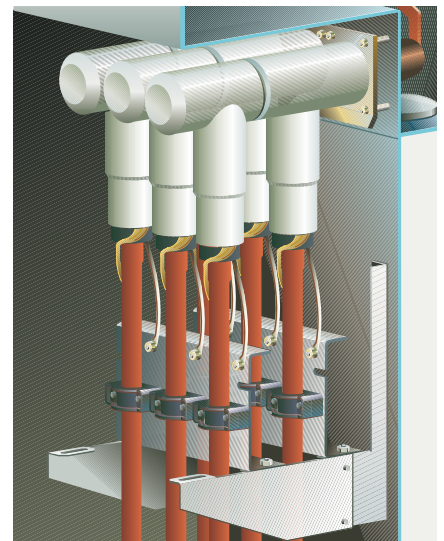
The cables are connected to the outer cone-type connectors via 630 A Tee screw-type plugs and, in the case of transformer outgoing feeders T1, with 250 A right-angle plugs.

All three outer cone-type bushings are arranged side by side on the front of each outgoing feeder. If phase-change of the cables is required, this is no problem and can be achieved within one outgoing feeder unit. Horizontally and vertically adjustable cable supports enable a great variety of cable systems to be fixed. The cable supports feature round or oblong holes to accommodate commonly used cable clips.

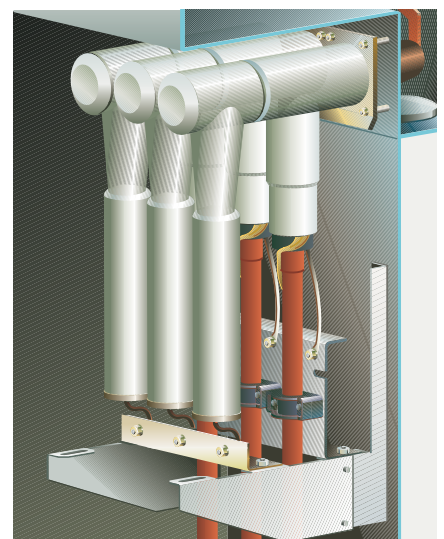
Additional supporting structures can be provided as an option for 1380 mm high switchgear, for the installation of double cable connections or surge arresters.



Single cable connection



*Double cable connection
(1380 mm high switchgear only)*



*Surge arresters
(1380 mm high switchgear only)*

Plastic-insulated cable – single connection for switch disconnector C, transformer outgoing feeder with vacuum circuit-breaker T2, Busbar riser R and RE

Appliance couplers 630A, outer cone-type to EN 50181, connection type C, screw-type contact with internal thread M16x2.

Examples

updated 04.02.2005

Cable type	Manufacturer		12 kV		24 kV	
Plastic-insulated cable		Rated current	Connector type	for cross-section mm ²	Connector type	for cross-section mm ²
Fully insulated technology	EUROMOLD	630	400LR	25 - 300	K400LR	25 - 300
	EUROMOLD	630	AGT 10/630	95 - 240	AGT 20/630	25 - 240
	EUROMOLD	630	400LB/G	35 - 300	K400LB/G	25 - 300
	EUROMOLD	630	430TB	35 - 300	430TB	35 - 300
	EUROMOLD	630	400TB/G	35 - 300	K400TB/G	35 - 300
	Raychem	630	RSTI-L56xx	25 - 300 ¹⁾	RSTI-L56xx	25 - 300 ¹⁾
	nkt	630	CB 12/630	25 - 300 ¹⁾	CB 24/630	25 - 300 ¹⁾
	Südkabel	630	SET 12	50 - 300	SET 24	25 - 240
			SEHDT 13	400 - 500	SEHDT 23	300 - 500
Partially insulated technology	nkt	630	AB 12/630	25 - 300	AB24/630	25 - 300
	Raychem	400/630	RICS-51xx with cable end box IXSU-F for single-conductor cable	25 - 300	RICS-51xx with cable end box IXSU-F for single-conductor cable	25 - 300
		400/630	RICS-51xx with cable end box IXSU-F for three-conductor cable	25 - 300	RICS-51xx with cable end box IXSU-F for three-conductor cable	25 - 300
Earth cable						
Partially insulated technology	Raychem	400/630	RICS-51xx with cable end box UHGK for belted cables	16 - 300		
			RICS-51xx with cable end box IDST-51xx for paper-insulated single- and three-conductor cables	50 - 300	RICS-51xx with cable end box IDST-51xx for paper-insulated single- and three-conductor cables	35 - 240

¹⁾ Cross sections 300-500 mm² on request

Comply with the manufacturers' technical details and instructions for assembly.

SELECTION TABLES FOR CABLE CONNECTIONS

Transformer outgoing feeder T1 (250 A)

Appliance couplers 250 A, outer cone-type to EN 50181, connection type A, with pin contact Ø 7.9

Examples

updated 04.02.2005

Cable type	Manufacturer	12 kV		24 kV	
Plastic-insulated cable		Connector Type	for cross-section mm ²	Connector Type	for cross-section mm ²
Fully insulated technology	EUROMOLD	158LR	16 - 120 ¹⁾	K158LR	16 - 120 ¹⁾
	EUROMOLD	158LR+MC3-158LR-R02	16 - 120 ¹⁾	K158LR+MC3-158LR-R02	16 - 120 ¹⁾
	EUROMOLD	AGW 10/250	25 - 95	AGW 20/250	25 - 95
	EUROMOLD	AGWL 10/250	25 - 95	AGWL 20/250	25 - 95
	nkt	EASW 20/250	25 - 95	EASW 20/250	25 - 95
	nkt	EASW 20/250	25 - 95	EASW 20/250	25 - 95
	Raychem	RSES-52xx-R	25 - 120	RSES-52xx-R	16 - 120
	Südkabel	SEW 12	25 - 150	SEW 24	25 - 95

Comply with the manufacturers' technical details and instructions for assembly.

¹⁾ 150 mm² on request

Plastic-insulated cables – double connection for outgoing feeder cable with switch disconnector C, Busbar riser R and RE

Appliance couplers 630 A, outer cone-type to EN 50181, connection type C, screw-type contact with internal thread M16x2.

Examples

updated 04.02.2005

Cable type	Manufacturer		12 kV		24 kV	
Plastic-insulated cable		Rated current	Connector Type	for cross-section mm ²	Connector Type	for cross-section mm ²
Fully insulated technology	EUROMOLD	630	AGT 10/630 + CP AGT + AGT 10/630	95 - 240	AGT 20/630 + CP AGT + AGT 20/630	25 - 240
	EUROMOLD	630	AGTL 10/630 + CP AGT + AGTL 10/630	95 - 240	AGTL 20/630 + CP AGT + AGTL 20/630	95 - 240
	EUROMOLD	630	430 TB + 300 PB	35 - 300	430 TB + 300 PB	35 - 300
	Raychem	630	RSTI-L 56xx + RSTI-CC-L 56xx	25 - 300	RSTI-L 56xx + RSTI-CC-L 56xx	25 - 300
	nkt	630	CB 12/630 + CC 12/630	25 - 300	CB 12/630 + CC 12/630	25 - 300
	Südkabel	630	2x SET 12 + KV 23.2	50 - 300	2x SET 24 + KV 23.2	25 - 240
Partially insulated technology	nkt	630	AB 12/630 + AC 12/630	25 - 300	AB 12/630 + AC 12/630	25 - 300

The second cable support must be specified in the FBX order.

Installation of a surge arrester instead of a 2nd cable connector is possible. Appropriate metal supports available on request.

Comply with the manufacturers' technical details and instructions for assembly.

Plastic dual cable for outgoing transformer feeder T2

Appliance couplers 630 A, outer cone-type to EN 50181, connection type C, screw-type contact with internal thread M16x2.

Examples

updated 04.02.2005

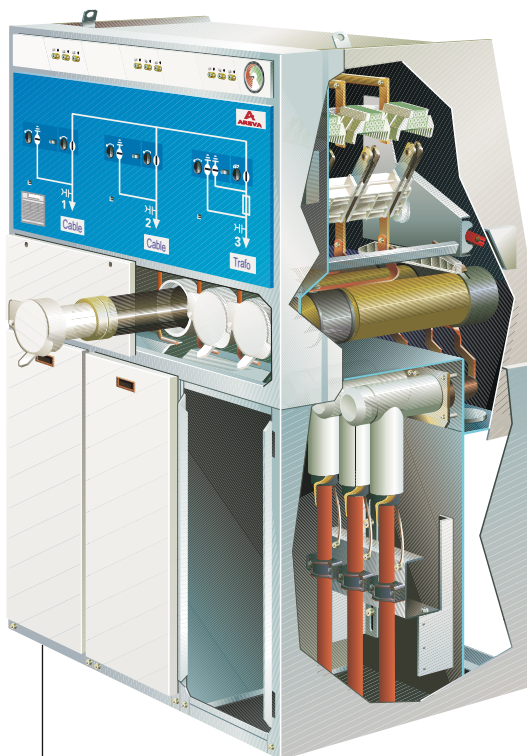
Cable type	Manufacturer		12 kV		24 kV	
Plastic-insulated cable		Rated current	Connector Type	for cross-section mm ²	Connector Type	for cross-section mm ²
	EUROMOLD	630	430 TB + 300 PB	35 - 300	430 TB + 300 PB	35 - 300
	Raychem	630	RSTI-L 56xx + RSTI-CC-L 56xx	25 - 300	RSTI-L 56xx + RSTI-CC-L 56xx	25 - 300
	nkt	630	CB 12/630 + CC 12/630	25 - 300	CB 12/630 + CC 12/630	25 - 300

HIGH-VOLTAGE FUSE LINKS

The fuse links are located in insulating tubes in normal atmosphere. The fuse locating tubes are integrated in the hermetically sealed, gas-filled, clad compartment as required by the system, which offers the following benefits:

- > The electrical field is contained within the SF₆ atmosphere.
- > The grip end of the fuse is located in the field intensity “shadow”.
- > The area within the gas-filled, clad compartment is completely protected.
- > The grip end area is insensitive – in particular, the closed grip end is not used to ensure electric tightness (insulating arrangement).

Option available: water-proof design of the fuse locating tubes and grip ends.



FBX with fuse links

Fuse tripping

The stored-energy mechanism and the tripping linkage ensure that all three conductors of the switch fuse combination are switched off when tripped by the fuse striker. If the striker of only one HV HRC fuse link operates, all-pole breaking is effected mechanically.



It is recommended that all three fuse links are replaced at the same time

Replacement of fuses

The interrogation interlock ensures maximum operator safety on fuse replacement. The fuse cover can only be opened if correct earthing has been carried out. Conversely, the earthing can only be reset after the fuse cover has been closed and locked.

Two make-proof earth switches (upstream and downstream of the fuse links) enable the fuses to be replaced without the use of auxiliary equipment. Both earth switches are make-proof and are switched via a common snap-action making mechanism.



Do not twist the grip surfaces



Removal of the fuse link

SELECTION OF HV HRC FUSE LINKS

1. HV HRC fuse links

This project document gives the recommendations of the switchgear manufacturer, as required by the applicable Standards. The specified data enables the user to choose suitable HV HRC fuse links.

Types of HV HRC fuse links

To protect distribution transformers, we recommend the use of HV HRC backup fuses with integrated thermal cut-outs for gas-insulated FBX switchgear, according to the selection tables on page 33.

The thermal cut-out of the HV HRC fuses will operate:

- > in the event of overload currents,
 - > in the event of fuse link damage by previous transients,
- causing a shut-off by the switch-disconnector.

This prevents thermal overloading of the fuse locating tubes.

Ordering data

The following data must be specified in the Purchase Order:

- > Transformer rated power
- > Transformer service voltage
- > Rated current of the selected HV HRC fuses.

Technical data

The technical data on page 33 has been prepared for normal application of switchgear units and takes account of all appropriate standards.

These standards are:

- > Protection of distribution transformers according to IEC 60787, Transformer connection symbol Dy5
- > Fuse links acc. to IEC 60282-1
- > Specifications of IEC 62271-105
- > Max. ambient temperature for switchgear: 40 °C to IEC 60694, and also for switchgear within the housing of a packaged substation, to IEC 61330.

No transformer operation during overload.

LV HRC fuse links gTr to VDE 0636, Part 2011, can be selected as an alternative to the HV HRC fuse links.

The HV HRC fuse links can carry 1.3 times the transformer rated current for a minimum of 10 hours. Shut-off is effected at 1.5 times the transformer rated current within two hours.

High ambient temperature

The selection tables are also valid for a max. ambient temperature of 50 °C, e.g. for the switchgear within the housing of a packaged substation according to IEC 61330, DIN EN 61330, for very hot climate conditions.

Temperature-rise limits

The selection tables take into account the temperature-rise limits within the switchgear enclosure.

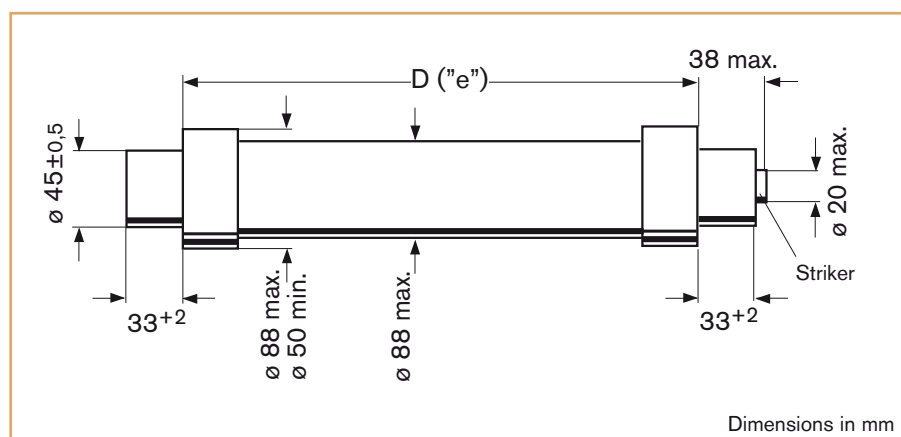
2. HV HRC fuse links Selection data

Back-up fuse links

Fuse links must correspond with:

- > IEC Publication 60282-1 with dimensions according to data sheet I (design I)
- > striker type "medium" with maximum initial tripping force of 80 N.

HV HRC fuse link, dimensions



When using back-up fuses without integrated, temperature-limiting striker pin release, the following requirements must be met:

- > In the event of overload currents, shut-off must be effected by the LV HRC fuse links, as indicated on page 12.
- > In case of switchgear installed in an exposed location, where fuse links may be subject to damage caused by transient events (for example lightning strikes), it should be ensured that all fuse links are changed at appropriate maintenance intervals.

If these requirements are not satisfied, only HV HRC backup fuse links with integrated striker tripping and cut-out feature must be used in the gas-insulated FBX switchgear to protect the switchgear against thermal overload.

The following types of HV HRC fuse links with integrated striker tripping and thermal cut-out feature are acceptable:

Series	Supplier
HV HRC backup fuses with thermal cut-outs	AREVA
HV HRC fuse links with thermal cut-outs	SIBA
HV HRC backup fuses with overload release (thermal cut-outs)	EFEN
HV HRC fuse links type IKUS, with thermo-striker	JEAN MÜLLER

Length of fuse links

FBX switchgear is designed to accommodate fuselink lengths of "D" or "e" as follows:

Type designation	Fuse length "D" or "e" in mm
FBX./12./... with adapter for mechanical extension to 442 mm	292
FBX./17./...	442
FBX./24./...	442

General-purpose fuses

General-purpose fuses are recommended for the exceptional case in which the switch disconnecter is to be equipped with an SFU ON/OFF snap-action drive (instead of an SF stored energy mechanism), when all-pole fuse tripping is not possible.

**Selection table for HV HRC back-up fuses FDwT (AREVA T&D)
with integrated thermal cut-out**

Rated voltage of transformer kV	Rated voltage of HV HRC fuse link kV	Length D (“e”) of HV HRC fuse link mm	Type of switch-gear	Transformer rated voltage in kVA						
				250	315	400	500	630	800	1000
				uk = 4 %				uk = 6 %		
				Maximum permissible short-circuit duration = 2s						
				Rated normal current in A of HV HRC fuse links						
6	7.2	292 with adapter 24 kV	FBX, 12 kV	50	–	–	–	–	–	–
10	12	292 with adapter 24 kV	FBX, 12 kV	31.5	40	50	–	–	–	–
15	17.5	442	FBX, 24 kV	25	31.5	31.5	40	50	–	–
20	24	442	FBX, 24 kV	16	25	25	31.5	40	–	–
		LV HRC fuse link		Rated power in kVA (of the transformer to be protected)						
0.4	0.4/0.5	NH-gTr	kVA (A)	250 (361)	315 (455)	400 (577)	500 (722)	630 (909)	– –	– –

Rated short-circuit voltage uk and maximum admissible duration of short-circuit according to IEC 60076-5 and EN 60076-5.
This selection table must be used at ambient temperatures < +50 °C, without overload.

(...) = Rated current in A

**Selection table for HV HRC backup fuses (SIBA)
with integrated thermal cut-out**

Rated voltage of transformer	Rated voltage of HV HRC fuse link	Length D (“e”) of HV HRC fuse link	Type of switch-gear	Transformer rated voltage in kVA						
				250	315	400	500	630	800	1000 ¹⁾
				uk = 4 %				uk = 6 %		
				Maximum permissible short-circuit duration = 2s						
				Rated normal current in A of HV HRC fuse links						
kV	kV	mm								
6	6/12	292 with adapter 24 kV	FBX, 12 kV	50	63	80	100 SSK	–	–	–
10	6/12	292 with adapter 24 kV	FBX, 12 kV	31.5	40	50	63	80	100 SSK	–
15	10/24	442	FBX, 24 kV	25	31.5	31.5	40	50	63	–
20	10/24	442	FBX, 24 kV	16	25	25	31.5	40	63	63
		LV HRC fuse link		Rated power in kVA (of the transformer to be protected)						
0.4	0.4/0.5	NH-gTr	kVA (A)	250 (361)	315 (455)	400 (577)	500 (722)	630 (909)	800 (1155)	1000 (1443)

¹⁾ 1250 kVA for 20 kV at 80 A and higher ratings for 10-20 kV available on request (time delay required for mechanical tripping).

Rated short-circuit voltage and maximum permissible duration of short-circuit according to IEC 60076-5 and DIN EN 60076-5.
This selection table must be used at ambient temperatures < +50 °C, without overload.

(...) = Rated current in A



Ecological considerations

The switchgear satisfies to a high degree the ecological requirements in respect of environmental protection thanks to

- > optimization of material and energy consumption during manufacture
- > compliance with all ecological requirements during its service life
- > the use of recyclable materials for efficient disposal at the end of its service life.

Our design directive regarding environmentally compatible design specifies the use of materials which can be dismantled and are easily recyclable. The metals which form approximately 90 % of the switchgear are easily recyclable. They can be 100 % recycled as new metal components at the end of their service life.

Plastics can also be recycled. The thermosetting plastics can be fragmented and re-used as fillers in other plastic components; the thermoplastic materials can be recycled in new plastic components. This means that the material is recovered, processed and re-used in the manufacture of new parts.

To ensure efficient and environmentally friendly dismantling and sorting of materials by responsible disposal experts, all plastic components are identified accordingly. Moreover, material and utilization data sheets are available to provide the customer with an overview about the materials used, and the disposal company with important information regarding the recycling process.

Thus, the materials used for our products can be 100 % recycled.

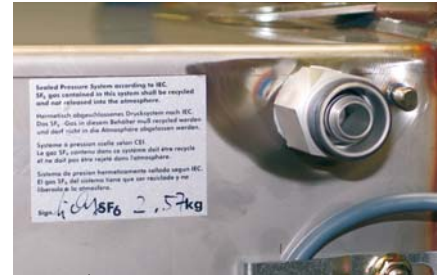
This provides a vital contribution to savings in global primary energy and material resources.

All materials were selected and developed so that, for example, switchgear affected by a fire in a building would have a minimal effect on the fire load (heat development and pollutants in the emissions).

Another important ecological aspect is the longevity of our products (approx. 30 years), which is an extremely long service life compared to other capital goods. Also, the FBX switchgear units have been designed to require little maintenance, giving further energy and material savings, and to enable straightforward replacement of component parts, e.g. if new controllers have been developed (upgrading).

The high-voltage conducting parts of our gas-insulated switchgear units are hermetically sealed in an insulating inert gas (sulphur hexafluoride SF_6 which is neither reactive nor toxic). Thus, all environmental influences which could reduce the service life are kept outside. The particular characteristic of the insulating gas also enables the overall size to be decreased by approximately 30 % compared to switchgear without insulating gas designed with equivalent technical characteristics. This again saves on material and saves on the energy required to produce the material.

The amount of insulating gas used in GMA is approx. 0.5 % of the total weight of the switchgear. Once the switchgear's service life has ended, the gas can be completely extracted via the disposal valve provided in each gas-filled compartment, and then recycled. To this end, the gas suppliers have developed an efficient recycling method.



Disposal valve



SF_6 leakage test

In normal operation, the gas need never be replenished during the entire service life. The switchgear has been designed as a hermetically sealed pressure system according to IEC 60694 and EN 60694.

Average material distribution in gas-insulated switchgear

Materials		Percent by weight
Metals	Steel	80
	Copper	6.5
	Aluminium, Brass	2
Plastics	Thermosetting plastics	7
	Thermoplastics	2
	Elastomers	0.5
Electronics	Plastics	0.5
	Metals	1
Insulating	Sulphur hexafluoride	0.5

Metering Panel

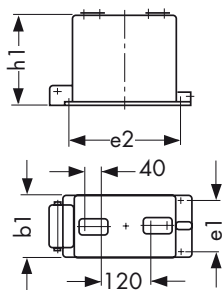
METERING PANEL

Current and voltage transformers designed to DIN 42600 (slim design) must be used in the metering panels.

Instrument transformer to DIN 42600

slim design

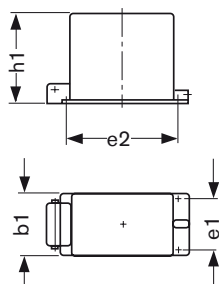
Current transformer (C)
(DIN 42600, part 8)



U_m in kV:

Dimension	12 kV	24 kV
b1	148	178
e1	125	150
e2	270	280
h1	220	280

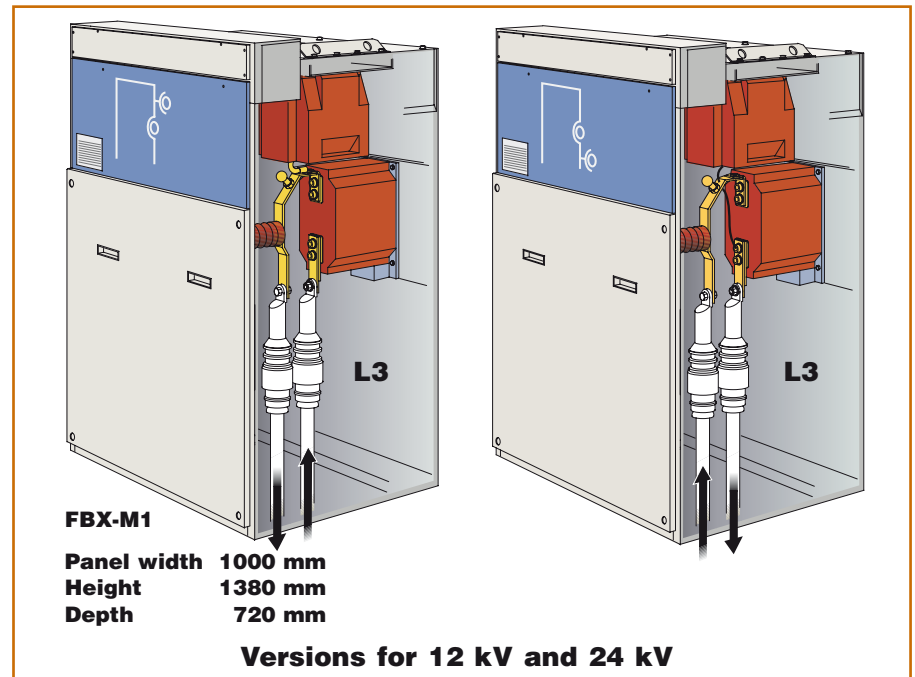
Single-pole voltage transformer (W)
(DIN 42600, part 9)



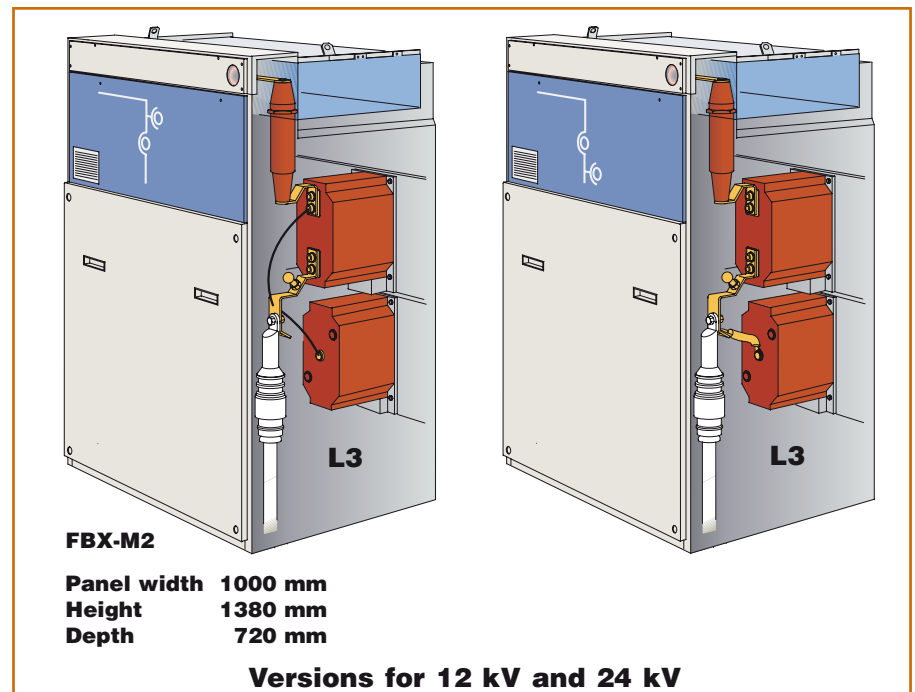
U_m in kV:

Dimension	12 kV	24 kV
b1	148	178
e1	125	150
e2	270	280
h1	220	280

Air-insulated metering panel M1



Air-insulated metering panel M2



M1 to M4 versions: The electrical order of current and voltage transformers can be changed by means of the voltage transformer connection cable terminals.

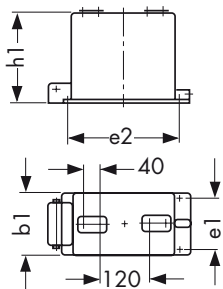
Options available:

- Bottom area tightly closed. In case of M1, M2 and M3 with rubber sleeves as cable bushings.
- Bottom area closed, however with pressure relief flaps.

Instrument transformer to DIN 42600

slim design

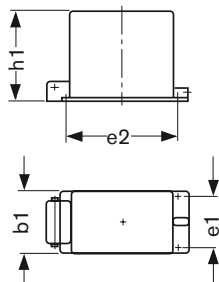
Current transformer (C)
(DIN 42600, part 8)



U_m in kV:

Dimension	12 kV	24 kV
b1	148	178
e1	125	150
e2	270	280
h1	220	280

Single-pole voltage transformer (W)
(DIN 42600, part 9)



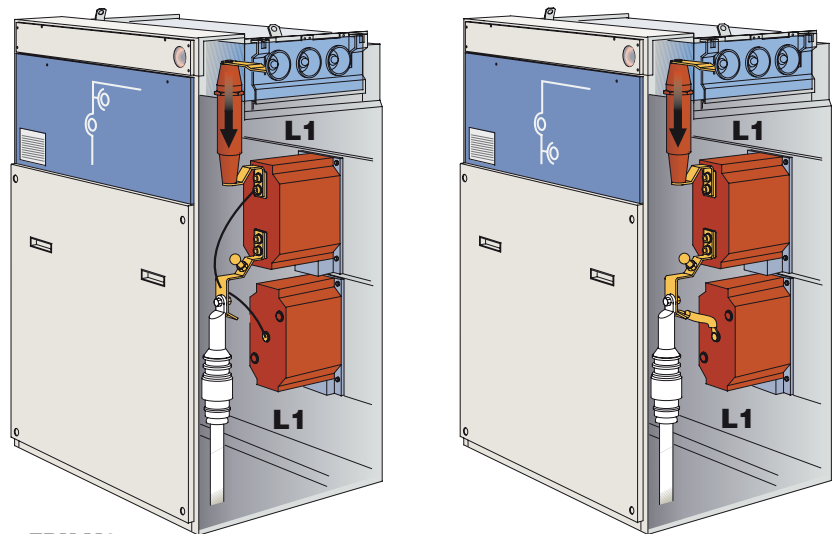
U_m in kV:

Dimension	12 kV	24 kV
b1	148	178
e1	125	150
e2	270	280
h1	220	280

Note:

- Installation of current and voltage measuring devices with or without change-over switch possible, if applicable with voltage indicator for the metering panels.
- Pre-assembled cable connections can be purchased as an option from the switchgear manufacturer.

Air-insulated metering panel M3



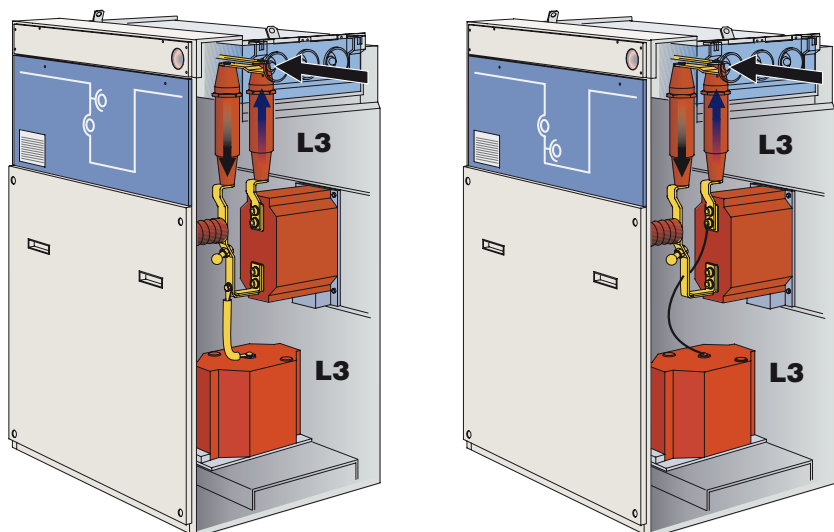
FBX-M3

Panel width 1000 mm
Height 1380 mm
Depth 720 mm

Versions for 12 kV and 24 kV

In metering panel M3: line sequence from left to right L3-L2-L1

Air-insulated metering panel M4



FBX-M4

Panel width 1000 mm
Height 1380 mm
Depth 720 mm

Versions for 12 kV and 24 kV

M1 to M4 versions: The electrical sequence of current and voltage transformers can be changed by means of the voltage transformer connection cable terminals.

Options available:

- Bottom area completely closed. In the case of M1, M2 and M3 with rubber sleeves as cable bushings.
- Bottom area closed, but with pressure relief flaps.

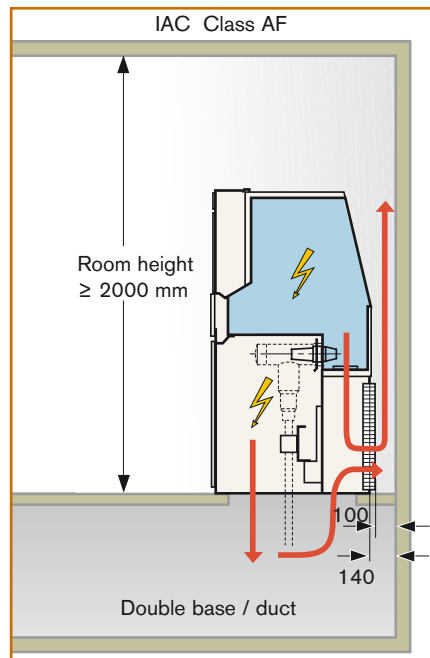


Design data

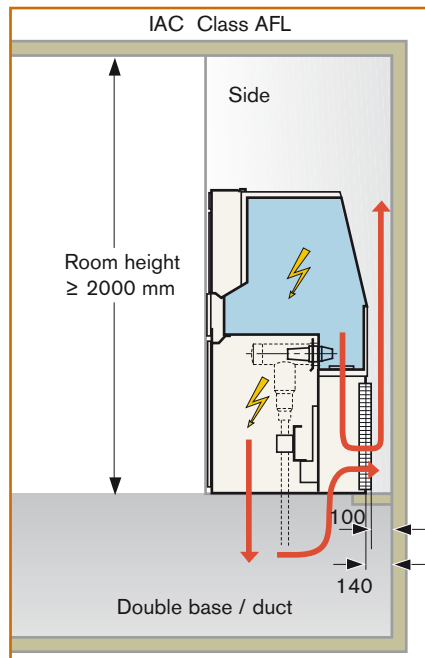
Pressure relief device, fastening and flooring ducts

PRESSURE RELIEF DEVICE

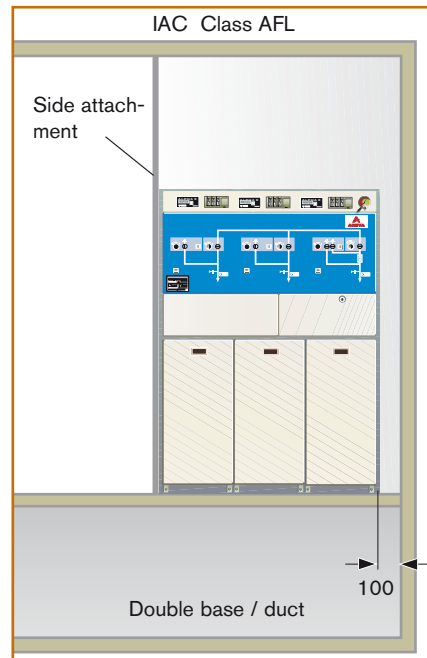
Installation examples for walk-in stations(IAC classification acc. to IEC 62271-200)



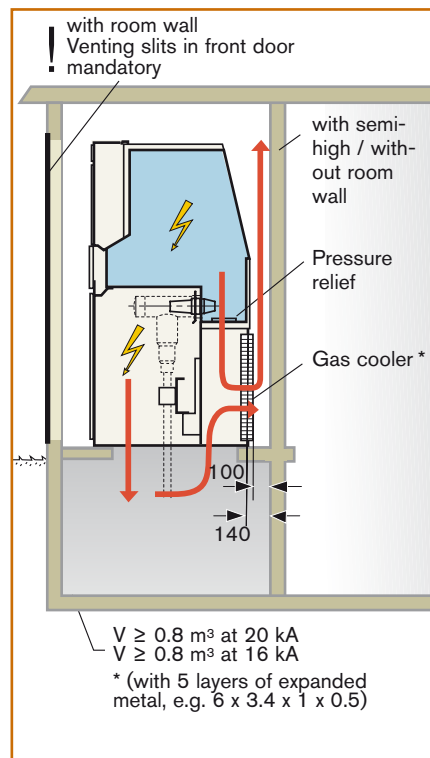
Installation example FBX-CCT1
Room height ≥ 2000 mm
(Pressure relief completely or partially into the switchgear room)



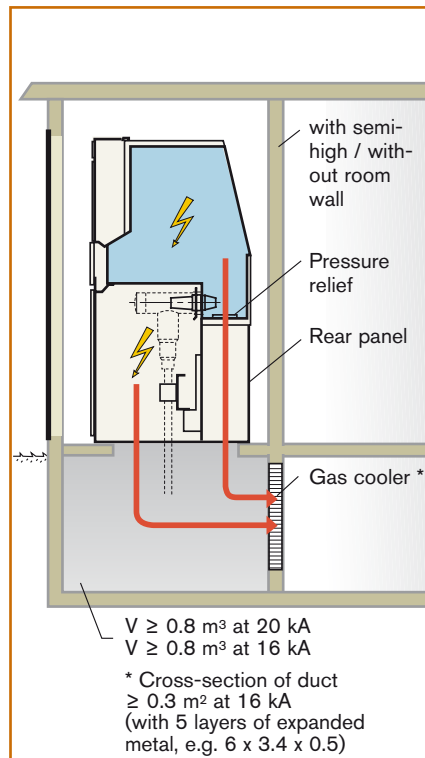
Installation example FBX-CCT1 with side
Room height ≥ 2000 mm
(Pressure relief completely or partially into the switchgear room)



Installation example in a corner with building partition

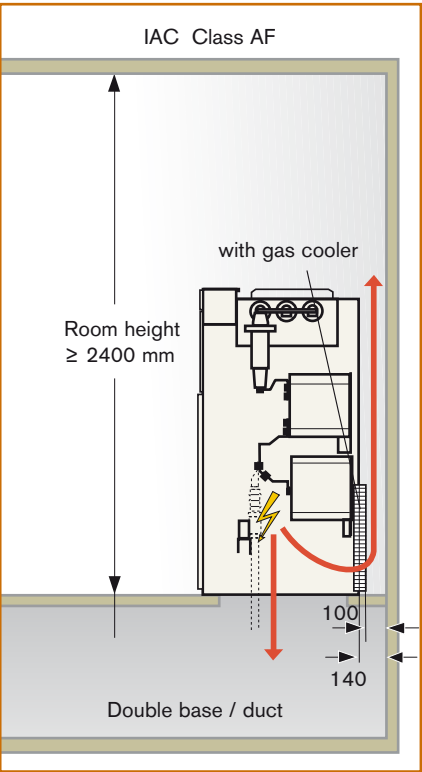


Installation example (cable feeder)
FBX-C-C-T1
Distance to wall and ceiling ≥ 100 mm
(Pressure relief completely or partially into the switchgear room)

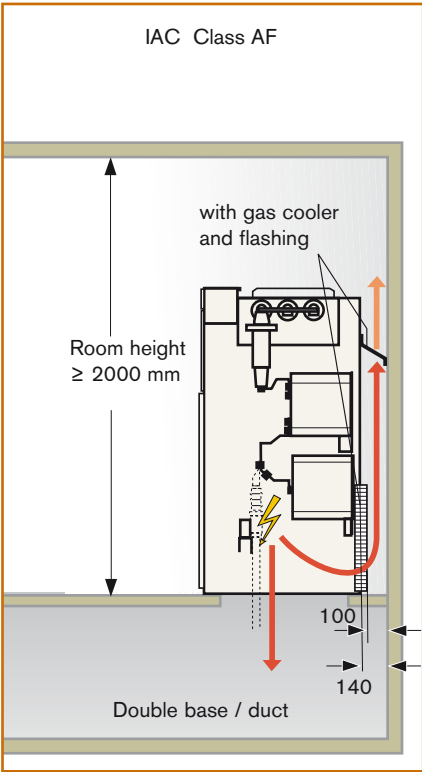


Installation example (cable feeder)
FBX-C-C-T1
Distance to ceiling ≥ 100 mm
Distance to wall ≥ 30 mm
(Pressure relief into cable duct with gas cooler)

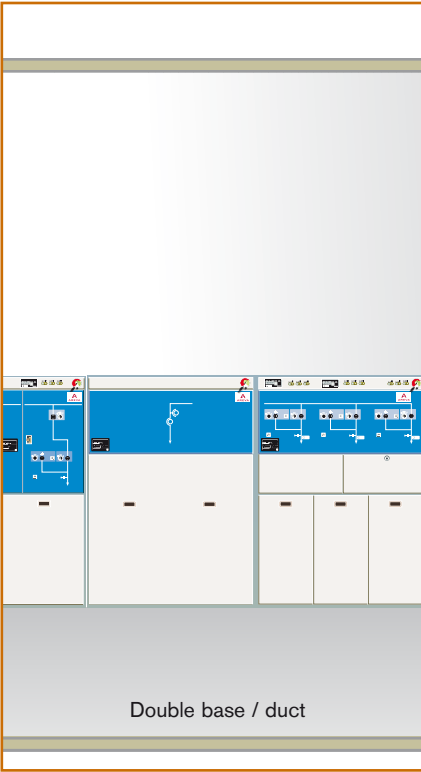
**Installation examples for accessible stations and switchgear rooms
(IAC classification to IEC 62271-200)**



Installation example, metering panel
Room height ≥ 2400 mm
(Pressure relief completely or partially into the switchgear room)



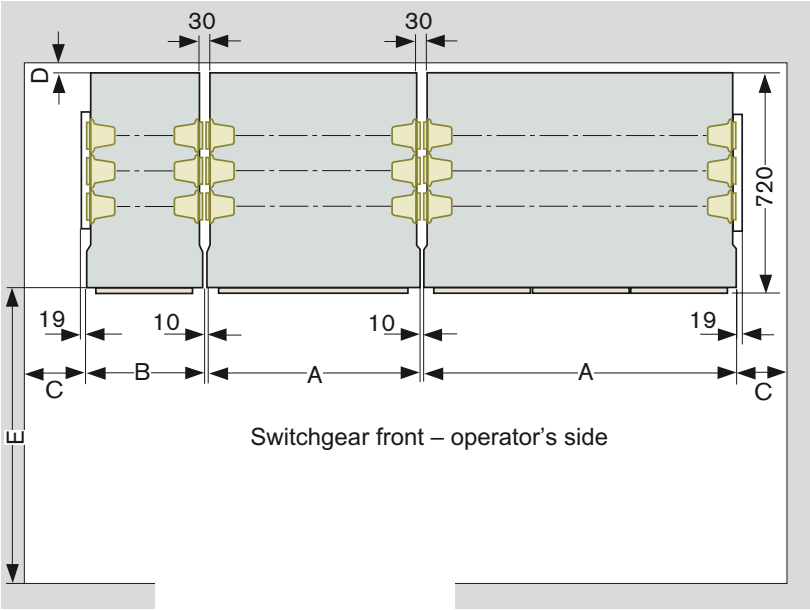
Installation example, metering panel
Room height ≥ 2000 mm, with flashing
(Pressure relief completely or partially into the switchgear room)



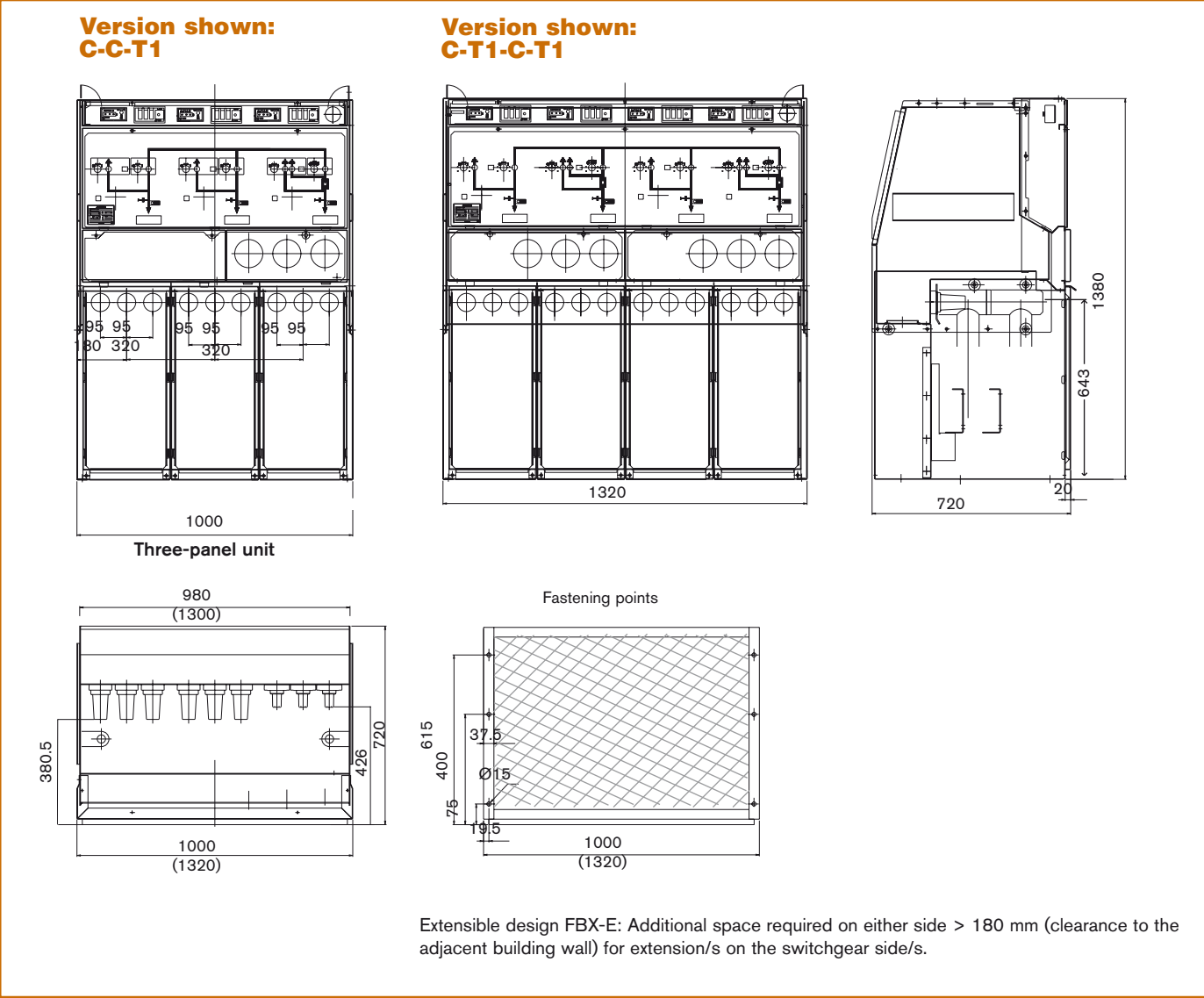
Example FBX with M3,
room height ≥ 2400 mm

**Minimum clearances of FBX-E
to the building walls**

	Functions and clearances	Dimensions [mm]
A	1-module unit M1, M2, M3, M4	1000
	2-module unit	680
	3-module unit	1000
	4-module unit	1320
B	1-module unit C, R, RE	360
	1-module unit T1, T2	490
C	Clearance to lateral building wall for extensions at the end of the switchgear	≥ 180
D	Clearance between rear of switchgear and building wall	Only downward pressure relief 30
		Pressure relief upwards to the rear 140
E	Minimum width of passage in front of switchgear FBX -E	National standards/ regulations must be complied with! For subsequent extension of existing FBX-E: assembly aisle E ≥ 950



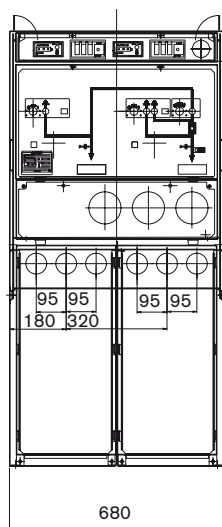
FASTENING AND FLOORING DUCTS



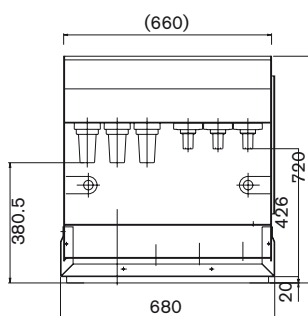
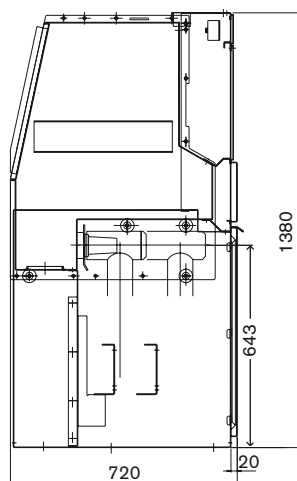
Type Designation	U	- I
	[kV]	- [kA]
FBX-C	12-16	C-C-T1
FBX-E	12-20	R-RE-T1
	17-16	C-C-C
	17-20	
	24-16	
	24-20	
FBX-C	12-16	C-C-C-T1
FBX-E	12-20	C-T1-C-T1
	17-16	C-C-C-C
	17-20	
	24-16	
	24-20	

Comply with chapter
“Pressure relief”!

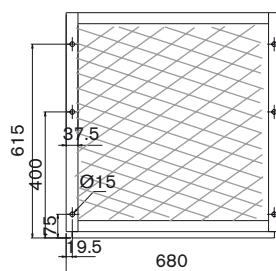
Version shown: RE-T1



Two-panel unit



Fastening points

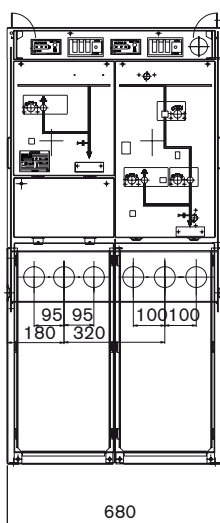


Extensible design FBX-E: Additional space required on either side > 180 mm (clearance to the adjacent building wall) for extension/s on the switchgear side/s.

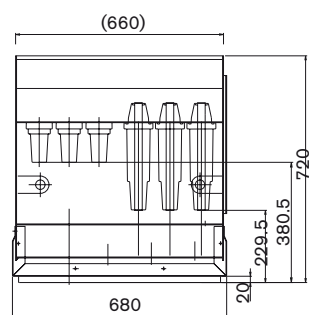
Type Designation	U - I [kV] - [kA]	
FBX-C	12-16	
FBX-E	12-20	C-T1
	17-16	
	17-20	RE-T1
	24-16	
	24-20	C-C

**Comply with chapter
“Pressure relief”!**

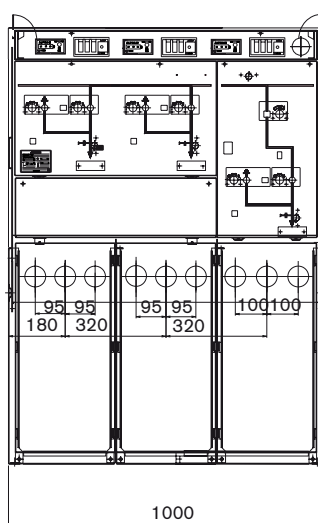
**Version shown:
RE-T2**



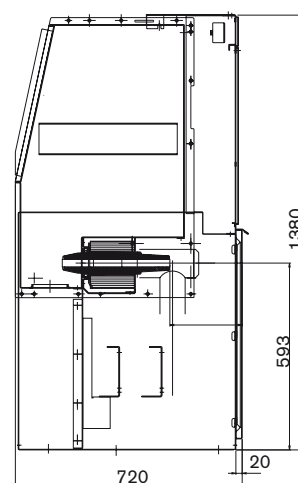
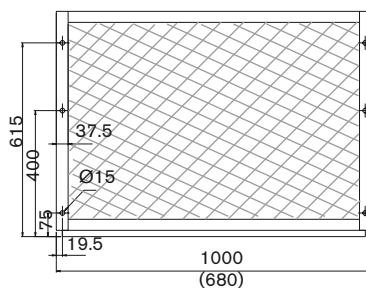
Two-panel unit



**Version shown:
C-C-T2**



Three-panel unit

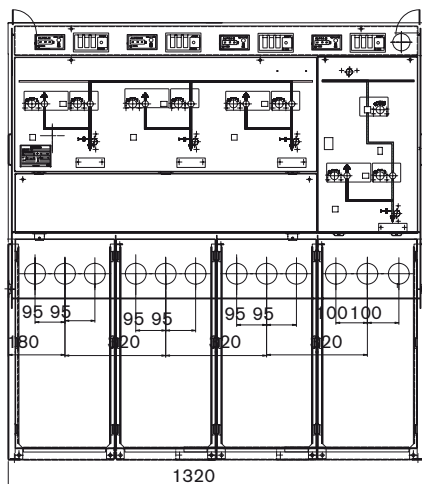


Extensible design FBX-E: Additional space required on either side > 180 mm (clearance to the adjacent building wall) for extension/s on the switchgear side/s.

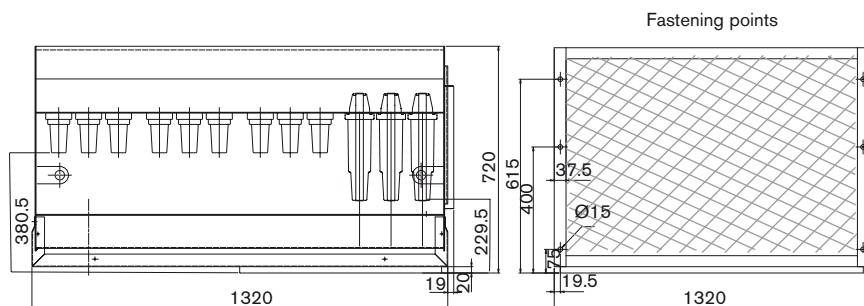
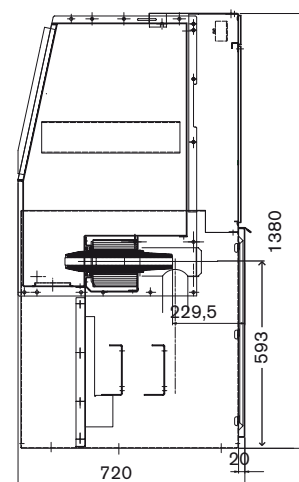
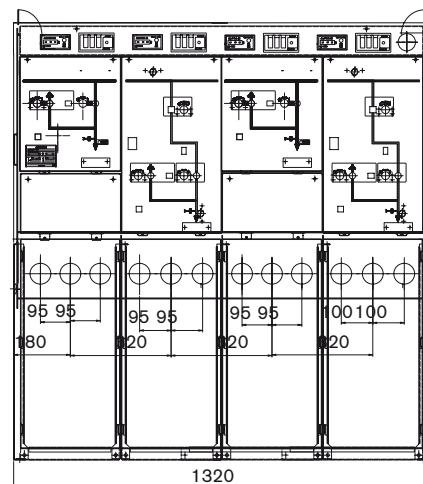
Type Designation	U - I [kV] - [kA]	
FBX-C	12-16	
FBX-E	12-20	RE-T2
	17-16	
	17-20	
	24-16	
	24-20	
FBX-C	12-16	C-C-T2
FBX-E	12-20	C-RE-T2
	17-16	R-RE-T2
	17-20	
	24-16	
	24-20	

**Comply with chapter
“Pressure relief”!**

Version shown:
C-C-C-T2



Version shown:
C-T2-C-T2

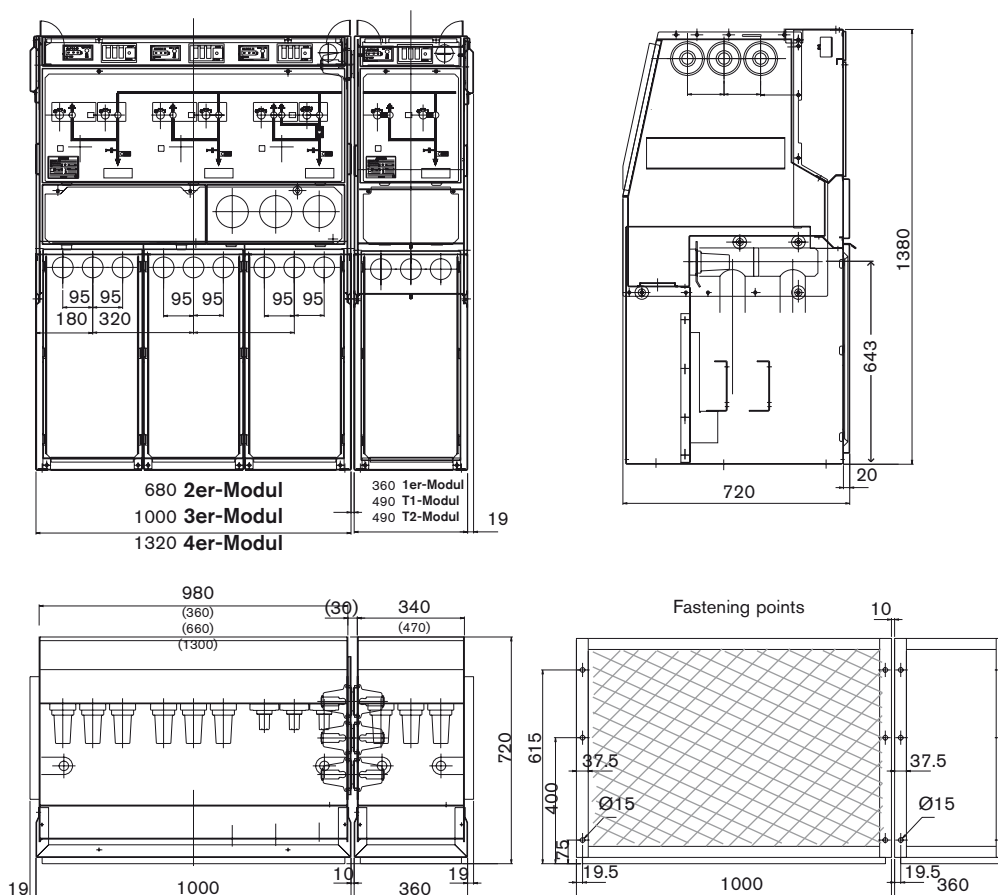


Extensible design FBX-E: Additional space required on either side > 180 mm (clearance to the adjacent building wall) for extension/s on the switchgear side/s.

Type Designation	U - I [kV] - [kA]	
FBX-C	12-16	C-C-C-T2
FBX-E	12-20	C-T2-C-T2
	17-16	
	17-20	
	24-16	
	24-20	

Comply with chapter “Pressure relief”!

Version shown: C-C-T1 + C

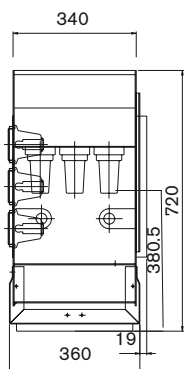
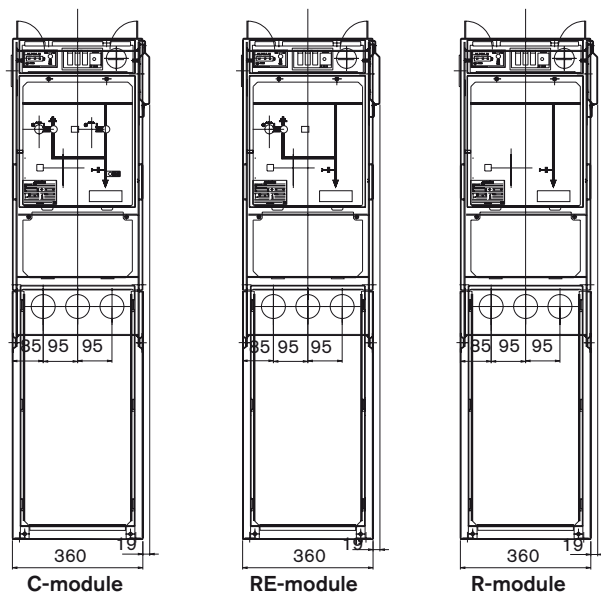


Extensible design FBX-E: Additional space required on either side > 180 mm (clearance to the adjacent building wall) for extension/s on the switchgear side/s.

Type Designation	U [kV]	I [kA]
FBX-E	12-16	
	12-20	C
	17-16	
	17-20	T1
	24-16	
	24-20	T2
FBX-E	12-16	
	12-20	C-T1
	17-16	
	17-20	RE-T1
	24-16	
	24-20	C-C
FBX-E	12-16	C-C-T1
	12-20	C-RE-T1
	17-16	R-RE-T1
	17-20	C-C-C
	24-16	
	24-20	
FBX-E	12-16	C-C-C-T1
	12-20	C-T1-C-T1
	17-16	C-C-C-C
	17-20	
	24-16	
	24-20	

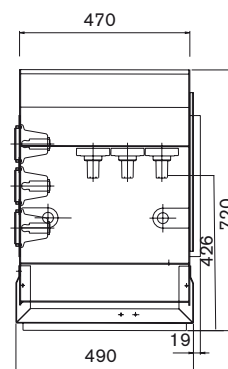
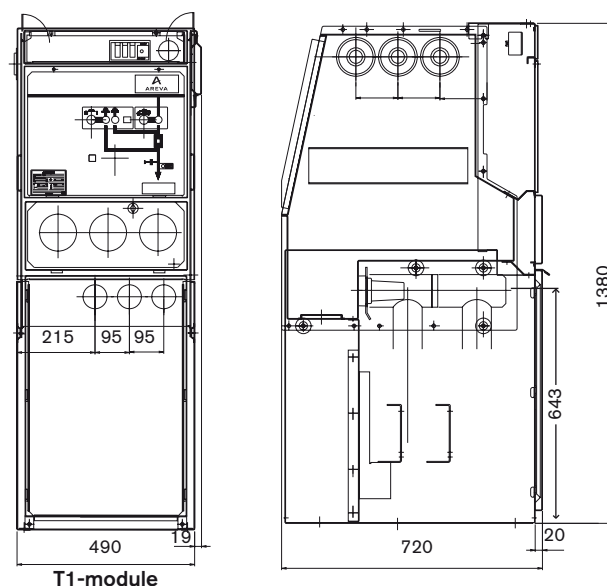
Comply with chapter
“Pressure relief”!

Version shown: C-RE-R

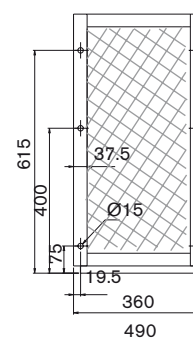


Extensible design FBX-E: Additional space required on either side > 180 mm (clearance to the adjacent building wall) for extension/s on the switchgear side/s.

Version shown: T1



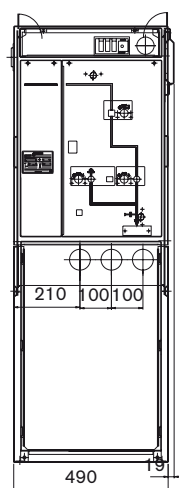
Fastening points



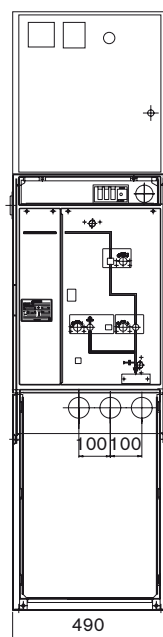
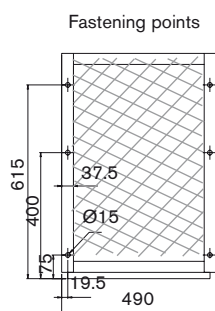
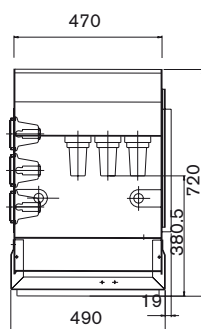
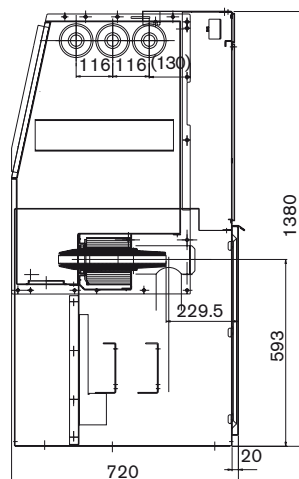
**Comply with chapter
“Pressure relief”!**

Type Designation	U [kV] - [kA]	I
FBX-E	12-16	
	12-20	C, R, RE
	17-16	
	17-20	T1
	24-16	
	24-20	

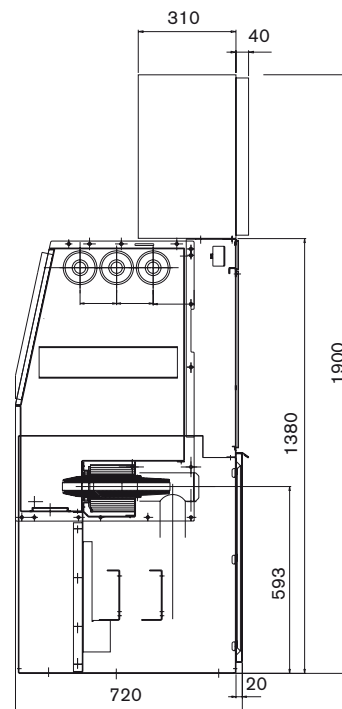
Version shown: T2



T2-module



T2-module
optional with low-voltage cabinet

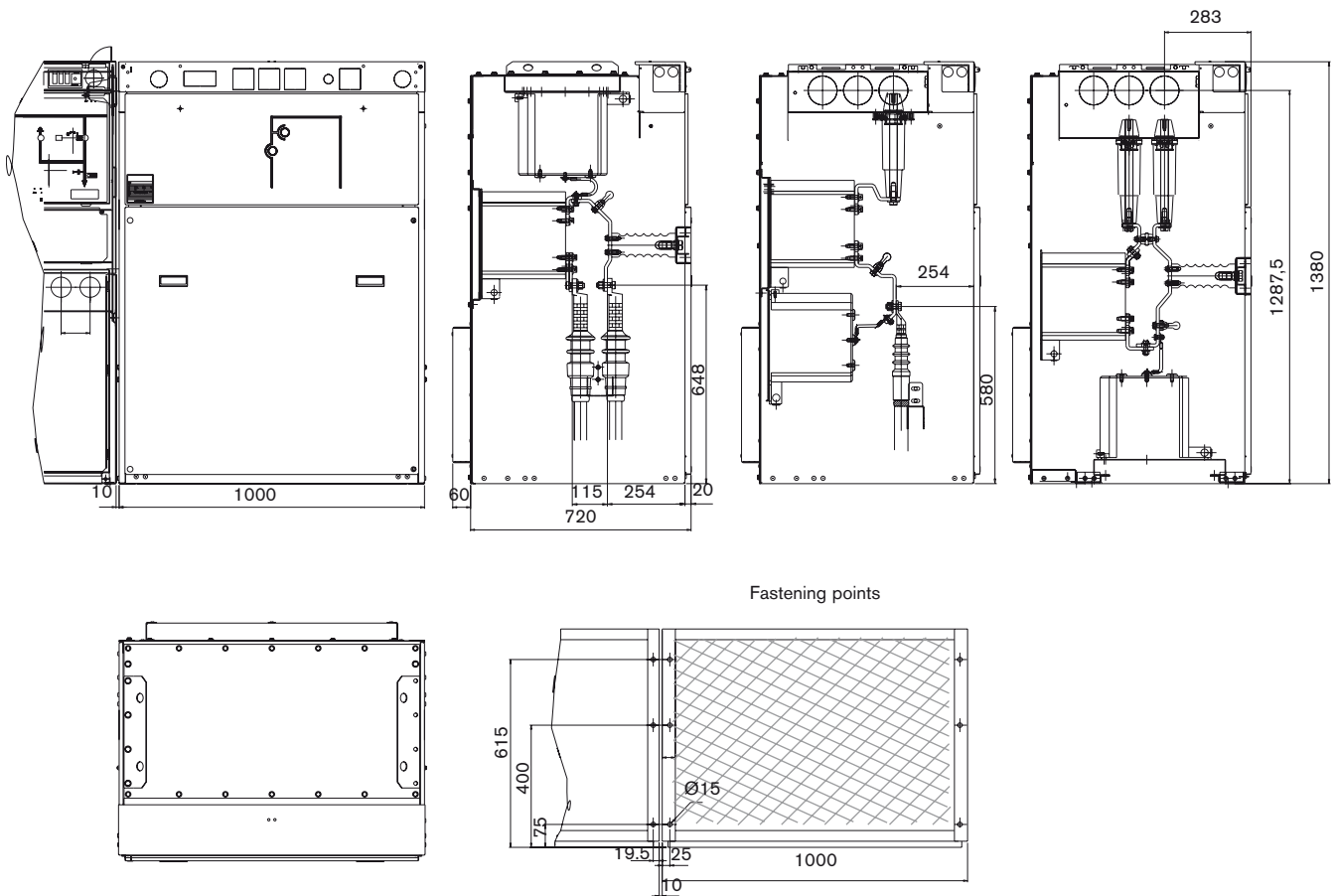


Extensible design FBX-E: Additional space required on either side > 180 mm (clearance to the adjacent building wall) for extension/s on the switchgear side/s.

Type Designation	U - I [kV] - [kA]	
FBX-E	12-16	T2
	12-20	
	17-16	
	17-20	
	24-16	
	24-20	

**Comply with chapter
“Pressure relief”!**

Metering panel type: M2 M3



Extensible design FBX-E: Additional space required on either side > 180 mm (clearance to the adjacent building wall) for extension/s on the switchgear side/s.

**Comply with chapter
"Pressure relief"!**

ACCESSORIES

Auxiliary products and accessories are available from AREVA Sachsenwerk GmbH. The use of other auxiliary products and accessories is not permitted.

Standard accessories supplied with the switchgear are control levers and, in the case of motor-operated drives, emergency handles and double-bit keys.



Double-bit key



Control lever for earth switch



*Control lever for disconnect,
switch disconnect, circuit-breaker*



*Emergency handle for motor drive
(optional)*



Shipping

Packing and transport

Packing

- > If packed for truck transport, switchgear units are delivered on pallets with PE protective film. Plastic straps are used to secure the switchgear units to the pallets.
- > For sea transport, the units are packed in sealed aluminium film with desiccant, in a closed case with a close-boarded wooden base.
- > For air transport, the switchgear units are wrapped in blister film for dust protection and packed in either wooden crates or wooden cases, all with close-boarded wooden bases.

Leave the equipment in its original packaging during storage. If units or parts are unpacked for checking, they must be repacked for continued storage, using the original packaging. Avoid condensation.

Transport

When transporting the switchgear, it must be ensured that the units do not slip or tilt (if necessary, nail down transport pallets to the loading surface).

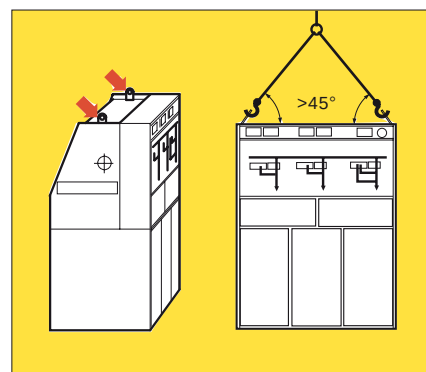
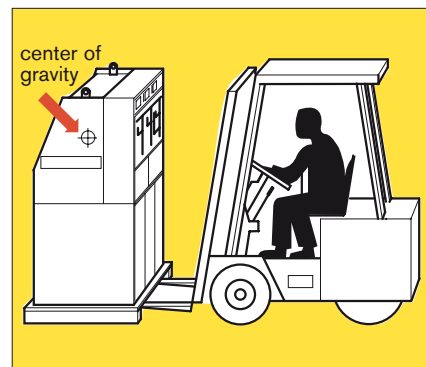
Ensure that during transportation the main weight of the switchgear is at the top. The center of gravity is marked with a label on the side of the switchgear.

Transport using a forklift truck:
Only transport the switchgear on a pallet.

Transport without pallet:
A crane lifting harness must be hooked into the lifting rings on the switchgear. The angle at the crane lifting harness should be at least 45°.

Transport of screw-fastened modules and single panels:

- max. 2 module connections
- max. width of transport unit 1820 mm



[illegible]

[illegible]

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