



Product catalogue

ABB AS, Electrification Products division

Gas-insulated ring main unit type SafeRing Air 12 kV

Gas-insulated compact switchgear type SafePlus Air 12 kV

Power and productivity
for a better world™



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1 Compact and eco-friendly medium voltage switchgear

Meeting the need for more environmentally friendly power distribution products

Climate concern related to the high global warming potential of SF₆ is key driver for ABB to develop a next generation retrofitable power distribution products.

ABB succeeded in a new design that relies on insulating gases no more potent than CO₂ itself. From an environmental perspective dry air is preferred when the dielectric properties of dry air perform as well within the compact, established dimensions laid down by SF₆ insulated units. Dry air is the most desirable alternative for 12 kV, being a natural gas.

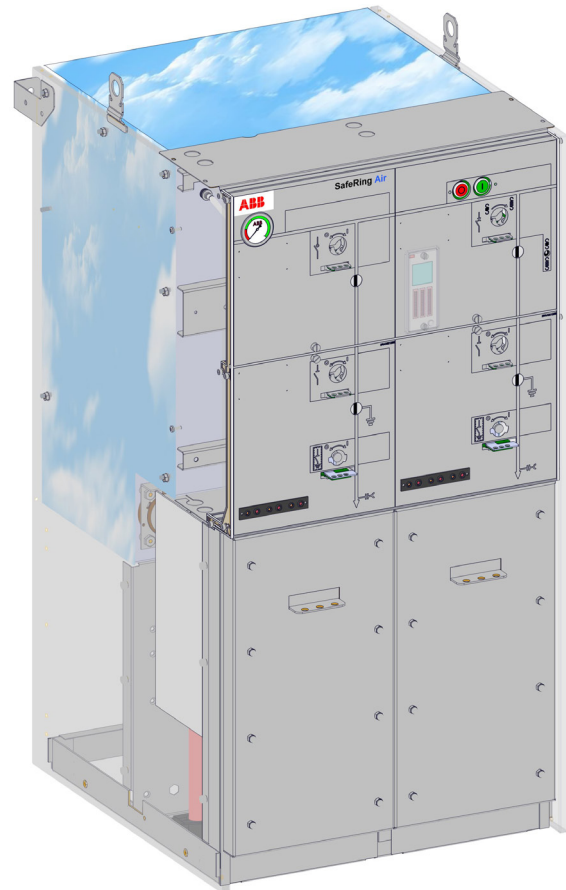
DryAir eco-efficient technology -ABB's solution for voltages up to 12 kV

Composition

Dry air alternative insulation gas is made up of compressed air with a very low humidity - either based on processed natural air, or synthetical air mixed from pure nitrogen (N₂) and oxygen (O₂). In either case the mixture contains approximately 80% N₂ and 20% O₂.

Global warming potential (GWP)

Dry air is an ideal gas from environmental perspective. It has no GWP thus does not contribute to global warming.



2 Introduction

SafeRing Air and SafePlus Air switchgear for secondary distribution were developed by ABB in Skien and introduced to the markets in 2014.

ABB has developed a new ring main unit with dry air as insulation medium, as an extension to the existing portfolio.

The switchgear portfolio is constantly under development to adjust to new markets requirements and customers' needs.

The new modules are harmonised with existing SafeRing and SafePlus portfolio as follows:

- Same physical dimensions (fully compatible with existing SafeRing and SafePlus lineup) and look
- Available modules: C, V and D
- User interface and operating sequence as for existing SafeRing and SafePlus portfolio
- Smart Grid enabled
- Same accessories and spare parts

Product highlights

- New technology with low environment impact and high level of recyclability
- Compact design with small footprint and low physical weight
- Down stream earthing switch
- Intuitive operation sequence and position indication
- Retrofitting of C-module to V-module at site
- Accessories, additional equipment and spare parts same as for SafeRing and SafePlus
- Maintenance free high voltage functions
- Ring main unit with wide range of standard configurations up to 5 modules
- V-module up to 630A
- 18 standards configurations
- Available internal arc classified switchgears for better personnel safety and for installation in limited spaces
- The possibility of integrating Grid Automation solution provides support for smart grid developments

Application

SafeRing Air and SafePlus Air is a completely sealed system with a stainless steel tank containing all live parts and switching functions. A sealed steel tank with constant atmospheric conditions ensures a high level of reliability as well as personnel safety and a maintenance-free system.

The SafeRing Air and SafePlus Air is the most compact solution on the market, which makes it ideal for utility, CSS, light industry, buildings and infrastructure applications.



2 Introduction

General

SafeRing Air is a ring main unit for the secondary distribution network. SafeRing Air can be supplied in 18 different configurations suitable for most switching applications in the 12 kV distribution networks.

SafePlus Air is a metal enclosed compact switchgear system for up to 12 kV distribution applications. The switchgear has a unique flexibility due to the possible combination of fully modular and configurations.

SafeRing Air and SafePlus Air is a completely sealed system with a stainless steel tank containing all the live parts and switching functions. A sealed steel tank with constant atmospheric conditions ensures a high level of reliability as well as personnel safety and a maintenance free medium voltage system.

Customer Benefits

- Alternative technologies with low environment impact and high level of recyclability
- Low physical weight
- Compact design with small footprint
- Down stream earthing switch
- Intuitive operation sequence and position indication
- Retrofitting of C panel to V panel on site
- Known and proved accessories, additional equipment and spare parts
- Maintenance free high voltage solution
- Ring main unit up to 5 modules

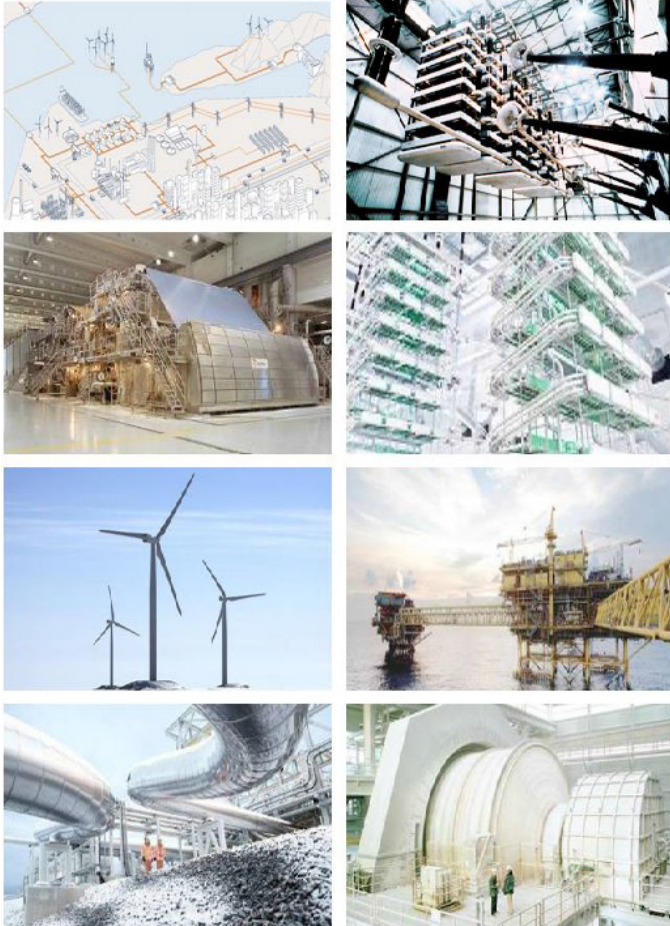
Modularity

All modules for SafeRing Air and SafePlus Air are only 325 mm wide, which is the same as for existing SafeRing and SafePlus portfolio.

SafeRing Air and SafePlus Air can be configured with a maximum of 5 modules in one Air tank with an internal busbar.



2 Introduction



Applicable Standards

All relevant IEC standards of the latest edition

IEC 62271-1	Common specifications
IEC 62271-200	Metal enclosed switchgear
IEC 62271-100	Circuit breakers
IEC 62271-103	Switches
IEC 67271-102	Disconnectors and earthing switches
IEC 60529	Degrees of protection

SafeRing Air and SafePlus Air are also tested together with CSS according to IEC 62271-202 standard. Tests have been performed on CSS from various manufacturers.

Protection degrees

SafeRing Air and SafePlus Air have degree of protection in accordance with IEC 60529:

- IP 67 for the tank with high voltage components
- IP 2X for the front covers of the mechanism
- IP 3X for the cable connection front covers

Industry

- Pulp and Paper
- Cement
- Textiles
- Chemicals
- Food
- Automotive
- Petrochemical
- Quarrying
- Oil and gas pipelines
- Rolling mills
- Mines

Utilities and Power Plants

- Power generation stations
- Transformer stations and metering
- Main and auxiliary switchgear

Transport

- Airports
- Ports
- Railways
- Underground transport

Infrastructure

- Supermarkets
- Shopping malls
- Hospitals
- Large infrastructure and civil works

Normal operation conditions

The rated characteristics of the switchgear are valid under the following ambient conditions:

- minimum ambient temperature: $-25\text{ }^{\circ}\text{C}$
- maximum ambient temperature: $+40\text{ }^{\circ}\text{C}$

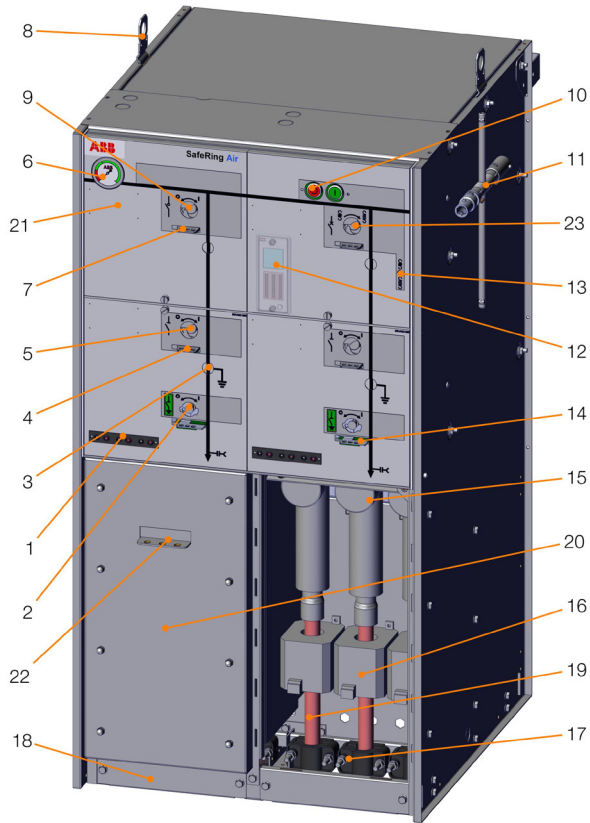
For different temperature ranges, please contact your ABB sales representative.

Ambient humidity

- maximum 24 h average of relative humidity 95%
- maximum 24 h average of water vapour pressure 2.2 kPa
- maximum monthly average of relative humidity 90% RH
- maximum monthly average of water vapour pressure 1.8 kPa

The normal operational altitude is up to 1,500 m above sea level. For higher altitude applications, please contact your ABB sales representative. The switchgear is designed for operation in presence of normal, non-corrosive and uncontaminated atmosphere

3 External arrangement



Description

1. Capacitive voltage indication
2. Operation shaft earthing switch
3. Disconnecter / earthing switch position indicator
4. Padlock device disconnecter
5. Operation shaft disconnecter
6. Pressure indicator
7. Padlock device load break switch
8. Lifting lug
9. Operation shaft load break switch
10. Push buttons
11. Operating handle
12. Self-powered protection relay
13. Charged spring indicator
14. Padlock device earthing switch
15. Cable connector
16. Current transformer
17. Cable clamps
18. Bottom list
19. Cable
20. Arc proof cable compartment
21. Rating plate
22. Door handle
23. Operation shaft circuit-breaker

4 Production

4.1 Completely sealed system

Exterior construction

Upper and lower front cover have a thickness of 3 mm aluminium which is covered with a polycarbonate foil. These foils contain the mimic diagram of the main circuit integrated with the position indicators for the switching devices. Background colour for these foils is light grey (RAL 7035). The upper front cover is removable. The lower front cover can be opened.

There are four different cable compartment covers available: standard, with inspection window, arc proof and with extra depth for parallel cables. These covers are manufactured from 1.25 mm aluzink (except the arc proof cover) and are powder painted with colour RAL 7035.

All cable compartment covers are removable. Each module has a separate cable compartment which is divided from the others by means of partition walls. These partition walls can easily be removed, allowing a comfortable access for connection of cables.

A vertical partition wall is fitted to divide the cable compartment(s) from the rear side of the switchgear / ring main unit.

In case of an arc fault inside the air tank, followed by an opening of the pressure relief in the bottom of the tank, this partition wall will prevent the hot gases blowing out from the pressure relief to enter the cable compartments.

Side covers are made of 2 millimeter hot rolled steel and powder painted with colour RAL 7035.

Enclosure

SafeRing Air and SafePlus Air use dry air as insulation medium. The air is contained in a welded stainless steel tank, which is sealed for life.

The pressure system is defined as a sealed for life system with an operating lifetime exceeding 30 years. The leakage rate is less than 0,1% per year.

In order to ensure a reliable and tight welding, all welding work is carried out by computer controlled robots. Electrical and mechanical bushings penetrating the tank are clamped and sealed to the tank by high quality O-rings.

The mechanical bushing has in addition a rotating shaft which connects the shaft of the switch to the corresponding shaft of the mechanism. The bushing shaft is sealed by a double set of gas seals.

All air tanks have to pass a leakage test before gas filling. Leakage test and gas filling are done inside a vacuum chamber. The first step in the leakage test is to evacuate all air inside both air tank and vacuum chamber simultaneously. Then the air tank is filled with Helium. Due to the characteristics of Helium this test will detect all possible leakages. If the air tank passes this test, the Helium will be evacuated and replaced by dry air.

The air tank has a degree of protection of IP67 and can be immersed into water and still maintain all functions in a satisfactory way.



4.2 Fully routine tested

ABB has set a high quality automated system for production and quality control which assures sustainability of factory output. Part of the assurance is standard routine testing procedures according to IEC62271-200 performed on every manufactured switchgear.

IEC factory routine tests

- Visual inspection and check
- Mechanical operations check
- Check of secondary wiring
- Electrical sequence operations
- Power frequency withstand voltage test
- Partial discharge measurement
- Measurement of resistance of the main circuits
- Secondary insulation test
- Control of the Air tightness in tank

State of the art

For the routine testing, ABB is using the latest technologies and systems, as for example:

- Fully automated high voltage testing cabin
- Temperature compensated gas filling system
- Automated connection counting system
- Automated screw torque control
- Computer aided mechanical characteristics central



5 Safety

5.1 Internal Arc Classification (IAC)

During development of all ABB products, focus is put on personnel safety. This is why the SafeRing Air and SafePlus Air portfolio was designed and tested for a variety of internal arc scenarios in order to withstand internal arc of same current level as a maximum short circuit current. The tests show that the metal enclosure of SafeRing Air and SafePlus Air switchgear is able to protect personnel standing close to the switchgear during internal arc fault.

Causes and effects of IAC

An internal arc is a highly unlikely fault, although it can theoretically be caused by various factors, such as:

- Insulation defects due to quality deterioration of the components. The reasons can be adverse environmental conditions and a highly polluted atmosphere
- Inadequate training of the personnel in charge of the installation, leading to incorrect installation of the cables
- Breakage or tampering of the safety interlocks
- Overheating of the contact area, e.g. when the connections are not sufficiently tightened
- Short circuits caused by small animals that have entered into the cable compartment (i.e. through cable entrance)

The energy produced by the internal arc causes the following phenomena:

- Explosive increase of the pressure and temperature
- Mechanical stresses on the switchgear structure
- Melting, decomposing and evaporation of materials
- Burning marks and other visual damage on switchgear may occur

Tested according to IEC standard 62271-200

The capability of SafeRing Air and SafePlus Air switchgear to withstand internal arc is proven by the type test according to internal arc classification (IAC), described in the standard IEC 62271-200 as follows:

Accessibility: A, B or C (switchgear)

A=Accessible to authorized personnel only

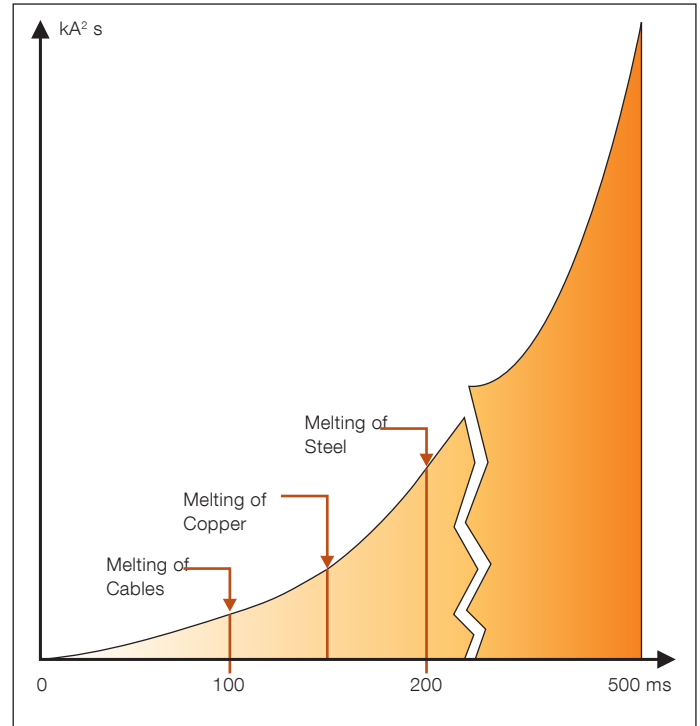
B=public access

C=not accessible due to installation

F-Front=Access from the front

L-Lateral=Access from sides

R-Rear=Access from the rear



Arc duration and damage caused



All test specimens passed the following test criteria according to the standards:

1. Correctly secured doors and covers do not open
2. No fragmentation of the enclosure occurs within the time specified for the test
3. Arcing does not cause holes in the enclosure of the switchgear for classified sides
4. Indicators do not ignite due to the effect of hot gases
5. The enclosure remains connected to its earthing point

5.1 Internal Arc Classification (IAC)

SafeRing Air and SafePlus Air are available for a wide range of installations and applications in order to secure highest safety for operators. Switchgears are designed and type-tested for internal arc classification according to the following configurations:

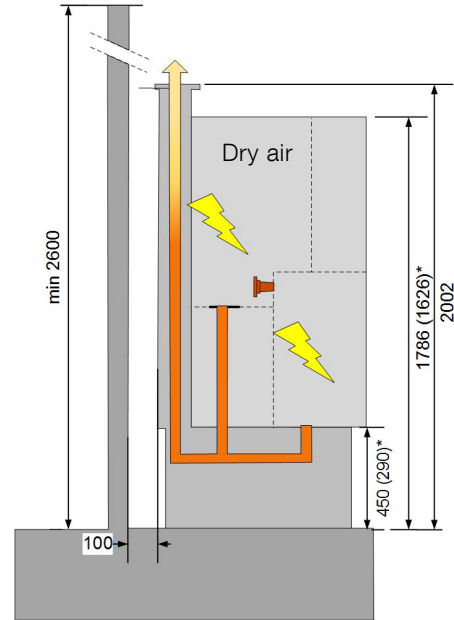
5.1.1 IAC AFLR - with ventilation upwards through exhaust channel

With this setup, hot gases and pressure are evacuated, through the gas exhaust channel above the switchgear into the safe area of the switchgear room. In this setup the switchgear can be installed as free standing. With this solution, a base frame of 450 is included as standard.

Basic parameters of setup:

- IAC AFLR up to 20 kA / 1s
- Minimum height of ceiling: 2600 mm
- Recommended distance to backwall: 100 mm

For number of modules, availability, heights and specifications, see table no. 5.1.1.



* 290 mm base frame available as option.

Note:

Height of exhaust channel is always 2002 mm, according to requirements in IEC standards. When base frame is 290 mm, the exhaust channel is extended to reach 2002 mm height

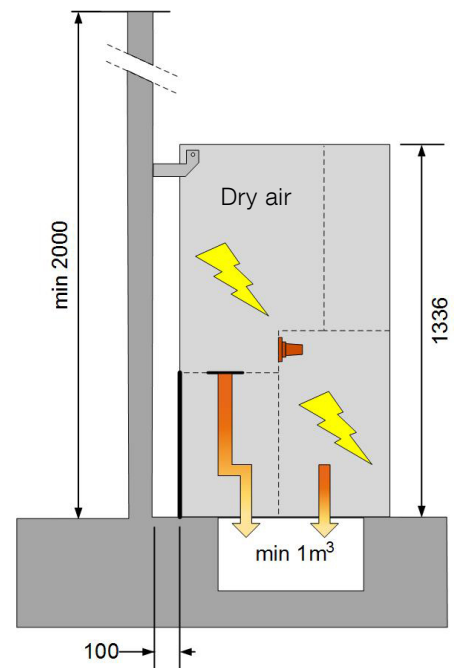
5.1.2 IAC AFL(R) - with ventilation down to the cable trench

With this setup, hot gases and pressure are evacuated downwards in the cavity in the floor. The size of the hole needs to be at least 1m³. The cable trench should be at least 2 meters long, with an opening of minimum 0.5 m². Hot gases are led to the cable trench by means of a back plate installed on the rear side of the cable compartment.

Basic parameters of set-up:

- IAC AFL(R) up to 20 kA / 1s
- Minimum height of ceiling: 2000 mm
- Pressure relief way through cable trench
- Distance to backwall: 100 mm

For number of modules, availability, heights and specifications, see table no. 5.1.1.



5.1 Internal Arc Classification (IAC)

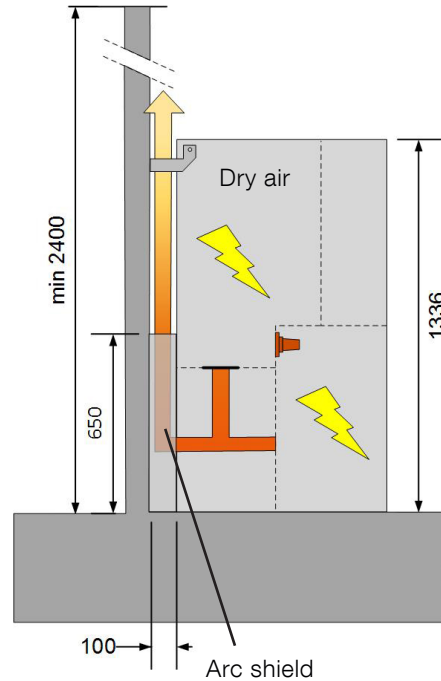
5.1.3 IAC AFL - with ventilation behind the switchgear

With this setup, hot gases and pressure are evacuated behind the switchgear, either if the arc fault occurs inside the air tank or in the cable compartment. Hot gases are led to the safe areas of the switchgear room by means of arc shields installed on each side of the switchgear.

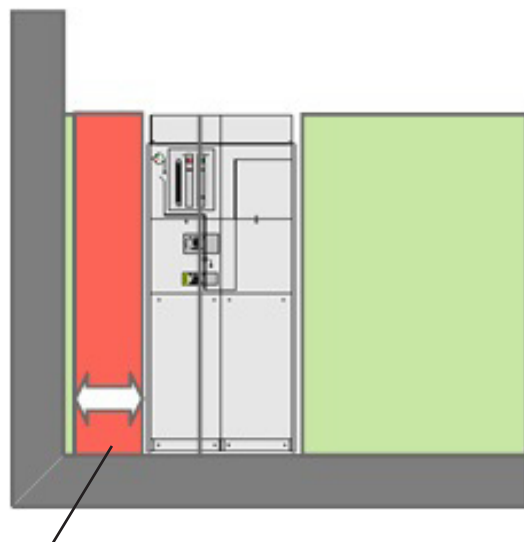
Basic parameters of setup:

- IAC AFL up to 20 kA / 1s
- Minimum height of ceiling: 2400 mm
- Distance to backwall: 100 mm
- If distance from sidewall is more than 20 mm, arc shields are required on both sides

For number of modules, availability, heights and specifications, see table no. 5.1.1.



Switchgear must be installed maximum 20 mm from sidewall. If installed with larger distance than 20 mm from sidewall, arc shields on both sides are required. For easier installation, it is recommended that any switchgear requiring the arc shields, to be installed minimum of 300 mm from sidewall.



20 - 300 mm. Marked area is restricted, but installation is allowed if mounting of arc shield is feasible.

5.1 Internal Arc Classification (IAC)

5.1.4 Non-arc proof version

The non-arc proof version of the switchgear is not verified for any of the IAC-classes. In the highly unlikely event of an internal arc fault in the switchgear, hot gases and pressure could evacuate randomly in any direction at any place of enclosure.

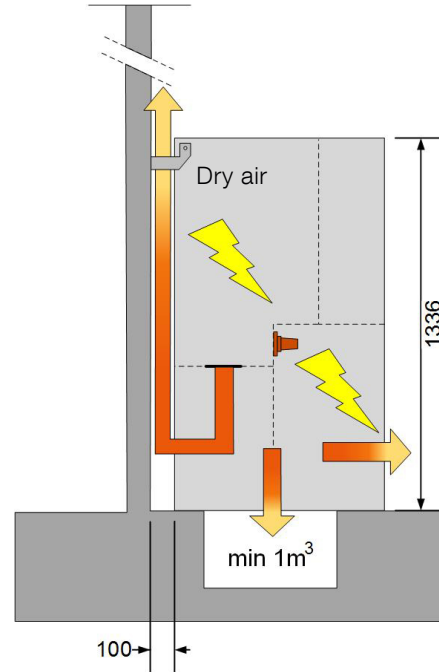


Table 5.1.1

Arc current (kA/1s)	IAC class	Ventilation	Height of switchgear (mm)	Roof height (mm)	Arc suppressor	Base frame	Max sets of current transformers	Number of modules
16	AFL	Backwards	1336 (standard) 1100 (low)	2400 (standard) 2400 (low)	optional	optional (290/450 mm) ⁴⁾	2 ²⁾	2 - 5
	AFL	Downwards ³⁾	1336 (standard) 1100 (low)	2000 (standard) 2000 (low)	optional	optional (290/450 mm) ⁴⁾	2 ²⁾	2 - 5
	AFLR	Upwards ⁵⁾	1786 ¹⁾	2600	optional	mandatory (450/290 ⁶⁾ mm)	2 ²⁾	2 - 5
20	AFL	Backwards	1336 (standard) 1100 (low)	2400 (standard) 2400 (low)	optional	optional (290/450 mm) ⁴⁾	2 ²⁾	2 - 5
	AFL	Downwards ³⁾	1336 (standard) 1100 (low)	2000 (standard) 2000 (low)	optional	optional (290/450 mm) ⁴⁾	2 ²⁾	2 - 5
	AFLR	Upwards ⁵⁾	1786 ¹⁾	2600	optional	mandatory (450/290 ⁶⁾ mm)	2 ²⁾	2 - 5

¹⁾ Height of exhaust channel is 2002 mm. This dimension is independent of the height of the base frame. If base frame is 290 mm, exhaust channel is extended to reach 2002 mm

²⁾ In case two sets of CT's are required, additional base frame is mandatory. Second set of CT's will be installed in base frame

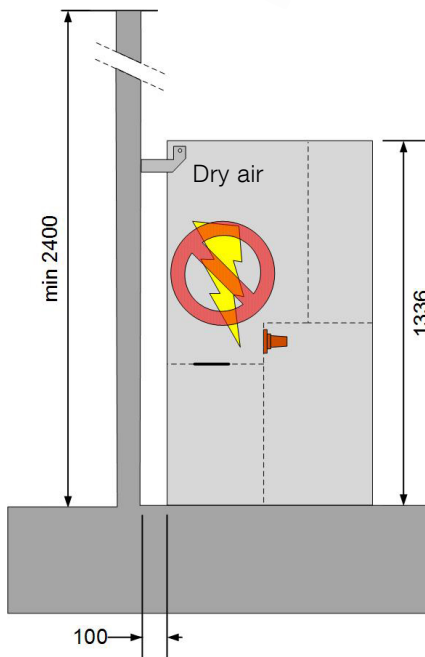
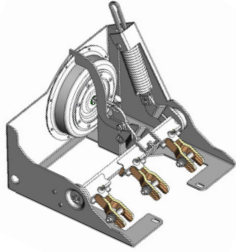
³⁾ IAC classification is unavailable in case of use of gland plates

⁴⁾ If base frame is added, roof height needs to be 2400 mm

⁵⁾ Not allowed with gland plate between switchgear and base frame, gland plate can be installed below base frame

⁶⁾ 290 mm base frame as option

5.2 Arc suppressor



Arc suppressor - active device for increased safety

The arc suppressor is an optimal quick-make short circuit device with a mechanical pressure detector which can be installed in each module inside the sealed air tank of SafeRing Air and SafePlus Air switchgear.

If an arc fault should occur inside the Air tank the pressure device of the arc suppressor will automatically trip and short circuit the incoming feeder(s) within milliseconds, thereby extinguishing the arc and preventing a gas blowout. The arc is extinguished without any emission of hot gases and the short circuit will be interrupted by the upstream circuit-breaker.

No links or release mechanisms are installed outside the tank. Corrosion and any environmental influences are therefore prevented, giving optimum reliability.

The pressure detector is insensitive to pressure changes due to variation in atmospheric temperature or pressure, as well as external phenomena such as vibrations or shocks.

The arc suppressor will operate for internal arc currents in the range of 1kArms to 21kArms and it will reduce the generated arc energy to less than 5% of the arc energy released during an arcing time of 1 sec.

Since the system is self-contained, an internal arc fault in the tank will have no impact on the surroundings, so there will be no cleaning work required. No arc fault tests have to be repeated in combination with channel release systems or transformer stations.

Arc protection in IED (Intelligent Electronic Device)

Protection relays REF615, and REF620 IED can optionally be fitted with a fast and selective arc flash protection. It offers a two- or three-channel arc-fault protection system for arc flash supervision of different cable compartments of switchgear modules. Total tripping time is less than 100 ms.



From IAC-test without arc suppressor 20kA/1s



From IAC-test with arc suppressor 20kA/1s

5.3 Interlocking and locking

Interlocks

The safety mechanical interlocks between switches are standard, detailed information is described for each module. They are set out by the IEC standards and are necessary to guarantee the correct operation sequence. ABB safety interlocks enable the highest level of reliability, even in the case of an accidental error, and ensures highest operator safety system of interlocks.

Keys

The use of key interlocks is very important in realizing the interlocking logics between panels of the same switchgear, or of other medium, low and high voltage switchgear. The logics are realized by means of distributors or by ringing the keys. The earthing switch closing and opening operations can be locked by means of keys. For more detailed description, see dedicated interlocking pages for each module and chapter "Key interlocks".

Padlocks

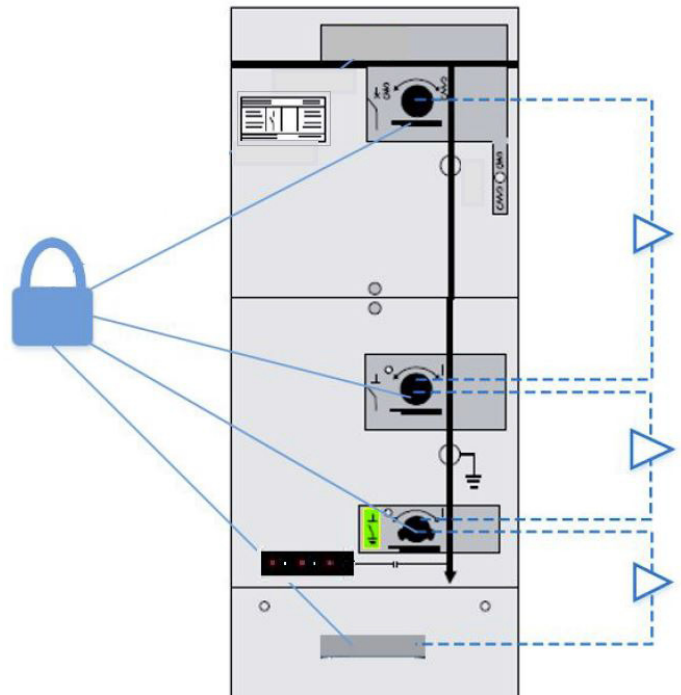
The cable compartment doors can be locked in the closed position by means of padlocks. The padlock can also be applied to the switches to avoid improper operation of the switchgear. For more detailed description, see dedicated interlocking pages for each module. Padlocks from 4 to 8 mm diameter can be accommodated.

Blocking coil/electrical interlocking

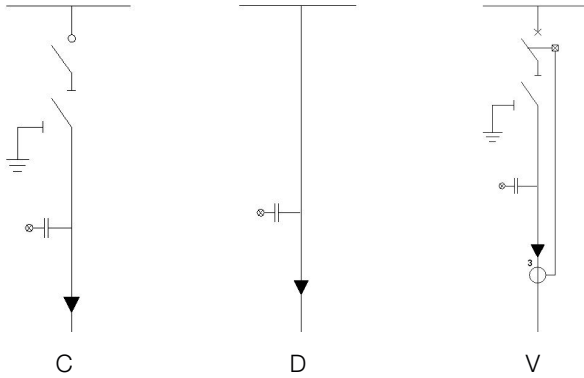
The switchgear closing/opening operations can be electrically interlocked by use of electrical blocking coils. For more detailed description, see dedicated interlocking pages for each module.

Undervoltage release coil

This release opens the circuit-breaker when there is a sharp reduction or cut in the auxiliary power supply voltage. This is an optional feature. Voltage presence system with signalling contact is required. Time delay is possible, to avoid undesirable opening of circuit breaker. Opening time can be set to 0.5, 1, 1.5, 2 or 3 seconds.



6 Applications SafeRing Air and SafePlus Air



SafeRing Air and SafePlus Air are designed for use in the following applications:

- Compact secondary substations
- Small industries
- Wind power plants
- Hotels, shopping centers, office buildings, business centers etc.
- Light mining applications, airports, hospitals, tunnels and underground railways

Available modules:

- C - Cable switch
- D - Direct cable connection
- V - Vacuum circuit-breaker

SafeRing Air - Defined configurations

SafePlus Air - Fully modular configurations

7 SafeRing Air configurations

General

SafeRing Air is a ring main unit for the secondary distribution network. It can be supplied in 18 different configurations suitable for most switching applications in 12 kV distribution networks.

SafeRing Air combined with the SafePlus Air concept, which is ABB's flexible, modular compact switchgear, represents a complete solution for 12 kV secondary distribution networks. SafeRing Air and SafePlus Air have identical user interfaces.

SafeRing Air is a completely sealed system with a stainless steel tank containing all the live parts and switching functions. A sealed steel tank with constant atmospheric conditions ensures a high level of reliability as well as personnel safety and a virtually maintenance-free system.

The SafeRing Air and SafePlus Air concept offers a circuit-breaker with relay for protection of the transformer.

SafePlus Air can be supplied with an integrated remote control and monitoring unit and additional equipment which makes the switchgear more intelligent. (Low voltage compartment required)

SafeRing Air is supplied with the following standard equipment

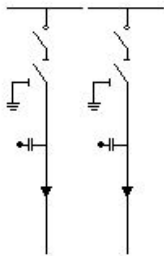
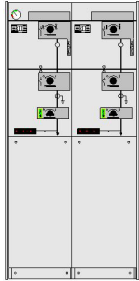
- Earthing switches
- Operating mechanisms with integrated mechanical interlocking
- Operating handle
- Facilities for padlocks on all switching functions
- Bushings for cable connection in front with cable covers
- Lifting lugs for easy handling
- Busbar, 630A
- Earthing bar
- Capacitive voltage indication (VPIS)

Additional equipment

- Arc suppressor, on incoming feeder only (C, D)
- Interlocked cable covers
- Cable cover with window
- Cable cover for double T-contacts
- Arc proof cable covers complete incl. interlocking
- Extra base frame (h=450 or 290 mm)
- Trip coil open
- Trip coil open and close
- Motor operation
- Auxiliary switches for all switching functions
- Prepared for relay test equipment
- Capacitive voltage indication (VDS)
- Short circuit indicator
- VCB - tripped signal
- Current metering
- Top entry box
- Ronis key interlock
- Self -powered relays for V-module
 - Woodward's WIC1-2-P-E
 - ABB REJ603 r.1.5

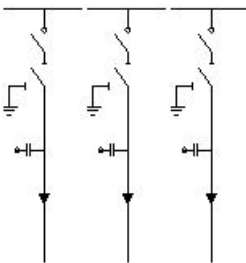
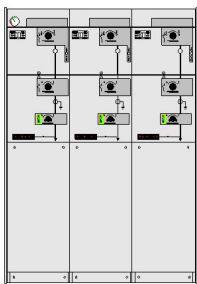


7 SafeRing Air configurations



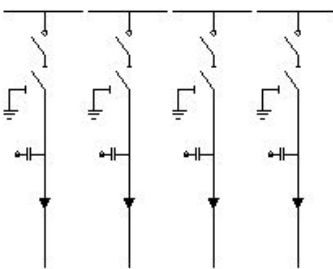
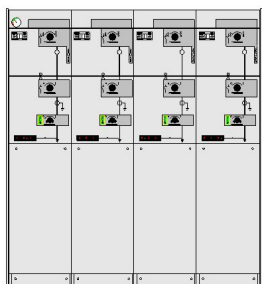
CC

Depth: 765 mm
Width: 696 mm
Height: 1336 mm



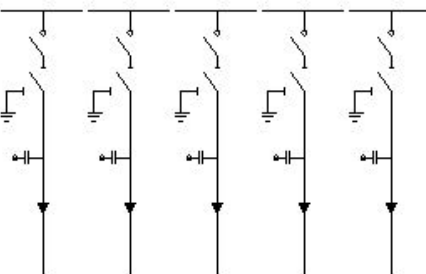
CCC

Depth: 765 mm
Width: 1021 mm
Height: 1336 mm



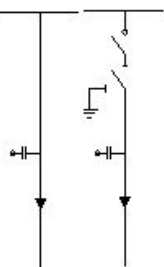
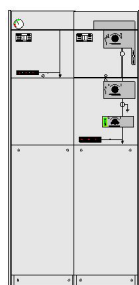
CCCC

Depth: 765 mm
Width: 1346 mm
Height: 1336 mm



CCCCC

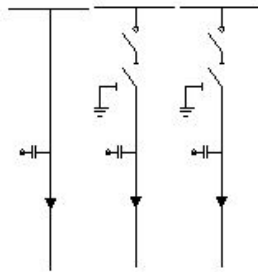
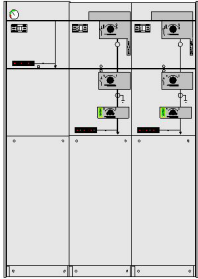
Depth: 765 mm
Width: 1671 mm
Height: 1336 mm



DC

Depth: 765 mm
Width: 696 mm
Height: 1336 mm

7 SafeRing Air configurations

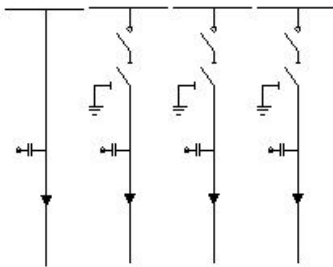
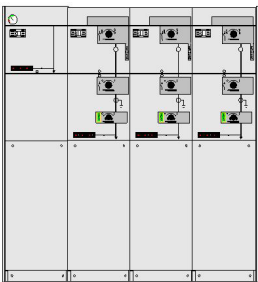


DCC

Depth: 765 mm

Width: 1021 mm

Height: 1336 mm

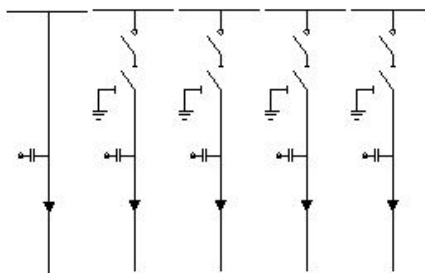


DCCC

Depth: 765 mm

Width: 1346 mm

Height: 1336 mm

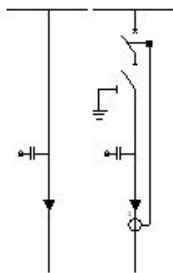
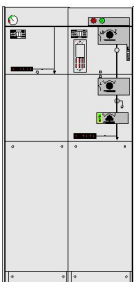


DCCCC

Depth: 765 mm

Width: 1671 mm

Height: 1336 mm

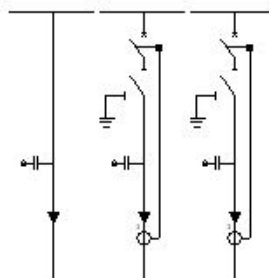
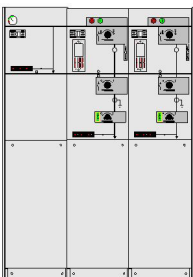


DV

Depth: 765 mm

Width: 696 mm

Height: 1336 mm



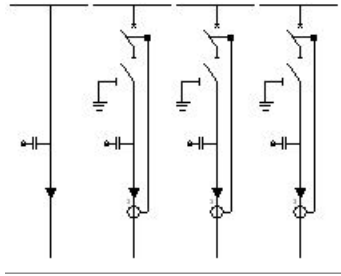
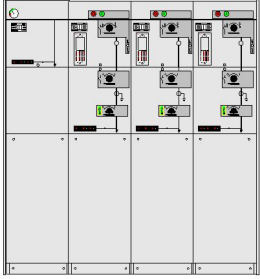
DVV

Depth: 765 mm

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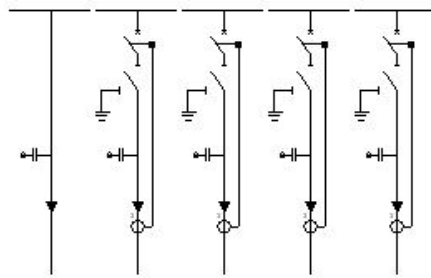
Height: 1336 mm

7 SafeRing Air configurations



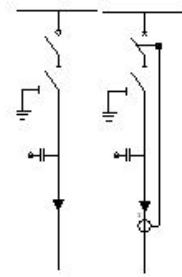
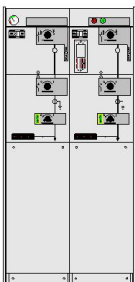
DWV

Depth: 765 mm
Width: 1346 mm
Height: 1336 mm



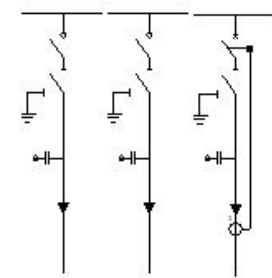
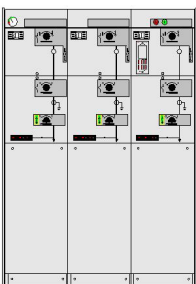
DWVV

Depth: 765 mm
Width: 1671 mm
Height: 1336 mm



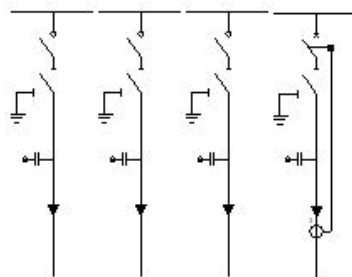
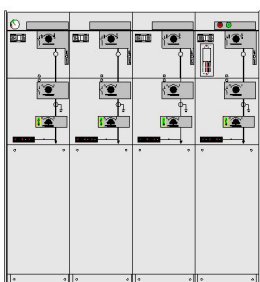
CV

Depth: 765 mm
Width: 696 mm
Height: 1336 mm



CCV

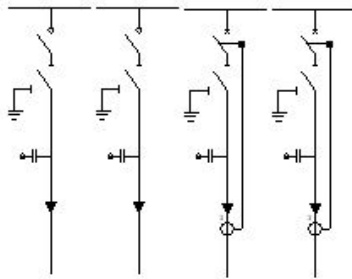
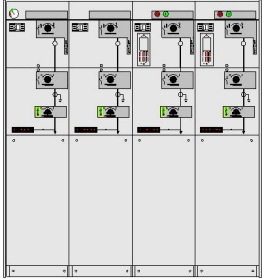
Depth: 765 mm
Width: 1021 mm
Height: 1336 mm



CCCV

Depth: 765 mm
Width: 1346 mm
Height: 1336 mm

7 SafeRing Air configurations

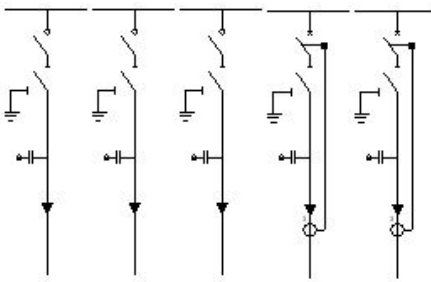


CCVV

Depth: 765 mm

Width: 1346 mm

Height: 1336 mm

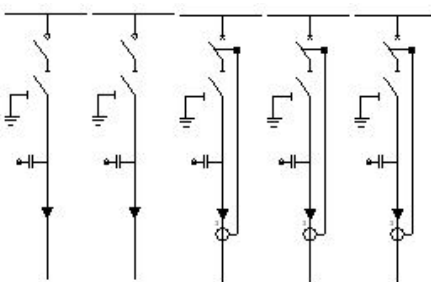


CCCVW

Depth: 765 mm

Width: 1671 mm

Height: 1336 mm



CCVWV

Depth: 765 mm

Width: 1671 mm

Height: 1336 mm

8 SafePlus Air modules



General

SafePlus Air is a metal enclosed compact switchgear system for up to 12 kV distribution applications. The switchgear has a unique flexibility due to the possible combination of any modules.

SafePlus Air combined with SafeRing Air, which is ABB's standard ring main unit, represents a complete solution for 12 kV distribution networks.

SafePlus Air and SafeRing Air have identical user interfaces, operation procedures, spare parts and components.

SafePlus Air is a completely sealed system with a stainless steel tank containing all live parts and switching functions.

A sealed steel tank with constant gas conditions ensures a high level of reliability as well as personnel safety and a virtually maintenance-free system.

The SafePlus Air system offers a circuit-breaker with relay for protection of the transformer.

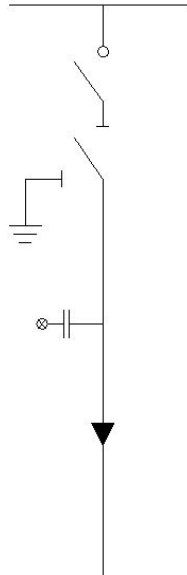
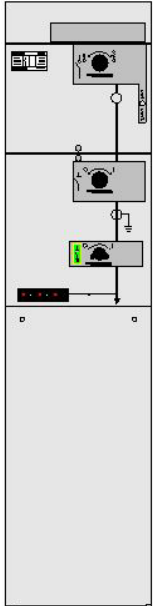
SafePlus Air accommodates a wide selection of protection relays for most applications.

SafePlus Air can also be supplied with remote control and monitoring equipment.

Additional equipment

- Arc suppressor
- Interlocked cable covers
- Cable cover with window
- Cable cover for double T-contacts
- Arc proof cable covers complete incl. interlocking
- Extra base frame (h=450 or 290 mm)
- Trip coil open
- Trip coil open and close
- Motor operation
- Auxiliary switches for all switching functions
- Prepared for relay test equipment
- Capacitive voltage indication (VDS)
- Short circuit indicator
- VCB - tripped signal
- Current metering
- Low voltage compartment
- Top entry box
- Ronis key interlock
- Self-powered relays for V-module
 - SEG WIC1-2-P-E
 - ABB REJ603 r.1.5

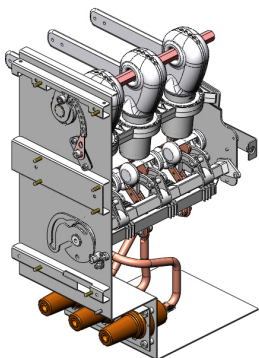
8.1 C - Cable switch module



The cable switch (C-Module) has vacuum bottles as interrupters of the current. In series with the two-position load break switch, main circuit is connected through a three-position disconnector/earthing switch.

The operation between load break switch and disconnector/earthing switch is mechanically interlocked.

Rebuild of C-module to V-module at site is possible.



Common features

All modules share many common features. These are described in the chapter "SafeRing Air configurations".

Technical data

Switch disconnecter

Rated voltage	kV	12
Power frequency withstand voltage	kV	28
Impulse withstand voltage	kV	75
Rated normal current	A	630
Breaking capacities:		
- active load	A	630
- closed loop	A	630
- off load cable charging	A	10
- earth-fault	A	200
- earth-fault cable charging	A	115
- single capacitor bank breaking current		135
Making capacity	kA	50
Short time current 3 sec.	kA	20
Number of mechanical operations		1000 close / open manual
Electrical and mechanical classes		E3, C2, M1

Earthing switch

Rated voltage	kV	12
Power frequency withstand voltage	kV	28
Impulse withstand voltage	kV	75
Making capacity	kA	50
Short time current 3 sec.	kA	20
Number of mechanical operations		1000 close / open manual
Electrical and mechanical classes		E2, M0

Standard features

- Two position single spring mechanism load break switch
- Three positioning single spring mechanism for downstream disconnector/earthing switch
- Interlocking between load break switch and disconnector/earthing switch
- Switch positioning indication for load break switch and disconnector/earthing switch
- Trip coil (for relay tripping)
- Cable bushings horizontal in front, Interface C with integrated voltage divider for voltage indication

Optional features

- Arc suppressor with signal (1NO) wired to low voltage terminals
- Signal (1NO) from internal pressure indicator wired to terminals (only one each air tank)
- Single spring mechanism

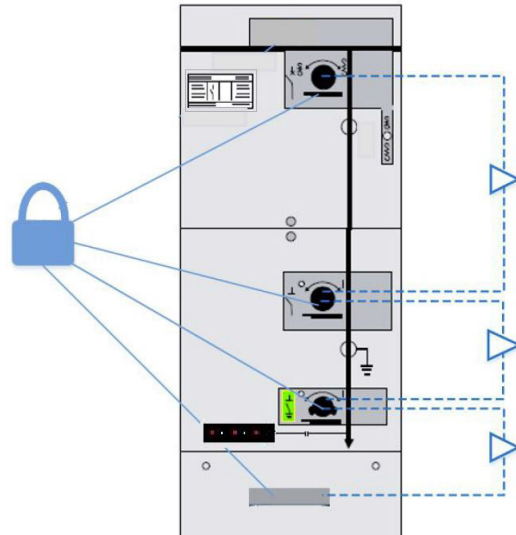
Optional features also available as retrofit


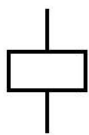


- Motor operation for load break switch
- V-modul rebuild
- Rebuild from standard switchgear to arc proof

8.1.1 C - Cable switch module - Interlocking

Abbreviations

LBS	Load break switch
ES	Earthing switch
D	Disconnecter



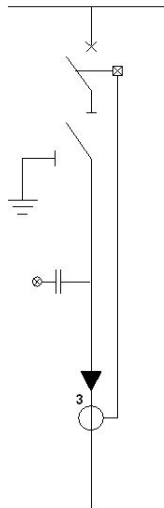
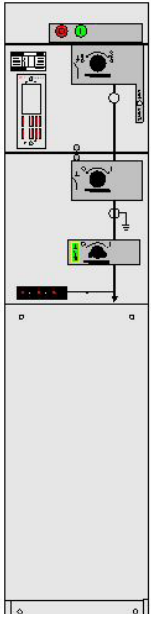
Interlock type	Operation	Condition	Comment
Mechanical interlock C-module 	Closing LBS	None	
	Opening LBS	None	Standard
	Closing D	LBS is open, ES is open, cable compartment cover is on	Cable compartment interlock is optional
	Opening D	LBS is open, ES is open	Standard
	Closing ES	D is open	Standard
	Opening ES	D is open	Standard
	Opening cable compartment	ES is closed	Optional feature
	Closing cable compartment	ES is closed	Optional feature
Electrical interlock C-module 	Closing ES	Incoming cable is without voltage	Optional feature. Voltage detection system with signalling contact is required.
Padlocks C-module Padlocks to be provided by customer 	Lock on ES	None	Standard feature (Diameter of padlock: 4 -8 mm)
	Lock on LBS	None	Standard feature (Diameter of padlock: 4 -8 mm)
	Lock on D	None	Standard feature (Diameter of padlock: 4 -8 mm)
	Lock cable compartment cover in closed position	None	Optional feature (Diameter of padlock: 4 -8 mm)
	Lock cable compartment cover in open position	None	Optional feature (Diameter of padlock: 4 -8 mm)
Key interlock C-module 	Key lock on D	See details in chapter 22 "Key interlocks"	Optional feature
	Key lock on ES	See details in chapter 22 "Key interlocks"	Optional feature

8.2 V - Vacuum circuit-breaker module

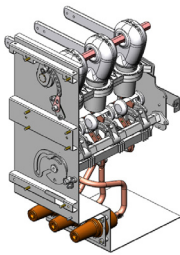
The vacuum circuit-breaker (V-Module) has vacuum bottles as interrupters of the current.

A three-position disconnector/earthing switch is connected in series with the circuit-breaker main circuit.

The operation between vacuum circuit-breaker and disconnector/earthing switch is mechanically interlocked.



Depth: 765 mm
Width: 325 mm
Height: 1336 mm / optional 1100 mm



Common features

All modules share many common features. These are described in the chapter "SafeRing Air configurations".

Standard features

- 630A vacuum circuit-breaker for feeder protection
- Two position double spring mechanism for vacuum circuit-breaker
- Downstream three position disconnector/earthing switch from vacuum circuit-breaker
- Three positioning single spring mechanism for disconnector/earthing switch
- Interlocking between vacuum circuit-breaker and disconnector/earthing switch

Technical data

Vacuum circuit-breaker

Rated voltage	kV	12
Power frequency withstand voltage	kV	28
Impulse withstand voltage	kV	75
Rated normal current	A	630
Breaking capacities:		
- active load	A	630
- off load cable charging	A	25
- short-circuit breaking current	kA	21
- single capacitor bank breaking current	A	135
Making capacity	kA	50
Short time current 3 sec.	kA	20
Number of mechanical operations	2000 close / open manual	
Electrical and mechanical classes	E2, M1	
Operation sequence	0 - 3min - CO - 3min - CO	

Earthing switch

Rated voltage	kV	12
Power frequency withstand voltage	kV	28
Impulse withstand voltage	kV	75
Making capacity	kA	50
Short time current 3 sec.	kA	20
Number of mechanical operations	1000 close / open manual	
Electrical and mechanical classes	E2, M0	

- Switch positioning indication for vacuum circuit-breaker and disconnector/earthing switch
- Self-powered electronic protection relay with ring core CTs on cables
- Trip coil (for relay tripping)

Optional features

- Cable bushings:
 - Interface C (400 series bolted) combisensors with integrated voltage divider for voltage indication or integrated sensor for current and voltage presence system
- Arc suppressor with signal (1NO) wired to terminals
- Signal (1NO) from internal pressure indicator wired to terminals (only one each air tank)

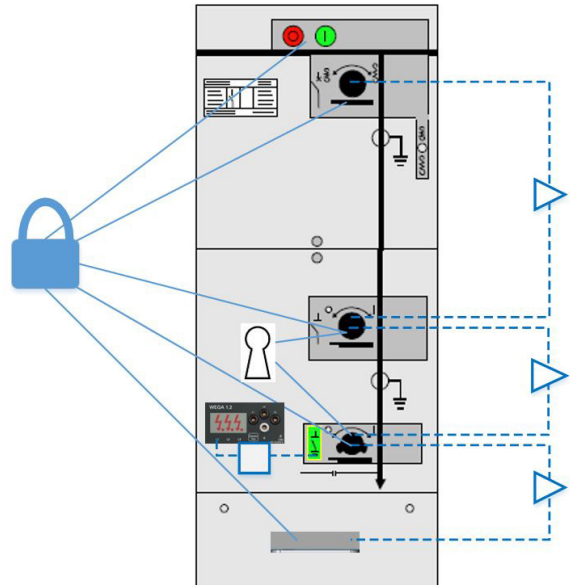
Optional features also available as retrofit


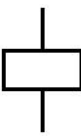


- Motor operation for vacuum circuit-breaker
- Auxiliary switches; Vacuum circuit breaker position 2NO+2NC, disconnector position 2NO+2NC, earthing switch position 2NO+2NC and vacuum circuit-breaker tripped signal 1NO
- Blocking coil
- Undervoltage release coil with/without time delay

8.2.1 V - Vacuum circuit-breaker module - Interlocking

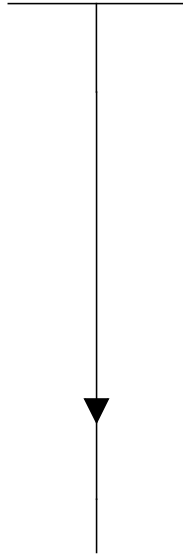
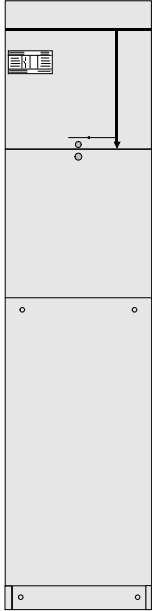
Abbreviations

ES	Earthing switch
CB	Circuit breaker
D	Disconnecter



Interlock type	Operation	Condition	Comment
Mechanical interlock V-module 	Closing CB	None	
	Opening CB	None	
	Closing D	CB is open, ES is open, cable compartment cover is on	Cable compartment interlock is optional
	Opening D	CB is open, ES is open	Standard
	Closing ES	D is open	Standard
	Opening ES	D is open	Standard
	Opening cable compartment	ES is closed	Optional feature
	Closing cable compartment	ES is closed	Optional feature
Electrical interlock V-module 	Closing ES	Incoming cable is without voltage	Optional feature. Voltage presence system with signalling contact is required.
Padlocks V-module Padlocks to be provided by customer 	Lock on ES	None	Standard feature (Diameter of padlock: 4 -8 mm)
	Lock on CB	None	Standard feature (Diameter of padlock: 4 -8 mm)
	Lock on D	None	Standard feature (Diameter of padlock: 4 -8 mm)
	Lock on push buttons	None	Optional feature (Diameter of padlock: 4 -8 mm)
	Lock cable compartment cover in closed position	None	Optional feature (Diameter of padlock: 4 -8 mm)
	Lock cable compartment cover in open position	None	Optional feature (Diameter of padlock: 4 -8 mm)
Key interlock V-module 	Key lock on D	See details in chapter 22 "Key interlocks"	Optional feature
	Key lock on ES	See details in chapter 22 "Key interlocks"	Optional feature

8.3 D - Direct cable connection module



Depth: 765 mm
Width: 325 mm
Height: 1336 mm / optional 1100 mm

Technical data

Direct cable connection

Rated voltage	kV	12
Power frequency withstand voltage	kV	28
Impulse withstand voltage	kV	75
Rated normal current	A	630
Short time current 3 sec.	kA	25

Common features

All modules share many common features. These are described in the chapter "SafeRing Air configurations".

D-module is a direct connection module, which can be the first or the last module of a switchgear unit with common gas volume.

Locking

Padlock on cable compartment cover (optional)

9 Current transformers

Toroidal current transformers

Toroidal transformers are insulated either in epoxy-resin or encapsulated in a plastic housing. They are used either for power measuring devices or protection relays.

Some of these transformers can be closed or split-core type. They can all be used both for measuring phase current and for detecting earth fault current. They conform to standard IEC 61869-1.

KOKM 072 xA 10 – These indoor ring core current transformers supply metering and protection devices at a maximum nominal voltage of 0.72 kV and nominal frequency of 50 or 60 Hz.

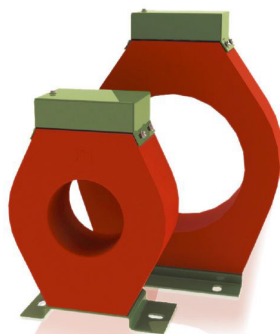
The transformers can be mounted inside the ring main unit / switchgear. Secondary circuits should be mounted using copper wires with a cross-section up to 4 mm² (strand) or up to 6 mm² (solid conductor).

CTs with secondary current 0,075A are specially designed and applicable for self-powered relays.

KOLA and KOLMA are used for measurement of residual current.



KOKM 072



KOLMA



KOLA

10 Measuring transformers

Ring core current transformers and earth-fault transformers

Protection relay standard CT's typical	Ring core current transformer type	Ratio - burden
Transformer type: class 10P10	KOKM 072 or SVA 100-100-45	50-100-200/1 A 1,5/3/6 VA
Transformer type: class 5P10	KOKM 072 or SVA 100-100-45	150/1 A 4 VA
Transformer type: class 5P10	KOKM 072 or SVA 100-100-45	100-200/1 A 4 - 7 VA
Transformer type: class 5P10	KOKM 072 or SVA 100-100-45	300-600/1 A 4 - 7 VA
Transformer type: class 5P10	KOKM 072 or SVA 100-100-45	400-600/1 A 4 - 7 VA
Earth-fault transformer		
Earth-fault transformer, class 10P10, burden 0,5 - 15VA dependent on selected ratio	KOLMA 06A1 (90 mm)	Multi-tap secondary: 50-150/1 A or 50-750/5 A
Earth-fault transformer, class 10P10, burden 0,5 - 15VA dependent on selected ratio	KOLMA 06D1 (180 mm)	Multi-tap secondary: 50-150/1 A or 50-750/5 A
Earth-fault transformer, 0,5 - 20VA	KOLA 100 mm ring type	50 - 1600 A
Earth-fault transformer, 0,5 - 20VA	KOLA 180 mm ring type	50 - 1800 A
Earth-fault transformer, 0,5 - 5VA	KOLA 397 x 300 mm rectangular type	50 - 1250 A

Current transformers for self-powered relays, see chapter 17
"Relays"

11 Combisensor

Sensor variants

Combined sensors with type designation KEVCY 36 RE1. This type is used for both SafeRing Air and SafePlus Air, due to higher dielectrical capability. Sensor provides current measurement and voltage measurement together with voltage indication capability.

Linearity

Due to the absence of a ferromagnetic core the sensor has a linear response over a very wide primary current range, far exceeding the typical CT range.

Current sensor

Current measurement in KEVCY xx RE1 sensors is based on the Rogowski coil principle. A Rogowski coil is a toroidal coil, without an iron core, placed around the primary conductor in the same way as the secondary winding in a current transformer.

Voltage sensor

Voltage measurement in KEVCY xx RE1 sensors is based on the capacitive divider principle.

Sensor application

KEVCY xx RE1 are compact and very small bushing type sensors designed to be used in gas-insulated switchgear type SafeRing Air and SafePlus Air.

The external cone type of the sensor is designed according to the standard EN 50181, Interface C (400 series 630 A, M16 bolt), and therefore enables connection of all compatible cable plugs.

Secondary cables

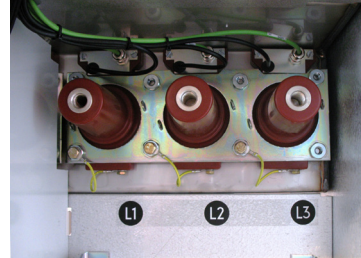
The sensor is equipped with two cables:

- Cable for coupling electrode with BNC connector
- Current and voltage signal cable with RJ-45 connector for connection with the IED

The cable connector for connection with the IED is type RJ-45. The sensor accuracy classes are verified up to the RJ-45 connector, i.e. considering also its secondary cable. This cable is intended to be connected directly to the IED, and subsequently neither burden calculation nor secondary wiring is needed. Every sensor is therefore accuracy tested when equipped with its own cable and connector.

Standard cable length for connection with IED: 2.2 m

Standard cable length for connection with coupling electrode: 0.45 m



Technical data, general

Rated primary current of application	up to 630 A
Rated primary voltage of application	up to 36 kV
Highest voltage for equipment, U_m	36 kV
Rated power frequency withstand voltage	70 kV
Rated lightning impulse withstand voltage	170 kV

Technical data, voltage sensor

Technical data, voltage sensor	Value
Rated primary voltage, U_{pr}	33/ $\sqrt{3}$ kV
Maximum rated primary voltage, U_{primax}	36/ $\sqrt{3}$ kV
Rated frequency, f_n	50/60 Hz
Accuracy class	0.5/3P
Rated burden, R_{br}	10 MOhm
Rated transformation ratio, K_n	10 000 : 1
Rated voltage factor, k_u	1.9/8h

Technical data, current sensor

Rated primary current, I_{pr}	80 A
Rated transformation ratio, K_{ra}	80A /0.150 V at 50 Hz 80 A/0.180 V at 60 Hz
Rated secondary output, U_{sr}	3mV/Hz i.e 150 mV at 50 Hz or 180 mV at 60 Hz
Rated continuous thermal current, I_{cth}	630 A
Rated short-time thermal current, I_{th}	25 kA / 3 s
Rated dynamic current, I_{dyn}	63 kA
Rated frequency, f_r	50/60 Hz
Rated extended primary current factor, K_{pcr}	7.875
Accuracy limit factor, K_{alf}	100
Rated burden, R_{br}	10 MOhm

Cables

Current and voltage sensing:	
Length	2.2 m
Connector	RJ-45 (CAT-6)
Coupling electrode:	
Length	0.45 m
Connector	BNC

12 SeSmart sensor

KECA 80 C85 Indoor current sensor

With KECA 80 C85 sensors measuring class 0.5 is reached for continuous current measurement in the extended accuracy range from 5% of the rated primary current I_{pr} not only up to 120% of I_{pr} (as being common for conventional current transformers), but even up to the rated continuous thermal current I_{cth} .

For dynamic current measurement (protection purposes) the ABB sensors KECA 80 C85 fulfil requirements of protection class 5P up to an impressive value reaching the rated short-time thermal current I_{th} . That provides the possibility to designate the corresponding accuracy class as 5P630, proving excellent linearity and accuracy measurements.

Sensor applications

The current sensors type KECA 80 C85 are intended for use in current measurement in low voltage or medium voltage switchgear. In medium voltage switchgear the current sensor shall be installed over a bushing insulator, insulated cable, insulated and shielded cable connectors or any other type of insulated conductor. The current sensor is equipped with a clamping system which provides easy and fast installation and therefore makes the sensor suitable for retrofit purposes.

Secondary cables

The sensor is equipped with a cable for connection with the IED. The cable connector is type RJ-45. The sensor accuracy classes are verified up to the RJ-45 connector, i.e. considering also its secondary cable. These cables are intended to be connected directly to the IED, and subsequently neither burden calculation nor secondary wiring is needed. Every sensor is therefore accuracy tested when equipped with its own cable and connector.

The design of the sensor is optimized to be easily assembled on the shielded cable connectors used with bushings designed according to the standard EN 50181, Interface C.

Correction factors

The amplitude and phase error of a current sensor is, in practice, constant and independent of the primary current. Due to this fact it is an inherent and constant property of each sensor and it is not considered to be an unpredictable and influenced error. Hence, it can be easily corrected in the IED by using appropriate correction factors, stated separately for every sensor.



Parameters for application

Rated primary current of application	up to 2500 A
Sensor parameters	
Highest voltage for equipment, U_m	0,72 kV
Rated power frequency withstand voltage	3 kV
Rated primary current, I_{pr}	80 A
Rated continuous thermal current I_{cth}	2500 A
Rated transformation ratio, K_{ra}	80A / 150 mV at 50 Hz 180 mV at 60 Hz
Current accuracy class	0,5/5P630
Length of cable	2,2/3,4/3,6 m

Values of the correction factors for the amplitude and phase error of a current sensor are mentioned on the sensor label (for more information please refer to Instructions for installation, use and maintenance) and should be uploaded without any modification into the IED before the sensors are put into operation. To achieve required accuracy classes it is recommended to use all correction factors (Cfs): amplitude correction factor (α) and phase error correction factor (ϕ) of a current sensor.

12 SeSmart sensor

KEVA 24 C Indoor voltage sensor

KEVA 24 voltage sensors are intended for use in voltage measurement in gas-insulated medium voltage switchgear.

The voltage sensors are designed to easily replace the insulating plugs originally used in the cable T-connectors. Due to their compact size and optimized design sensors can be used for retrofit purposes as well as in new installations.

Correction factors

The amplitude and phase error of a voltage sensor is, in practice, constant and independent of the primary voltage. Due to this fact, it is an inherent and constant property of each sensor and is not considered to be an unpredictable and influenced error. Hence, it can be easily corrected in the IED by using appropriate correction factors, stated separately for every sensor.

Values of the correction factors for the amplitude and phase error of a voltage sensor are mentioned on the sensor label (for more information please refer to Instructions for installation, use and maintenance) and should be uploaded without any modifications into the IED before the sensors are put into operation (please check available correction in the IED manual). To achieve required accuracy classes it is recommended to use both correction factors (Cfs): amplitude correction factor (aU) and phase error correction factor (pU) of a voltage sensor.



Parameters for application

Rated primary voltage of application	up to 24 kV
Sensor parameters	
Rated primary voltage, U_{pn}	22/√3
Highest voltage for equipment, U_m	24 kV
Rated power frequency withstand voltage	50 kV
Rated lightning impulse withstand voltage	125 kV
Rated continuous thermal current I_{cth}	2500 A
Rated transformation ratio, K_{ra} for voltage measurement	10000 : 1
Voltage accuracy class	0,5/3P
Length of cable	2,2 m

Sensor variants and use in cable T-connectors

Sensor type designation	Cable T-connectors	
	Manufacturer	Type
KEVA 24 C10	Nexans-Euromold	400 TB/G
		440 TB/G
		K400 TB/G
		K440 TB/G
		400PB-XSA
KEVA 24 C21	Kabeldon	CSE-A 12630
		CSEP-A 12630
		CSE-A 24630
		CSEP-A 24630
		SOC 630 - 1/2
KEVA 24 C22	NKT	CB 12-630
		CC 12-630
		CB 24-630
		CC 24-630
	Raychem	RSTI L56xx
		RSTI-CC L56xx
KEVA 24 C23	Raychem	RSTI 58xx/39xx
		RSTI CC 58xx/39xx
		RSTI LCxx/LAxx (older)
	NKT	CB 12-630
		CC 12-630
		CB 24-630
		CC 24-630
		CC 24-630

13 Cable bushings



The connection of the MV-cables is made by cable bushings. The bushings are made of epoxy resin with moulded-in conductors. In addition, a screen is moulded in to control the electrical field and is also used as the main capacitor supplying the voltage indicating systems.

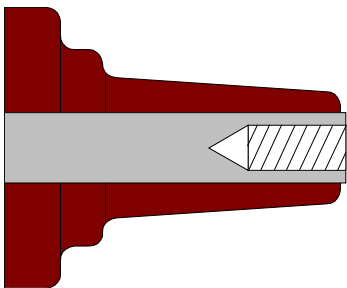
Up-to-date production facilities and advanced robots and test equipment ensure the high quality required for each single device.

A very high number of units have been installed worldwide in distribution networks, power stations and industrial complexes.

Used together with full-screened connectors, an ideal solution for areas with humidity or condensation problems is achieved. The bushings are designed according to CENELEC EN 50181, EDF HN 52-S-61 and IEC 60137.

There are two types of cable bushings:

- Interface C (400 series with M16 bolted contact, $I_n=630A$)
- Interface C (400 series with M16 bolted contact and integrated voltage and current sensors, $I_n=630A$).
See combisensors



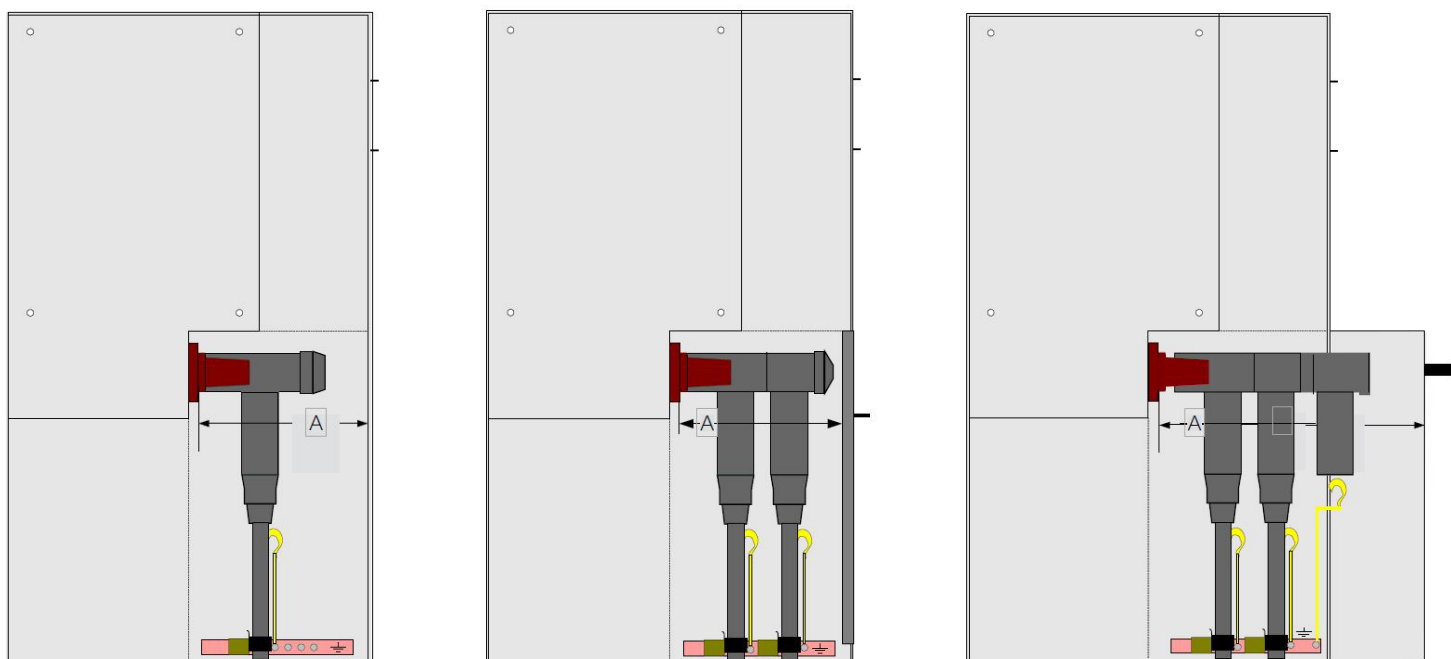
Interface C with M16 x 2 metric threads
400 series, $I_n = 630 A$
Standard on C, V and D modules
Cable cross-section: See table 12.1.1.

The installation instructions from the manufacturer of cable terminations must be followed. Be sure to lubricate the bushings thoroughly with the silicone supplied.

Where cables are not connected, the earthing switch must be locked in closed position or the bushings must be fitted with dead end receptacles before the unit is energized.

14 Cable termination

All bushings are situated at the same height from the floor and are protected by a cable compartment cover. The three drawings below show typical arrangements with cable connectors for single and double cables.



The table below shows the net distance A in millimeters from cable bushing to the inner part of cable compartment cover.

Cable compartment type	Interface C (400 series bolted)
Standard	360
With window	353
Arc proof with/without window	337
Deep	555

The following manufacturers of cable terminations are recommended:

- ABB Kabeldon
- Südkabel
- Euromold/Elastimold
- nkt cables
- Tyco Electronics
- Prysmian
- 3M

14 Cable termination



CSE-A 12250



CSE-A 12400



CSE-A 12630

Screened separable cable connectors

CSE-A 12 kV, 250 A, 400 A, 630 A

Application area

Pre-moulded, screened, separable connectors for XLPE insulated 1- or 3-core cables with aluminium or copper conductors for 12–42 kV. Can be installed both indoors and outdoors.

Fits standard bushings of outer cone type according to EN 50181. Connectors with rated current:

- 630 A: interface type C with bolt M16

Standard

Meets the requirements of:

- CENELEC, HD 629.1 S2

Design

CSE-A is premoulded and manufactured in rubber with three layers, a conductive inner layer, an insulation layer and a conductive outer layer, that are vulcanized together for the best possible interface between the layers.

The cable connectors include both a capacitive test point with protection and an integrated earthing wire.

The connectors are delivered in 3-phase kits, complete with cable lugs, bolt connection and stress grading adapter, designed to ensure a reliable installation.

Note:

For 3-core cable with common Cu-screen wires, a screen separation kit must be used.

Designation	XLPE/EPR Ø mm ²	Conductor cross section mm ²	Rated current	Bushing type	Weight kg/unit
Elbow cable connector with capacitive test point, 12kV					
CSE-A 12630-01	13 - 20	25 - 70	630 A	Interface type C with bolt M16	5.1
CSE-A 12630-02	18.5 - 30.5	95 - 300	630 A	Interface type C with bolt M16	5.5
CSE-A 12630-03	30.5 - 45.0	400 - 630	630 A	Interface type C with bolt M16	7.7

14 Cable termination

Table 14.1

12 kV: Separable connectors interface C, I _p = 630 A							Cable compartment with									
Manufacturer	Designation	Conductor [mm ²]	XLPE / EPR Ø [mm]	Earthing shield Yes / No	Additional equipment for dual cable arrangement	Surge Arrester with	Single cable + surge arrester				Dual cables					
							Standard Distance A = 360 mm	With window Distance A = 353 mm	Arc proof Distance A = 337 mm	Deep Distance A = 555 mm	Standard Distance A = 360 mm	With window Distance A = 353 mm	Arc proof Distance A = 337 mm	Deep Distance A = 555 mm		
3M	93-EE 705-6/-95	50-95	15.0-23.5	Y	KU 23.1+93-EE 705-6/95	MUT 23										
3M	93-EE 705-6/-240	120-240	21.8-32.6	Y	93-EE 718-6/150-240	MUT 23										
ABB Kabeldon	CSE-A 12630-01	25-70	13.0-20.0	Y	CSEP-A 12630-01	CSAP-A 12	X	X		X	X	X	X	X	X	X
ABB Kabeldon	CSE-A 12630-02	95-300	18.5-30.5	Y	CSEP-A 12630-02	CSAP-A 12	X	X	X	X	X	X	X	X	X	X
ABB Kabeldon	CSE-A 12630-03	400-630	30.5-45.0	Y	CSEP-A 12630-03	CSAP-A 12	X	X		X	X	X	X	X	X	X
Euromold	430TB/G	25-300	12.0-37.5	Y	300 PB/G ²⁾	300SA ²⁾	X	X	X	X	X	X	X	X	X	X
Euromold	484TB/G ³⁾	50-630	16.0-56.0	Y	804PG/G ²⁾	800SA ²⁾	X	X	X	X	X	X	X	X	X	X
nkt cables	CB12-630	25-300	12.7-34.6	Y	CC 12-630	CSA 12	X	X	X	X	X	X	X	X	X	X
nkt cables	AB12-630	25-300	12.7-34.6	N	AC 12-630	ASA 12	X	X	X	X	X	X	X	X	X	X
nkt cables	CC24-630(1250)	400-630	34.0-45.6	Y	CC24-630(1250) or CC 12-630	CSA 12	X	X	X	X	X	X	X	X	X	X
Prysmian	FMCTs-400	70-300	18.5-30.4	Y	FMPCs-400-12+ FMCTs-400	Yes ¹⁾				X						X
Prysmian	FMCTs-400/1250	70-300	18.5-42.0	Y	FMPCs-400-12+ FMCTs-400/1250	Yes ¹⁾				X						X
Südkabel	SET 12	50-300	15.0-32.6	Y	SEHDK 13.1	MUT 23	X	X	X	X						X
Südkabel	SET 12	50-300	15.0-32.6		KU 23.2/22 +SET 12	MUT 23	X	X	X	X						X
Südkabel	SEHDT 13	400-500	31.3-36.4	Y	None	KU33+MUT 23				X						
Tyco Electronics	RSTI-L	25-300	12.7-34.6	Y	RSTI-CC-L	RSTI-SA	X	X	X	X	X	X	X	X	X	X
Tyco Electronics	RICS	25-300	Flexible	N	None	RDA	X	X	X	X						
Tyco Electronics	RSTI-36Lxx	400-630	28.9-45.6	Y	RSTI-66CP-M16+ RSTI-36Lxx	None				X						X

¹⁾ Combination with surge arrester possible with Euromold 400PBX-XSA

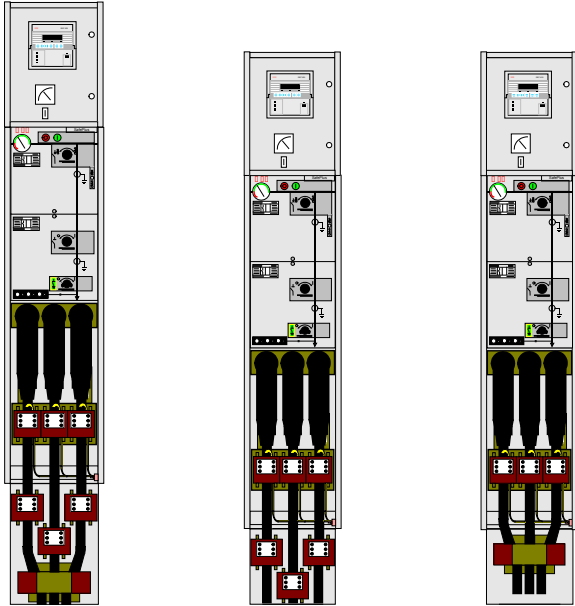
²⁾ For dual cable + surge arrester, deeper cable compartment is required. Solution available for Euromold connectors only.

³⁾ Available up to 1250 A.

Separable connectors without earthing shield are not recommended.

For dynamic and thermal short-circuit currents, please compare the values expected in your network with the rated values of the connector from the different suppliers

15 Base frame



Base frame 450 mm with earth-fault transformer and extra set of current transformers

Base frame 290 mm with an extra set of current transformers

Base frame 290 mm with earth-fault transformers

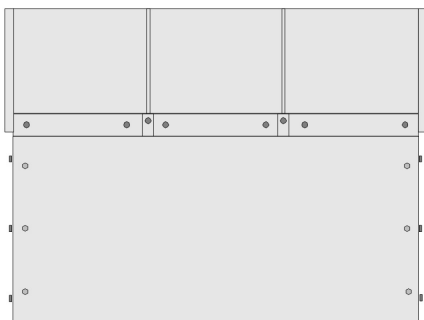
When SafeRing Air and SafePlus Air are placed directly on a floor, the height from the floor to the centre of the cable bushings is 595 millimeter. If there is no cable trench, this height might not be sufficient for some applications. It is then possible to place the switchgear on an additional base frame.

This base frame is available in two different heights; 290 and 450 millimeter.

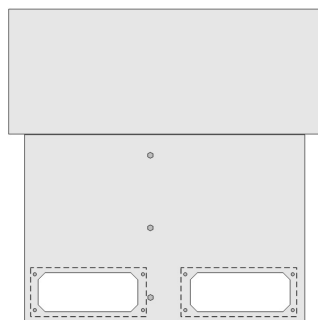
Inside the standard cable compartment for the vacuum circuit-breaker there will be enough space for three current transformers for protection relay.

If an earth fault transformer or an extra set of current transformers are required, an additional base frame is necessary, please see examples on left hand side.

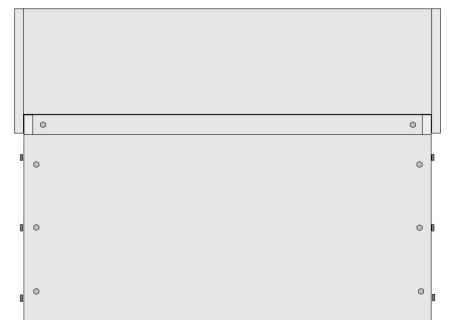
The base frame has openings for cable entrance from the bottom and from both sides. It is delivered as a kit and has to be assembled on site.



Front view

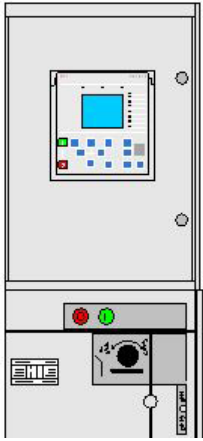


Side view



Rear view

16 Low voltage compartment / Top entry box



Low voltage compartment with REF615 relay

Low voltage compartment

Additionally all SafePlus Air switchgears can be supplied with a low voltage compartment.

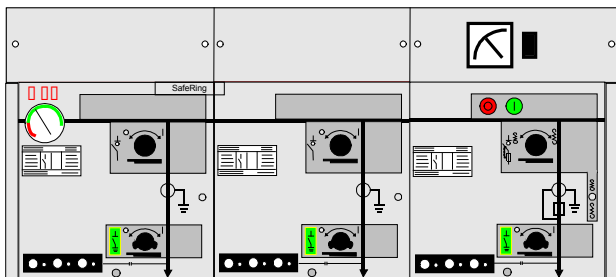
This compartment may be equipped with protection relays, meters, position switches, terminal blocks etc.

The compartment is fixed to the side covers of the air tank and must cover the total width of the switchgear. Each module has a separate hinged door, but there are no partition walls between the modules.

The low voltage compartment has the possibility of external cable entry from either left- or right-hand side.

Locking system for the door is available on request.

Different heights for low voltage compartment are available. (470 and 700 mm).



Top entry box with A-meter and selector switch

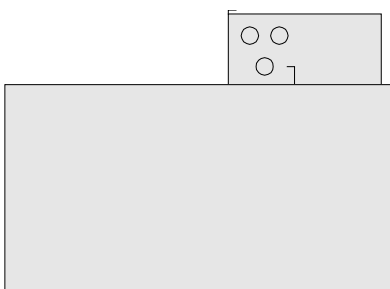
Top entry box

If motor operation, coils, auxiliary switches, self-powered protection relay etc. are mounted on a SafeRing Air or SafePlus Air module, the terminal blocks and the wiring are located behind the front covers.

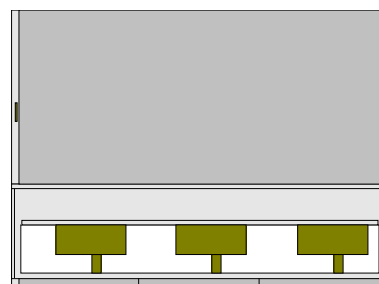
However, an additional top entry box can be mounted on the top of all SafeRing Air switchgears. Since the top entry box is fixed to the side covers of the air tank, the total width of the switchgear must be covered.

The top entry box allows entrance of the customer's low voltage wiring from the rear side, left-hand side and right-hand side.

Furthermore, the top entry box gives the opportunity to install ammeters with position switches, a local/remote switch for motor operation etc.



Side view top entry box



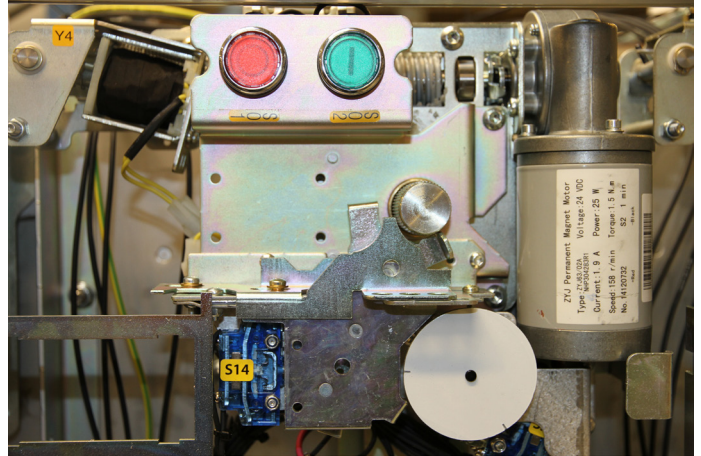
Top entry box seen from above when front / top covers have been removed

17 Motor operation and operation coil

Closing and opening operations of the load-break switches and charging of the springs of the mechanisms for the circuit-breaker may be performed by motor operation (optional solution). The disconnecter and all earthing switches do not have this possibility. All motor devices require DC voltage. If the control voltage is either 110 or 220 V AC, a rectifier is integrated in the control unit.

The operating cycle for V-module motor operation is O-3min-CO-3min-CO (i.e. it may be operated with a frequency of up to one close and one open operation every third minute).

Motors and coils can be mounted to the mechanisms after delivery (retrofit). Test voltage for tables below is +10/ -15% for motor operations and closing coils and +10/ -30% for trip coils and opening coils.



Characteristics of motor operation for C-module

Rated voltage (V)	Power consumption (W) or (VA)	Operation times		Peak start current (A)	Fuse
		Closing time (s)	Opening time (s)		
24	90	6 - 9	6 - 9	14	F 6,3 A
48	150	4 - 7	4 - 7	13	F 4 A
60	90	6 - 9	6 - 9	7	F 4 A
110	90	6 - 9	6 - 9	3	F 2 A
220	90	6 - 9	6 - 9	1,7	F 1 A

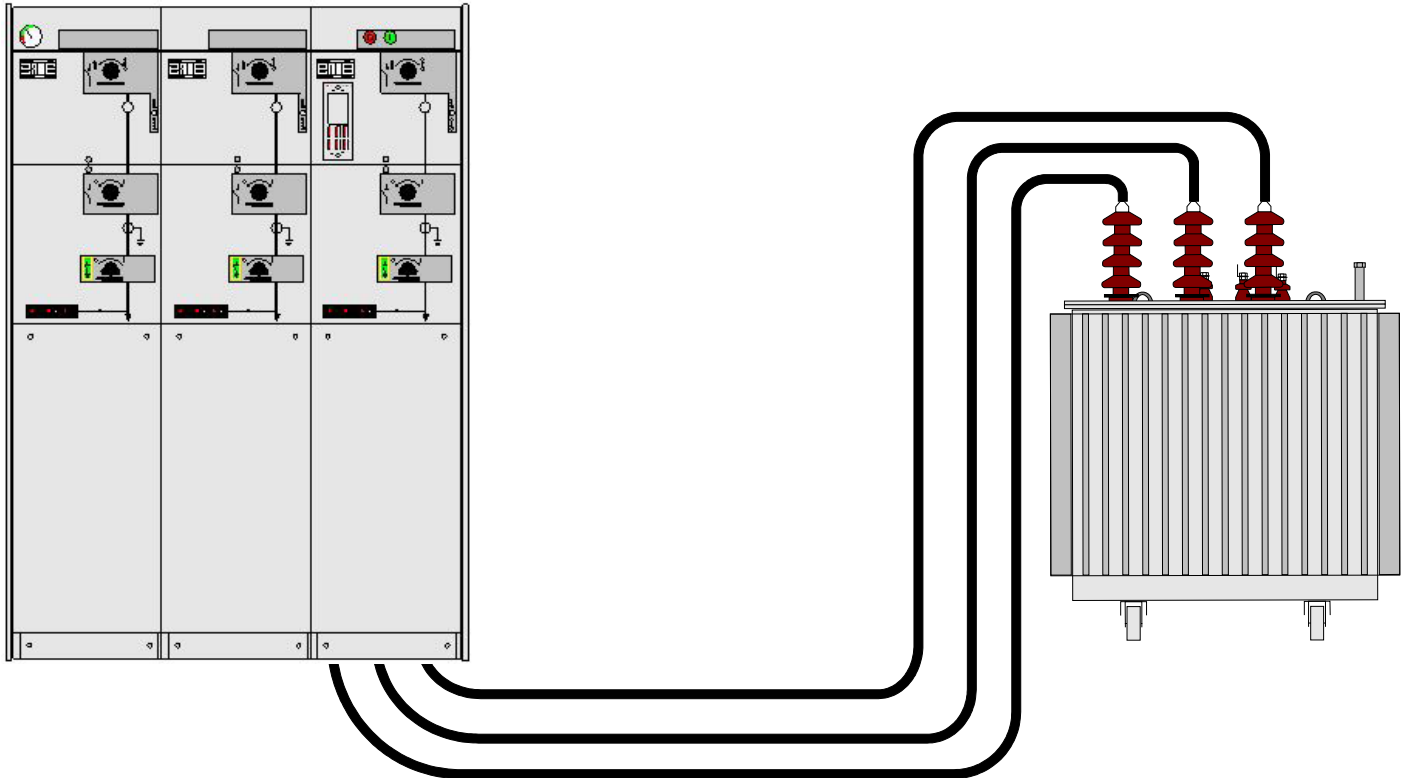
Characteristics of motor operation for V-module

Rated voltage (V)	Power consumption (W) or (VA)	Operation times		Peak start current (A)	Fuse
		Charge/Closing time (s)	Opening time (ms)		
24	180	10-17	40-60	14	F 6,3 A
48	220	5-9	40-60	13	F 4 A
60	150	9-13	40-60	7	F 4 A
110	170	9-13	40-60	3	F 2 A
220	150	9-14	40-60	1,7	F 1 A

Characteristics of shunt trip coils, closing coils and opening coils for V-module

Rated voltage (V)	Power consumption (W) or (VA)	Operation times		Peak start current (A)	Fuse for closing coil Y2 (Opening coil Y1 is unfused)
		Closing time (ms)	Opening time (ms)		
24 V DC	150	40-60	40-60	6	F 3,15 A
48 V DC	200	40-60	40-60	4	F 2 A
60 V DC	200	40-60	40-60	3	F 1,6 A
110 V DC	200	40-60	40-60	2	F 1 A
220 V DC	200	40-60	40-60	1	F 0,5 A
110 V AC	200	40-60	40-60	2	F 1 A
230 V AC	200	40-60	40-60	1	F 0,5 A

18 Transformer protection



SafeRing Air and SafePlus Air offer a solution with circuit-breaker in combination with relay for transformer protection.

The circuit-breaker with relay offers better protection against low over-currents. It also handles good protection against short-circuits. Circuit-breaker with relay is always recommended for higher rated transformers.

SafeRing Air and SafePlus Air are delivered with a 630 A rated V-module.

Both SafeRing Air and SafePlus Air is equipped with a self-powered relay that utilizes the energy from the CTs under a fault situation to energizing the trip coil.

The self-powered relay can also be used for cable protection. More details on the different relays can be found from tables in relay chapter.

Transformer protection with self-powered relay

Recommended types:

- ABB relay type REJ 603 r.1.5
- Woodward relays type WIC 1 and WIB 1 PE
- Kries relay type IKI-30

Important features V-module:

The relay is placed behind the front cover. There is no need for additional low voltage box for the self-powered relays used for transformer protection.

Typical for vacuum circuit breaker protection:

- Good protection against short-circuits
- Very good for protection of over currents
- Small fault currents are detected in an early stage

18 Relays



SafePlus Air can be delivered with a V-module with 630A vacuum circuit-breaker. This chapter describes the different choices of protection relays and feeder terminals that can be used in SafePlus Air. These relays require an additional low voltage compartment.

Standard test procedure is functional test of trip circuit of the relays. All customer settings must be done on site.

REF type feeder terminals are configured according to customer specification for protection functions. Special control requirements on request only.

The V-module can also be delivered prepared for customer installation of protection relays, at two levels, where the factory provides:

- Trip coil and auxiliary contact.
- Cut out in LV-compartment, trip coil, aux. contact, wiring and drawings.

There are two main groups of relays delivered:

- A. ABB feeder protection relays
- B. Self-powered relays

A. ABB offers a wide range of feeder protection relays.

These relays have been sold for a long period and have an excellent reputation for reliability and secure operation.

These relays have either 18-80VDC or 80-265VAC/DC auxiliary supplies and are connected to conventional CTs and VTs.

B: Self-powered relays are suitable for rough conditions and places without the possibility of auxiliary supply.

SafeRing Air and SafePlus Air can be delivered with different types to fulfill all relevant needs in a distribution network.

19 Relays



Feeder protection

The power protection applications can roughly be divided into two categories, namely standard applications (utilizing basic current based protection) and high requirement applications (utilizing current and voltage based protection) and also the combination of the two.

The selected power protection scheme or system has to fulfil the application-specific requirements regarding sensitivity, selectivity and operating speed of the power protection. The power protection requirements are mainly determined by the physical structure of the power network or system and in most cases the requirements can be fulfilled with non-directional/directional over-current protection IEDs.

In power networks or systems with a more complex structure, more advanced power protection functions like distance protection or line differential protection may have to be introduced.

The purpose of the over- and under-voltage power protection system is to monitor the voltage level of the network. If the voltage level deviates from the target value by more than the permitted margin for a set time period, the voltage protection system is activated and it initiates actions to limit the duration of this abnormal condition and the resulting stresses caused to the power system or its components.

To prevent major outages due to frequency disturbances, the substations are usually equipped with under-frequency protection IEDs, which in turn control various power load-shedding schemes. These are just a few examples of the protection for power feeders provided by ABB relays.

Powered Relays

For features and functions, see table at page 45.

REF601

REF601 is a dedicated feeder protection relay, intended for the protection of utility substations and industrial power systems, in primary and secondary distribution networks. REF601/REJ601 is a member of ABB's Relion® product family and part of its 601 series. The relay is available in three alternative application configurations: A, B and C.

REC615

REC615 is a dedicated grid automation IED designed for remote control and monitoring, protection, fault indication, power quality analyzing and automation in medium-voltage secondary distribution systems, including networks with distributed power generation, with secondary equipment such as medium-voltage disconnectors, switches and ring-main units.



19 Relays



REF611

REF611 is a dedicated feeder IED designed for the protection, control, measurement and supervision of utility substations and industrial power systems including radial, looped and meshed distribution networks with or without distributed power generation. REF611 is available in two alternative standard configurations.

REF615

REF615 is a dedicated feeder IED perfectly aligned for the protection, control, measurement and supervision of utility and industrial power distribution systems. It mainly provides protection for overhead lines, cable feeders and busbar systems of power distribution substations. It fits both isolated neutral networks and power networks with resistance or impedance earthed.

REF620

REF620 is a dedicated feeder IED perfectly aligned for the protection, control, measurement and supervision of utility and industrial power distribution systems, including radial, looped and meshed distribution networks. REF620 is a member of ABB's Relion® protection and control product family and its 620 series. The 620 series IEDs are characterized by their functional scalability and withdrawable-unit design. The 620 series has been designed to unleash the full potential of the IEC 61850 standard for communication and inter-operability of substation automation devices.

REF630

REF630 is a comprehensive feeder management IED for protection, control, measuring and supervision of utility and industrial distribution substations. REF630 is a member of ABB's Relion® product family and a part its 630 product series characterized by functional scalability and flexible configurability.

REF630 also features necessary control functions constituting an ideal solution for feeder bay control. REF630 provides main protection for overhead lines and cable feeders of distribution networks. REF630 fits both isolated neutral networks and networks with resistance or impedance earthed neutral. Four pre-defined configurations to match typical feeder protection and control requirements are available.

The pre-defined configurations can be used as such or easily adapted or extended with freely selectable add-on functions, by means of which the IED can be fine-tuned to exactly satisfy the specific requirements of your present application. REF630 incorporates local and remote control functions. The IED offers a number of freely assignable binary inputs/outputs and logic circuits for establishing bay control and interlocking functions for circuit breakers and motor operated switch-disconnectors.

REF630 supports both single and double busbar substation busbar layouts.

19 Relays

For full overview of protection relay functionality refer to the data sheet of each specific relay.

Technical functions powered relays	Powered relays							
	IEC61850	IEC60617	IEEE device no.	REF601	REF611	REF615	REF620	REF630
Functionality groups								
Overcurrent functions								
Three-phase transformer inrush detector	INROPHARI	3I2f>	68	X	X	X	X	X
Three-phase non-directional overcurrent protection, low stage	PHLPTOC	I>	51P-1	X	X	X	X	X
Three-phase non-directional overcurrent protection, high stage	PHHPTOC	I>>	51P-2	X	X	X	X	X
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC	I>>>	50P/51P	X	X	X	X	X
Three-phase directional overcurrent protection, low stage	DPHLPTOC	I>->	67-1			X	X	X
Three-phase directional overcurrent protection, high stage	DPHHPPTOC	I>>->	67-2			X	X	X
Earth-fault functions								
Non-directional earth-fault protection, low stage	EFLPTOC	Io>	51N-1	X	X	X	X	X
Non-directional earth-fault protection, high stage	EFHPTOC	Io>>	51N-2	X	X	X	X	X
Non-directional earth-fault protection, instantaneous stage	EFIPTOC	Io>>>	50N/51N	X	X	X	X	X
Directional earth-fault protection, low stage	DEFLPDEF	Io>->	67-N1			X	X	X
Directional earth-fault protection, high stage	DEFHPDEF	Io>>->	67N-2			X	X	X
Over-/undervoltage								
Three-phase overvoltage protection	PHPTOV	U>/>>/>>>	59			X	X	X
Three-phase undervoltage protection	PHPTUV	U</<</<<<	27			X	X	X
Residual overvoltage protection	ROVPTOV	Uo>	59G		X	X	X	X
Frequency protection function								
	FRPFRQ	f>/f<,df/dt	81			X	X	X
Thermal protection function								
Three-phase thermal protection	T1PTTR	3Ith>F	49F	X	X	X	X	X
Arc protection function								
Arc protection	ARCSARC	ARC	50L/50NL			X	X	
Advanced protection functions								
Auto-reclosing	DARREC	O -> I	79	X	X	X	X	X
Fault locator	SCEFRFLO	FLOC	21FL			X		X
Distance protection	DSTPDIS	Z<	21,21P,21N					X
Synchro check	SYNCRSYN	SYNC	25			X	X	X
Measuring functions								
Three-phase current measurement	CMMXU	3I	3I		X	X	X	X
Voltage	VMMXU	3U	3V			X	X	X
Power and energy measurement (S,P,Q,PF)	PEMMXU	P,E	P,E			X	X	X
Frequency	FMMXU	f	f			X	X	X
Disturbance recorder	RDRE	DR	DFR		X	X	X	X
Residual current measurement	RESCMMXU	Io	In		X	X	X	X
Residual voltage measurement	RESVMMXU	Uo	Vn		X	X	X	X
Load profile recorder	LDPMSTA	LOADPROF	LOADPROF			X	X	
Communication functions								
103				X		X	X	X
IEC61850					X	X	X	X
Modbus				X	X	X	X	

19 Relays



Self-powered relays

REJ603 r.1.5

REJ603 r.1.5 relay is intended to be used for the selective short-circuit and earth-fault protection of feeders in secondary distribution networks and for protection of transformers in utilities and industries. This relay has dual mode of earth-fault measurement - internal vector summation or external CBCT input. Functions are easy to set up by using the dip-switches.



IKI30

The Trafomonitor IKI-30 is applicable for monitoring and protection of distribution network transformers between 160 kVA and 12 000 kVA. By means of split-core CTs overcurrents and short-circuit currents can be detected in the lines.

Applications:

- a) Overcurrent- and short circuit/earth-fault protection by combination of IKI-30 and circuit breaker / load breaker
- b) Overcurrent protection by combination of IKI-30 with load breaker and high voltage fuses.



WIB1

All available versions of the WIB1 relay are a high-tech and cost-optimized protection for MV switchboards. Specifically in compact switchboards, the WIB12PE and WIB12FE protection system in combination with a circuit breaker can replace the combination of load-break-switch with HV fuses. The overload protection for the attached unit is clearly improved. When power distribution networks are extended more and more high powered transformers are used and HV fuses are inadmissible. For such applications the WIB1 protection system is an optimal replacement.



WIC1

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WIP1

The WIP1 is an overcurrent relay with multi-characteristics. Definite time and inverse time tripping characteristics can be selected. The WIP1-1 does not require any auxiliary voltage supply, consequently it can also be used for switchboards without built-in batteries. It takes its power supply energy from the current transformers' circuits and provides the tripping pulse energy to the circuit breaker. Due to its wide setting ranges, the tripping characteristic can be selected to protect a wide variety of different equipment. Optionally the WIP1 is available with earth fault element (option IE) and negative sequence element (option IS).

19 Relays

Technical functions self-powered relays

Functionality				Relay				
Features	Description	IEC 60617	IEEE device no.	WIP 1	REJ 603 r.1.5	WIC 1	WIB 1	IKI 30
Protection functions	Three-phase transformer inrush detector	3I2f>	68	-	X	-	-	X
	Phase overcurrent (multi-characteristic)	3I> (low set)	50/51	X	X	X	X	X
	Short-circuit protection	I>>	50/51	X	X	X	X	X
	Number of overcurrent elements		50/51B	2	2	2	2	2
	Earth-fault current	I0> (low set)	50N/51N	X	X	X	X	X
	Number of earth-fault elements			2	2	1	2	2
Characteristic curves	Overcurrent element			DEFT,INV ¹⁾	DEFT,INV ¹⁾	DEFT,INV ¹⁾	DEFT	DEFT,INV ¹⁾
	Earth-fault current			DEFT,INV ¹⁾	DEFT,INV ¹⁾	DEFT	DEFT,INV ¹⁾	DEFT
Additional functions	Trip indication			X	X	X (option)	X	X
	Electro-impulse			1	1	1	2	1
	input remote tripping (voltage)			230VAC	-	115/230VAC	115/230VAC	24VDC/ 115/230VAC
	Auxiliary power, voltage (option)							
Measuring circuit	Rated secondary current			ring core CT with Isec = 1A	wide range special CT	wide range special CT	wide range special CT	wide range special CT
	Measuring range, start current I> (A)			0,17 ³⁾	7,2	7,2	7,2	7,2
Climatic withstand	Storage temperature (°C)			-40 ...+85	-40 ...+85	-40 ...+85	-40 ...+85	-30 ...+70
	Operating temperature (°C)			-20 ...+55	-40 ...+85	-40 ...+85	-40 ...+85	-25 ...+55

- ¹⁾ - Definite time overcurrent (DEFT)
 - Normal inverse time overcurrent (NINV)
 - Very inverse time overcurrent (VINV)
 - Extremely inverse time overcurrent (EINV)
 - Long time inverse time overcurrent (LINV)

- Resistance inverse time overcurrent (RINV)
 - Characteristics of high voltage fuse-link (HV-FUSE)
 - Characteristics of full range fuse (FR-FUSE)
 - Definite time overcurrent
 - Inverse characteristics, please contact us for further information

³⁾ secondary current

19 Relays

Ring core current transformers and earth-fault transformers

REJ603 r.1.5 transformer protection and cable protection kit (self-powered)	Ring core current transformer type	Current range
Transformer type	KOKM 072 CT1	8 - 28 A
Transformer type	KOKM 072 CT2	16 - 56 A
Transformer type	KOKM 072 CT3	32 - 112 A
Transformer type	KOKM 072 CT4	64 - 224 A
Transformer type	KOKM 072 CT5	128 - 448 A
Woodward WIC1 and WIB1 transformer protection and cable protection kit (self-powered)	Ring core current transformer type	Current range
Transformer type	KOKM 072 CT2 or WIC1-W2	16 - 56 A
Transformer type	KOKM 072 CT3 or WIC1-W3	32 - 112 A
Transformer type	KOKM 072 CT4 or WIC1-W4	64 - 224 A
Transformer type	KOKM 072 CT5 or WIC1-W5	128 - 448 A

20 Capacitive voltage indicators



HR-module (VDS)



VIM 3



VIM 1

SafeRing Air and SafePlus Air switchgears are equipped with voltage indicators in accordance either with IEC 61958 standard for voltage presence indication system (VPIS) or IEC 61243-5 standard for voltage detection system (VDS).

Voltage indicators VPIS

VPIS indicators indicate only presence of the medium voltage. Absence of the voltage needs to be confirmed by use of voltage detection system.

Phase comparison and testing of VPIS

Each phase of the integrated voltage presence indicating system has a connection point on the front panel, which can be used to perform phase comparison and to test the voltage presence indicator.

Voltage indicators VDS

VDS is used to detect the presence or absence of medium voltage according to IEC 61243-5.

The VDS system delivered by ABB can be either based on the LRM or the HR- system.

Voltage indicators VDS LRM

With the VDS LRM system, the following can be indicated:

- Overvoltage
- Nominal voltage presence
- Isolation problems
- No voltage
- Broken lead indication (Optional feature)

Indication is done visually on the display.

Voltage indicators VDS HR

SafeRing Air and SafePlus Air can be delivered with a voltage detection system (VDS HR) according to IEC 61243-5.

The indicator itself consists of two parts, a fixed part assembled on the switchgear and portable indicator lamps, type VIM-1 and VIM-3 which can be connected to the coupling system interface.

Phase comparator

Phase comparator is used for controlling the phase sequence when connecting two voltage systems together, e.g during the switching from one source of power supply to another. Phase comparison can be done by any phase comparator according to IEC 61243-5.

20 Capacitive voltage indicators

Technical functions capacitive voltage indicators

Manufacturer	Maxeta	Anda	Maxeta	Horstmann	Horstmann	Horstmann	Kries	Kries
Model	VPIS	DNX5	HR module	WEGA 1.2C (45 deg)	WEGA 2.2C (45 deg)	WEGA 1.2C Vario	Capdis S1+(R4)	Capdis S2+(R4)
Type	VPIS	VPIS	VDS	VDS	VDS	VDS	VDS	VDS
Standard	62271-206	62271-206	61243-5	61243-5	61243-5	61243-5	61243-5	61243-5
Capacity variable sec.	no	no	no	no	no	yes	yes	yes
Voltage range	9-15kV 15-24kV	3-6kV 6-12kV 12-24kV 24-40,5kV	6-12kV 12-24kV	3-6kV 6-12kV 10-24kV	3-6kV 6-12kV 10-24kV	Adjustable	Adjustable	Adjustable
Signalling contacts	no	no	no	yes * (1)	yes * (2)	yes *	no	yes *
Self testing	external	no	external	internal	internal	internal	internal	internal
Phase comparison	yes	yes	yes	yes	yes	yes	yes	yes
Indicating lamps	yes	yes	Yes (external VIM-1 or VIM-3)	internal	internal	internal	internal	internal
Resistivity type	-	-	HR	LRM	LRM	LRM	LRM	LRM
Link up to FPI	no	no	no	Compass B, Sigma D, Sigma D+	Compass B, Sigma D, Sigma D+	-	-	IKI 50
Way of indication	Led lamps	Led lamps	Led lamps (external)	Display, symbols	Display, symbols	Display, symbols	Display, symbols	Display, symbols
External source for testing	no	no	no	no	no	no	no	no
Broken signal leash detection	no	no	no	no	no	no	yes	yes

* For signalling contact, auxiliary voltage is required

21 Short-circuit and earth-fault indicators



The increasing demand for reliability and effectiveness of distribution networks requires higher flexibility and more automated ring main units.

As one of the biggest players in medium voltage distribution segment, ABB replies to this demand by installation of grid automation devices. One of the basic devices is a fault passage indicator.

Fault passage indicators

A fault passage indicator may be delivered as an option to the SafeRing Air and SafePlus Air switchgears. The indicator is usually placed in the front panel of the switchgear. It makes it possible to detect any faults, including short circuits, earth-faults and short current direction, and makes it easier to locate any fault.

A fault passage indicator offers different functionalities to the customers, either short circuit indication which is designed to detect, display and remotely indicate short-circuits in medium voltage distribution networks, or earth fault indication which is designed to detect, locally indicate and remotely report earth fault currents in medium voltage distribution networks.

Both functionalities can be combined in one device.

21 Short-circuit and earth-fault indicators

Technical functions capacitive voltage indicators

Manufacturer	Horstmann	Horstmann	Horstmann	Horstmann	Horstmann	Horstmann	Horstmann	Horstmann	Horstmann	Horstmann	Horstmann	Kries	Kries	Kries	Kries	Kries	Kries	Kries	Anda		
Model	Sigma	Sigma F-IE3	Sigma D	Sigma D+	Compass B	Compass B	Compass B	Compass B	Compass B	Compass B	Compass B	IKI-50	IKI-50-PULS- EW	IKI-20	IKI-20PULS	IKI-20C	IKI-20C	IKI-20C	IKI-22	EKL-7	
Dedicated volt.ind.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STC fault ind.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Directional ind.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Directly earthed neutral	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Isolated neutral - Wattmetric (sin)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Compensated neutral - Wattmetric (cos)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Compensated neutral - transient	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Compensated neutral - puls	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monitoring	X	X	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Trip current short-circuit	100-1000A	200-2000A	50-2000A	50-2000A	50-2000A	50-2000A	50-2000A	50-2000A	50-2000A	50-2000A	50-2000A	100-1000A	100-1000A	100-2000A	100-1000A	400-1000A	400-1000A	400-1000A	100-2000A	400,600,800,1000A	40,60,80,100ms
Response time short-circuit	40-80ms	40/80/200/300ms	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	60-1600ms	60-1600ms	60-200ms	60-200ms	100ms	100ms	100ms	60-200ms	40,60,80,100ms	40,60,80,100ms
Trip current earth-fault	-	20-160A	20-1000A	20-1000A	20-1000A	20-1000A	20-1000A	20-1000A	20-1000A	20-1000A	20-1000A	40-200A + 4-30A (cosphi methode)	40-200A + 4-30A (cosphi methode) + transient methode	40-200A	40-150A	400-1000A	400-1000A	400-1000A	400-200A + transient methode	20, 40, 60, 80A	20, 40, 60, 80A
Response time earth-fault	-	60/80/200/300ms	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	60-1600ms	60-1600ms	60-200ms	Appr. 9s after detecting pulsating current	100ms	100ms	100ms	60-200ms	80, 120, 160, 200ms	80, 120, 160, 200ms
Remote test/reset	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Automatic reset time	1,2,4,8 h	2,4,8,24h	1 min - 24h	1 min - 24h	1 min - 24h	1 min - 24h	1 min - 24h	1 min - 24h	1 min - 24h	1 min - 24h	1 min - 24h	1,8h or automatic after load current is recovered	1,8h or automatic after load current is recovered	2,4h	2,4h	2,4h	2,4h	2,4h	2,4h	2,4h	1,2,4,8h
Supply	Long life lithium cell	Long life lithium cell	CT powered	CT powered, aux.supply possible: 24V AC, 24-60V DC	24-230V AC/ DC (ext)	24-230V AC/ DC (ext)	24-230V AC/ DC (ext)	24-230V AC/ DC (ext)	24-230V AC/ DC (ext)	24-230V AC/ DC (ext)	24-230V AC/ DC (ext)	24-230V AC/ DC	24-230V AC/ DC	3 options: Aux (ext), capacitor buffered, battery, dep. on version	2 options: Aux (ext), capacitor buffered, dep. on version	Self-powered capacitor	Self-powered capacitor	Self-powered capacitor	24-230V AC/ DC, ony for sensitive earth-fault function + battery	230V AC/DC (ext), 3.6V battery (int)	230V AC/DC (ext), 3.6V battery (int)
Life time of battery	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	17- years (batteries)	12 h for cap. buffering	4 h for capacitor	4 h for capacitor	4 h for capacitor	15 years (batteries)	10 years (batteries)	10 years (batteries)
No. of relay contacts	1	3	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	1-3	2	2
Comm. protocol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Configuration	DIP	DIP	DIP/SW	DIP/SW	Menu/SW	Menu/SW	Menu/SW	Menu/SW	Menu/SW	Menu/SW	Menu/SW	Modbus Menu nav.	Modbus Menu nav.	DIP	DIP	DIP	DIP	DIP	DIP	DIP	DIP

22 Manometers / Pressure indicators

SafeRing Air and SafePlus Air are sealed systems, designed and tested according to IEC 62271-200 as maintenance free switchgear for lifetime (30 years).

ABB applies state of the art technology for gas tightness providing the equipment with an expected leakage rate lower than 0.1 % per annum, referring to the filling-pressure of 1.4 bar*. The switchgear will maintain air-tightness and a airpressure better than 1.35 bar* throughout its designed life-span. This pressure value is still within a good margin from pressure used during the type tests, which is 1.3 bar*.

*) at 20°C.


For increased safety under operation of the switchgear, manometers may be used for each tank.

In case remote indication is needed, manometers can be equipped with signalling contacts. Detailed descriptions of manometer functions are described in the table below.

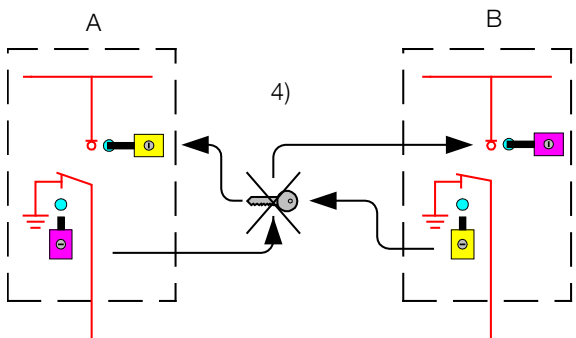
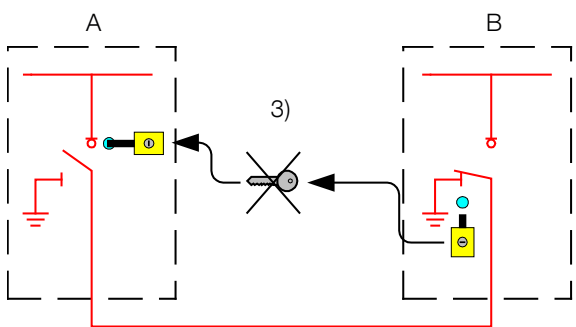
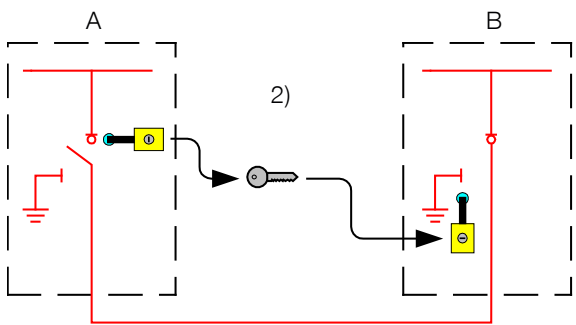
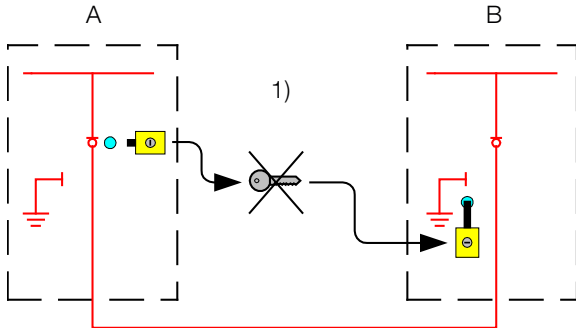
Altitude

Max height above sea level for installation without reducing gas pressure is 1500 meters. In the interval from 1500 to 2000 meters, gas pressure has to be reduced. For installation above 2000 meters, please contact ABB for instructions.



			
Producer	Wika air	Elektron-system	Lanso kony
Model	2RAA023753P0001	Density switch GMD1	3KL.494.269
Insulation medium	Dry air	Dry air	Dry air
Temperature compensation	X	X	X
Accuracy	+/- 1% (20 deg.), +/- 2,5% (-35..+60 deg.)	+/- 2% (-40..+70 deg.)	+/- 1% (20 deg.), +/- 2,5% (-35..+60 deg.)
Scale range (Absolute)	1..2 bar	-	1..2 bar
Appearance (Absolute)	red zone 1,0...1,3 bar, green zone 1,3...1,6 bar	-	red zone 1,0...1,3 bar, green zone 1,3...2,0 bar
Marking of scale (Absolute)	mark at 1,4 bar	-	mark at 1,4 bar
Over-pressure indication	-	-	-
Signalling contact	-	X	-
Threshold pressure	-	1,15/1,25 bar	-
Connection to the tank	solid	solid	flexible

23 Key interlock



Available key locks are: Ronis, Castell, Kirk and STI. Ronis is default and recommended by ABB. For features, see table on next page.

Except for vacuum circuit-breaker, all load break switches, earthing switches and disconnectors may be equipped with any single key interlock. For double key lock, Ronis is the only type that fits SafeRing Air and SafePlus Air.

Example for single key interlock

Key interlocks can be used as follows: Two switchgears A and B are connected to each other by cables. The purpose of interlocks is to prevent closing of the earthing switch unless the load break switch in the other switchgear is locked in open position.

1) One key interlock will be mounted close to the operating shaft of the load break switch in switchgear A. An identical key interlock will be mounted close to the operating shaft of the earthing switch in switchgear B. As long as the load break switch in switchgear A is in closed position, it will be impossible to remove or operate the key in the key interlock.

2) First you have to operate the load break switch in switchgear A to open position. Then it will be possible to operate the key interlock and turn the key which extends the locking bolt. This will prevent access to the operating shaft of the load break switch. Then withdraw the key and insert it into the identical key interlock on the earthing switch of switchgear B.

3) When the key is inserted, you will be able to operate the key interlock and turn the key which will withdraw the extended locking bolt. Then there will be access to operate the earthing switch to closed position. As long as the earthing switch is in closed position, the key will be captured, making it impossible to close the load break switch in switchgear A.

4) If the load break switch in switchgear B and earthing switch in switchgear A are equipped with another identical key interlock which has a different key combination than described above, it will be impossible to make an earth connection of an incoming energized cable from neither switchgear A nor B.

Another example for use of key interlocks is to prevent access to the distribution transformer before the primary side of the transformer is connected to earth. This can be solved by means of two identical key interlocks: one mounted on the earthing switch for the distribution transformer feeder and the other one on the door in front of the transformer.

23 Key interlock

Types and features of locks

C- and V-modules							
Type	D off	D on	D on/off double	ES off single key	ES on	ES on/off	Doorlock
Ronis	X	X	X	X	X	X	N/A
Castell	X	X	N/A	X	X	N/A	N/A
Kirk	X	X	N/A	X	X	N/A	N/A
STI	X	X	N/A	X	X	N/A	N/A

24 Smart Grid applications



SafeRing Air and SafePlus Air for Smart Grid applications

The 12 kV SafeRing Air and SafePlus Air portfolio from ABB is prepared to meet the increasing demand for Smart Grid applications in secondary distribution networks.

Thanks to the flexibility of SafeRing Air and SafePlus Air modules, grid automation solutions can also be delivered with different switchgear configurations with low voltage compartments if required.

Standard packages for Smart Grid applications can provide monitoring, control, measurement and supervision functionalities including feeder automation devices with wired and/or wireless communication interfaces and power supply back-up.

Customer benefits

The integrated smart grid functionalities enable the network operators to:

- Monitor the grid so that they are able to remotely locate the fault.
- Reconfigure the network so that the faulty part of the network is disconnected.
- Reconfigure the network so that the energy loss is minimized and/or achieve savings for future investments.

Additional benefits for utilities and energy consumers are: Improved quality of the power supply.

- Fewer and shorter outages and improved voltage quality.
- Ensured safety for personnel.
- Enhanced operational efficiency and network stability.
- Improved tools for the network operators and the field crews.
- Less need to travel to locations with difficult access.

24 Smart Grid applications

Ring main unit for Smart Grid applications is equipped with an advanced Feeder Automation device, which in cooperation with additional devices (e.g. Fault Passage Indicators) provides various data to the remote control centers. Key functions of all standard packages from the factory are described in the next pages. There are seven different selections which give the end users possibility to adjust the package to fit their requirements.

All secondary devices within the Ring Main Unit are powered by a 24V DC battery. The battery is charged by its charger, which needs external power supply:

- 90...264V AC 50/60 Hz or 85...200V DC in case of Feeder Automation device ARC600 (internal battery charger) is used.
- 94...132V AC or 184...264V AC 50/60 Hz in case of Feeder Automation device RTU560CIG10 or REC615 (external battery charger) is used.

Please contact us in case you need another main power supply option.

Remote and local communication

A. Remote communication (communication to the remote control center)

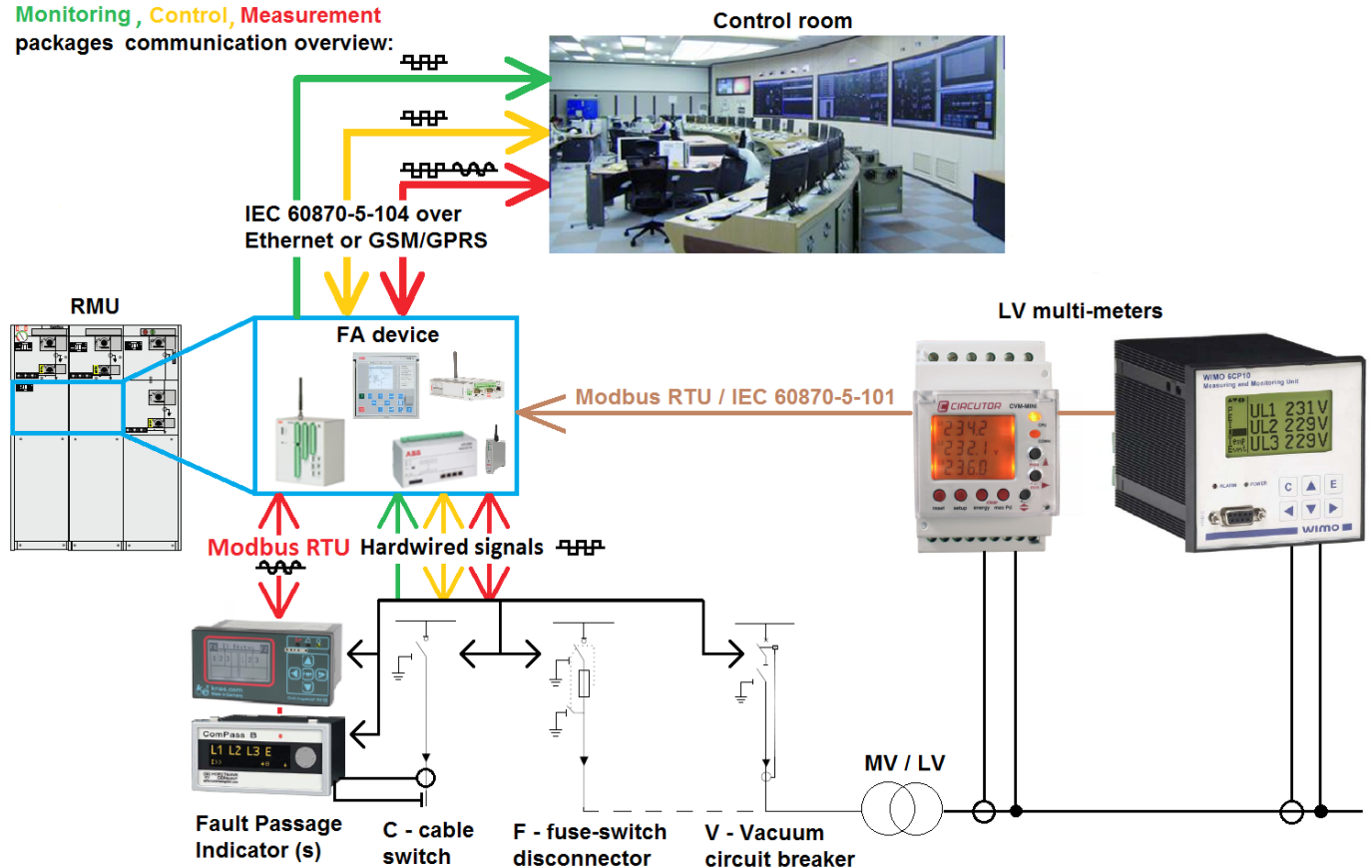
Default delivery (standard package solution) comes with IEC 60870-5-104 remote communication protocol implementation. The communication media is either wired Ethernet and/or wireless (GSM/GPRS) communication. Please contact us in case you need another remote communication protocol option.

B. Local communication (communication between different automation devices within the RMU)

The signals from the ring main unit switches, Fault Passage Indicators and low voltage multi-meters are brought to the Feeder Automation device by two different ways:

- Digital signals (e.g. switch positions indication and control) are hardwired
- Analog signals (e.g. measurements from the Fault Passage Indicators and low voltage multi-meters) are obtained over local communication bus which can be serial Modbus RTU or serial IEC 60870-5-101 communication protocol. Modbus RTU is used within Measurement package together with RTU560CIG10 Feeder Automation device (via its CPA port), IEC 60870-5-101 is used for connecting low voltage multi-meters in case ARC600 Feeder Automation device (via its RS1/RS2 ports).

Monitoring, Control, Measurement packages communication overview:



24 Smart Grid applications

Packages

All standard packages include:

- Power supply backup source for automation devices (24V DC batteries and battery charger)
- Wire (Ethernet) and/or wireless (GSM/GPRS) communication interfaces (SIM card is not part of delivery)
- IEC 60870-5-104 host (slave) communication protocol

Three levels of automation packages are defined below.

There are additional options which can be selected for each package.

Main selections and their options are (*)default values)

1. Automation level

- Remote Monitoring package
- Remote Control package*)
- Remote Measurement package

2. Feeder automation device

- ARC600 *)
- RTU560CIG10
 - GPRS communication/modem:
 - No *)
 - ARP600
 - 560MDD10
- REC615
 - GPRS communication/modem:
 - None *)
 - ARP600

3. MV network fault types

- OC and EF directional
- OC and EF non directional *)
- Fault

4. Fault passage indicators

- Kries - IKI-50_1F (directional)
- Horstmann - ComPass B (directional)
- Kries - IKI-20U2 *)
- Horstmann - SIGMA F+E (AC/DC)

5. Fault passage indicators remote reset

- No
- Yes *)

6. Distribution transformer feeders common remote emergency trip

- No
- Yes *)

7. Supervision of the LV side of the distribution transformer

- None *)
- Vamp: WIMO 6CP10
- Circutor: CVM-MINI-ITF-RS485-C2

Options description

1. Automation level

The three automation levels (packages) are described below.

Remote Monitoring

This package provides remote monitoring of:

- The position of load break switches in C modules (-> grid topology supervision)
- Fault passage indicator fault signalization (-> fast fault localization, reduced outage time, efficient use of manpower)
- Faults in the transformer feeders

Remote Control

This package includes the features from the Remote Monitoring package and in addition provides:

- Remote control of load break switches in C modules (-> fast fault isolation, fast restoration of healthy part of the MV network, operator safety)

Remote Measurement

This package includes the features from the Remote Control package and in addition provides:

- MV network analog data values such as: currents, voltages, frequency, power, energy, load flow direction etc. (-> improved notification of overloaded equipment, better maintenance planning, improved power quality).

Note: There are spare inputs (1 – 5 pieces) which can be used for additional customer specified „digital/binary” signals such as: air pressure signal, low voltage fuses tripped signal, transformer overheating signal etc. The number of spare inputs depends on configuration of ring main unit (CCV, CCCV etc.) and on the type of fault detection for the MV network.

2. Feeder automation device

Compact Feeder Automation devices secure remote monitoring and control of the secondary substations in the distribution network. It enables the network control centers to monitor and control the field devices over the different communication infrastructures.

24 Smart Grid applications

ARC600

The Wireless Controller ARC600 is a compact, solution based device for the remote control and monitoring of secondary substations such as network disconnectors, load break switches and ring main units in distribution networks.

ARC600 enables the network control system to monitor and control the field devices over the public communication infrastructure (GPRS). The Wireless Controller ARC600 utilizes the built-in GPRS for reliable and secure end-to-end communication providing remote monitoring and control of up to three objects.



RTU560CIG10

The DIN rail mounted RTU560 provides advanced functionality and makes it the perfect fit for existing and future Grid Automation solutions. The compact housing with the possibility to integrate hardwired information fulfills complex requirements and space restrictions at the same time.

3. MV network fault types

Different signals from Fault Passage Indicators can be transmitted to the control centers. These are selected based on type of the MV network (isolated neutral, compensated neutral, high resistance earthing, low resistance earthing or solidly earthing).

Available options are:

OC and EF directional

With this selection, two different types of events can be transferred to the remote control centers:

- Fault in forward direction (does not differentiate overcurrent and earth fault)
- Fault in backward direction (does not differentiate overcurrent and earth fault)

OC and EF non directional

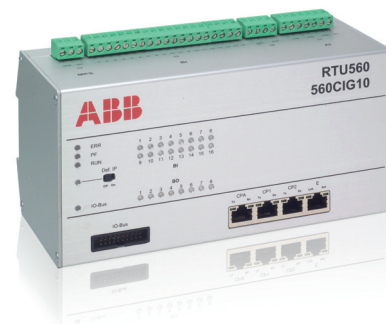
With this selection, two different types of events can be transferred to the remote control centers:

- Over-current fault (does not differentiate fault direction)
- Earth fault (does not differentiate fault direction)

Fault

With this selection, one type of event can be transferred to the remote control centers:

- Fault (does not differentiate over-current and earth fault nor fault direction)



24 Smart Grid applications

4. Fault Passage Indicators

Fault Passage Indicators are devices which detect faults in the MV network. Some of them are also able to provide MV analog value measurements to the Feeder Automation device which transfers these signals to the control centers.

5. Fault passage indicators remote reset

Selection No

The Fault Passage Indicators signalization will be reset according to its setting (e.g. manually, automatically after fixed set time).

Selection Yes

This option gives possibility to reset Fault Passage Indicators remotely from the control centers.

Note: There is one common reset command for all Fault Passage Indicators by use of ARC600 Feeder Automation device – all Fault Passage Indicators within the ring main unit will be reset at the same time.

6. Distribution transformer feeders common remote emergency trip

Selection No

No possibility to remotely trip distribution transformer modules.

Selection Yes

This option gives the possibility to remotely trip distribution transformer modules (usually V modules) from the control centers.

Note: There is one common trip command for all distribution transformer modules – all modules will be tripped at the same time.

7. Supervision of the LV side of the distribution transformer

This option gives the possibility to remotely supervise the secondary (Low Voltage) side of the distribution transformer. Different multi-function monitoring devices with extensive measuring and calculation functions will be available in this selection. The unit measures currents, voltages and frequencies, and calculates power and energy values. The interconnection cable between Feeder Automation device and low voltage multi-meters is not part of delivery.

None

No possibility to remotely supervise LV network analog data.



24 Smart Grid applications



Vamp: WIMO 6CP10

WIMO 6CP10 secondary substation measuring and monitoring unit is a compact multi-function monitoring device with extensive measuring and calculation functions. WIMO 6CP10 is ideal for secondary substation measuring and monitoring management. The unit measures currents, voltages and frequencies, and calculates power and energy values.

Circutor: CVM-MINI-ITF-RS485-C2

The CVM-MINI panel analyzer is a programmable measuring instrument; it offers a series of options, which may be selected from configuration menus on the instrument itself.

The CVM-MINI measures, calculates and displays the main electrical parameters for three-phase, balanced or unbalanced industrial systems.

Measurements are taken as true effective values using the three alternating and neutral voltage inputs and three current inputs to measure In /1A or In /5A secondary from external measurement transformers. The CVM-MINI allows the display of all electrical parameters, using the backlit LCD display, showing three instant electrical parameters, maximum or minimum on each page jump.

Note: The availability depends on the selected Feeder Automation device and Ring Main Unit module configuration. These devices are by default mounted in a top entry box or low voltage compartment.

25 Low version switchgear

Available functional units for low version applications are the same as for standard SafeRing Air and SafePlus Air.

The switchgear is delivered for ratings up to 12kV and can be manufactured in any combination of the SafeRing Air and SafePlus Air modules, from 2 up to 5 modules.

Optional arc suppressor to avoid any damages occurring in case of an internal arc inside the gas tank is available.

- CT's must be placed beneath the switchgear
- Height: 1100 mm
- Same width as standard units
- Only arc proof cable compartment door is available

IAC AFL for low version of SafeRing Air and SafePlus Air

For the low-version switchgear, AFL is the highest IAC classification.

Available solution is blow-out down to cable trench.

Basis parameters of set-up:

- IAC AFL up to 20 kA / 1 s
- Minimum height of ceiling for blow-out down to cable trench: 2000 mm
- Minimum height of ceiling for blow-out behind switchgear: 2400 mm
- Minimum distance from backwall: 100 mm

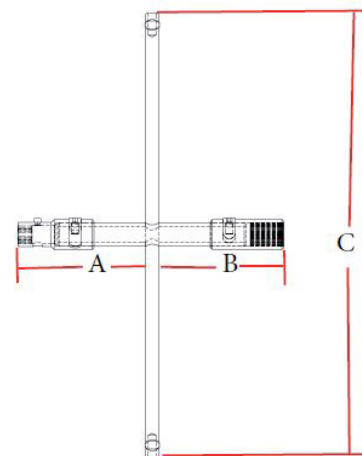
Parameters and technical data are the same as for standard SafeRing Air and SafePlus Air.

26 Dimensions

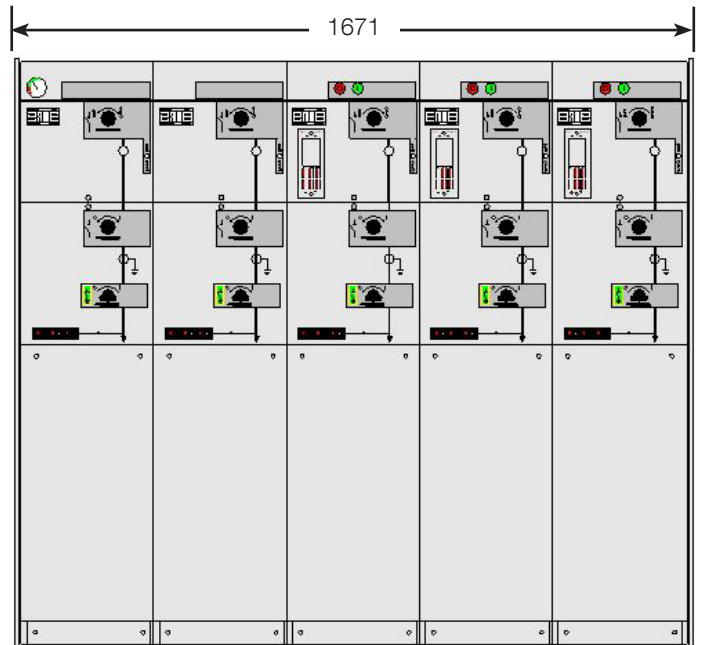
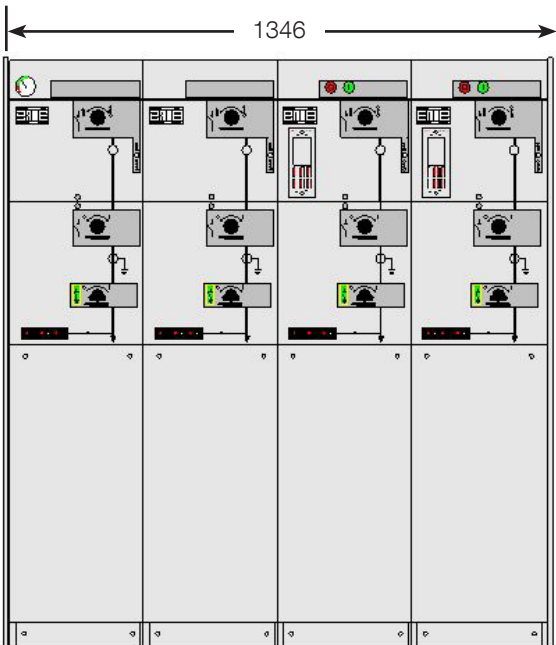
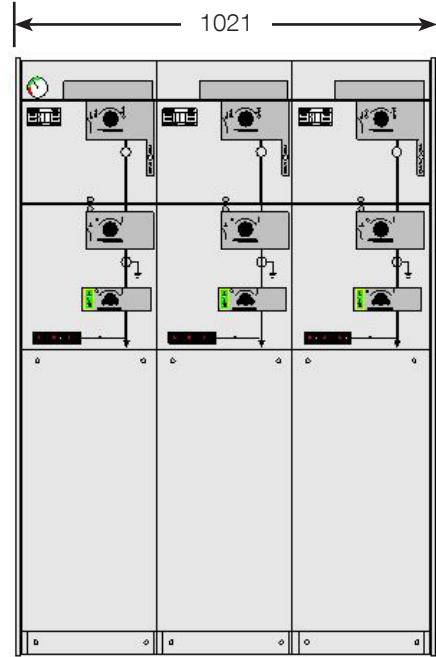
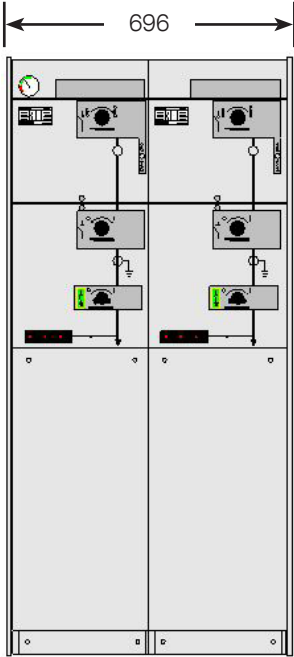
Height (mm)	Standard switchgear					Lower version switchgear		
	Non IAC/IAC AFL without base frame	Non IAC/IAC AFL with 290 mm base frame	Non IAC/IAC AFL with 450 mm base frame	IAC AFLR with 290 mm base frame	IAC AFLR with 450 mm base frame	Non IAC/IAC AFL without base frame	Non IAC/IAC AFL with 290 mm base frame	Non IAC/IAC AFL with 450 mm base frame
Unit without low voltage compartment or top entry box	1336	1626	1786	2002	2002	1100	1390	1550
Unit with top entry box(124 mm)	1460	1750	1910	2002	2002	1224	1514	1674
Unit with low voltage compartment (470 mm)	1806	2096	2256	2096	2256	1570	1860	2020
Unit with low voltage compartment (700 mm)	2036	2326	2486	2326	2489	1800	2090	2250

Dimensions operating handle

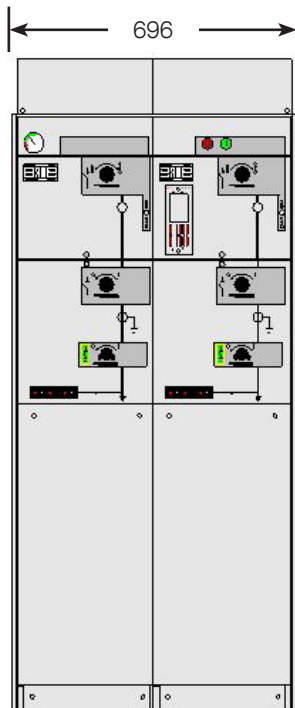
Part no.	1VDP000443R1	1VDP000437R1	2RAA027294A1
Description	Standard handle	Long shaft	Extra long shaft
A	136 mm	293 mm	443 mm
B	133 mm	290 mm	440 mm
C	468 mm	393 mm	468 mm



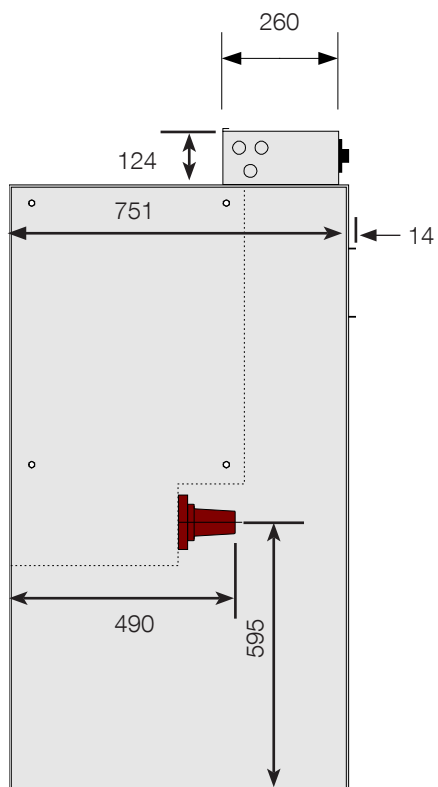
26 Dimensions



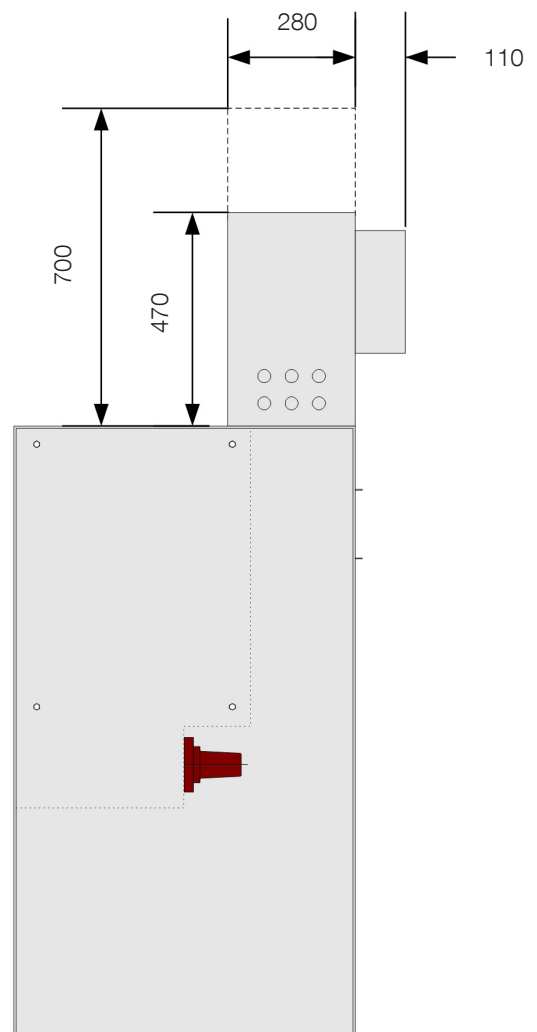
26 Dimensions



Top entry box

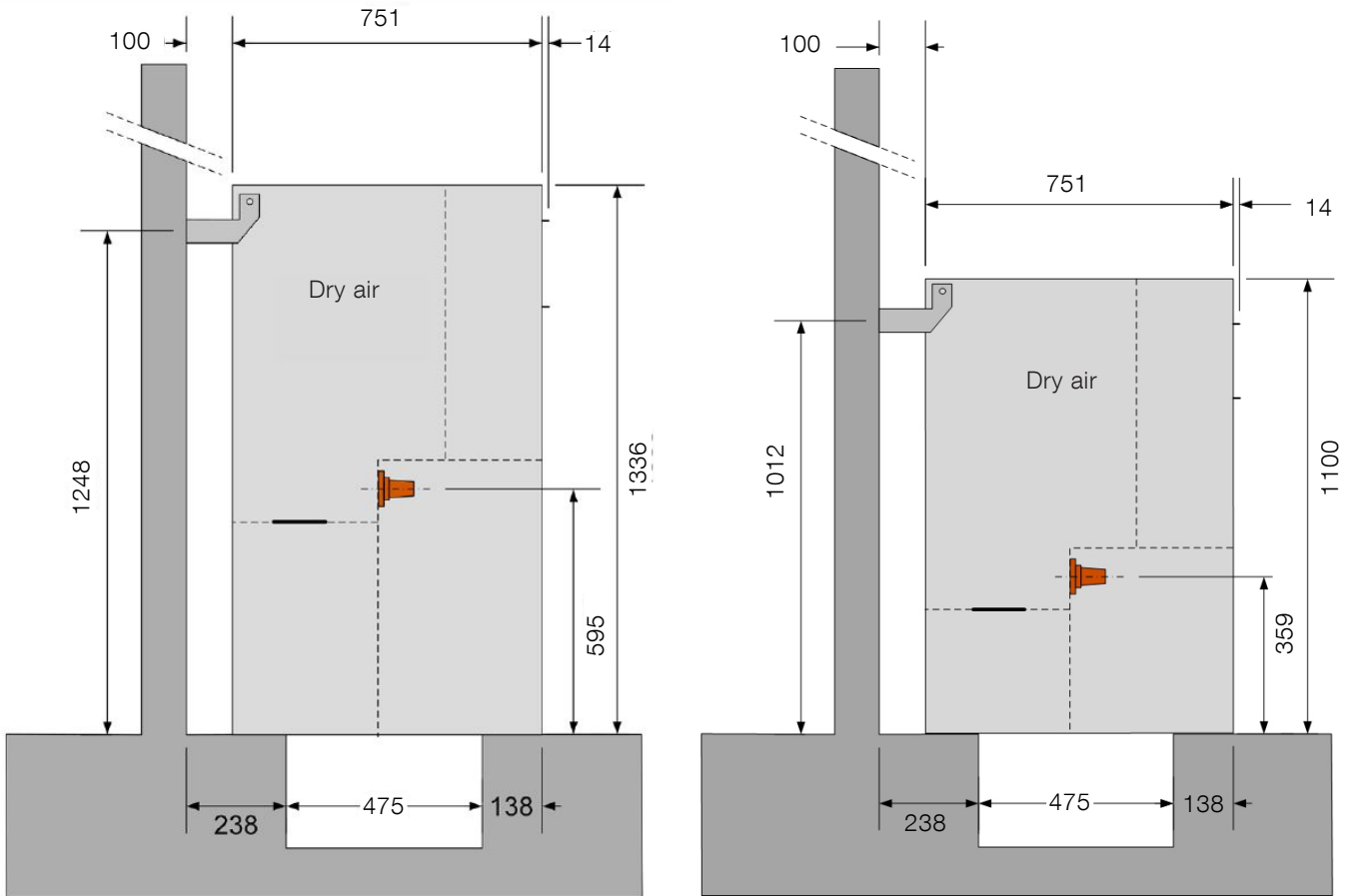


Top entry box - side view



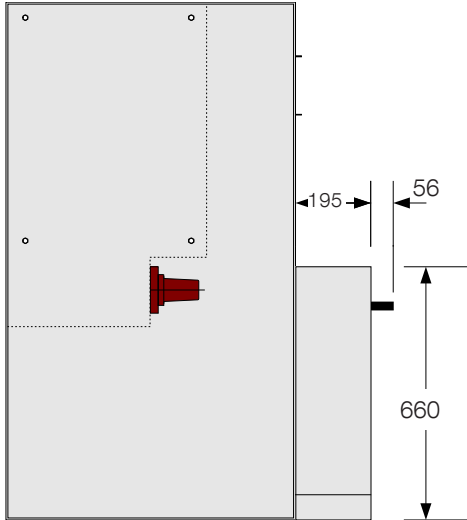
Low voltage compartment with relay type REF541

26 Dimensions

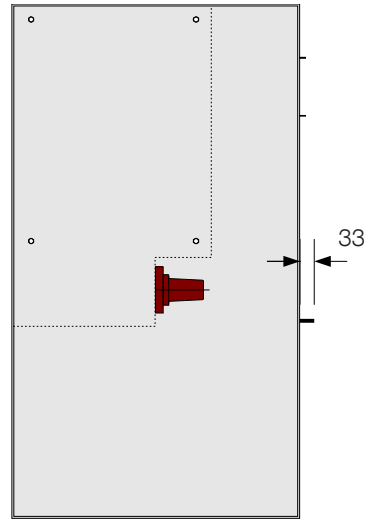


Standard version compared to lower version. Lower version is an optional solution.

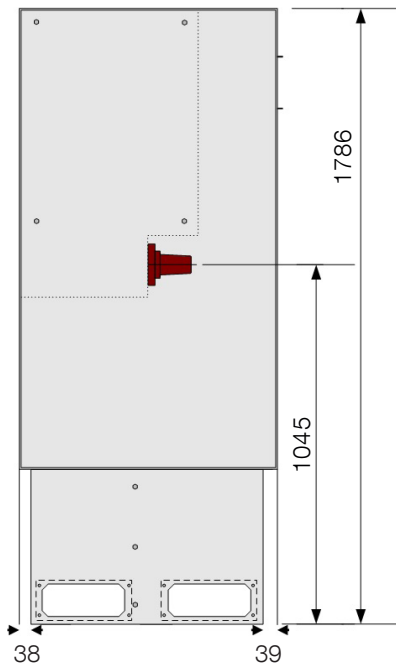
26 Dimensions



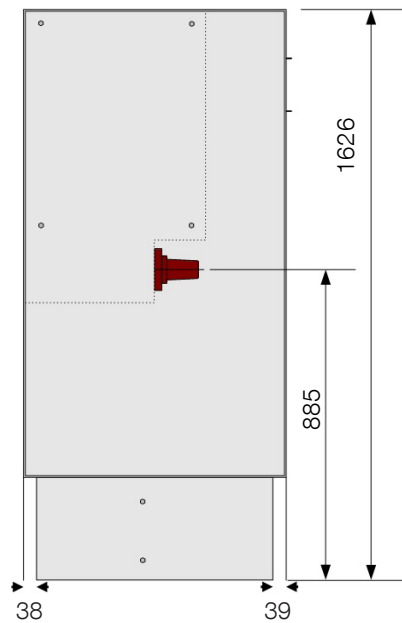
Cable compartment cover for parallel cables with surge arrester



Arc proof cable cover



Base frame, height 450 mm



Base frame, height 290 mm

27 Technical data

Codes and standards

SafeRing Air and SafePlus Air are manufactured and tested in accordance with the latest version of the below IEC regulations.

Code	Description
IEC 62271-1	High-voltage switchgear and controlgear - Part 1: Common specifications
IEC 62271-100	High-voltage switchgear and controlgear - Part 100: Alternating-current circuit-breakers
IEC 62271-102	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches
IEC 62271-200	High-voltage switchgear and controlgear - Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV
IEC 62271-103	High-voltage switchgear and controlgear- Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 61243-5	Voltage detection system (VDS)
IEC 62271-206, IEC 61958	Voltage presence indication systems (VPIS)
IEC 60255	Electronic protection relays
IEC 61869-1	Instrument transformers - general requirements
IEC 61869-2	Current instrument transformers
IEC 61869-3	Voltage instrument transformers
IEC 60044-7	Voltage sensors
IEC 60044-8	Current sensors
IEC 61243-5, IEC 62271-206, IEC 60137, CENELEC EN 50180, CENELEC EN 50181, EDF HN 52-S-61	Bushings
IEC 60044-7, IEC 60044-8, IEC 62271-206, IEC 61243-5, CENELEC EN 50181	Combined bushings sensors
IEC 60137, IEC 60502-4, CENELEC EN 50180, CENELEC EN 50181	Cable connection

27.1 Technical data - SafeRing Air and SafePlus Air

SafeRing Air and SafePlus Air - electrical data

Rated voltage	U_r	kV	12
Rated power frequency withstand voltage	U_d	kV	28
- across disconnecter		kV	32
Rated lightning impulse withstand voltage	U_p	kV	75
- across disconnecter		kV	85
Rated frequency	f_r	Hz	50 ¹⁾
Rated normal current (busbars)	I_r	A	630
Rated normal current (cable switch)	I_r	A	630
Rated normal current (vacuum circuit-breaker)	I_r	A	630
Rated short-time withstand current	I_k	kA	16
Rated duration of short-circuit	t_k	s	3
Rated peak withstand current	I_p	kA	50
Internal arc classification IAC AFL	I_a, t_a	kA/s	20/1
Partition class			PM
Loss of service continuity category			LSC 2
Making and breaking capacities C-module:			
Rated mainly active load breaking current	I_{load}	A	630
Number of operations for mainly active load breaking	n		100
Rated distribution line closed-loop breaking current	I_{loop}	A	630
Rated single capacitor bank breaking current	I_{sb}	A	135
Rated earth-fault breaking current	I_{ef1}	A	200
Rated cable- and line-charging breaking current under earth-fault conditions	I_{ef2}	A	115
Rated short-circuit making current	I_{ma}	kA	50
Rated cable-charging breaking current	I_{cc}	A	63
Line charging capacity	I_{lc}	A	1
Electrical and mechanical classes			E3, C2, M1
Rated short-time current (earthing switch)	I_k	kA	20
Rated short-circuit making current (earthing switch)	I_{ma}	kA	50
Making and breaking capacities V-module:			
Rated mainly active load breaking current	I_r	A	630
Rated short-circuit breaking current	I_{sc}	kA	16
Rated cable-charging breaking current	I_c	A	25
Rated short-time current (earthing switch)	I_k	kA	16
Rated short-circuit making current (earthing switch)	I_{ma}	kA	40
Electrical and mechanical classes			E2, C2, S1, M1
Normal service conditions for indoor switchgear according to IEC 62271-200			
Ambient temperature ²⁾			
- maximum value		°C	+40
- maximum value of 24 hours mean		°C	+35
- minimum value ³⁾		°C	-25
Altitude for installation above sea level ⁴⁾		m	1500
Relative humidity max. 24 hours mean			95%

¹⁾ De-rating for current parameters needs to be applied for 60Hz

²⁾ De-rating allows for higher maximum temperature

³⁾ Lower temperature available upon request

⁴⁾ For installation above 1500 m, reduced gas pressure is required

27.2 Technical data - general

General data, enclosure and dimensions

Type of ring main unit (RMU) and compact switchgear (CSG)	Metal-enclosed switchgear and controlgear according to IEC 62271-200		
Number of phases	3		
Type-tested RMU and CSG	Yes		
Pressure test on equipment tank or containers	2.64 bar abs		
Facility provided with pressure relief	Yes		
Insulating gas	Dry air		
Nominal operating gas pressure	1,4 bar abs 20°C		
Rated filling level for insulation P_{re}	1,4 bar		
Minimum functional level of insulation P_{me}	1,3 bar		
Gas leakage rate / annum	< 0,1%		
Expected operating lifetime	30 years		
Equipment provided for gas monitoring ¹⁾	Yes, temperature compensated manometer can be delivered		
Material used in tank construction	Stainless steel sheet, 2,5 mm		
Busbars	569 mm ² Al		
Earth bar (external)	100 mm ² Cu		
Earth bar bolt dimension	M10		
Overall dimensions of the fully assembled RMU / CSG	Height mm	Depth mm	Width mm
2-way unit	1336	765	696
3-way unit	1336	765	1021
4-way unit	1336	765	1346
5-way unit	1336	765	1671

¹⁾ Manometer with 1NO or 1NO/1NC upon request

Weight table

Maximum weights for standard SafeRing Air and SafePlus Air

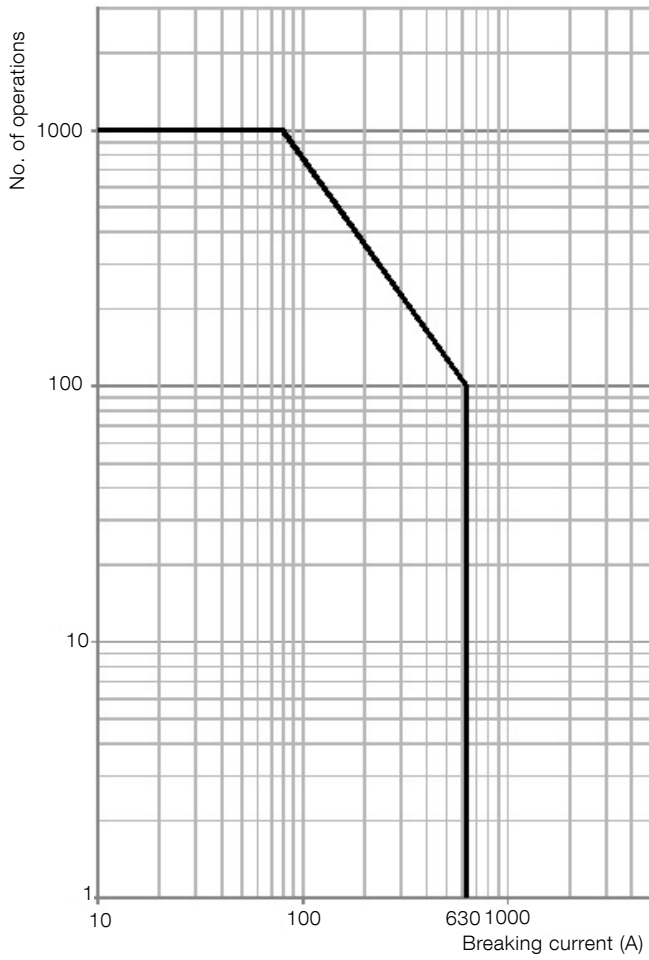
2-way CV	300 kg
3-way CCV	450 kg
4-way CCCV	600 kg
5-way CCVV	750 kg

27.2 Technical data - general

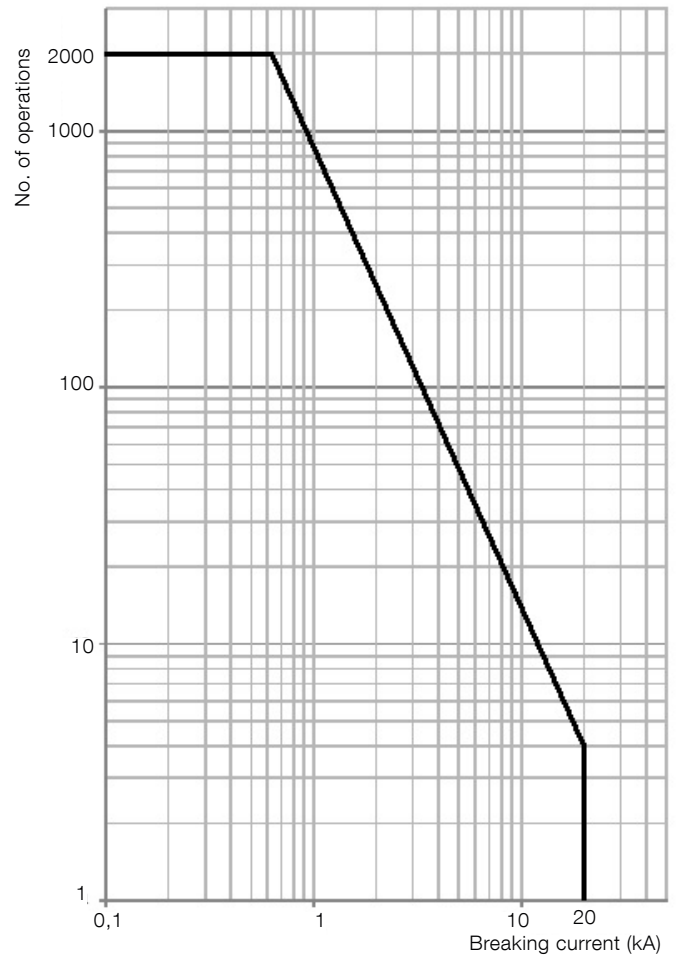
Operations, degree of protection and colours	
Means of disconnecter and earthing switch operation	separate handle
Means of load break switch operation	separate handle and push buttons
Rated operating sequence of circuit-breaker (V-module)	O – 3 min – CO – 3 min – CO
Total opening time of circuit-breaker	approx. 100 ms (depending on protection relay and opening/tripping coil)
Closing time of circuit-breaker	approx. 40 – 60 ms (depending on protection relay and opening/tripping coil)
Mechanical operations of load break switch	1000 CO - class M1
Mechanical operations of earthing switch	1000 CO - class M0
Mechanical operations of circuit-breaker (V-module)	2000 CO - class M1
Mechanical operations of disconnecter (V-module)	1000 CO - class M0
Principle switch-disconnector and earthing switch	3 position combined switch-disconnector and earthing switch
Load break switch:	
Rated operations on short circuit current (class E3)	5 - class E3
Rated operations mainly active load (class E3)	100 - class E3
Degree of protection:	
High voltage live parts, air tank	IP 67
Front cover mechanism	IP 2XC ¹⁾
Cable covers	IP 3X
Protection class of fuse compartment	IP 67
Low voltage compartment	IP 2XC ¹⁾
Colours:	
Front covers	RAL 7035
Side and cable covers	RAL 7035
¹⁾ IP22 on request	
Cable box for heat shrinkable termination:	
Phase to phase clearance	107 mm
Phase to earth clearance	54,5 mm
Phase to earth over insulator surface (creepage)	120 mm
Type of cable termination adapters	Elbow or T-connector

27.3 Technical data - number of operations

SafeRing Air C-module 12kV



SafeRing Air V-module 12 kV



28 Environmental Certification

Life expectancy of product

The product is developed in compliance with the requirements denoted by IEC 62271-200. The design incorporates a lifespan under indoor service conditions exceeding 30 years.

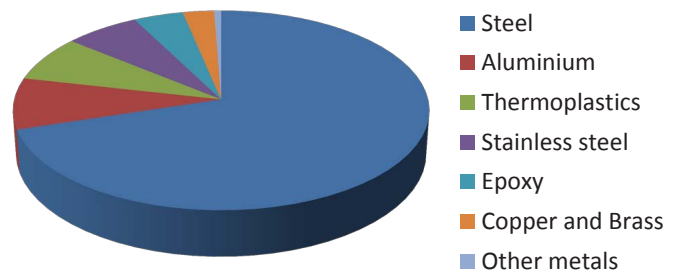
SafeRing Air and SafePlus Air are sealed gas insulated switchgears filled with air taken from the atmosphere and which is dried to contain less than 20ppm of H₂O. SafeRing Air and SafePlus Air are manufactured in Norway and the manufacturing site is certified according to ISO 9001:2008, ISO 14001:2004, and OHSAS 18001:2007.

The switchgear is gas-tight with an expected diffusion rate of less than 0,1% per annum. With a rated filling pressure of 1,4 bar absolute at 20°C, the switchgear will maintain gas-tightness and a gas-pressure better than the minimum functional pressure of 1,3 bar absolute at 20°C throughout its designed lifespan.

Recycling capability

Constituents of a CCV switchgear:

Material	% of total weight	Recycle
Aluminium	8,3	Yes
Steel	70,2	Yes
Stainless steel	6,5	Yes
Copper and Brass	2,7	Yes
Other metals	0,6	Yes
Thermoplastic	7,4	Yes
Epoxy	4,3	Yes
Total recyclables	100 %	
Total weight (kg)	450	



End-of-life

ABB continuously strive to replace hazardous substances. The SafeRing Air and SafePlus Air switchgear do not contain any substances listed in ABB List of prohibited and restricted substances.

SafeRing Air and SafePlus Air is designed to facilitate disassembling and recycling.

The thermoplastics are marked to facilitate sorting and they do not contain any halogenated flame retardants.

There exist no explicit requirements for how to handle discarded switchgears at end-of-life. No special action is required, non-recoverable parts can be disposed and reused normally according to local regulations.

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