

CATALOG

SafeRing/SafePlus - Air 12kV

SafeRing/SafePlus - AirPlus 24kV

Gas-insulated ring main unit and compact switchgear



- Eco-efficient with a GWP of < 1
- Retains advantages of established GIS technology
- Avoids SF₆ regulations
- Available in well-proven and reliable switchgear products

ABB developed sustainable alternatives to SF₆.

AirPlus™, ABB's breakthrough innovation, is a pioneering gas mixture that reduces global warming potential by almost 100 percent and is applicable for 24kV applications.

Dry Air has even a global warming potential of zero and is applicable for 12kV applications.

Dry Air and AirPlus are the first green alternatives to SF₆ for all medium-voltage (MV) gas-insulated switchgear.

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General information

ABB's eco-efficient alternatives to SF₆ cover the whole range of medium-voltage switchgear applications. Dry Air and AirPlus solutions can be supplied as a 2, 3, 4 or 5-way unit in standard configurations, with additional equipment according to customer specification.

SafeRing and SafePlus Air/AirPlus are completely sealed systems with a stainless steel tank which contains all live components and switching functions.

Routine tests are carried out on all units before dispatch. No special tools are required for installing the equipment.

Available functional units are:

- C = Load break switch with disconnect and earthing switch
- D = Direct cable connection
- V = Vacuum circuit-breaker with disconnect and earthing switch

The units are delivered directly from the factory, ready for installation at site.

General

SafeRing Air/AirPlus is a ring main unit for the secondary distribution network. SafeRing Air/AirPlus can be supplied in 18 different configurations suitable for most switching applications in 12kV (Air) and 24kV (AirPlus) distribution networks.

SafePlus Air/AirPlus is a metal enclosed compact switchgear system for up to 24kV distribution applications. The switchgear has a unique flexibility thanks to the possible combination of semi-modular configurations.

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.

The switchgear portfolio is constantly under development, to adjust to new markets requirements and customers needs. Both SafeRing/SafePlus Air/AirPlus modules are harmonized with existing SafeRing/SafePlus portfolio.

Insulation gas

After years of research in a strong partnership with 3M, ABB has developed an eco-efficient alternative to SF₆ insulation. The AirPlus insulation gas has a global warming potential (GWP) of less than 1, which makes medium voltage (MV) gas-insulated switchgear (GIS) available as both an eco-efficient and compact alternative. Climate concerns 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 and AirPlus are the alternatives for customers, who would like to switch to a climate-friendly alternative gas.

Composition

AirPlus insulation gas is based on the C5- perfluoroketone molecule (C5-FK). In order to guarantee that C5-FK is always gaseous, approx. 8 percent C5-FK is mixed with Dry Air.

Global warming potential (GWP)

Dry Air is an ideal gas from an environmental perspective. It has a GWP of zero, thus does not contribute to global warming. AirPlus eco-efficient technology - ABB's solution for voltages up to 24kV. The pure C5-FK gas has a GWP of approx. 1 and mixing C5-FK in a ration of approx 8/92 with Dry Air render a gas mix with a GWP far less than the GWP of CO₂ and thus eliminates the climate concern related to insulating gases.

Modularity

All modules are only 325 mm wide, which is the same width as SafeRing/SafePlus. SafeRing/SafePlus Air/AirPlus can be configured with a maximum of 5 modules in one air tank with an internal busbar.

Application

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

General information

Customer benefits



Eco-friendly

- Alternative technologies with low environment impact and high level of recyclability
- Eco-efficient with a GWP < 1
- Low climate impact
- Avoid regulations for the use of SF₆



Compact

- Compact design, all modules only 325 mm wide
- Up to 5 modules in one common Air/AirPlus unit
- Less material, used in a more efficient way
- Compact design with small footprint
- Lower thermal losses



Safety

- Reliable current breaking capability
- Maintenance free medium-voltage solution
- Safe switching in case of gas leaking
- Virtually maintenance-free switchgear minimizes operations, reduces danger to operators
- Mechanical interlocks prevent unsafe operations
- Key interlocks available for additional safety
- Loss of service continuity – IEC 62271-200 describes the extent to which a switchgear's high-voltage compartments and/or functional units may remain energized when a main circuit compartment of this functional unit is opened.
- Robust internal arc protections



Flexibility

- High degree of recycle capability
- Can be fitted with Motor operation, AC or DC
- Can be fitted with wide a range of indicators
- Up to 5 modules in one and same gas tank
- 18 standard configurations defined as SafeRing Air/AirPlus

General information

Applications

1



Utilities and Power Plants

- Power generation stations
- Transformer stations and metering
- Main and auxiliary switchgear
- Wind turbines
- Solar

2



Industry

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

3



Transport

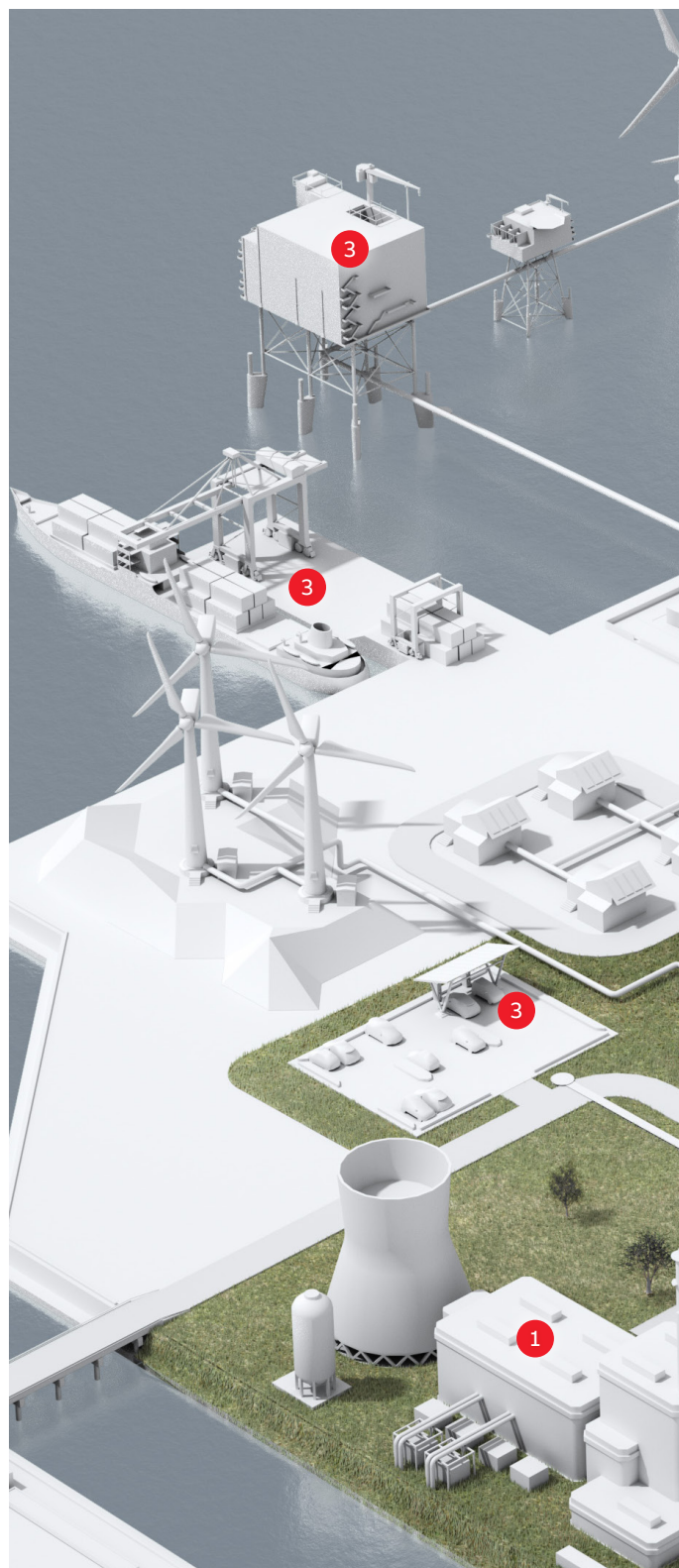
- Airports
- Ports
- Railways
- Underground transport
- E-mobility

4



Building and infrastructure

- Hotels
- Shopping centers
- Hospitals
- Data centres
- Commercial buildings
- Large infrastructure and civil works





General information

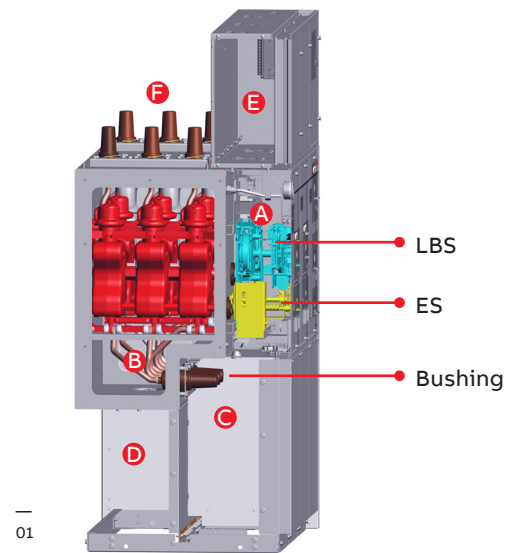
Structure of the modules

—
01 C-module feeder
panel with LBS and low-
voltage compartment

—
02 V-module with
circuit-breaker and low-
voltage compartment

Modular structure C-module

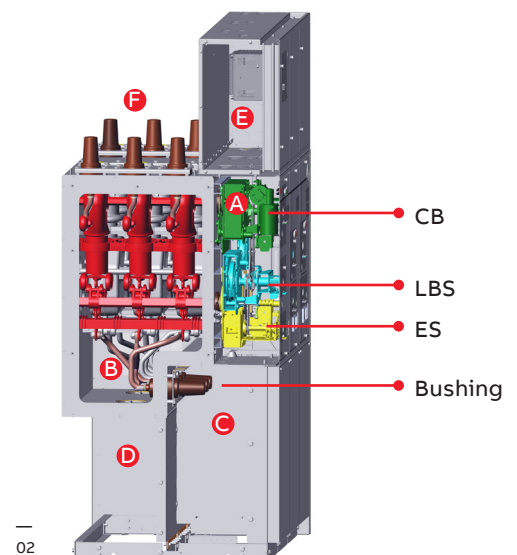
The feeder panel consists of the load break switch and earthing switch in compartment **A**, busbar compartments **B**, the cable termination compartment **C**, the pressure relief duct for the busbar compartment and for the cable termination compartment **D** and the low-voltage compartment **E**. The cable bushing at the top is for incoming and outgoing feeders **F**. The busbar compartments are filled with Dry Air or AirPlus gas.

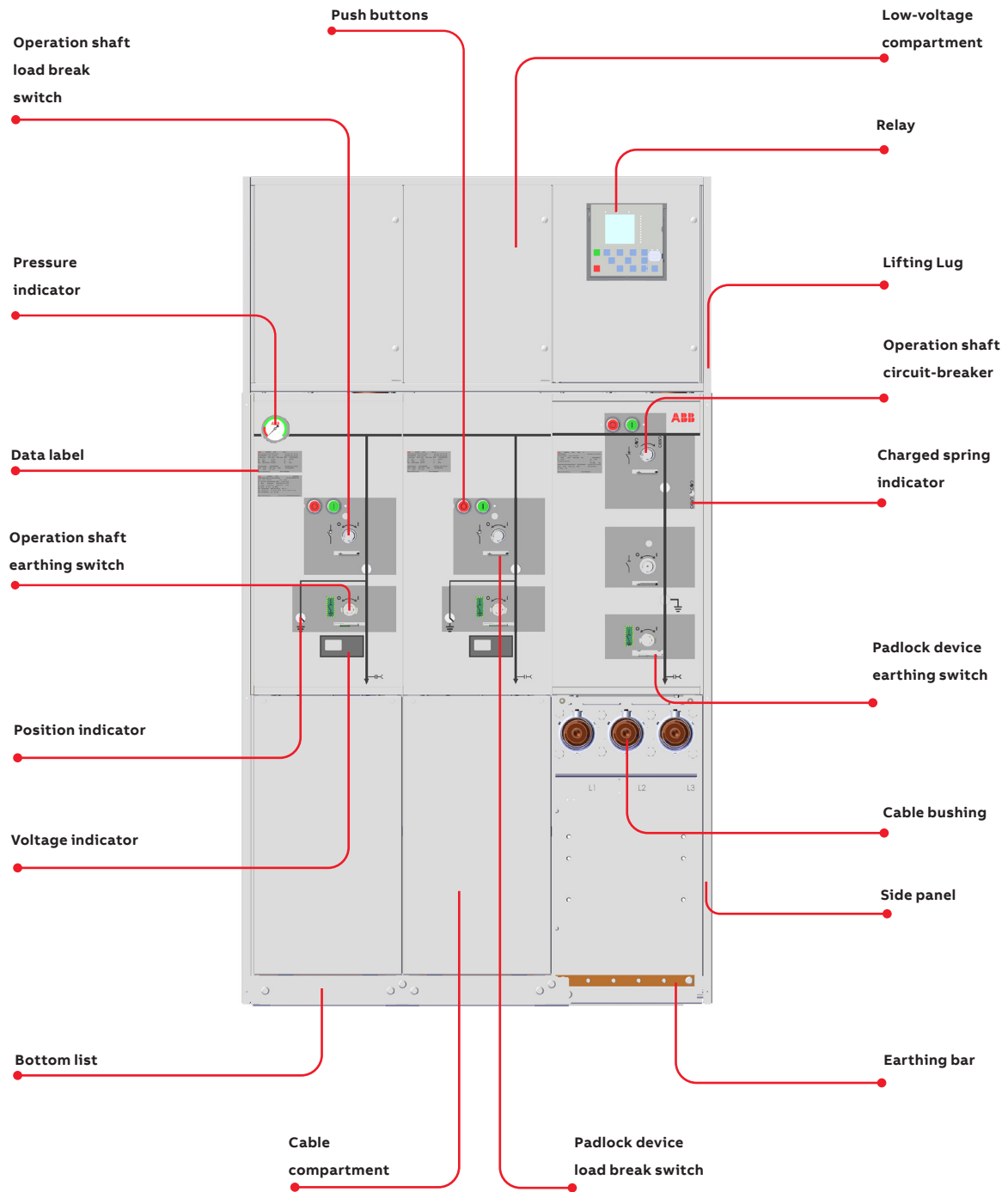


Modular structure V-module

The vacuum switch panel consists of the circuit-breaker, load break switch and earthing switch in compartment **A**, busbar compartments **B**, the cable termination compartment **C**, the pressure relief duct for the busbar compartment and for the cable termination compartment **D** and the low-voltage compartment **E**. The cable bushing at the top is for incoming and outgoing feeders **F**.

The busbar compartments are filled with Dry Air or AirPlus gas.





Production of SafeRing/SafePlus

Completely sealed system

Exterior construction

A new design of the front panels has been introduced with this new generation of gas-insulated switchgear.

One common steel plate covered with polycarbonat foil upgrades the front design and creates a completely new look and feel. Now the hole front panel can be removed for easy access to low-voltage compartment of mechanism inspection. These foils contain the mimic diagram of the main circuit integrated with the position indicators for the switching devices. Background color for these foils is light grey (RAL 7035).

There are different cable compartment covers available; standard and arc proof. These covers are manufactured from 1.25 mm aluzink (except the arc proof cover) and are powder painted with color 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. 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. The redesign of the side panel results in a clean and even surface without screw and components. For this, hot rolled steel, colored in RAL 7035, is used.

Enclosure

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

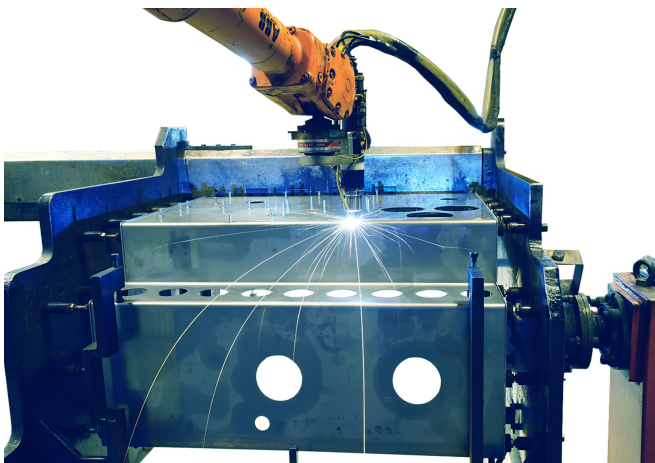
The pressure system is defined as a sealed for life system with an operating life time exceeding 30 years. The leakage rate is less than 0,1 percent per year.

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 GIS 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 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 or AirPlus.

The SafeRing and SafePlus gas compartment have a degree of protection of IP67, and can be immersed into water and still maintain all functions in a satisfactory way.



Gas tank velding

Production of SafeRing/SafePlus

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:

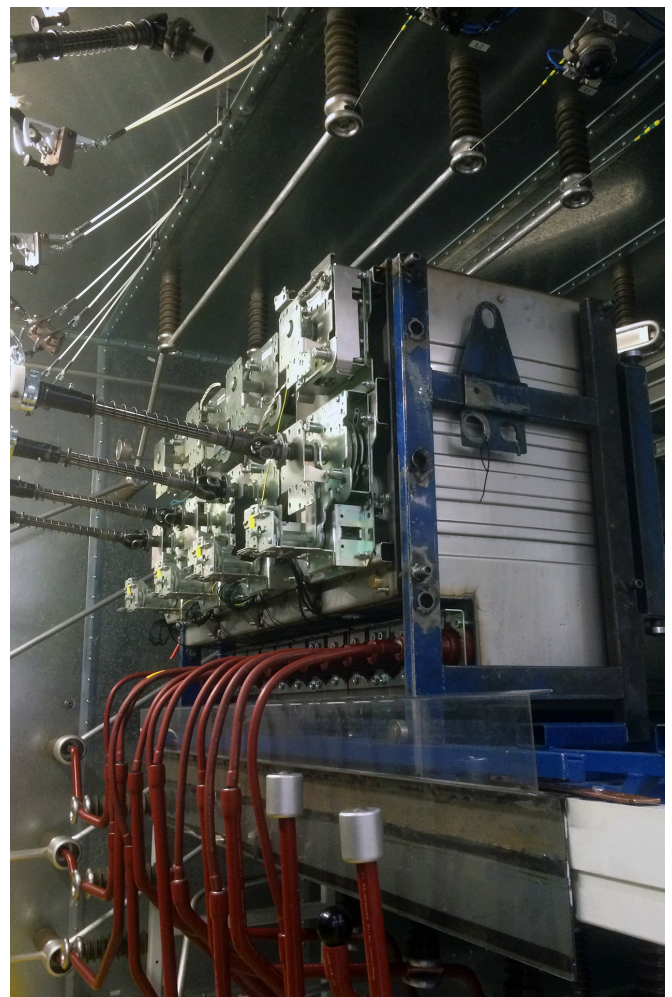
- Visual inspection and check
- Mechanical operations check
- Check of secondary wiring
- Electrical sequence operations
- Power frequency withstand voltage test
- Partial discharge measurement
- Measurement of resistance of the main circuits
- Secondary insulation test
- Control of the tightness in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

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



CCV AirPlus at gas tightness test



CCCV AirPlus at high voltage test

Personal safety

—
01 Arc duration and
damage caused

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

Causes and effects of internal arcs

Although an internal arc fault is highly unlikely 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.
- Broken or modified 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:

- Increase of the internal pressure
- Increase of the temperature
- Visual and acoustic effects
- Mechanical stresses on the switchgear structure
- Melting, decomposing and evaporation of materials

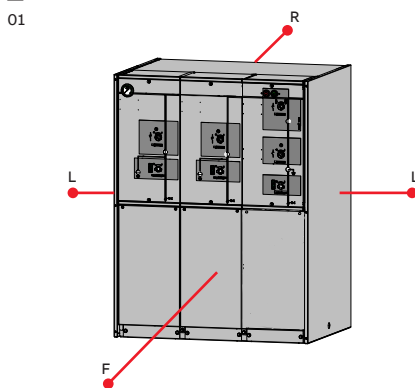
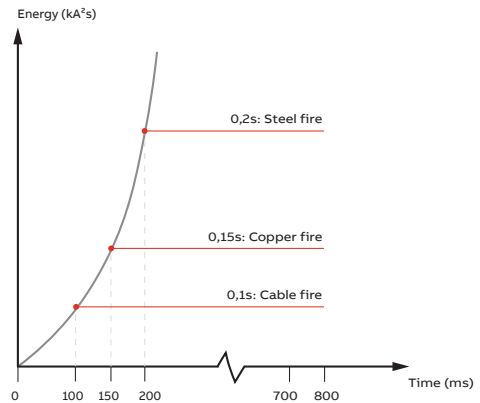
Tested according to IEC standard 62271-200

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

Accessibility: A and B (switchgear)

A = Accessible to authorized personnel only
300 mm safety distance on accessible sides of the switchgear (also distance to sensors during testing)

B = public access, 100 mm safety distance on accessible sides of the switchgear (also distance to sensors during testing)



Front (F) = Access from the front

Lateral (L) = Access from sides

Rear (R) = Access from the rear

Accessible sides of switchgear = Area that personnel can enter freely. For accessibility A this means a 300 mm safety distance + 500 mm or more in safe moving area.

Non-accessible side of switchgear = Area that is physically blocked or clearly marked as not safe for personnel.

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.
Projection of small parts up to an individual mass of 60 g are accepted
3. Arcing does not cause holes in the enclosure of the switchgear up to a height of 2 m
4. Indicators do not ignite due to the effect of hot gases
5. The enclosure remains connected to its earthing point

Internal Arc Classification (IAC)

01 *290 mm base frame available as an option. Note: The height of the exhaust channel must always be 2002 mm in order to comply with the requirements in IEC standards. When the base frame is 290 mm, the exhaust channel is extended to reach 2002 mm height

02 Downwards ventilation

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

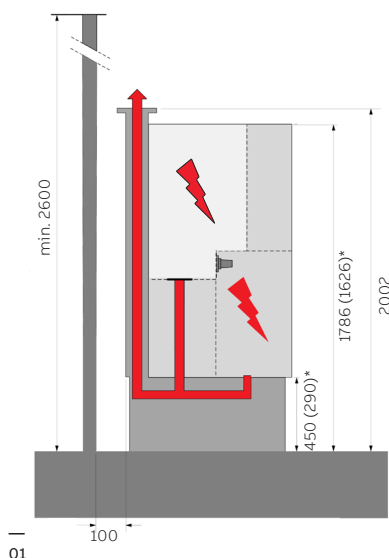
IAC AFLR - with ventilation upwards through an exhaust channel

With this setup, hot gasses and pressure are evacuated into the safe area of the switchgear room above the switchgear through the gas exhaust channel. In this setup the switchgear can be installed as free standing. This solution is not available for M-module. With this solution, a base frame of 450 mm (optional 290 mm) is included as standard.

Basic parameters of setup:

- IAC AFLR up to 20 kA / 1s
- Minimum height of ceiling: 2600 mm
- Minimum distance from backwall:
 - 800 mm with accessible rear side
 - 100 mm with non-accessible rear side
- Switchgear needs to be installed and fixed to the floor in accordance with "SafeRing / SafePlus 12-24kV Installation and operating instructions"

For number of modules, availability, heights and specifications, see table.



IAC AFLR or AFL - downwards ventilation With ventilation down to the cable trench.

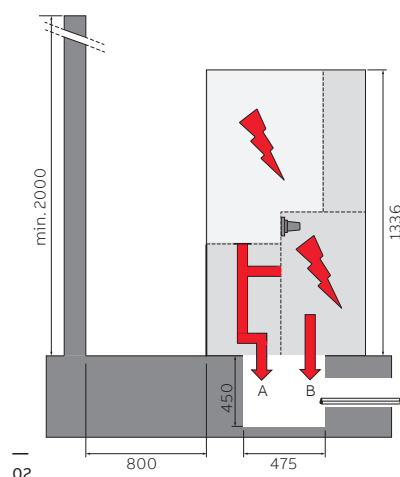
With this setup, hot gases and pressure are evacuated downwards in the cavity in the floor beneath the switchgear. Hot gases are led to the cable trench by means of a back plate installed on the rear side of the switchgear, forcing the hot gases down during an arc fault. The switchgear must be arranged as instructed according to the basic parameters below.

Basic parameters of set-up:

- IAC AFLR or AFL up to 20 kA / 1s
- Minimum height of ceiling: 2000 mm
- Recommended distance to back wall:
 - 800 mm with accessible rear side
 - 100 mm recommended for non-accessible rear side (possible down to 20mm)
- Back plate installed on the switchgear
- Requires a minimum opening between switchgear and cable trench in the "pressure relief area" for each module shown as opening "A" in illustration "02".
 - Opening "A" in a 1-way module: 250 x 205 mm
 - Opening "A" in 2-5 way modules: 150 x 205 mm

It is optional to cover opening "B" between the switchgear cable compartment and the cable trench with a gland plate. This is not an allowed option for low version switchgears.

- Minimum width of cable trench: 475 mm
- Minimum depth of cable trench: 450 mm
- A pressure relief channel to a safe area is required and it must have a free opening area of 0,1m²
- Switchgear needs to be installed and fixed to the floor in accordance with "SafeRing/SafePlus 12-24kV Installation and operating instructions".



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01 If the distance from the side wall is greater than 20 mm, arc shields on both sides are required. Marked area is restricted, but installation is allowed if mounting of arc shield is feasible.

—
02 Arc shield

—
03 Arc shield with base frame.

IAC AFL – Backwards ventilation

With ventilation behind the switchgear. With this setup, hot gases and pressure are evacuated behind the switchgear. Hot gases are led to the safe areas of the switchgear room by means of arc shields installed on accessible lateral sides of the switchgear or as a combined solution with additional ventilation down into a cable trench.

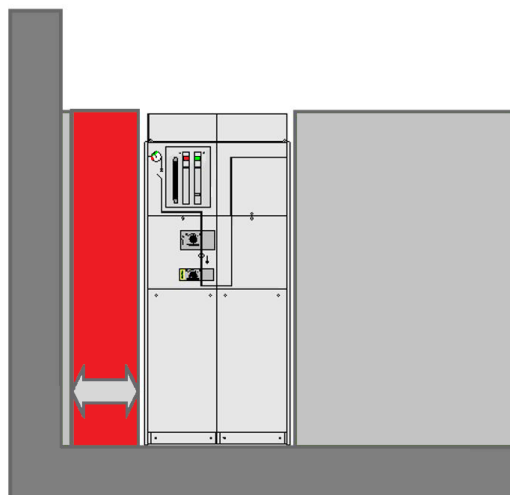
Basic parameters of set-up:

- IAC AFL up to 20 kA / 1s
- Minimum height of ceiling: 2400 mm
- Arc shields need to be installed if the distance between the switchgear and respective sidewall(s) is more than 20 mm to maintain its AFL classification. If both sides of the switchgear are more than 20 mm from any sidewalls then arc shields are required on both sides
- Arc shields are 100 mm
- Minimum distance to back wall: 100 mm
Larger distances can be accepted if the area between the switchgear and back wall is non-accessible
- Switchgear needs to be installed and fixed to the floor in accordance with “SafeRing / SafePlus Air/AirPlus Installation and operating instructions”

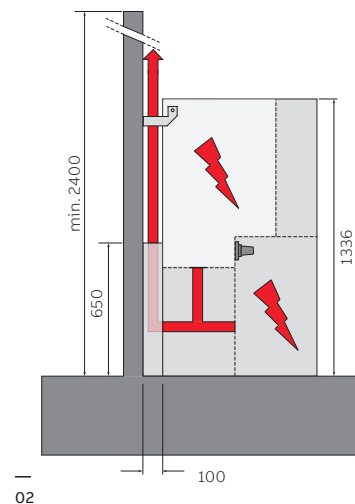
For number of modules, availability, heights and specifications, see table.

Non-arc proof version

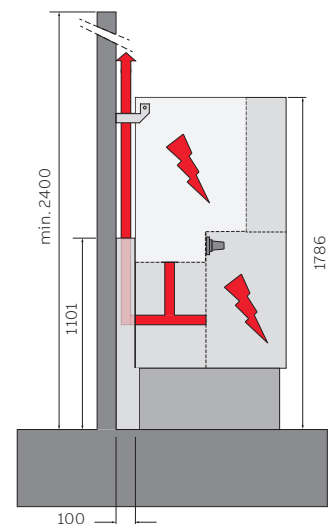
The non-arc proof version of the switchgear is not verified for any of the IAC-classes. In the highly unlikely event of an internal arc fault in the switchgear, hot gases and pressure could evacuate randomly in any direction at any place of enclosure.



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01



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02



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03

Table for IAC

ISC (kA/1s)	IAC class	Ventilation	Height of switchgear (mm)	Roof height (mm)	Base frame	Max sets of current transformers
16	AFL	Backwards	1336 (standard)	2400 (standard)	Optional (290/450 mm)	2 ²⁾
	AFL	Downwards ³⁾	1336 (standard)	2000 (standard)	Optional (290/450 mm)	2 ²⁾
	AFLR	Downwards ³⁾	1336 (standard)	2000 (standard)	Optional (290/450 mm)	2 ²⁾
	AFLR	Upwards ⁴⁾	2002 ¹⁾	2600	Mandatory ⁵⁾ (290/450 mm)	2 ²⁾
20	AFL	Backwards	1336 (standard)	2400 (standard)	Optional (290/450 mm)	2 ²⁾
	AFL	Downwards ³⁾	1336 (standard)	2000 (standard)	Optional (290/450 mm)	2 ²⁾
	AFLR	Upwards ⁴⁾	2002 ¹⁾	2600	Mandatory ⁵⁾ (290/450 mm)	2 ²⁾

1) Height of exhaust channel is always 2002 mm. This dimension is independent of the height of the base frame and switchgear.

2) In case two sets of CT's are required, additional base frame is mandatory and it is not allowed with gland plate as second set of CT's will be installed in base frame.

3) IAC classification is unavailable in case of installation deviating from basic parameter set-up described in "downwards ventilation" section on previous pages.

4) Upwards ventilation solution requires a base frame for attaching the gas exhaust channel. Only available from 2-way to 5-way switchgears.

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

Arc suppressor for Air 12kV

—
01 Arc suppressor
inside the tank

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02 No ventilation of
hot gases after arc
fault inside the tank.

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 incoming feeder inside the sealed tank of SafeRing and SafePlus switchgear.

If an arc fault should occur inside the 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 bolted 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.

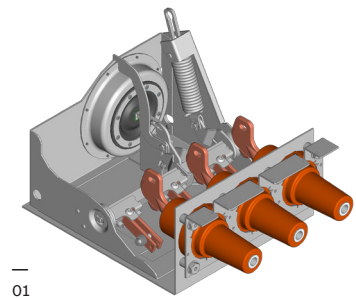
The pressure detector is insensitive to pressure changes due to variation in atmospheric temperature or pressure, as well as external phenomena such as vibrations or shocks.

The arc suppressor is tested for short-circuit 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 second.

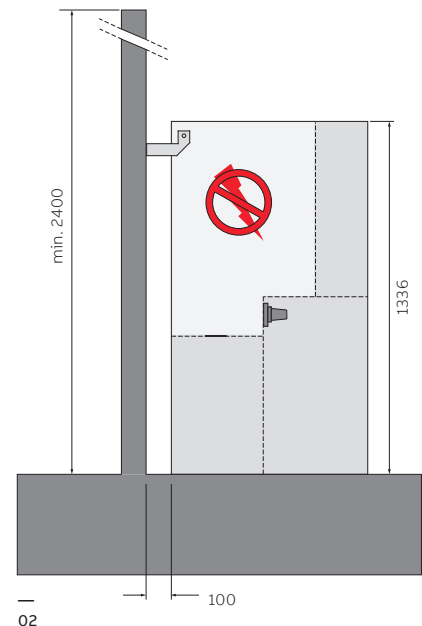
Since the system is self-contained, an internal arc fault in the tank will have no impact on the surroundings, so there will be no cleaning work required. No arc fault tests have to be repeated in combination with channel release systems or transformer stations.

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.



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01



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02

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 medium 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

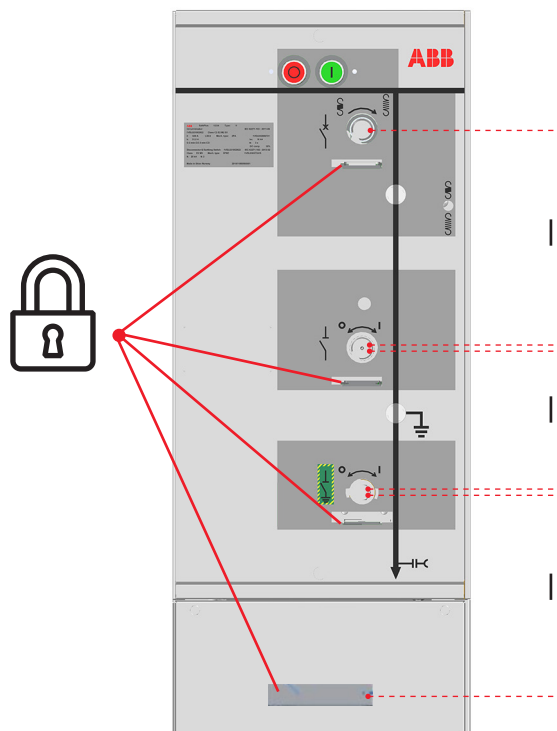
The cable compartment doors can be locked in the closed position by means of padlocks. The padlock can also be applied to the switches to avoid improper operation of the switchgear. For more detailed description, see dedicated interlocking pages for each module. Padlocks from 4 to 8 mm diameter can be 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. Can be set to 0.5, 1, 1.5, 2 or 3 seconds.



SafeRing Air/AirPlus configurations

General

SafeRing Air - up to 12kV

SafeRing AirPlus - up to 24kV

SafeRing Air/AirPlus is a ring main unit for the secondary distribution network. It can be supplied in 18 different configurations suitable for most switching applications in 12-24kV distribution networks.

The SafeRing Air/AirPlus concept offers a choice of circuit breaker with relay for protection of the transformer.

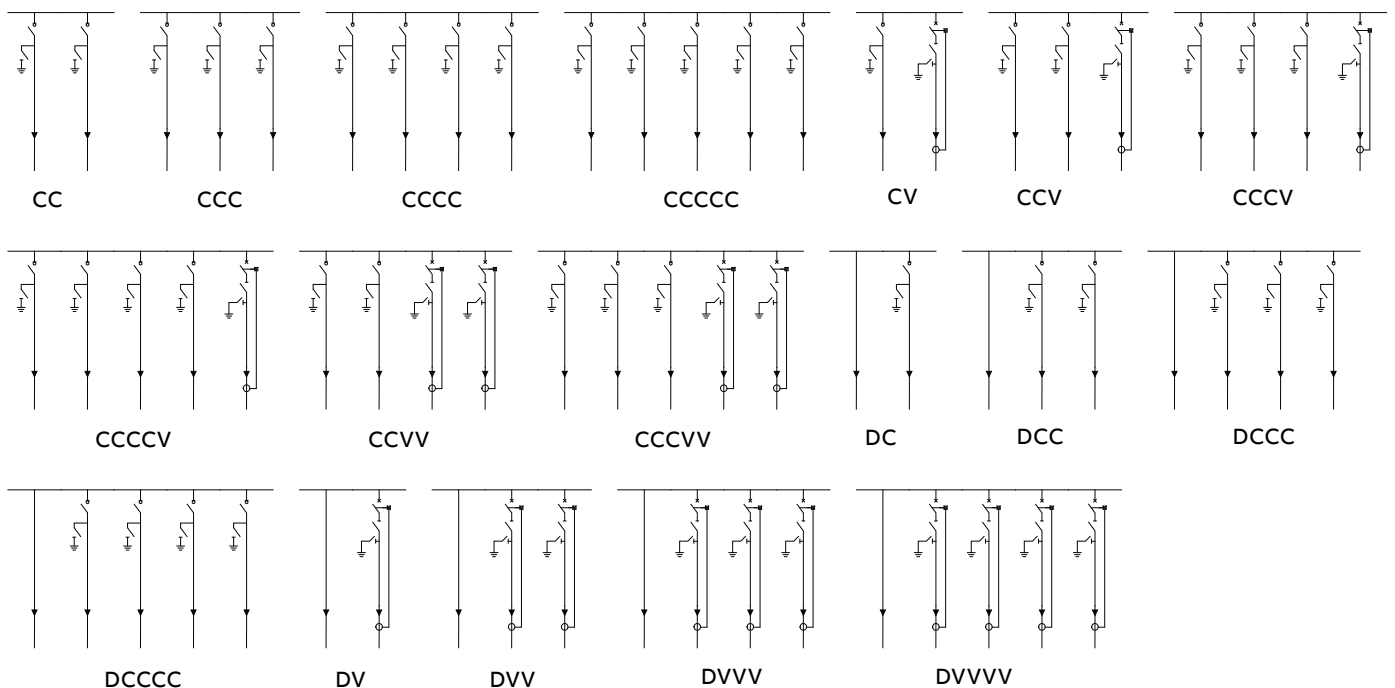
SafeRing Air/AirPlus is supplied with the following standard equipment

- Downstream earthing switches
- Operating mechanisms with integral 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 for SafeRing Air
- 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
- LV compartment
- Top entry box
- Ronis key interlock
- Self Powered Relays for V-module
 - Woodward WIC1-2-P-E
 - ABB REJ603 r.1.5

The 18 different configurations:



SafePlus Air/AirPlus modules

General

SafePlus Air/AirPlus is a metal enclosed compact switchgear system for up to 24kV distribution applications. The switchgear has a unique flexibility due to the possible combination of fully modular and semi-modular configurations.

SafePlus Air/AirPlus, which is ABB's standard ring main unit, represent a complete solution for 12-24kV distribution networks.

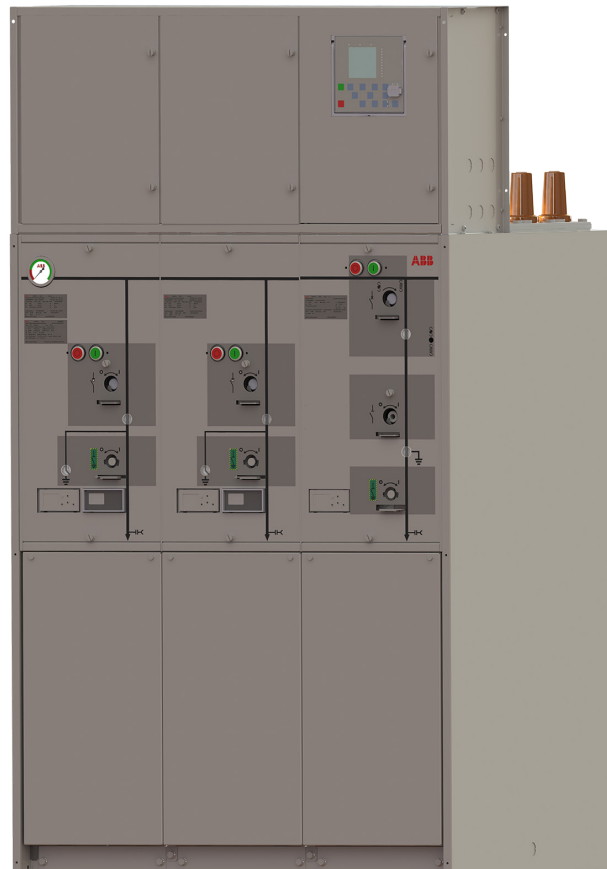
SafePlus Air/AirPlus have identical user interfaces, operation procedures, spare parts and components. SafePlus Air is a completely sealed system with a stainless steel tank containing all live parts and switching functions.

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.

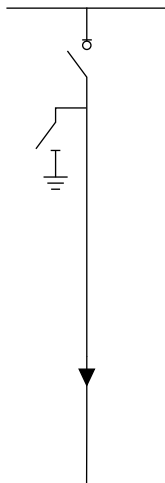
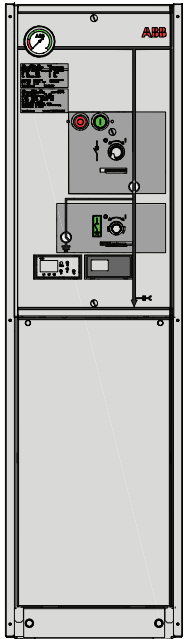
The SafePlus Air/AirPlus system offers a choice of a circuit-breaker with relay for protection of the transformer.

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

SafePlus Air/AirPlus can also be supplied with remote control and monitoring equipment which makes the switchgear more intelligent. (Low-voltage compartment is required).



C - Cable switch module



Depth: 751 mm
Width: 325 mm
Height: 1336 mm

In the new C-panel, the load switching operation is performed with a linear switch disconnecter based on the puffer principle. Due to the linear motion of the contacts inside a small interruption chamber, the insulating gas is compressed and forced directly onto the current arc, cooling it down and interrupting the current flow. The principle is well known from high voltage circuit breakers and high-duty medium voltage applications. However, through years of innovation and fundamental research, ABB can utilize the same principle in a scaled down version as a cost effective and robust alternative to vacuum interrupters.

The puffer principle allows several advantages over alternative switching technologies. During interruption, the linear contacts are separated to a safe disconnecting gap, not requiring a separate device for disconnecter as with vacuum interrupter-based devices. Further, the arc quenching power is provided directly by the forced cooling of compressed gas, as generated by the motion of the external mechanical drive. No vacuum gap, metal vapor or ablation effects are required, offering a robust performance at all current levels. The natural disconnecter gap and replacement of hot- with cold gas during the switching operation quickly re-establish the insulation level,

allowing the robust interruption of loads with high transient voltages, such capacitive duties and switch-fuse transfer currents.

The switch-disconnector is fitted with a two-position earthing switch. The combination of these devices offers a simplified operation sequence and single-line diagram of the C-module, similar to the present SafeRing/SafePlus solutions from ABB with SF6

Common features

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

Standard features

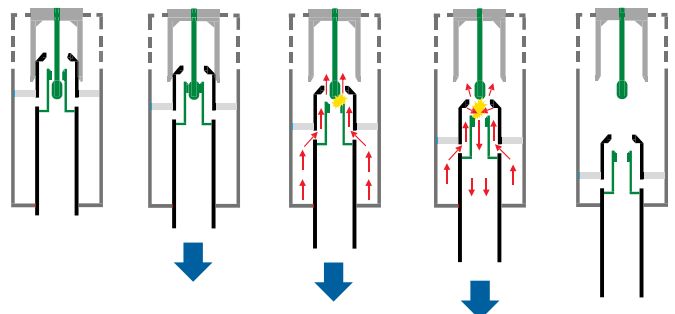
- Two position load break puffer switch and separate earthing switch
- Two-position single spring operating mechanisms with two separate operating shafts for load break function and earthing function
- Interlocking between load break switch and earthing switch
- Switch position indication for load break switch and earthing switch
- Cable bushings horizontal in front, Interface C with integrated voltage divider for voltage indication

Optional features

- Arc suppressor (for Air 12kV only) with signal (1NO) wired to low voltage terminals
- Signal (1NO) from internal pressure indicator wired to terminals (only one each air tank)
- Auxiliary switches
 - Switch position 2NO+2NC
 - Earthing switch position 2NO+2NC

Optional features also available as retrofit

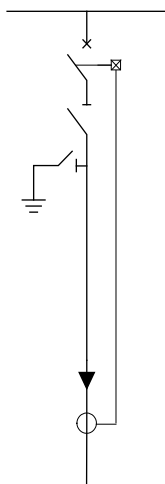
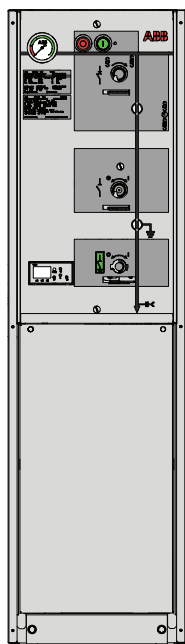
- Motor operation for load break switch



Puffer interrupter technology

V - Vacuum circuit-breaker module

The vacuum circuit-breaker (V-Module) has vacuum bottles as interrupters of the current.
A three-position disconnect/earthing switch is connected in series with the circuit-breaker main circuit.
The operation between vacuum circuit-breaker and disconnect/earthing switch is mechanically interlocked.



Depth: 751 mm
Width: 325 mm
Height: 1336 mm

Common features

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

Standard features

- 630A vacuum circuit-breaker for feeder protection
- Two position double spring mechanism for vacuum circuit-breaker
- Downstream three position disconnect/earthing switch from vacuum circuit-breaker
- Three positioning single spring mechanism for disconnect/earthing switch
- Interlocking between vacuum circuit-breaker and disconnect/earthing switch
- Switch positioning indication for vacuum circuit-breaker and disconnect/earthing switch
- Interface C, 630A (400 bolted)
- Trip coil (for relay tripping)
- Capacitive voltage indication

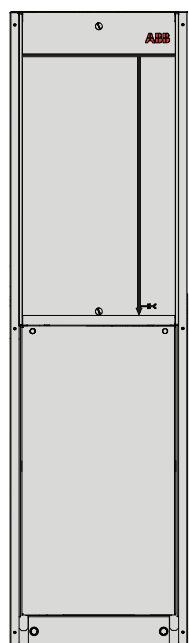
Optional features

- Interface C (400 series bolted) combisensors with integrated voltage divider for voltage indication and integrated sensor for current and voltage monitoring
- 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, disconnect position 2NO+2NC, earthing switch position 2NO+2NC and vacuum circuit-breaker tripped signal 1NO
- Blocking coil
- Undervoltage release coil with/without time delay

D - Direct cable connection module



Depth: 751 mm
Width: 325 mm
Height: 1336 mm

Common features

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

Optional features

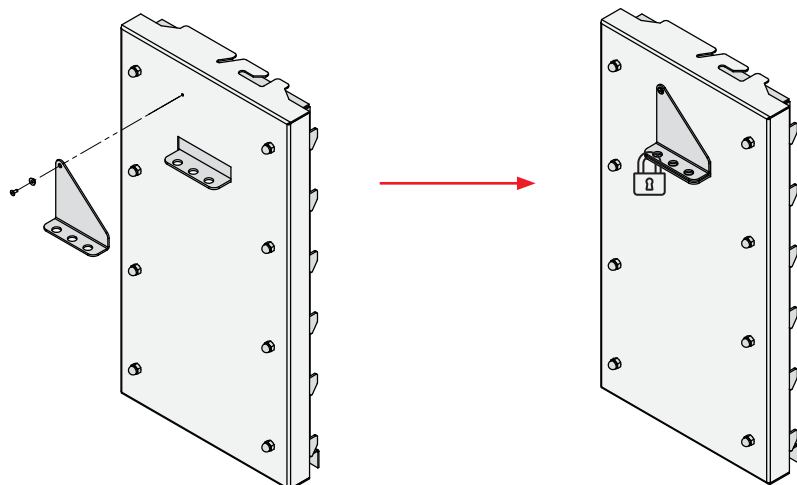
- Cable bushings:
Interface C (400 series bolted) combisensors with integrated capacitor for voltage indication sensors
- Current and voltage monitoring

Locking

Padlock on cable compartment cover (optional, only for Arc proof cable cover, see drawing below))

To mount the padlock, add a hole Ø3,2 in the cable cover.

- Top to hole = 54,5mm
- From the right side to the hole = 203,8mm



Transformers and sensors

Current transformers

Toroidal current transformers

Toroidal transformers are insulated either in epoxyresin 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.

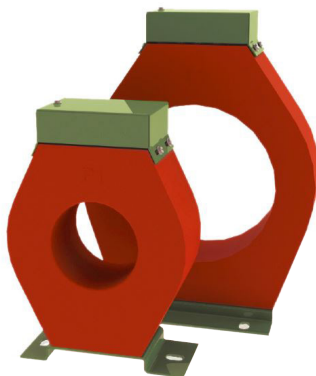
The transformers can be mounted inside the ring main unit / switchgear. Secondary circuits should be mounted using copper wires with a cross-section up to 4 mm² (strand) or up to 6 mm² (solid conductor).

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

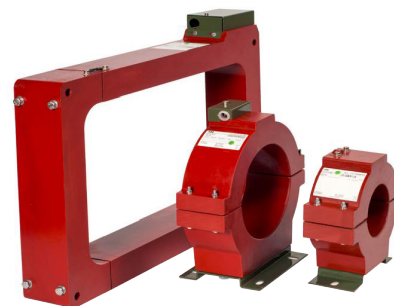
KOLA and KOLMA are used for measurement of residual current.



KOKM 072



KOLMA



KOLA

Transformers and sensors

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

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

Transformers and sensors

Combisensor for Air 12kV

Sensor variants

Two versions are available: one providing voltage measurement together with voltage indication capability or a second one providing both of these plus the possibility of current measurement (KEVCY 24 RE1).

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 24 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 24 RE1 and KEVCY 24 RF1 sensors is based on the capacitive divider principle.

Sensor application

KEVCY 24 RE1 & RF1 are compact and very small bushing type sensors designed to be used in air insulated switchgear type SafeRing Air/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

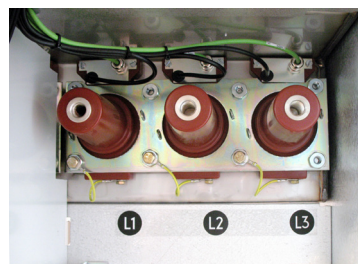
The sensor is equipped with two cables:

- 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 630A
Rated primary voltage of application	up to 12kV
Highest voltage for equipment, U_m	12kV
Rated power frequency withstand voltage	50kV
Rated lightning impulse withstand voltage	125kV

Technical data, voltage sensor

Technical data, voltage sensor	Value
Rated primary voltage, U_{pr}	22/√3kV
Maximum rated primary voltage, U_{primax}	22/√3kV
Rated frequency, f_n	50/60Hz
Accuracy class	0.5/3P
Rated burden, R_{br}	10MOhm
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}	80A
Rated transformation ratio, K_{ra}	80A /0.150V, 50Hz 80A/0.180V, 60Hz
Rated secondary output, U_{sr}	3mV/Hz i.e 150mV at 50Hz or 180mV at 60Hz

Rated continuous thermal current, I_{cth}	630A
Rated short-time thermal current, I_{th}	25kA / 3s
Rated dynamic current, I_{dyn}	63kA
Rated frequency, f_r	50/60Hz
Rated extended primary current factor, K_{pcr}	7.875
Accuracy limit factor, K_{alf}	100
Rated burden, R_{br}	10MOhm

Cables

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

Transformers and sensors

Current 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 case of medium voltage switchgear the current sensor shall be installed over a bushing insulator, insulated cable, insulated & 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.



Parameters for application

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

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 as 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 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 (aI) and phase error correction factor (pI) of a current sensor.

Transformers and sensors

Voltage sensor

KEVA 24 C Indoor voltage sensor.

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

The voltage sensors are designed as easy replacement of originally used insulating plugs 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 as 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 24kV
Sensor parameters	
Rated primary voltage, U_{pn}	22/ $\sqrt{3}$
Highest voltage for equipment, U_m	24kV
Rated power frequency withstand voltage	50kV
Rated lightning impulse withstand voltage	125kV
Rated continuous thermal current I_{cth}	2500A
Rated transformation ratio, K_{ra} for voltage measurement	10000 : 1
Voltage accuracy class	0,5/3P
Length of cable	2,2m



Sensor variants and use in cable connectors

Sensor type designation	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 C23	Raychem	RSTI 58xx/39xx
		RSTI CC 58xx/39xx
		RSTI LCxx/LAxx (older)
	NKT	CB 12-630
		CC 12-630
KEVA 24 C24	Nexans (Euromold)	CB 24-630
		CC 24-630
		CC 24-630
	Prysmian	430 TB/G
		300 PBM/G-630A
		300SA-10-xN
		MSCEA/EC-630-C

Cable bushing

—
01 Interface C
for Air 12kV
—
02 Interface C
for AirPlus 24kV

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.

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 and IEC 60137.

There are different 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 for Air 12kV)

SafeRing/SafePlus AirPlus uses interface C bushings made of different epoxy mixture. Appearance of the bushing is different due to white color, but function is the same.

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.

Due to compability with insulating gas



01



02

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.

Application area

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

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.

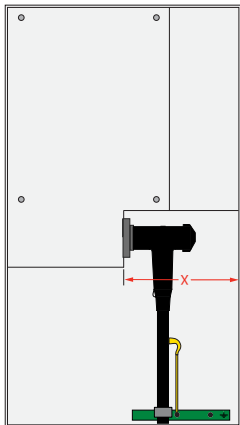
Standard

- Fits standard bushings of outer cone type according to EN 50181
- Connectors with rated current 630A, interface type C with bolt M16
- Meets the requirements of CENELEC, HD 629.1 S2

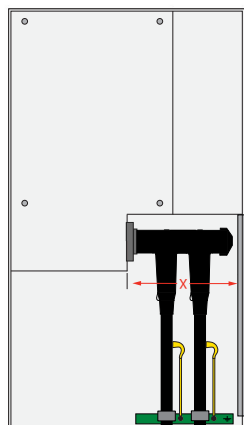
Note:

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

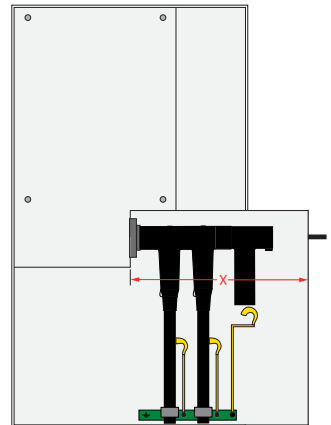
Standard



Arc proof



Extended



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

Cable compartment type	Distance (X)
Standard	360
With window	353
Arc proof with/without window	337
Extended	555

Table 12kV Separable connectors interface C, $I_r = 630$ A

Manufacturer	Designation	Conductor (mm ²)	•LP/EPR (Ø mm)	Earthing Shield Yes/No	Dual cable arr.	Surge arrester
3M	93-EE 705-6/-95	50-95	15.0-32.6	Y	KU 23.2 + 93-EE 705-6/95	MUT 23
3M	93-EE 705-6/-240	95-240	15.0-32.6	Y	KU 23.2 + 93-EE 705-6/95	MUT 23
Euromold	480TB/G	16-300	12.0-37.5	Y	800PB	800SA
Euromold	484TB/G	50-630	16.0-56.0	Y	804PB	800SA
NKT	CSE-A 12630-0x	25-630	13.0-45.0	Y	CSEP-A 12630-xx	CSAP-A
NKT	CB 24-630 Type xx	25-300	12.7-34.6	Y	CC 24 630 M16	CSA M16
Raychem	RSTI58XX	25-300	12.7-34.6	Y	RSTI CC	RSTI-SA
Südkabel	SET 12	50-300	15.0-32.6	Y	SEHDK 13.1	MUT 23
Südkabel	SAT 12	185-300	22.1-34.6	Y	SEHDK 13.1	MUT 23

Table 24kV Separable connectors interface C, $I_r = 630$ A

Manufacturer	Designation	Conductor (mm ²)	•LP/EPR (Ø mm)	Earthing Shield Yes/No	Dual cable arr.	Surge arrester
3M	93-EE 705-6/-xxx	50-240	15.0-32.6	Y	KU 23.2 + 93-EE 705-6/xxx	MUT 23
Euromold	K480TB/G	16-300	12.0-37.5	Y	800PB	800SA
Euromold	K484TB/G	35-630	16.0-56.0	Y	804PB	800SA
NKT	CSE-A 24630-0x	25-630	17.0-45.0	Y	CSEP-A 24630-01	CSAP-A
NKT	CB 24-630 Type 0x	25-300	12.7-34.6	Y	CC 24 630 M16	CSA M16
Raychem	RSTI58XX	25-300	12.7-34.6	Y	RSTI CC	RSTI-SA
Südkabel	SET 24	25-240	15.0-32.6	Y	SEHDK 23.1	MUT 23
Südkabel	SAT 24	95-300	22.1-34.6	Y	SEHDT 23.1	MUT 23

- For dual cable + surge arrester, deeper cable compartment is required.
- 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

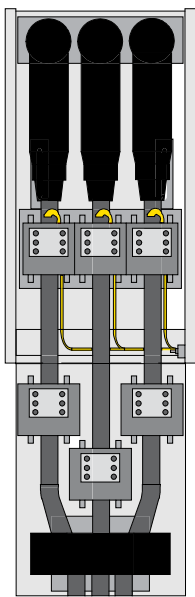
Base frame

When SafeRing/SafePlus Air/AirPlus 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.

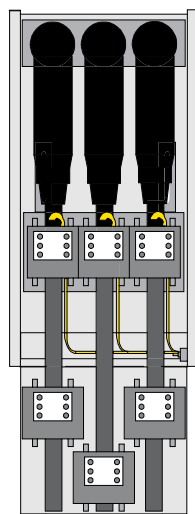
Inside the standard cable compartment for the vacuum circuit-breaker there will be enough space for three current transformers for protection relay.

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

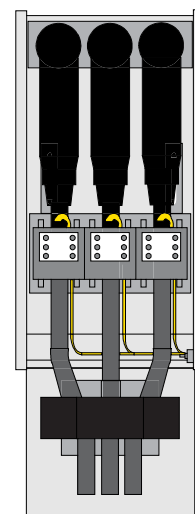
The base frame has openings for cable entrance from the bottom and from both sides. It is delivered as a kit and has to be assembled on site.



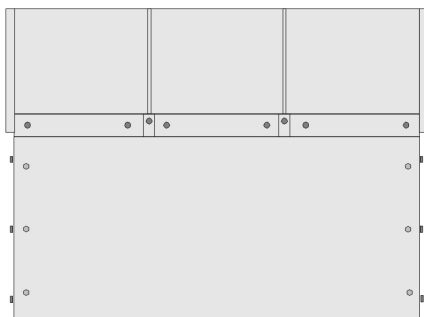
Base frame 450mm with earth-fault transformer and extra set of current transformers



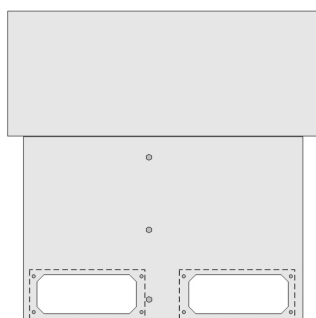
Base frame 290mm with an extra set of current transformers



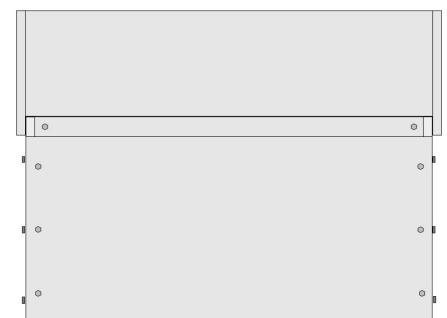
Base frame 290mm with earth-fault transformers



Front view



Side view



Rear view

Low-voltage compartment/Top entry box

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).

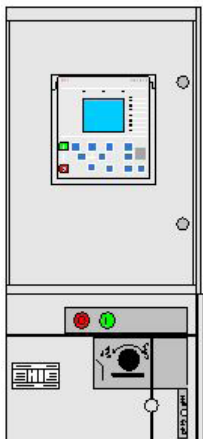
Top entry box

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.

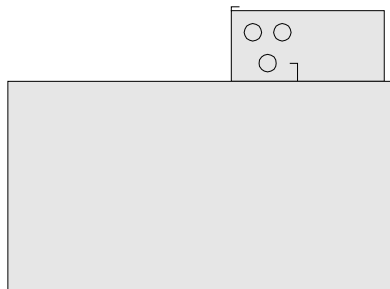
However, an additional top entry box can be mounted on the top of all SafeRing Air switchgears. Since the top entry box is fixed to the side covers of the air tank, the total width of the switchgear must be covered.

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

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



Low-voltage compartment with REF615 relay



Side view top entry box



Top entry box seen from above when front and top covers has been removed

Motor operation and coils

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 220VAC, a rectifier is integrated in the control unit.

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.

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).

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 6,3A
48	150	4 - 7	4 - 7	13	F 4A
60	90	6 - 9	6 - 9	7	F 4A
110	90	6 - 9	6 - 9	3	F 2A
220	90	6 - 9	6 - 9	1,7	F 1A

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 6,3A
48	220	5-9	40-60	13	F 4A
60	150	9-13	40-60	7	F 4A
110	170	9-13	40-60	3	F 2A
220	150	9-14	40-60	1,7	F 1A

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)		
24VDC	150	40-60	40-60	6	F 6,3A
48VDC	200	40-60	40-60	4	F 4A
60VDC	200	40-60	40-60	3	F 4A
110VDC	200	40-60	40-60	2	F 2A
220VDC	200	40-60	40-60	1	F 1A
110VAC	200	40-60	40-60	2	F 2A
230VAC	200	40-60	40-60	1	F 1A

Transformer protection

The Air/AirPlus portfolio offers 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.

The Air/AirPlus portfolio is delivered with a 630A 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 energize 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:

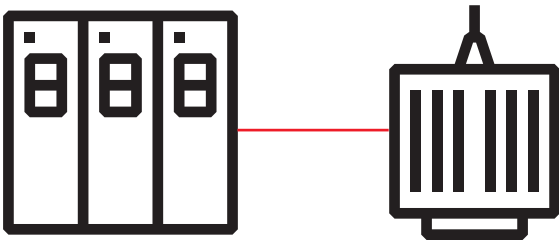
- ABB relay type REJ 603
- Woodward relays type WIC 1 and WIB 1 PE
- Kries relay type IKI-30/IKI-35

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 protection for over currents
- Small fault currents are detected in an early stage



Relays

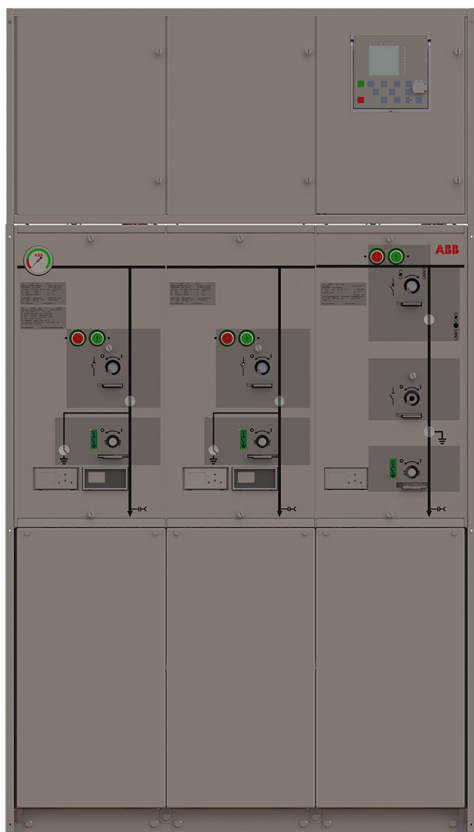
SafePlus Air/AirPlus can be delivered with a V-module with 630A vacuum circuit-breaker. This chapter describes the different choices of protection relays and feeder terminals that can be used in SafePlus Air/AirPlus. These relays require an additional low-voltage compartment.

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.

There are two main groups of relays delivered:

- A. Auxilliary powered relays
 - B. Self-powered relays
- A. ABB offers a wide range of feeder protection relays. These relays have an excellent reputation for reliability and safe operation and 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.



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.



Auxiliary powered relays



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.

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 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. It 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.

Self-powered relays



REJ603 v.3.0



REJ603 v.1.5



IKI-30



IKI-35



WIB1



WIC1



WIP1

REJ603

REJ603 is designed for selective short-circuit and earth-fault protection of feeders in secondary distribution networks and for protection of small transformers in utilities and industries. REJ603 is a current-transformer-powered numerical feeder protection relay designed for applications where auxiliary power is not available or cannot be guaranteed, thereby making it an ideal choice for installation in remote locations. The relay is primarily used in ring main units and secondary distribution switchgear within distribution networks.

REJ603 v.1.5: Functions are easy to set up by using the dip-switches.

REJ603 v.3.0: Contains LCD display, LED indicators and navigation keys. Measurement, events and settings can be viewed in the display.

IKI-30/IKI-35

The Transformer protection relay IKI-30 is applicable for transformers with nominal power between 160 and 12 500 kVA; as overcurrent, short-circuit or earth-fault protection relay in combination with a circuit-breaker and as overcurrent protection in combination with load-break switch and switch-fuse devices. IKI-35 is a self-powered overcurrent protection relay with self test function and event recorder. For transformer or feeder protection with a wide range of CT's.

WIB1/WIC1

All available versions of the WIB1/WIC1 relay are a high-tech and cost-optimized protection for MV switchgears. Specifically in compact switchboards, the WIB1/WIC1 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/WIC1 protection system is an optimal replacement.

WIP1

The WIP1 is an overcurrent relay with multiple characteristics. Definite time and inverse time tripping characteristics can be selected. 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).

Technical functions self-powered relays

Functionality			Relay					
Features	Description	IEC 60617	WIP 1	REJ603 r.1.5	WIC 1	WIB 1	IKI 30	IKI 35
Protection functions	Three-phase transformer inrush detector	3I2f>		•			•	•
	Phase overcurrent (multi-characteristic)	3I> (low set)	•	•	•	•	•	•
	Short-circuit protection	I>>	•	•	•	•	•	•
	Number of overcurrent element		2	2	2	2	2	2
	Earth-fault current	IO> (low set)	•	•	•	•	•	
	Number of earth-fault elements		2	2	1	2	2	2
Characteristic curves	Overcurrent element		DEFT,INV ¹⁾	DEFT,INV ¹⁾	DEFT,INV ¹⁾	DEFT	DEFT,INV ¹⁾	DEFT,INV ¹⁾
	Earth-fault current		DEFT,INV ¹⁾	DEFT,INV ¹⁾	DEFT	DEFT,INV ¹⁾	DEFT	DEFT,INV ¹⁾
Additional functions	Trip indication		•	•	• (option)	•	•	•
	Electro-impulse		1	1	1	2	1	
	input remote tripping (voltage)		230VAC		115/230VAC	115/230VAC	24VDC/115/230VAC	24 ... 230VAC/DC
	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	wide range special CT
	Measuring range, start current I> (A)		0,17 ²⁾	7,2	7,2	7,2	7,2	7,2
Climatic withstand	Storage temperature (°C)		-40 ...+85	-40 ...+85	-40 ...+85	-40 ...+85	-30 ...+70	-30 ...+70
	Operating temperature (°C)		-20 ...+55	-40 ...+85	-40 ...+85	-40 ...+85	-25 ...+55	-40 ...+70

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

²⁾ Secondary current

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
WIB1 transformer protection and cable protection kit (self-powered)		Ring core current transformer type	Current range
Transformer type		KOKM 072 CT1 or WIC1-W1	8 - 28 A
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

Indicators

Capacitive voltage indicators

—
01
VPIS
—
02
WEGA
—
03
Capdis
—
04
HR module (VDS)
—
05
VIM 3
—
06
VIM 1

SafePlus switchgears are equipped with voltage indicators in accordance with IEC 62271-213 standard for voltage detecting and indication system.

Voltage indicators VPIS

VPIS indicators indicate only presence of the medium voltage. Absence of the voltage needs to be confirmed by the functionality test of the VPIS.

Phase comparison and testing of VPIS

Each phase of the integrated voltage presence indicating system has a connection point on the front panel that 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. The VDS system delivered by ABB can be either based on the LRM or the HR- system.

Voltage indicators VDS LRM

With 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

SafePlus can be delivered with a Voltage Detection System (VDS HR).

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

Phase comparator

A phase comparator is used for controlling the phase sequence, in case of 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 62271-215.



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01



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02



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03



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04



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05



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06

Technical functions capacitive voltage indicators

Manufacturer	Maxeta	Anda	Maxeta	Horstmann	Horstmann	Horstmann	Kries	Kries
Model	VPIS	DXN5-T	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 25-40,5kV	3-6kV 6-12kV 12-24kV 24-40,5kV	6-12kV 10-24kV 27-40,5kV	3 - 6kV 5 - 12kV 8 - 15kV 10 - 24kV 20 - 40,5kV	3 - 6kV 5 - 12kV 10 - 24kV 20 - 40,5kV	Adjustable	Adjustable	Adjustable
Signalling contacts	no	no	no	no	yes *	no	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 tape	-	-	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

Indicators

Short-circuit and earth-fault indicators



Compass B

The increasing demand for reliability and effectiveness of distribution networks requires more flexibility and automation in ring main units. As one of the biggest manufacturers in the medium voltage distribution segment, ABB replies to this demand by installation of grid automation devices. One of the basic devices is the fault passage indicator.

Fault passage indicators

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



IKI-50

A fault passage indicator offers different functionalities 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.

Technical functions short-circuit indicators

Manufacturer	Horstmann	Horstmann	Horstmann	Horstmann	Horstmann	Horstmann	Kries
Model	Sigma	Sigma F+E3	Sigma D	Sigma D+	Compass B	Compass B CS1	IKI-50
Dedicated volt. ind.			Wega 1.2C/ Wega 1.2 vario/ Wega 2.2C	Wega 1.2C/ Wega 1.2 vario/ Wega 2.2C	Wega 1.2C/ Wega 1.2 vario/ Wega 2.2C	ABB Combi-sensor	Capdis S1/S2-R4
STC fault ind.	•	•	•	•	•	•	•
Directional ind.			•	•	•	•	•
Directly earthed neutral		•	•	•	•	•	•
Isolated neutral - Wattmetric (sin)				•	•	•	
Compensated neutral - Wattmetric (cos)				•	• (with Sum- Sensor) IE>10A	• (IE>10A)	•
Compensated neutral - transient				•			
Compensated neutral - puls				•	• (only type Bp)		
Monitoring	•	•			•	•	•
Trip current short-circuit	100-1000A	200-2000A	50-2000A	50-2000A	50-2000A	200-2000A	100-1000A
Response time short-circuit	40-80ms	40/80/200/300ms	40ms-60s	40ms-60s	40ms-60s	40ms-60s	60-1600ms
Trip current earth-fault		20-160A	20-1000A (low imp. network)	20-1000A (low imp. network), 5-200A (wattmetric), 10-100A (transient), 1-	20-1000A (low imp. network), 5-200A (wattmetric)	100-1000A (low imp. network), 5-200A (wattmetric)	40-200A + 4-30A (cosphi methode)
Response time earth-fault		60/80/200/300ms	40ms-60s	40ms-60s	40ms-60s	40ms-60s (low imp. network), 200ms-60s (wattmetric)	60-1600ms
Remote test/reset	•	•	•	•	•	•	•
Automatic reset time	1,2,4,8h	2,4,8,24h	1 min - 24h	1 min - 24h	1 min - 24h	1 min - 24h	1,8h or automatic after load current is recovered
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
Life time of battery	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	
No. of relay contacts	1	3	4	4	4	4	4
Comm. protocole					Modbus	Modbus	Modbus
Configuration	DIP	DIP	DIP/SW	DIP/SW	Menu/SW	Menu/SW	Menu nav.

Technical functions short-circuit indicators

Manufacturer	Kries	Kries	Kries	Kries	Kries	Kries	Anda
Model	IKI-50-PULS-EW	IKI-20	IKI-20PULS	IKI-20C	IKI-20C PULS	IKI-22	EKL-7
Dedicated volt. ind.	Capdis S1/S2-R4					Capdis S1	
STC fault ind.	•	•	•	•	•	•	•
Directional ind.	•					•	
Directly earthed neutral	•	•	•	•	•	•	•
Isolated neutral - Wattmetric (sin)						•	
Compensated neutral - Wattmetric (cos)	•					•	
Compensated neutral - transient	•					•	
Compensated neutral - puls	•		•		•		
Monitoring	•	•	•			•	
Trip current short-circuit	100-1000A	100-2000A	100-2000A	400-1000A	400-1000A	100-2000A	400,600,800,1000A
Response time short-circuit	60-1600ms	60-200ms	60-200ms	100ms	100ms	60-200ms	40,60,80,100ms
Trip current earth-fault	40-200A + 4-30A (cosphi methode) + transient methode	40-200A	40-150A	400-1000A	pulsation	400-200A + transient methode	20, 40, 60, 80A
Response time earth-fault	60-1600ms	60-200ms	Appr. 9s after detecting pulsating current	100ms	100ms	60-200ms	80, 120, 160, 200ms
Remote test/reset	•	•	•	•	•	•	•
Automatic reset time	1,8h or automatic after load current is recovered	2,4h	2,4h	2,4h	2,4h	2,4h	1,2,4,8h
Supply	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	24-230V AC/DC, only for sensitive earth-fault function + battery	230V AC/DC (ext), 3,6V battery (int)
Life time of battery		17 years (batteries)	12h for cap. buffering	4h for capacitor	4h for capacitor	15 years (batteries)	10 years (batteries)
No. of relay contacts	4	1-3 dep. on version	2 dep. on version	2	2	1-3	2
Comm. protocole	Modbus	Modbus	Modbus				
Configuration	Menu nav.	DIP	DIP	DIP	DIP	DIP	DIP

Indicators

Manometers/Pressure indicators

SafeRing/SafePlus Air/AirPlus 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 an 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.

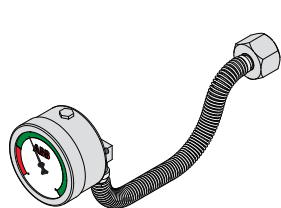
In case remote indication is needed, manometers can be equipped with signalling contacts. Detailed descriptions of manometer functions are found in the table below.

Altitude

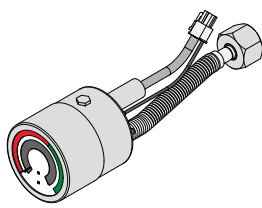
Max height above sea level for installation without reducing gas pressure is 1500 meters. In the interval from 1500 to 2000 meters, gas pressure has to be reduced.

For installation above 2000 meters, please contact ABB for instructions.

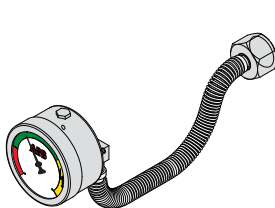
Model	Insulation medium	Temp. comp.	Accuracy	Scale range (Absolute)	Appearance (Absolute)	Marking of scale (Absolute)	Over-pressure ind.	Signalling contact	Threshold pressure	Connection to the tank
2RAA039247P0001	DryAir/AirPlus™	X	+/- 1% (20°C) +/- 2.5% (-20+60°C)	1 - 2 bar	red zone 1.0 – 1.2 bar green zone 1.2 – 2.0 bar	mark at 1.4 bar	-	-	-	flexible
2RAA039249P0001	DryAir/AirPlus™	X	+/- 1% (20°C)	1 - 2 bar	red zone 1 – 1.2 bar green zone 1.2 – 2.0 bar	mark at 1.2 bar	-	1x NO/NC	1.2 bar	flexible
2RAA039248P0001	DryAir/AirPlus™	X	+/- 1% (20°C) +/- 2.5% (-20+60°C)	1 - 2 bar	red zone 1.0 – 1.2 bar green zone 1.2 – 1.7 bar yellow zone 1.7 – 2.0 bar	mark at 1.4 bar	X (yellow indication)	-	-	flexible
2RAA045613P0001	DryAir/AirPlus™	X	+/- 1% (20°C) +/- 2.5% (-20+60°C)	0 - 2 bar	red zone 0 – 1.2 bar green zone 1.2 – 1.7 bar yellow zone 1.7 – 2.0 bar	mark at 1.4 bar	X (yellow indication)	1x NO/NC	1.2 bar	flexible
Density switch GMD1	DryAir/AirPlus™	X	+/- 2% (-25+70°C)	-	-	-	-	1x NC	1.15/1.25 bar	solid



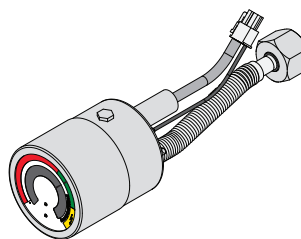
2RAA039247P0001



2RAA039249P0001



2RAA039248P0001



2RAA045613P0001



GMD1

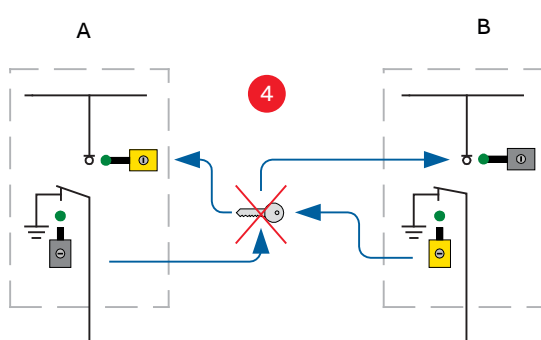
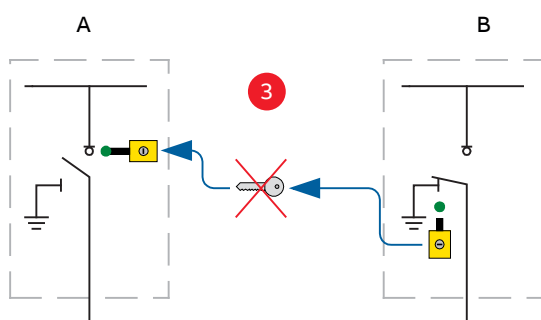
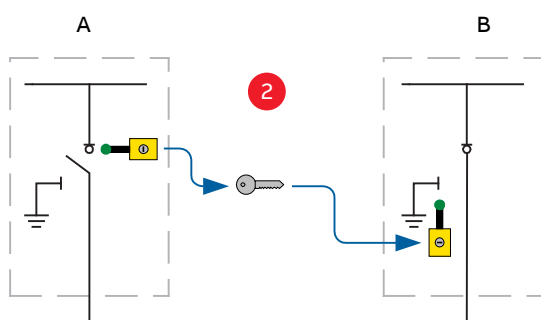
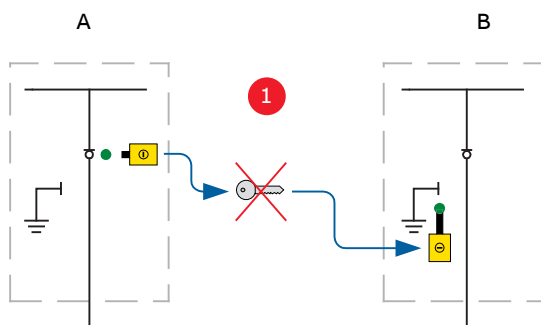
Key interlock

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.

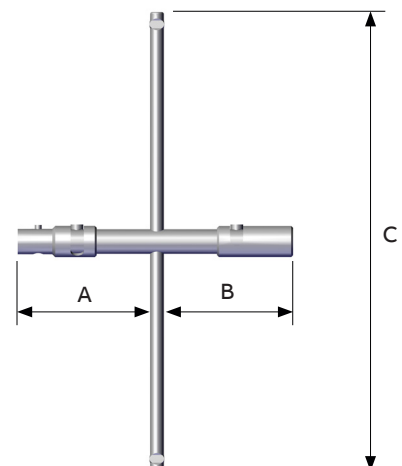
Dimensions

Dimensional drawings for installation. Note that the floor must be well levelled and the unit must be fixed by means of anchor bolts in accordance with the dimensional drawing for the number of modules as appropriate. The tolerance of the eveness is maximum 1mm per meter.

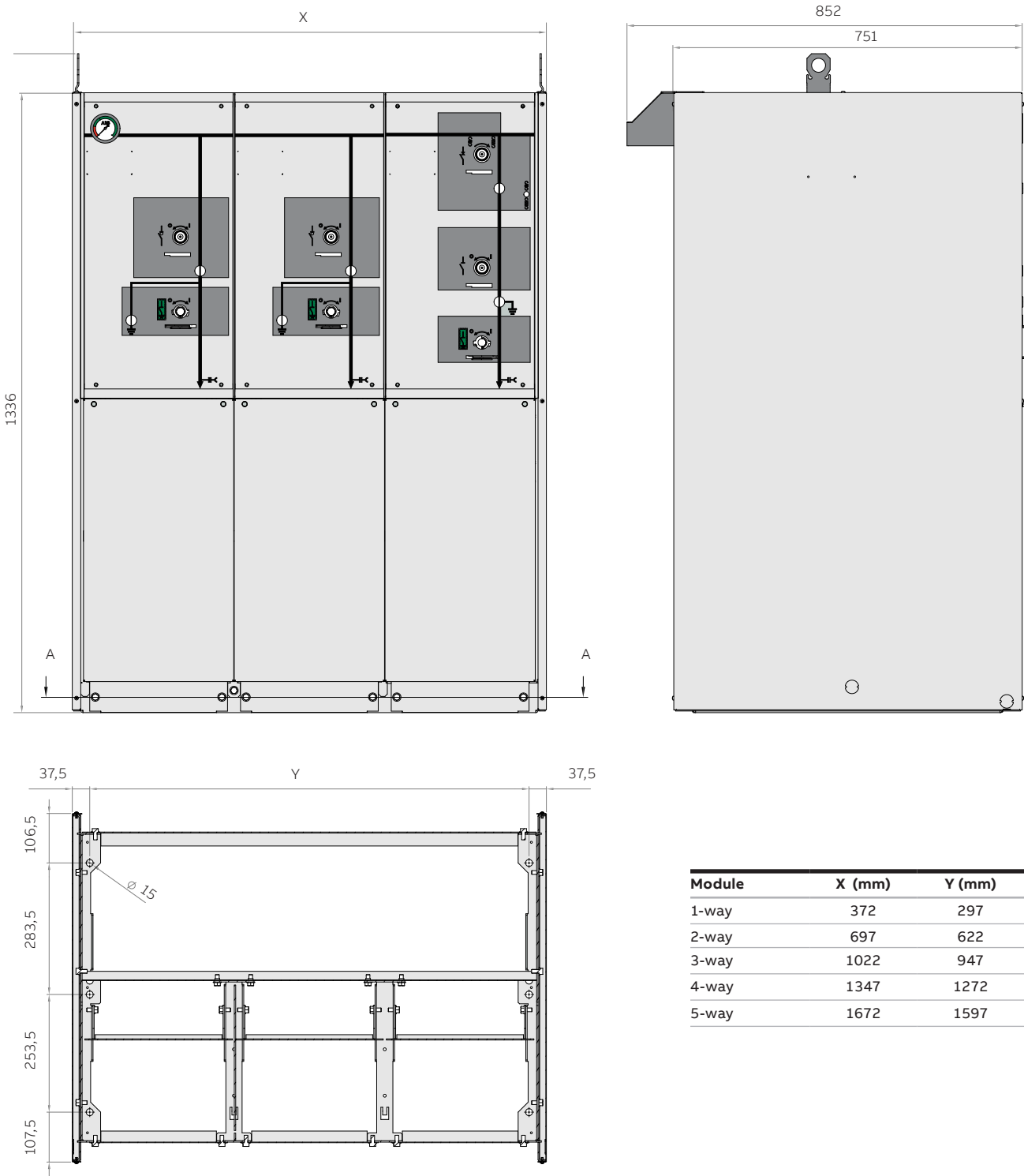
Height (mm)	Standard switchgear				
	Non IAC/IAC AFL without base frame	Non IAC/IAC AFL with 290 mm base frame	Non IAC/IAC AFL with 450 mm base frame	IAC AFLR with 290 mm base frame	IAC AFLR with 450 mm base frame
Unit without low-voltage compartment or top entry box	1336	1626	1786	2002	2002
Unit with top entry box (124 mm)	1460	1750	1910	2002	2002
Unit with low-voltage compartment (470 mm)	1806	2096	2256	2096	2256
Unit with low-voltage compartment (700 mm)	2036	2326	2486	2326	2489

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



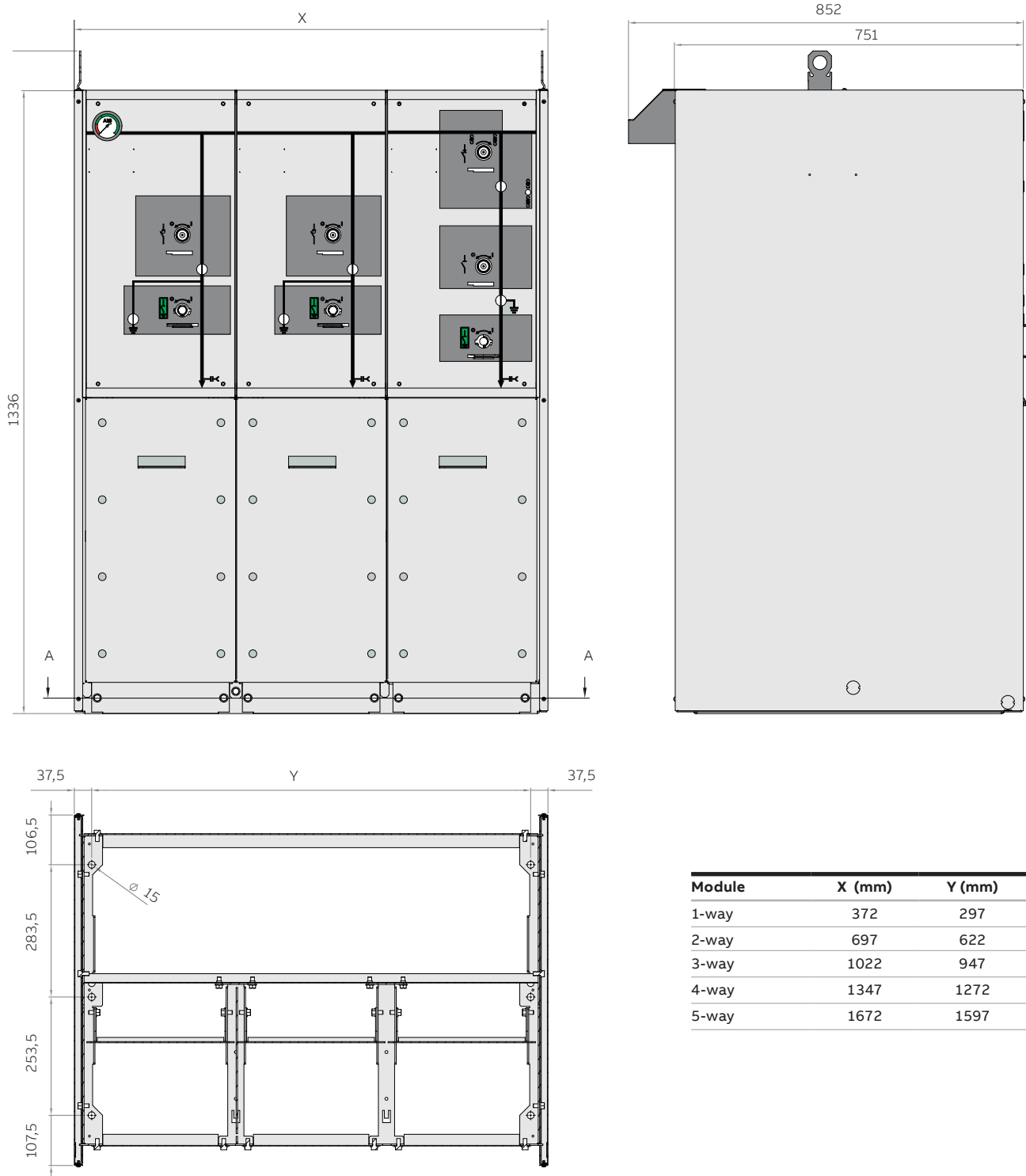
Standard



Section A-A

Module	X (mm)	Y (mm)
1-way	372	297
2-way	697	622
3-way	1022	947
4-way	1347	1272
5-way	1672	1597

Arc proof cable compartment



Section A-A

Module	X (mm)	Y (mm)
1-way	372	297
2-way	697	622
3-way	1022	947
4-way	1347	1272
5-way	1672	1597

Technical data

Codes and standards

The Air and AirPlus portfolio is 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 62271-213	Voltage detecting and indication system
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 60137, CENELEC EN 50181	Bushings
IEC 61869-11, IEC 61869-10	Combined bushings sensors
IEC 60502-4	Cable connection

Technical data - SafeRing/SafePlus Air/AirPlus

SafeRing/SafePlus - Electrical data				
Rated voltage	U _r	kV	12	24
Rated power frequency withstand voltage	U _d	kV	28	50
- across disconnector		kV	32	60
Rated lightning impulse withstand voltage	U _p	kV	75	125
- across disconnector		kV	85	145
Rated frequency	f _r	Hz	50	50
Rated normal current (busbars)	I _r	A	630	630
Rated normal current (cable switch)	I _r	A	630	630
Rated normal current (vacuum circuit-breaker)	I _r	A	630	630
Rated d.c. cable test voltage	U _{ct} (d.c)	kV	24	48
Rated power frequency cable test voltage	U _{ct} (a.c)	kV	12	24
Internal arc classification IAC AFL/AFLR	I _a , t _a	kA/s	20/1	16/1
Partition class			PM	PM
Loss of service continuity category			LSC 2	LSC 2
Rating C-module (LBS)				
Rated mainly active load breaking current	I _{load}	A	630	630
Number of operations for mainly active load breaking	n		100	100
Rated distribution line closed-loop breaking current	I _{loop}	A	630	630
Rated single capacitor bank breaking current	I _{sb}	A	190	135
Rated earth-fault breaking current	I _{ef1}	A	190	150
Rated cable- and line-charging breaking current under earth-fault conditions	I _{ef2}	A	110	87
Rated short-time withstand current	I _k	kA	25/21	21
Rated duration of short-circuit	t _k	s	1/3	3
Rated peak withstand current	I _p	kA	62,5/52,5	52,5
Rated short-circuit making current	I _{ma}	kA	62,5/52,5	52,5
Rated cable-charging breaking current	I _{cc}	A	63	50
Line charging breaking current	I _{lc}	A	1	1,5
Electrical and mechanical classes			E3, C2, M1	E3, C2, M1
Rated short-time current (earthing switch)	I _k	kA	25/21	21
Rated duration of short-circuit (earthing switch)	t _k	s	1/3	3
Rated short-circuit making current (earthing switch)	I _{ma}	kA	62,5/52,5	52,5
Rated short-time withstand current for earthing circuits (1-phase)	I _{ke}	kA	21	21
Rated duration of short-circuit for earthing circuits (1-phase)	t _{ke}	s	1	1
Electrical and mechanical classes (earthing switch)			E2, M0	E2, M0
Rating C-module (based on vacuum interrupter)				
Rated mainly active load breaking current	I _{load}	A	630	630
Number of operations for mainly active load breaking	n		100	100
Rated distribution line closed-loop breaking current	I _{loop}	A	630	630
Rated earth-fault breaking current	I _{ef1}	A	200	48
Rated cable- and line-charging breaking current under earth-fault conditions	I _{ef2}	A	115	28
Rated short-circuit making current	I _{ma}	kA	50	40
Rated short-time withstand current	I _k	kA	20	16
Rated duration of short-circuit	t _k	s	3	3
Rated peak withstand current	I _p	kA	50	40
Rated cable-charging breaking current	I _{cc}	A	63	16
Line charging breaking current	I _{lc}	A	1	1,5
Electrical and mechanical classes			E3, C2, M1	E3, C2, M1
Rated short-time current (earthing switch)	I _k	kA	20	16
Rated duration of short-circuit (earthing switch)	t _k	s	3	3
Rated short-circuit making current (earthing switch)	I _{ma}	kA	50	40
Electrical and mechanical classes (earthing switch)			E2, M0	E2, M0

Technical data - SafeRing/SafePlus Air/AirPlus

Rating V-module				
Rated mainly active load breaking current	I_r	A	630	630
Rated short-circuit breaking current (circuit-breaker)	I_{sc}	kA	20	16
Rated short-circuit making current (circuit-breaker)	I_{ma}	kA	50	40
Rated cable-charging breaking current (circuit-breaker)	I_c	A	25	31,5
Rated short-time withstand current (circuit-breaker)	I_k	kA	20	16
Rated duration of short-circuit (circuit-breaker)	t_k	s	3	3
Rated peak withstand current (circuit-breaker)	I_p	kA	50	40
Electrical and mechanical classes (circuit-breaker)			E2, C2, S1, M1	E2, C2, S1, M1
Rated short-time current (earthing switch)	I_k	kA	20	16
Rated duration of short-circuit (earthing switch)	t_k	s	3	3
Rated short-circuit making current (earthing switch)	I_{ma}	kA	50	40
Rated short-time withstand current for earthing circuits (1-phase)	I_{ke}	kA	20	16
Rated duration of short-circuit for earthing circuits (1-phase)	t_{ke}	s	1	3
Electrical and mechanical classes (earthing switch)			E2, M0	E2, M0
Rating D-module				
Rated short-time withstand current	I_k	kA	20	16
Rated duration of short-circuit	t_k	s	3	3
General data				
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	According to IEC 62271-200			
Facility provided with pressure relief	Yes			
Insulating medium	Dry Air (12kV) or AirPlus (24kV)			
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			
Normal service conditions for indoor switchgear according to IEC 62271-200				
Ambient temperature ²⁾				
- maximum value	+40°C			
- maximum value of 24 hours mean	+35°C			
- minimum value	-25°C			
Altitude for installation above sea level ³⁾	1500m			
Relative humidity max. 24 hours mean	95%			
Maximum weight for standard Air/AirPlus switchgear				
2-way unit	300kg			
3-way unit	450kg			
4-way unit	600kg			
5-way unit	750kg			
Overall dimensions of the fully assembled Air/AirPlus switchgear		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 INO or INO/INC upon request

²⁾ De-rating allows for higher maximum temperature

³⁾ For installation above 1500 m, contact your ABB sales representative

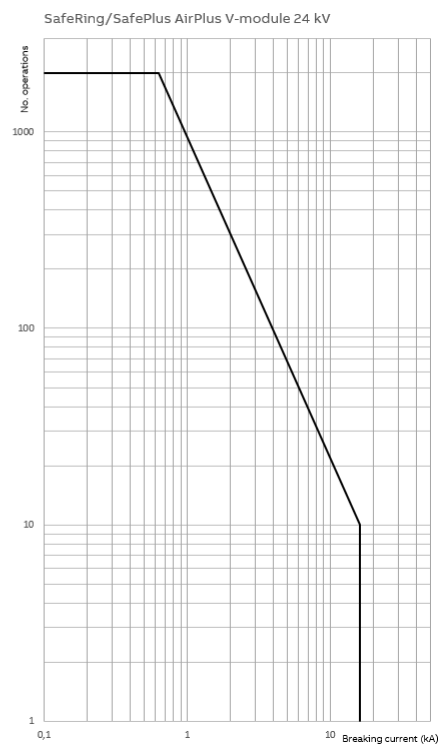
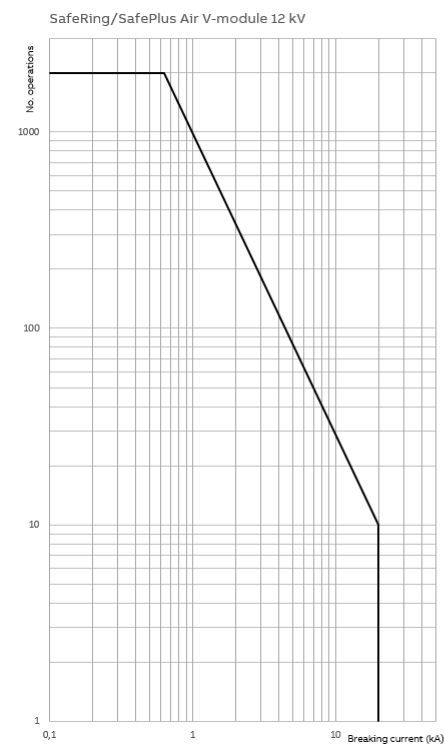
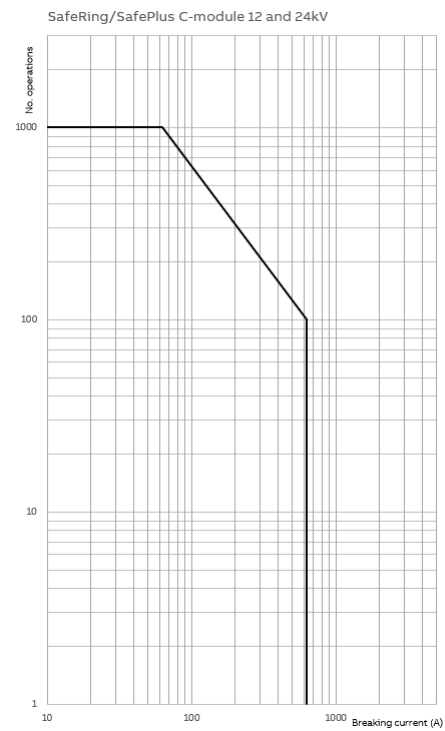
Technical data - General

Operations, degree of protection and colours	
Means of disconnector and earthing switch operation	separate handle
Means of circuit breaker operation	separate handle and push buttons
Rated operating sequence of circuit-breaker (V-module)	O – 3 min – CO – 3 min – CO (SafeRing/SafePlus Air) O – 15s – CO – 3 min – CO (SafeRing/SafePlus AirPlus)
Total opening time of circuit-breaker	approx. 100 ms (depending on protection relay and opening/tripping coil)
Closing time of circuit-breaker	approx. 30 – 70ms
Mechanical operations of load break switch (C-module)	2000 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 disconnector (V-module)	1000 CO - class M0
Principle switch-disconnector and earthing switch	3 position combined switch-disconnector and earthing switch
Load break switch:	
Making operations on rated short circuit making current	5 - class E3
Making and breaking operations on rated mainly active load	100 - class E3
Degree of protection:	
High voltage live parts, air tank	IP 67
Front cover mechanism	IP 2xC
Cable covers	IP 3x
Low-voltage compartment	IP 2xC
Colours:	
Front covers	RAL 7035
Side and cable covers	RAL 7035

Cable box for heat shrinkable termination:	
Phase to phase clearance	107mm
Phase to earth clearance	54,5mm
Phase to earth over insulator surface (creepage)	120mm
Type of cable termination adapters ¹⁾	Elbow or T-connector

¹⁾ Cable termination without earthing shield is not recommended for rated voltages above 12kV.

Technical data - Number of operation



Environmental certification

Life expectancy of product

The product is in compliance with the requirements denoted by IEC 62271-200. The design incorporates a life span under normal “indoor service conditions” (IEC 62271-1 Cl. 4.1) with an expected operating life exceeding 30 years and a leakage rate of less than 0.1 % per year (IEC 62271-1 Cl. 6.16).

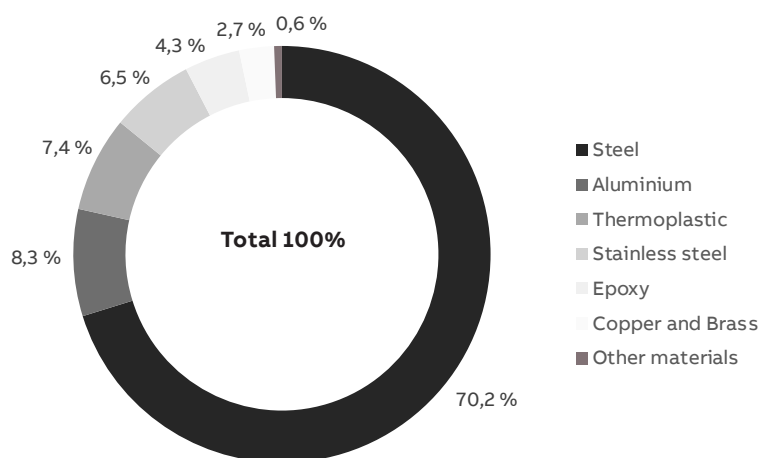
The switchgear is gas-tight with an expected diffusion rate of less than 0,1% per annum. With a rated filling pressure of 1,4 bar absolute at 20°C, the switchgear will maintain gas-tightness and a gas-pressure better than the minimum functional pressure of 1,3 bar absolute at 20°C throughout its designed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



Recycling capability

Constituents of a CCV switchgear:

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



End-of-life

ABB continuously strive to replace hazardous substances. The Air/AirPlus portfolio does not contain any substances listed in ABB List of prohibited and restricted substances. The portfolio 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 recovered and reused normally according to local regulations.

ABB ELECTRIFICATION NORWAY AS, is committed to the protection of the environment and adhere to ISO 14001 standards. It is our obligation to facilitate end-of-life recycling for our products



ABB Electrification Norway AS

P.O.Box 108, Sentrum

N-3701 Skien

Norway

Tel: +47 35582000

new.abb.com/medium-voltage/switchgear