

CATALOG

# SafePlus 36

Gas-insulated compact switchgear for ANSI markets



- Sealed system for lifetime
- High reliability and safety
- Compact dimensions



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# Introduction

SafeRing and SafePlus switchgears for secondary distribution were developed by ABB in Skien, Norway and introduced to the markets in 2000, replacing the previous SF<sub>6</sub> - insulated products RGC and CTC. The installed base of SafeRing / SafePlus is more than one million modules in more than 100 countries all over the world.

The switchgear portfolio is constantly under development to adjust to new market requirements and customers' needs. SafeRing is available in standard configurations based on a high-volume production. These standardized Ring Main Units (RMU), which comprise the most required configurations within a distribution network, can be extensible upon request.

## Customer benefits

- A wide range of functional units, easy to extend and upgrade
- Up to 38kV/20kA/600A
- No live parts exposed
- Fully sealed for lifetime
- Climatic independence
- Designed and tested according to all applicable IEC/IEEE/ANSI standards
- High reliability and safety
- Compact dimensions
- Safe and easy for operators in both maintenance and operating conditions
- All operations are carried out from the front of the switchgear
- Virtually maintenance-free for lifetime leading to low total cost of ownership





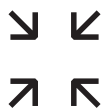


SafePlus provides complete, flexible, and compact switchgear solutions. The completely sealed system includes a stainless steel tank that contains all live parts and switching functions. This ensures a high level of reliability, personnel safety, and a virtually maintenance-free system. SafePlus offers flexible customized switchgear to cover all distribution needs, including advanced grid automation (smart RMUs).



#### **Personnel Safety**

Our design is able to protect personnel standing close to the switchgear during an internal arc fault. High safety with touch-proof design and no access to MV parts make maintenance and installation as safe as possible. Additional safety features include padlockable handles, cover interlocks, and gas pressure relief systems. The switchgear's features and design ensure an outstanding level of safety and protection.



#### **Compact**

Specific functions such as grounding, disconnecting, cable connections, busbar extension, protection, and switching are integrated in compact functional units.



#### **Sealed for lifetime**

The pressure system is defined as a sealed-for-life system with an operating lifetime better than 30 years. The MV parts inside the sealed gas tank are protected from environmental factors that can cause failures and require very little maintenance.

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# Applications

## Applicable standards

SafePlus is tested according to the following IEC and IEEE standards:

- IEC 62271-1: Specifications High-voltage switchgear
- IEC 62271-100: Alternating-current circuit-breakers
- IEC 62271-102: Alternating current disconnectors  
Grounding switches
- IEC 62271-103: High-voltage switches
- IEC 62271-105: Switch-fuse co-operation
- IEC 62271-200: Arc fault and switchgear
- IEC 60529: Degrees of protection provided by enclosures
- IEEE C37.20.3: IEEE Standard for metal-enclosed interrupter switchgear (1kV - 38kV)
- IEEE C37.58: Switchgear - Indoor AC medium-voltage switches for use in metal-enclosed switchgear -  
Conformance test procedures
- IEEE C37.54: For indoor Alternating Current High Voltage circuit breakers applied as removable elements in metal-enclosed switchgear
- Conformance test procedures

SafePlus can also be incorporated into eHouses or other modular systems. It has been tested according to IEC 62271-202 with a Compact Secondary Substations (CSS).

SafePlus is commonly used in a wide variety of applications, such as:

### Industry

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

### Utilities and Power Plants

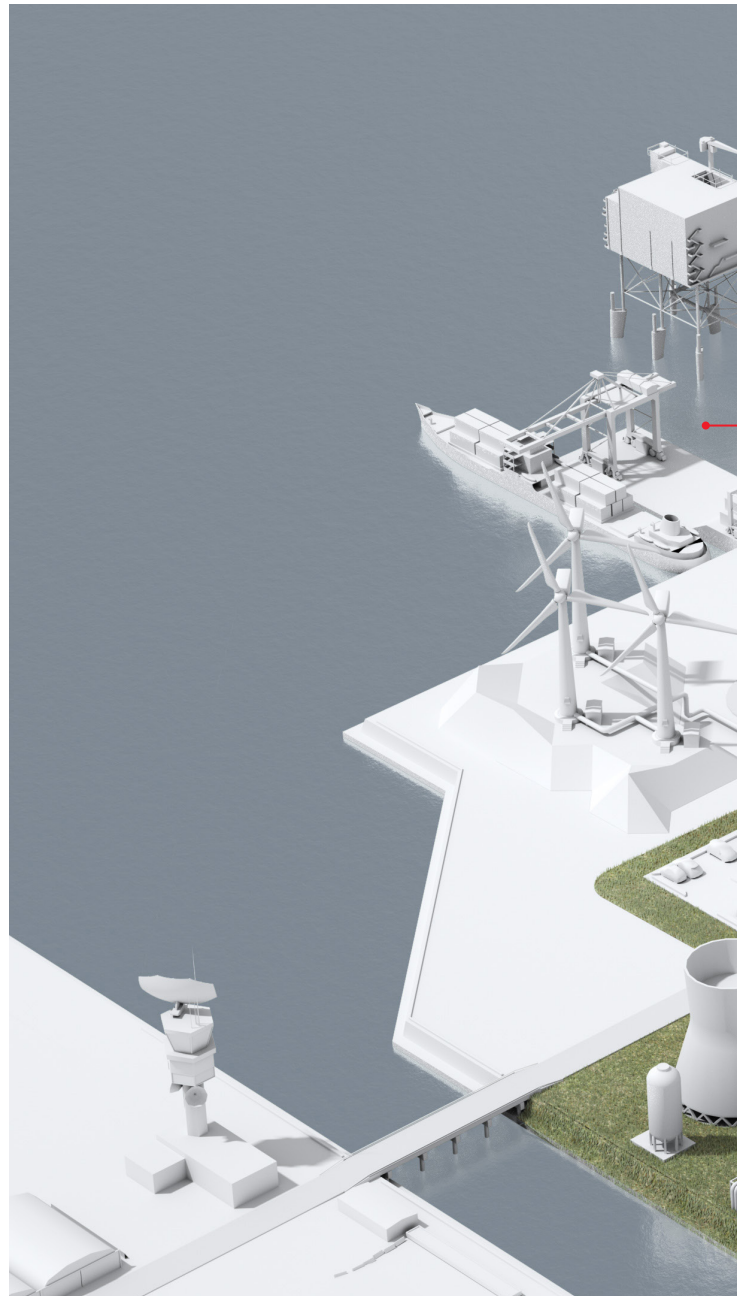
Power generation stations, Transformer stations and metering, Main and auxiliary switchgear, Wind turbines, Solar

### Transport

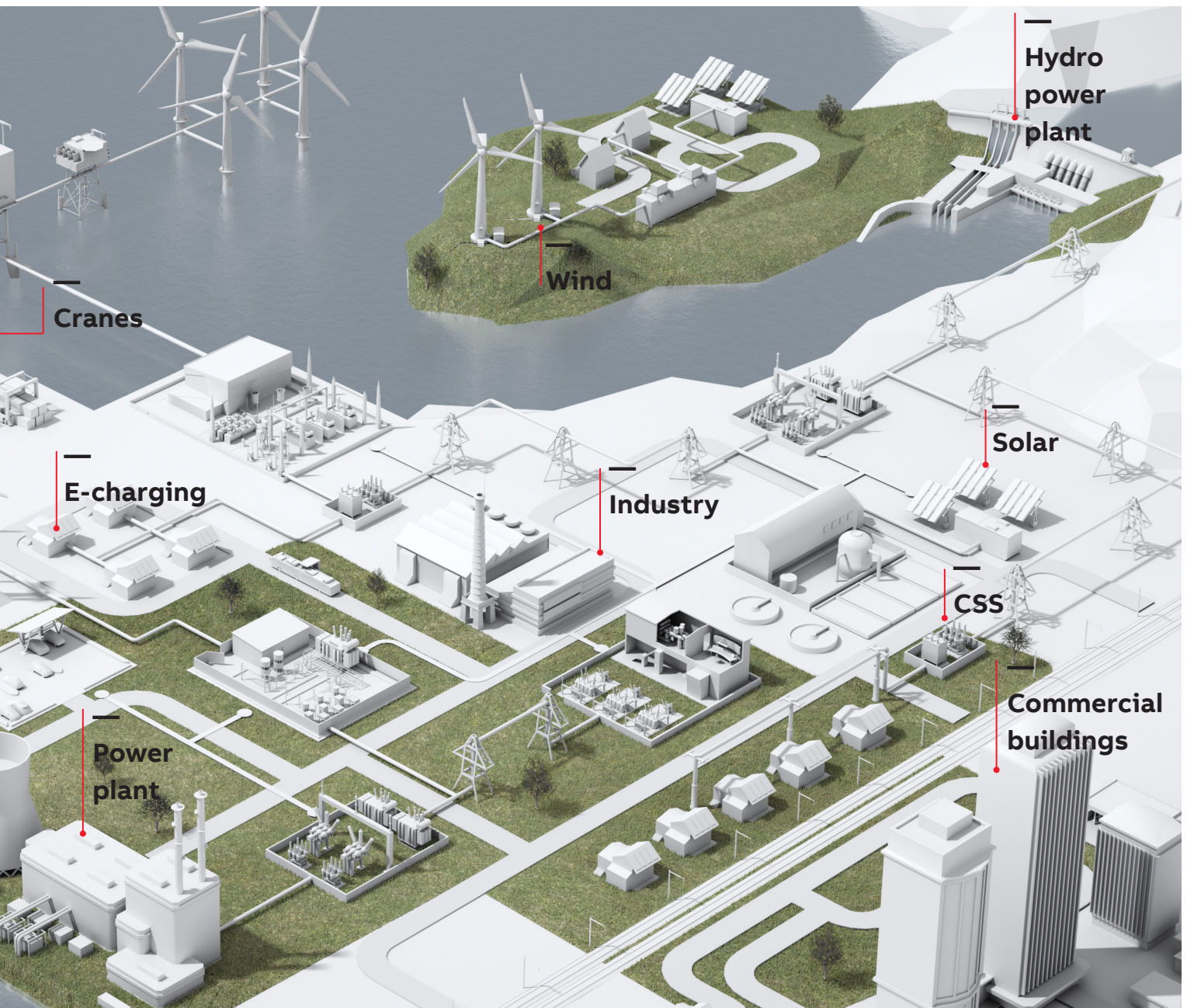
Airports, Ports, Railways, Underground transport

### Infrastructure

Hotels, Shopping centers, Hospitals, Commercial buildings, Large infrastructure and civil works









## Design philosophy

### **ABB switchgears for secondary distribution**

Secondary distribution switchgears have been the subject of significant development the past twenty years.

The traditional switching cells are substituted with complete switchgear systems. Specific functions such as grounding, disconnecting, cable connections, busbar extension, protection, and switching have become integrated features in compact functional units.

Compact switchgear systems fulfill customer MV application requirements. ABB has always taken an active role in this development.

The most unique specialization is the development of the compact secondary switchgear. Numerous distribution substations requested a unified switching functionality that ultimately evolved into the ring main unit concept. The ABB SafePlus range is one major contributor to this specialization.

### **Customer involvement**

The applied functionality in ABB SafePlus is a result of input from customers all over the world. Key customers are continuously involved with ABB design staff to ensure optimized switchgear operation.

### **Personnel – safety operation**

All products are designed and manufactured in compliance with ISO 9001, ISO 14001 and ISO 18001. The latest edition of relevant IEEE standards will always apply to our continuous test program. Safety is not only a specification and rating issue, but also a real life experience. All units are factory routine tested according to international standards. ABB takes this further to be an objective related to durability and repetitive manufacturing quality. Features for further enhancing personnel safety are available. "Integrated functionality" is a key objective to reduce the number of moving components, further reducing the risk of any mechanical defect.

### **We are responsible for the environment**

SafePlus is manufactured in Norway. Green policy assures focus on environmental factors in manufacturing as well as over the switchgear's lifespan.

All products are manufactured in accordance with ABB's ISO 14001 "Environmental Management Systems" certification. Materials are carefully selected to ensure reuse at end of life. Recycling capability is 88,8% (for details see chapter "Environmental certification"). To facilitate the recycling process we continuously work with our partners to improve end of life handling.

### **Modern - development and manufacturing**

Numerical simulations together with long experience ensure a safe, reliable, compact and robust design.

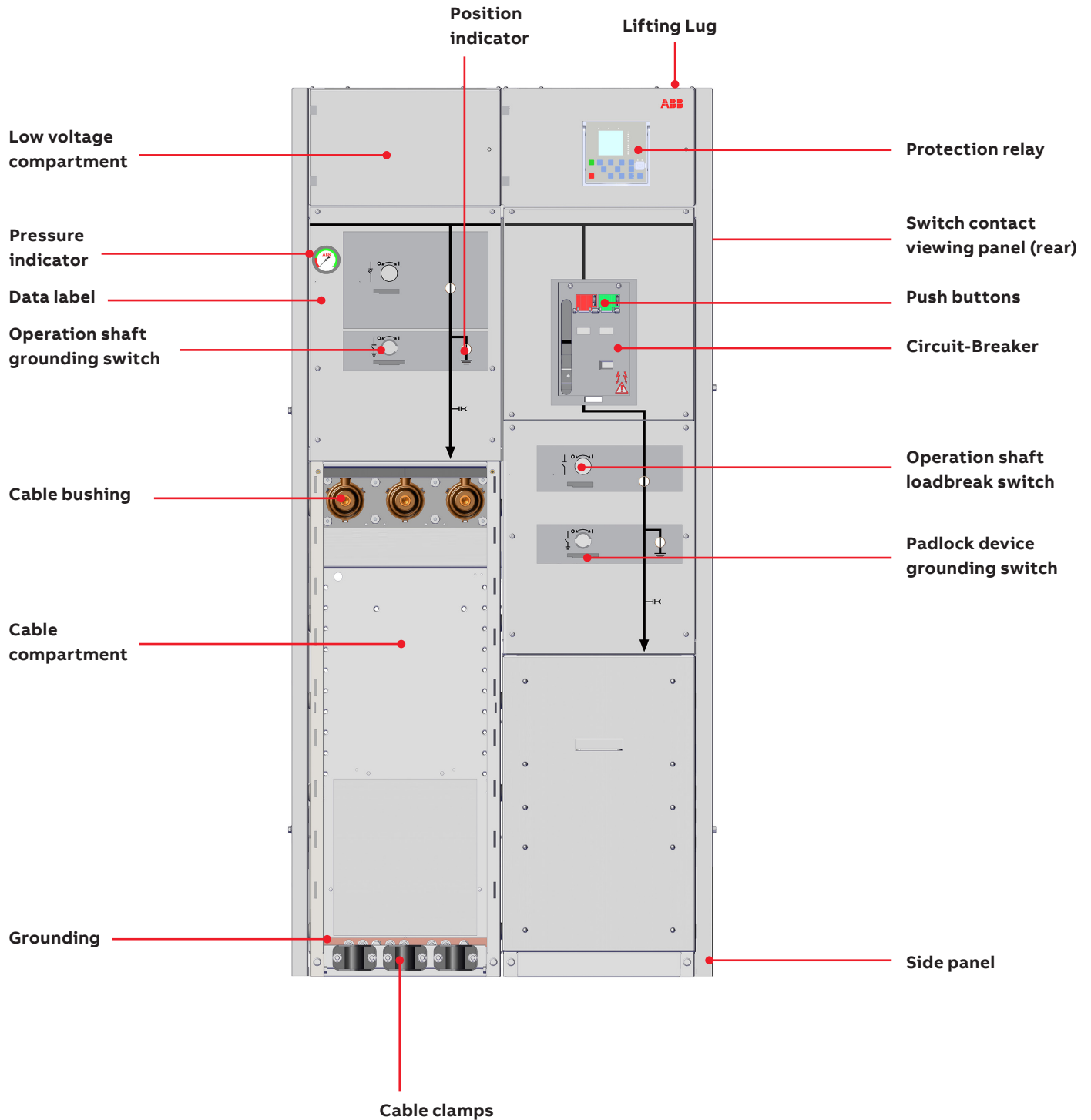
Dielectric simulations ensure that compactness does not influence the dielectrical capability.

The combination of design techniques, experience, and the most modern production technology guarantees state of the art products and durability.

### **Complete solutions – one supplier**

Complex applications involving remote control, monitoring, measurement and protection can be supplied from ABB. This makes large scale implementation feasible and simplifies engineering and procurement.

# Arrangement



## — Completely sealed system

### Exterior

Upper and lower front covers are made of 1,5mm aluzink and covered with a polycarbonate foil. These foils contain the mimic diagram of the main circuit with the position indicators for the switching devices. Background color for these foils is grey RAL 7035, which makes the black single line diagram stand out for easy reading of position indicators. Both the upper and lower front covers are removable.

Low voltage compartments are available in three different versions: integrated with front cover, integrated with hinged door, and high with hinged door. For the high version, total height of the switchgear will be 2180 mm / 86 inches.

There are three different cable compartment covers: standard, arc proof, and one with extra depth for parallel cables. All cable compartment covers are removable. Each module has a separate cable compartment which is divided from the others by means of partition walls. A vertical partition wall is fitted to divide the cable compartment(s) from the rear side of the switchgear / ring main unit. In the unlikely event of an internal arc inside a switchgear, the pressure relief disc in the bottom of the tank will open. This vertical partition wall will prevent the hot gases from entering the cable compartments. With arc proof classification IAC AFLR hot gases may enter the cable compartment.

Side covers are made of 1,25 millimeter hot rolled steel and powder painted in colour RAL 7035.

### Enclosure

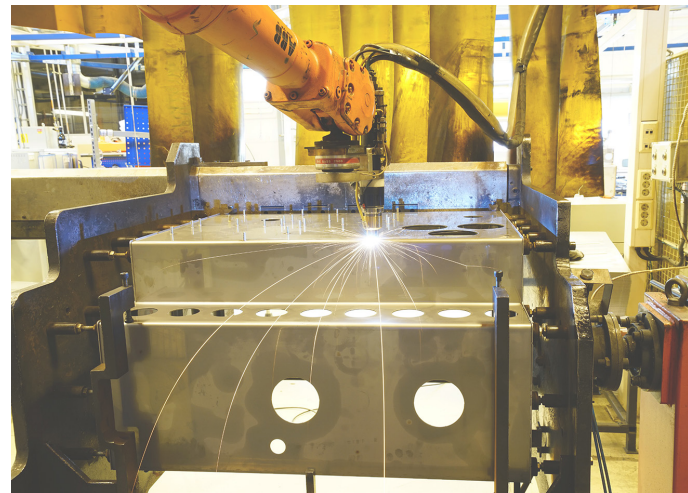
SafePlus 36 uses SF<sub>6</sub> gas (Sulfur hexafluoride) as insulation and quenching medium. The SF<sub>6</sub> is contained in a welded stainless steel enclosure.

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

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

All SF<sub>6</sub> enclosures are tested with helium to ensure there are no leakages before being filled with SF<sub>6</sub>. Due to the characteristics of helium, this test will detect any leakage. Leakage testing and gas filling are performed inside a vacuum chamber.

The SF<sub>6</sub> enclosure has a degree of protection of IP67. This means the SF<sub>6</sub> enclosure can be immersed into water and still maintain all functions in a satisfactory way.





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## Production testing

ABB utilizes a high-quality automated system for production and quality control that assures the sustainability of factory output. Part of the assurance is standard routine testing procedures performed on every manufactured switchgear. Routine tests and production tests are performed according to IEC62271-200 and IEEE C37.20.3.

**Routine production tests include:**

- Design and visual check
- Power frequency dry test
- Auxiliary and control circuits
- Measurement of resistance of the main circuits
- Control of gas tightness
- Partial discharge measurement
- Mechanical operations
- Test of auxiliary electrical devices

**State of the art**

ABB uses the latest technologies and systems for routine testing, for example:

- Fully automated high voltage testing cabin
- Temperature compensated gas filling system



# Safety

## Internal Arc Classification (IAC)

—  
01 Arc duration and  
damage caused

During development of all products, ABB maintains a relentless focus on personal safety. The 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 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 caused by such various factors as adverse environmental conditions or 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:

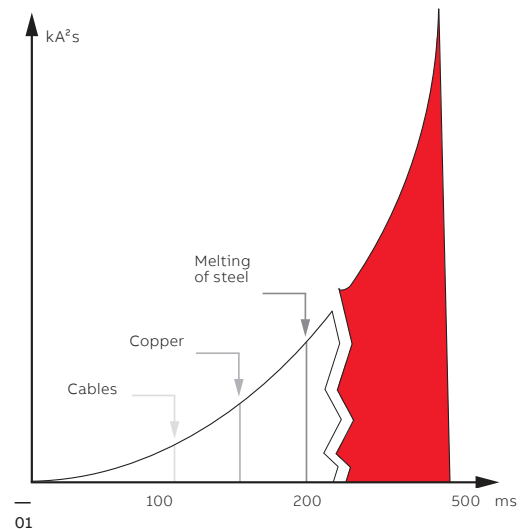
- Increase of the internal pressure.
- Increase of the temperature.
- Visual and acoustic effects.
- Mechanical stresses on the switchgear structure.
- Melting, decomposing, and evaporation of materials.

### Tested according to IEC standard 62271-200

Ask your local ABB sales representative about testing according to IEEE C37.20.7 (Class 1D-s). The capability of SafePlus switchgear to withstand an 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)

F-Front = Access from the front

L-Lateral = Access from sides

R-Rear = 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 60g 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 grounding point

# Internal Arc Classification (IAC)

01 IAC AFL - with ventilation to the cable trench

02 IAC AFL - with ventilation behind the switchgear

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

## IAC AFL - with ventilation downwards

With this setup, hot gasses and pressure are evacuated downwards in the cavity in the floor. The cable trench should be at least two meters long, with an opening of minimum 0.5 m<sup>2</sup>. Hot gasses are led to the cable trench by means of a back plate installed on the rear side of the cable compartment.

### Basic parameters of setup:

IAC AFL up to 25 kA / 1 s

- Height of ceiling (switchgear height 1930 mm/76 inches): min. 2530 mm/99,6 inches
- Height of ceiling (switchgear height 1700 mm/66,9 inches): min. 2300 mm/90,6 inches
- Distance to rear wall: min. 100 mm/4 inches
- Distance to side wall: min. 100 mm/4 inches

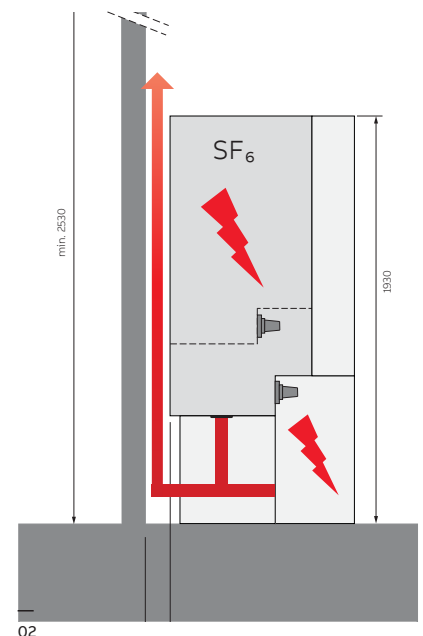
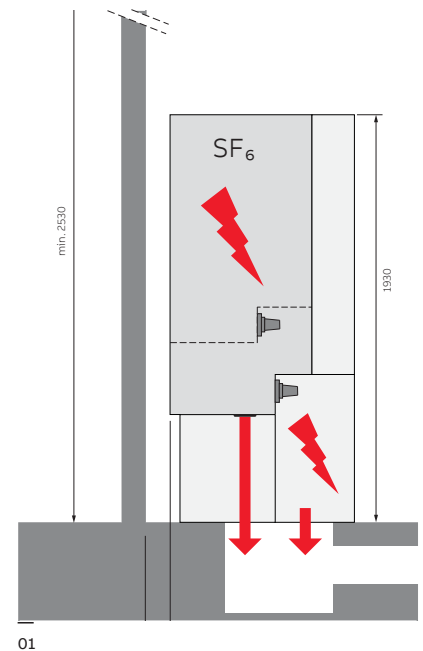
## IAC AFL - With ventilation backwards

With this setup, hot gasses and pressure are evacuated behind the switchgear, either if the arc fault occurs inside the SF<sub>6</sub>-tank or in the cable compartment. Hot gasses are led to the safe areas of the switchgear room.

### Basic parameters of setup:

- IAC AFL up to 25 kA / 1 s
- Height of ceiling (switchgear height 1930 mm/76 inches): min. 2530 mm/99,6 inches
- Distance from rear wall\*: min. 100 mm/4 inches
- Distance from sidewall: min. 100 mm/4 inches

\*non-accessible rear side





## Internal Arc Classification (IAC)

01 IAC AFLr - with  
ventilation up-  
wards through an  
exhaust channel

02 Non-arc  
proof version

### IAC AFLR - with ventilation upwards

With this setup, hot gases and pressure are evacuated into the safe area of the switchgear room above the switchgear through the gas exhaust channel.

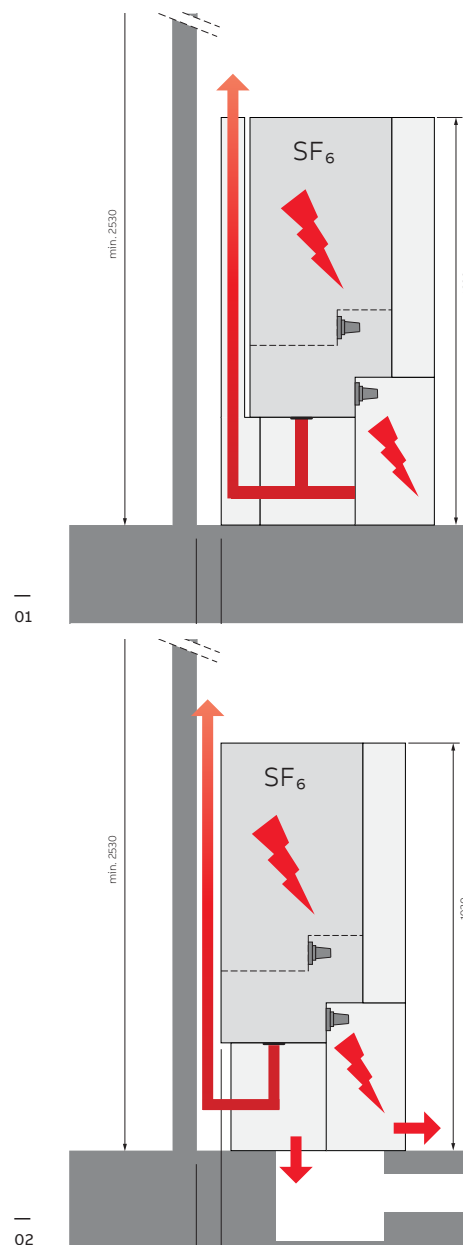
Basic parameters of setup:

- IAC AFLR (switchgear height 1930 mm/76 inches) up to 25 kA / 1s
- Height of ceiling min. 1930 mm/76 inches
- Minimum distance from backwall:
  - min. 800 mm/31,5 inches (with accessible rear side)
  - min. 100 mm/4 inches (with non-accessible rear side)
- Minimum distance from sidewall: min. 100 mm/4 inches

### 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 gasses and pressure could evacuate randomly in any direction at any place of the enclosure.

Non-arc proof is the standard option for all UL listed SafePlus switchgears.



ISC (kA)	IAC-class	Ventilation	Height of switchgear (mm/inch)	Roof height (mm/inch)	Arc suppressor	Base frame	Max sets of CTs
20	AFL	Downwards	1930/76 1700/66.9	2530/99.6 2300/90.6	optional	optional	2/1**
20	AFL	Backwards	1930/ 76	2530/ 99.6	optional	optional	2/1**
20	AFLR	Upwardswards	1930/ 76	2530/ 99.6	optional	optional	1
25	AFL	Backwards	1930/ 76	2530/ 99.6	optional	optional	1**
25	AFLR	Upwardswards	1930/ 76	2530/ 99.6	optional	optional	1

\*\* In case two sets of CT's are required, open ventilation downwards to cable trench is mandatory

# Arc suppressor

01 Arc suppressor  
inside the tank

02 with Arc  
suppressor

Internal Arc Classified switchgears provide a robust level of safety for personnel and operators, but an internal arc can still release hot gases into the surrounding environment. To avoid those hot gases entirely, add an optional arc suppressor to your switchgear.

The arc suppressor is an optimal quick-make short-circuit device with a mechanical pressure detector that can be installed with each incoming feeder inside the sealed  $\text{SF}_6$  tank of the SafePlus switchgear.

If an arc fault should occur inside the  $\text{SF}_6$  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 not sensitive to pressure changes due to variation in atmospheric temperature or pressure or external phenomena such as vibrations or shocks.

The arc suppressor will operate for short-circuit currents in the range of 5kArms to 25kArms and it will reduce the generated arc energy to less than 5% of the arc energy released during an arcing time of 1 second.

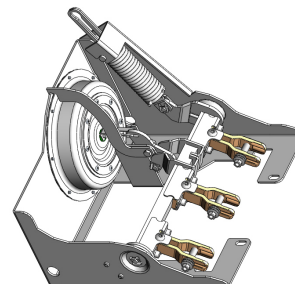
An optional signalling device (1NO) will provide local and/or remote indication that one or more arc suppressors has tripped.

Since the system is self-contained, an internal arc fault will have no impact on the surroundings. No arc fault tests have to be repeated in combination

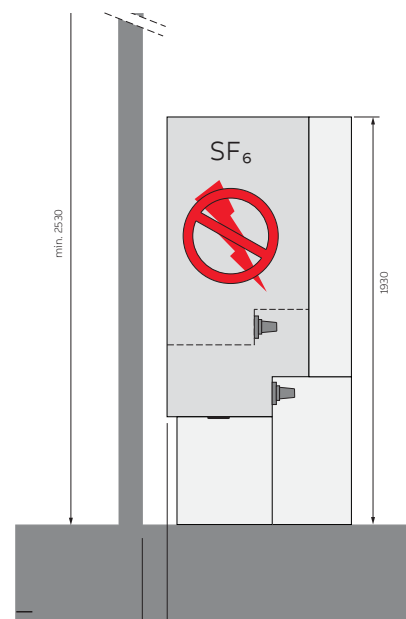
with channel release systems or transformer stations.

The costs of the cleaning work required after an internal arc fault during which the release flap has opened are reduced to zero.

Arc suppressors are available for ANSI switchgears, but are not approved for use when UL listing is required.



01



02

# Mechanisms

All operating mechanisms are situated outside the SF<sub>6</sub> enclosure behind the removable front covers with a degree of protection of IP2X.

This allows for easy access to all operating mechanisms if retrofit or service should be required.

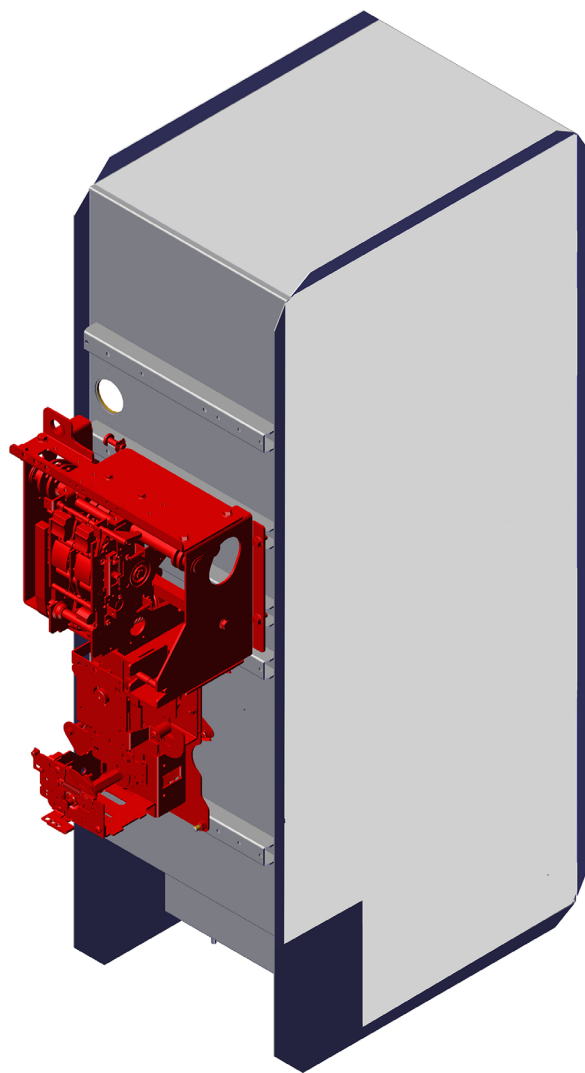
As an option, all units can be equipped with interlocked cable covers. This will prevent access to the cable compartment before the grounding switch is in closed position. It will also be impossible to operate the switch disconnecter to closed position before the cable compartment cover is put back in place.

Each mechanism is equipped with a padlocking device. Adding a padlock to this device prevents the access necessary to operate the mechanism. This device has three holes with nine millimeter diameter.

All operating mechanisms are equipped with true position indicators for all switches. In order to safeguard true indication, indicators are directly connected to the operating shafts of the switches inside the SF<sub>6</sub> tank.

The operating handle has an anti-reflex system which prevents an immediate re-operation of the switch. The speed of operation of these mechanisms is independent of how fast the handle is operated.

All steel parts have been electroplated with zinc and passivated against corrosion.

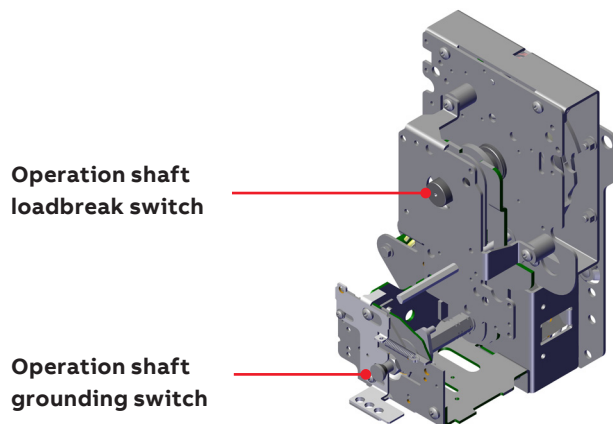




### Cable switch module (C)

The mechanism (3PKE) has two operating shafts: the upper one for the load break switch and the lower one for the grounding switch. Both shafts are single spring operated and they are directly connected to the switches inside the SF<sub>6</sub> enclosure. When both load break switch and grounding switch are in open position the switch satisfies the specifications of disconnector.

Due to the mechanical interlock between the upper and lower operating shafts, it is impossible to operate the load break switch when the grounding switch is in grounded position or operate the grounding switch when the load break switch is in closed position.



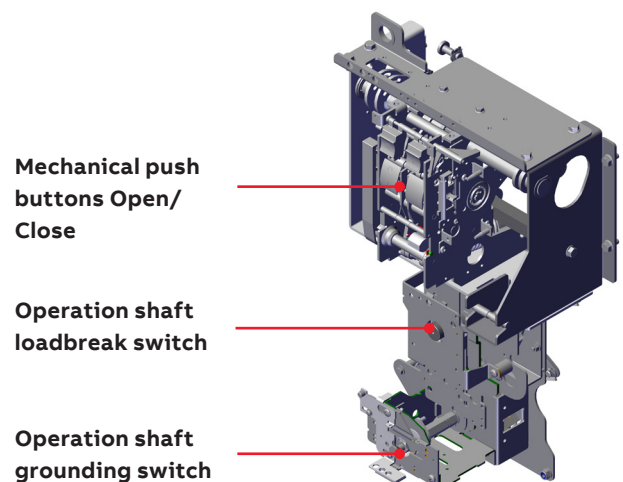
### Vacuum circuit-breaker (V)

This module has two mechanisms: the upper one (EL3) is for the circuit-breaker and the lower one (3PKE) with two operating shafts is for the disconnecter and grounding switches. The vacuum circuit-breaker has the possibility of rapid auto-reclosing. By means of mechanical push buttons it is possible to close and open the circuit-breaker. The opening spring is always charged when the circuit-breaker is in closed position and will be ready to open immediately if the protection relay gives a trip signal. If the mechanism is recharged after closing, it is possible to perform an open - close - open sequence.

The lower mechanism is identical to the one described above for the cable switch module.

There is a mechanical interlock between these two mechanisms which prevents operating the disconnecter when the circuit-breaker is in closed position.

When the grounding switch is in closed position it will be impossible to operate the disconnecter, but the circuit-breaker can be closed for testing.



# Interlocks

## Interlocking and locking

01 Under voltage  
coil MU

### Interlocks

The safety mechanical interlocks between switches are standard; detailed information is provided for each module. They are set out by IEEE and 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 ensure operator safety.

### Keys

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

### Padlocks

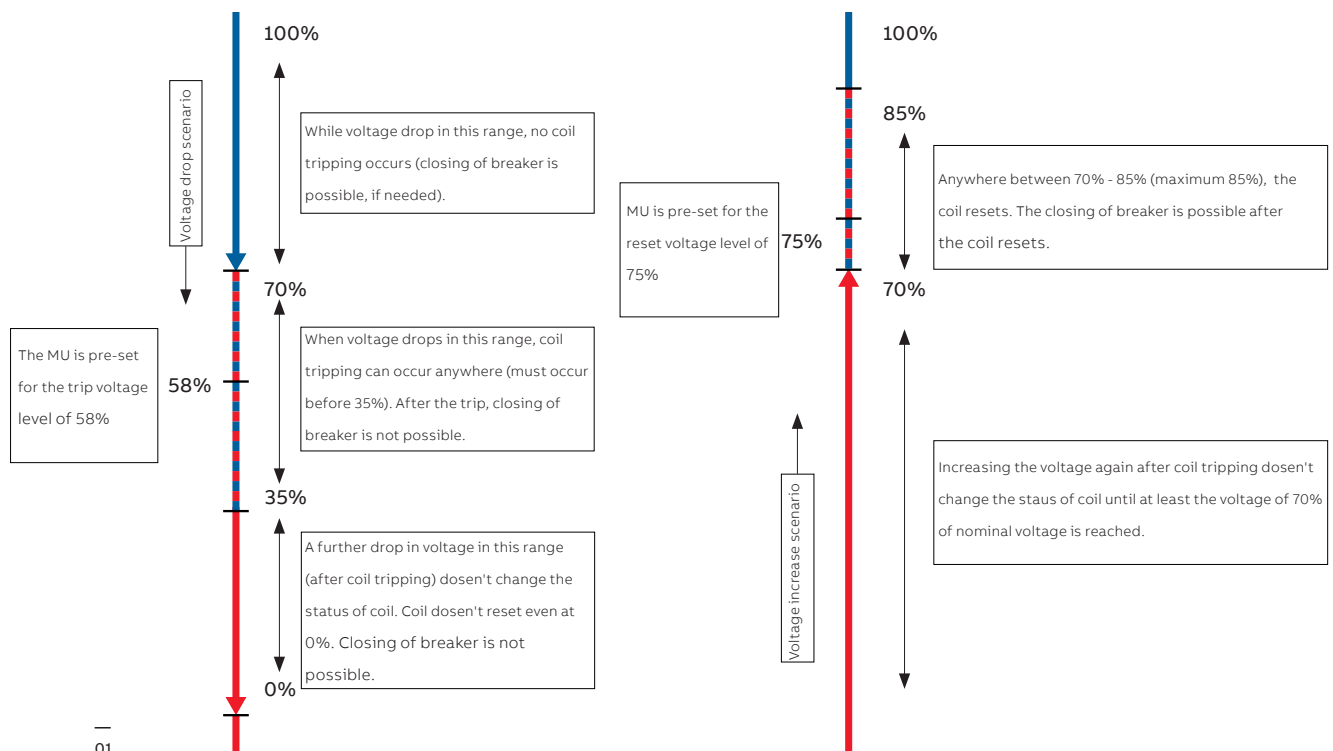
As an option, the cable compartment doors of arc-proof switchgears can be locked in the closed position by means of padlocks. The padlock can also be applied to the switches to avoid improper operation of the switchgear. For a more detailed description, see dedicated interlocking pages for each module. Padlocks from 0,16 to 0,31 inches diameter can be accommodated.

### Blocking coil/electrical interlocking

The grounding switch closing/opening operations can be electrically interlocked by use of an optional electrical blocking coil. Vacuum circuit-breaker (VCB) closing can be blocked by use of electrical blocking coil. For a more detailed description, see dedicated interlocking pages for each module.

### Undervoltage release

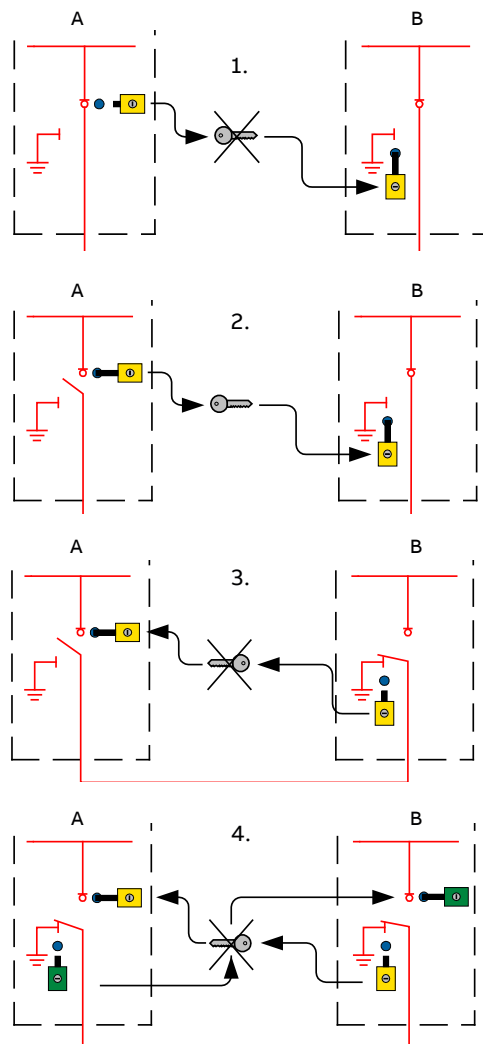
This optional release opens the circuit-breaker when there is a sharp reduction or cut in the power supply voltage.



# Key interlock

Key interlocks offer sequential control of SafeRing / SafePlus through the transfer of keys that are either trapped or released in a predetermined order. Available key locks are: Ronis, Castell, STI and Kirk. Ronis is default and recommended by ABB. For features, see table on the next page.

All load break switches, grounding switches, and disconnectors can be equipped with any single key interlock. For double key interlock, Ronis is the only type of key that fits ABB's switchgears. Fuse-switch and vacuum circuit-breaker switches cannot be equipped with a key interlock.



## 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 grounding 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 grounding 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 grounding 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 grounding switch to closed position. As long as the grounding switch is in closed position, the key will be captured and make it impossible to close the load break switch in switchgear A.
4. If the load break switch in switchgear B and grounding 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 a ground connection of an incoming energized cable from either switchgear A or B.

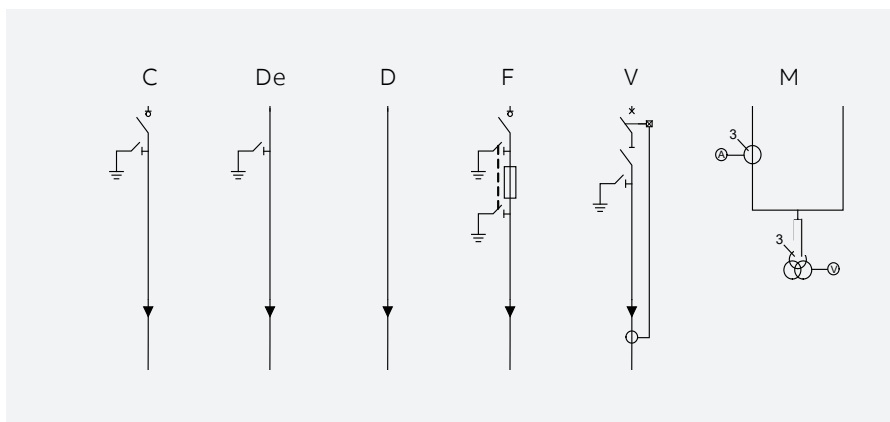
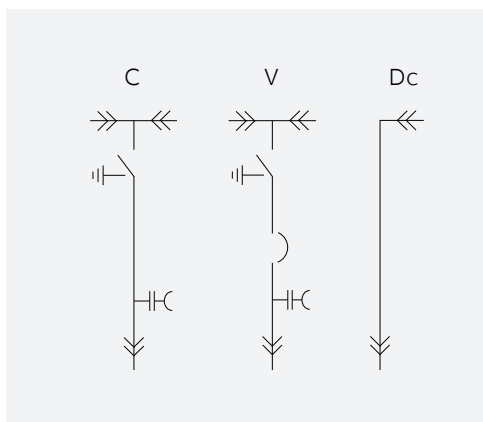
Another example for use of key interlocks is to prevent access to the distribution transformer before the primary side of the transformer is connected to ground. This can be solved by means of two identical key interlocks: one mounted on the grounding switch for the distribution transformer feeder and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

# Key interlock

Types and features of locks							
C-module							
Type	LBS off	LBS on	LBS on/off	ES off single key	ES on	ES on/off	Doorlock
Ronis	X	X	X	X	X	X	N/A
Castell	X	X	N/A	X	X	N/A	N/A
Kirk	X	X	N/A	X	X	N/A	N/A
V -module							
Type	DS off	DS on	DS on/off double				
Ronis	X	X	N/A	X	X	X	N/A
Castell	X	X	N/A	X	X	N/A	N/A
Kirk	X	X	N/A	X	X	N/A	N/A



# Modules



## Available modules ANSI:

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

## Available modules IEC:

C	Cable switch
De	Direct cable connection with earthing
D	Direct cable connection
F	Switch-fuse-disconnector
V	Vacuum circuit-breaker

## SafePlus is designed for customized application of switchgear in:

- Compact secondary substations and eHouses
- Small industries
- Wind power plants
- Hotels, shopping centres, office buildings, business centers etc.

## Normal indoor service conditions

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

- minimum ambient temperature: - 25°C
- maximum ambient temperature: + 40°C

## Ambient humidity:

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

The normal operational altitude is up to 1500 m above sea level. For higher altitude applications, please contact your ABB sales representative.

# Configurations

01 SafePlus CCV



01

## General

SafePlus is a metal enclosed compact switchgear system for up to 38 kV distribution applications. The switchgear has a unique flexibility due to its extendibility and the possible combination of fully modular and semi-modular configurations.

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

The sealed steel tank with constant atmospheric conditions ensures a high level of reliability, personnel safety, and a virtually maintenance-free system. As an option, SafePlus can be equipped with a set of busbar connections on the left and/or right side to allow for extension or full modularity.

The panels of modular or extended switchgears must be connected on site using an external busbar kit. No gas work is required on site to assemble the switchgears

The SafePlus system offers protection of the transformer by means of circuit-breaker in combination with a protection relay. Additional options, such as protection by switch-fuse combination, are available according to IEC standards.

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

## SafePlus is supplied with the following standard equipment:

- Operating handle
- Lifting lugs for easy handling
- Busbars, 600 A
- Grounding bar
- Manometer for SF<sub>6</sub> pressure
- Sidewalls - painted

## Factory assembled options

- Bushings for extension busbar
- Signal (1NO/1NC) from internal pressure indicator wired to terminals (one for each SF<sub>6</sub> enclosure)

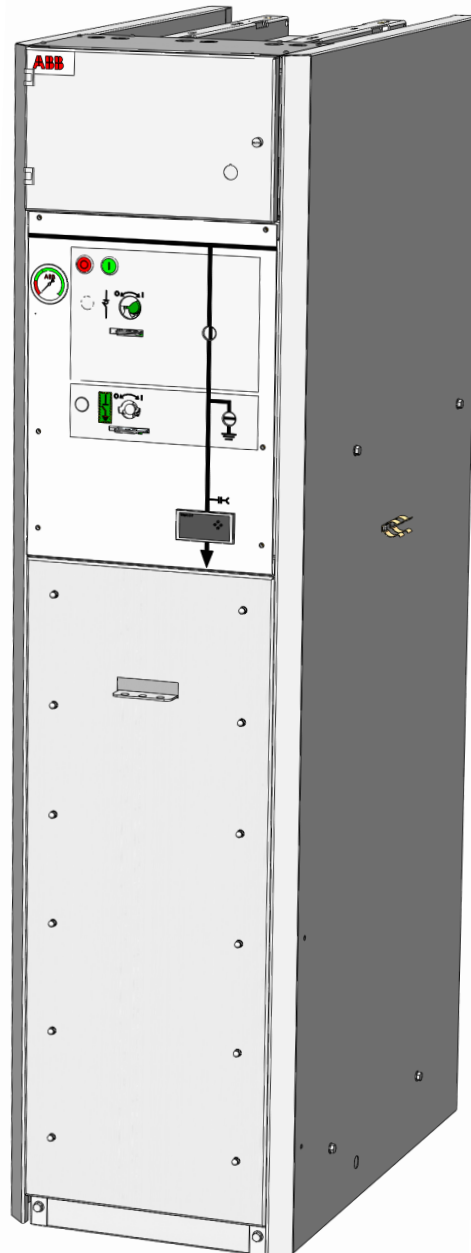
## Additional equipment also available as retrofit

- Integrated control and monitoring unit (ICMU)
- Adjustable cable support bars
- Short-circuit indicators
- Battery backups
- Motor operation
- Key interlocking system, EL 11 AP
- Current measuring

## C-module - Cable switch

The cable switch (C - Module) is a two position switch-disconnector using SF<sub>6</sub> gas as an arc quenching medium with a separate grounding switch.

The switch positions are close and open. In the open position the switch satisfies the disconnector requirements.



## C-module - Features

### Standard features

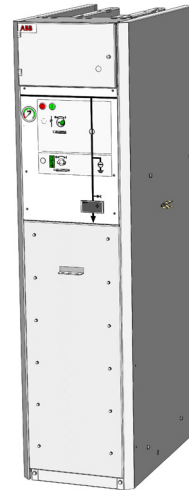
- Two-position load break puffer switch and separate grounding switch
- Two-position single spring operating mechanisms with two separate operating shafts for load break function and grounding function
- Switch position indication for load break switch and grounding switch
- Front-facing, horizontal cable bushings with integrated voltage divider for voltage indication
- Dead end outer cone cable termination system
- Cable compartment cover allowing double cable connection cable adapters; see section on cable terminations for more information
- Busbars, 600A
- Grounding bar
- Visible break-contacts for interrupter switch (non-drawout; IEEE only)

### Factory assembled options

- Interlocking
- Cable compartment front cover to prevent removal of the cover until the grounding switch has been closed

### Additional equipment also available as retrofit

- Motor operation for load break switch
- Auxiliary switches
  - Load break switch position 2NO+2NC
  - Grounding switch position 2NO+2NC
- Capacitive voltage indicator
  - VPIS acc. to IEC 61958 with integrated indicator lamps (LED)
  - HR- module (VDS) acc. to IEC 61243-5
- Short circuit and earth fault indicator
- External current transformers (CT)
- Current sensors and combined current and voltage sensors
- Key interlock



Depth: 888 mm/34.9 inches  
 Width: 420 mm/16.5 inches  
 Height: 1930 mm/76 inches \*)

\*) Height with high LV-compartment:  
 2180 mm/85.8 inches


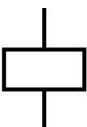






# C-module - Interlocking

## Abbreviations

<b>LBS</b>	Load break switch
<b>ES</b>	Grounding switch
<b>CB</b>	Circuit breaker
<b>DC</b>	Disconnecter
<b>SF</b>	Switch-fuse

Interlock type	Operation	Condition	Comment
Mechanical interlock C-module 	Closing LBS	ES is open, cable compartment cover is on	Cable compartment interlock is optional
	Opening LBS	ES is open, cable compartment cover is on	Cable compartment interlock is optional
	Closing ES	LBS is open	Standard
	Opening ES	LBS is open	Standard
	Opening cable compartment	ES is closed	Cable compartment interlock is optional
	Closing cable compartment	ES is closed	Cable compartment interlock is optional
Electrical interlock C-module 	Remote operation of LBS	Gas pressure in tank is under threshold	Optional feature. Manometer with signalling contact, contact can be used only for signalling purposes
	Closing ES	Incoming cable is without voltage	Optional feature. Voltage presence System with signalling contact is required.
Padlocks C-module Padlocks to be provided by customer 	Lock on LBS	None	Standard feature (Diameter of padlock: 8 mm)
	Lock on ES	None	Standard feature (Diameter of padlock: 8 mm)
	Lock cable compartment cover in closed position	None	Optional feature for arc proof cable compartment. Not possible for non-arc proof cable compartment. (Diameter of padlock: 8 mm)
	Lock cable compartment cover in open position	None	Optional feature for arc proof cable compartment. Not possible for non-arc proof cable compartment. (Diameter of padlock: 8 mm)
	Lock on local push buttons	None	Optional feature (Diameter of padlock: 8 mm)
Key interlock C-module 	Key lock on LBS	See details in chapter 28 "Key interlocks"	Optional feature
	Key lock on ES	See details in chapter 28 "Key interlocks"	Optional feature

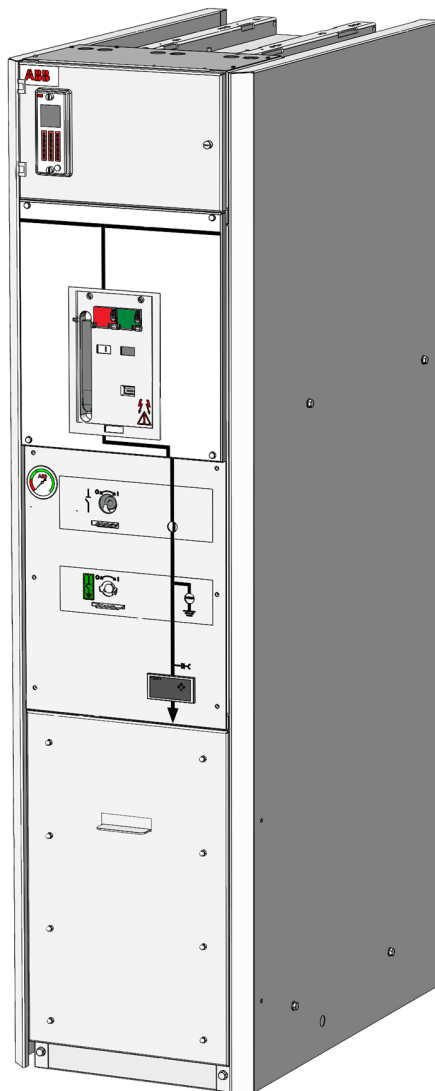
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## V-module - Vacuum circuit-breaker

The vacuum circuit-breaker (V-module) has vacuum interrupters for short-circuit current interruption.

A two-position disconnecter is connected in series with the circuit-breaker. After the disconnecter has been opened the integrated down-stream grounding switch can be closed.

The operation between vacuum circuit-breaker and disconnecter as well as between disconnecter and grounding switch are mechanically interlocked.



## V-module - Features

### Standard features

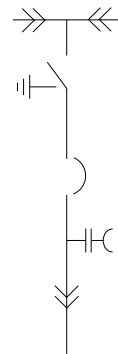
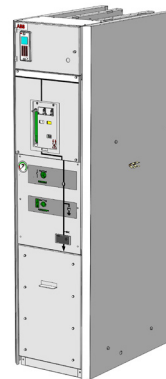
- Vacuum circuit-breaker
- Two position mechanism with auto-reclosing for vacuum circuit-breaker
- Two position operating mechanisms for the downstream disconnecter and grounding switches
- Interlocking between vacuum circuit-breaker and disconnecter
- Switch position indication for vacuum circuit-breaker, disconnecter and grounding switch
- Self powered electronic protection relay ABB type REJ603 with ring core CTs on cables
- Trip coil (for relay tripping)
- Front-facing, horizontal cable bushings with integrated voltage divider for voltage indication
- Dead end outer cone cable termination system available as either IEC type B plug in bushing, type C bolted profile bushing or IEEE Dead-Break bushings
- Cable compartment cover allowing double cable connection cable adapters; see section on cable terminations for more information
- Main busbars, 600A
- Grounding bar
- Visible break-contacts for stationary circuit breakers (non-drawout; IEEE only)

### Factory assembled options

- Interlocking
- Cable compartment front cover interlocked with grounding switch
- Signal (1NO/1NC) from internal pressure indicator wired to terminals (only one each SF<sub>6</sub> tank)

### Additional equipment also available as retrofit

- Motor operation for vacuum circuit-breaker
- High LV-compartment with hinged door
- Short circuit indicator
- Auxiliary switches
  - vacuum circuit-breaker position 2NO+2NC
  - disconnecter position 2NO+2NC
  - grounding switch position 2NO+2NC
  - vacuum circuit-breaker tripped signal 1NO
- Capacitive voltage indicating systems
  - HR-module (Voltage Detecting System, VDS, acc. to IEC 61243-5)
  - VPIS (Voltage Presence Indicating System, acc. to IEC 61958) with integrated indicator lamps
- Indicator lamp for HR-module, 1-phase VIM-1
- Indicator lamp for HR-module, 3-phase VIM-3
- Trip coil open
- Trip coil open and close
- Undervoltage release (optional electronic time delay device)
- Cable compartment cover
  - with extra depth (surge arrestor)
  - arc proof (if existing modules have interlocked covers)
- Key interlock on disconnecter/Grounding switch


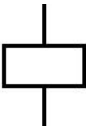



Depth: 888mm/34.9 inches  
 Width: 420 mm/16.5 inches  
 Height: 1930 mm/76 inches \*)

\*) Height with high LV-compartment:  
 2180 mm/85.8 inches

# V-module - Interlocking

Abbreviations			
LBS	Load break switch		
ES	Grounding switch		
CB	Circuit breaker		
DC	Disconnecter		
SF	Switch-fuse		

Interlock type	Operation	Condition	Comment
<div>Mechanical interlock V-module</div> <div></div>	Closing CB	None	
	Opening CB	None	
	Closing DC	CB is open, ES is open, cable compartment cover is on	Cable compartment interlock is optional
	Opening DC	CB is open, ES is open, cable compartment cover is on	Cable compartment interlock is optional
	Closing ES	DC is open	Standard
	Opening ES	DC is open	Standard
	Opening cable compartment	ES is closed	Cable compartment interlock is optional
	Closing cable compartment	ES is closed	Cable compartment interlock is optional
<div>Electrical interlock V-module</div> <div></div>	Closing ES	Incoming cable is without voltage	Optional feature. Voltage presence System with signalling contact is required.
<div>Padlocks V-module</div> <div>Padlocks to be provided by customer</div> <div></div>	Lock on ES	None	Standard feature (Diameter of padlock: 8 mm)
	Lock on DC	None	Standard feature (Diameter of padlock: 8 mm)
	Lock on push buttons CB	None	Optional feature (Diameter of padlock: 4 mm) 3 options: 1. each push button can be locked separately 2. both push buttons can be locked with one padlock 3. each push button can be locked separately and with open button locked with opening signal active
	Lock cable compartment cover in closed position	None	Optional feature for arc proof cable compartment. Not possible for non-arc proof cable compartment.
	Lock cable compartment cover in open position	None	Optional feature for arc proof cable compartment. Not possible for non-arc proof cable compartment.
Key interlock V-module	Key lock on DC	See details in chapter 28 "Key interlocks"	Optional feature
	Key lock on ES	See details in chapter 28 "Key interlocks"	Optional feature



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## Dc-module - Direct cable connection

The Dc-module is an air-insulated direct busbar connection.  
Connections can be added to the left side of the switchgear, the right side, or both.

### Standard features

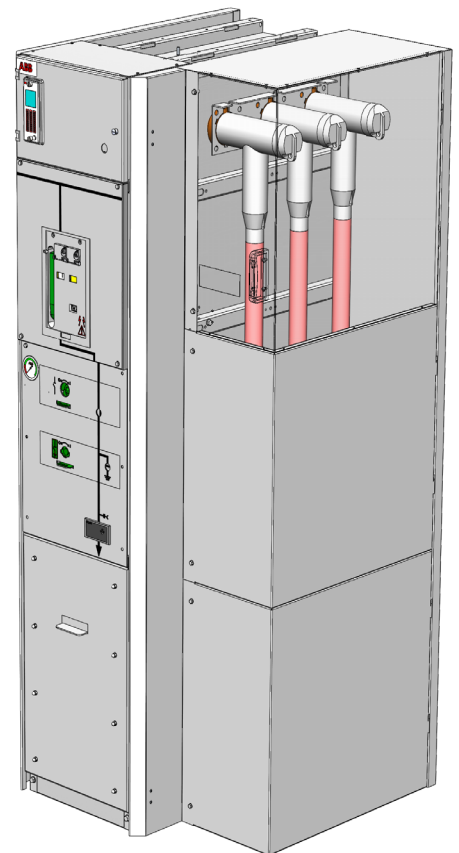
- Cable bushings horizontal on left and/or right side
- Voltage divider integrated for voltage indication
- Up to triple cable connection
- Non-arc proof cable cover is standard; switchgears can also be delivered without the side cover

### Factory assembled options

- Combined current and voltage sensors

### Optional features also available as retrofit

- Capacitive voltage indicating systems
  - HR-module (Voltage Detecting System, VDS, acc to IEC 61243-5)
  - VPIS (Voltage Presence Indicating System, acc. to IEC 61958) with integrated indicator lamps
- Indicator lamp for HR-module, 1-phase VIM-1
- Indicator lamps for HR-module, 3-phase VIM-3
- External current sensors (CT) for monitoring



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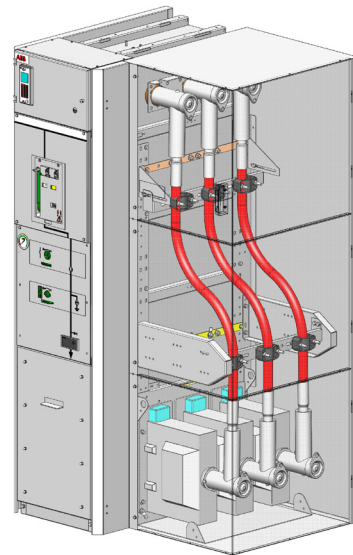
## Side-mounted solutions

The optional direct busbar connections on either side of the switchgear present unique solutions for integrated metering and auxiliary voltage.

### Side metering

#### Basic parameter of setup:

- Non-arc proof only
- 1 to 4-panel switchgear
- Additional width: 588 mm/23,2 inches
- Cover required to maintain touch proofing
- Right and left cable connection are available for all solutions
- UL approved VTs



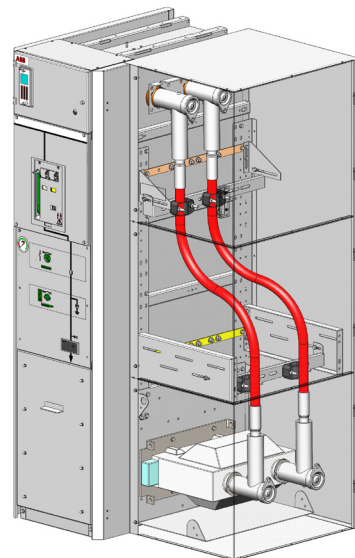
### Auxiliary voltage

#### Available solutions:

- 2 VTs double pole
- 1 VT double pole (shown in picture)

#### Basic parameter of setup:

- Non-arc proof only
- 1 to 4-panel switchgear
- Additional width: 588 mm/23,2 inches
- Cover required to maintain touch proofing
- Right and left cable connection is available for all solutions
- UL approved VTs



# Transformers and sensors

## Current transformers

—  
01  
KOKM 072  
for RMU  
—  
02  
KOLMA  
—  
03  
KOLA

### Toroidal current transformers

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

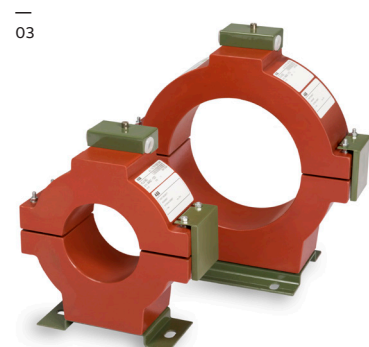
These transformers can be ring-core or split-core type. They can be used both for measuring phase current and for detecting earth-fault current. They conform to standard IEC 61869-1.

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.

Secondary circuits can be mounted using copper wires with a cross-section up to 4 mm<sup>2</sup> (strand) or up to 6 mm<sup>2</sup> (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.



# Measuring transformers

—  
01  
TPU 7x.xx  
up to 40,5 kV  
—  
02  
TJC 7x.xx  
up to 40,5 kV

## Current transformers to DIN standards

The DIN current transformers are insulated in resin and are used for powering measuring devices and protection relays. These transformers can have a wound core with one or more cores and come with performance and precision classes that suit the requirements of the installation.

These devices conform to standard IEC 61869-2.

Their dimensions normally comply with standard DIN 42600 Narrow Type.

The current transformers can also be supplied with a capacitive socket for connection to voltage signalling devices.

The ABB range of current transformers is called TPU.



## Voltage transformers

The voltage transformers are insulated in epoxy resin and are used for powering measuring devices and protection relays. In this case, the transformers can be equipped with a medium voltage protection fuse.

These devices conform to standard IEC 61869-3.

Their dimensions comply with standard DIN 42600 Narrow Type.

These transformers can have one or two poles and possess performance and precision classes that suit the functional requirements of the instruments to which they are connected.

The ABB range of voltage transformers is called TJC, TDC, TJP.





## Smart sensors

### KECA 80 C85 Indoor current sensor

KECA 80 C85 sensors are able to reach measuring class 0.5 for continuous measurement from 5% of the rated primary current ( $I_{pr}$ ) up to the rated continuous thermal current ( $I_{cth}$ ). This is beyond 120% of  $I_{pr}$  that is common for conventional CTs.

For dynamic current measurement (protection purposes), ABB KECA 80 C85 sensors fulfill 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

KECA 80 C85 sensors 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 and shielded cable connectors or any other type of insulated conductor. The current sensor is equipped with a clamping system that provides easy and fast installation and therefore makes the sensor suitable for retrofit purposes.



### Parameters for application

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

### Secondary cables

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

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

### Correction factors

The amplitude and phase error of a current sensor is, in practice, constant and independent of the primary current. Due to this fact it is an inherent and constant property of each sensor and it is not considered 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 label and should be uploaded into the IED without any modification before the sensors are put into operation. Please refer to the current sensor instructions and IED manual for more information.

# Combisensors

**Sensor variants**

KEVCY Combisensors are ABB's electronic instrument transformers (Sensors) offering current and voltage measurements for the protection and monitoring of medium voltage power systems up to 38 kV, 600 A.

**Linearity**

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

**Current sensor**

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

**Voltage sensor**

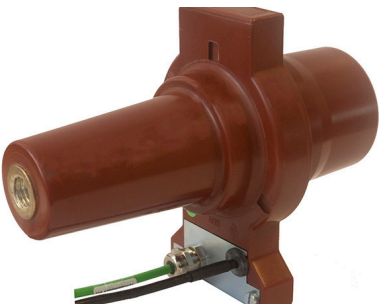
Voltage measurement in KEVCY xx RE1 sensors is based on the capacitive divider principle.

**Sensor application**

KEVCY xx RE1 is a compact and very small bushing type sensors designed to be used in SF<sub>6</sub>-gas insulated switchgear type SafeRing and SafePlus. 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 connectors.

**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



**Technical data. general**

Rated primary current of application	up to 630 A	
Rated primary voltage of application	up to 40,5 kV	
Highest voltage for equipment, U <sub>m</sub>	KEVCY 36 RE1	36 kV
	KEVCY 40,5 RE1	40,5kV
Rated power frequency withstand voltage	KEVCY 36 RE1	70 kV
	KEVCY 40,5 RE1	95 kV
Rated lighting impulse withstand voltage	KEVCY 36 RE1	170 kV
	KEVCY 40,5 RE1	185 kV

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 an IED is 2.2 meters. Standard cable length for connection with a coupling electrode is 0.45 meters.

# Terminations

## Cable bushings

—  
01  
400 series  
Interface C  
—  
02  
IEEE 386-2016 int. face 13  
600A dead-break bushing



—  
01



—  
02

The connection of the HV-cable is made by cable bushings. The bushings are made of cast resin epoxy 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 indicators.

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

These units have been installed worldwide in distribution networks, power stations, and industrial complexes.

Used together with fully screened connectors, these bushings present an ideal solution for areas with humidity or condensation problems. The bushings are designed according to CENELEC EN 50181, EDF HN 52-S-61, IEC 60137 and IEEE 386-2016.

Cable bushings available:

- Interface C,  
400 series with M16 bolted contact ( $I_n=630A$ )
- IEEE interface 13,  
600A dead-break bushing

The bushings fulfill the requirements of DIN47636T1.

Standard on all modules and for side connection.

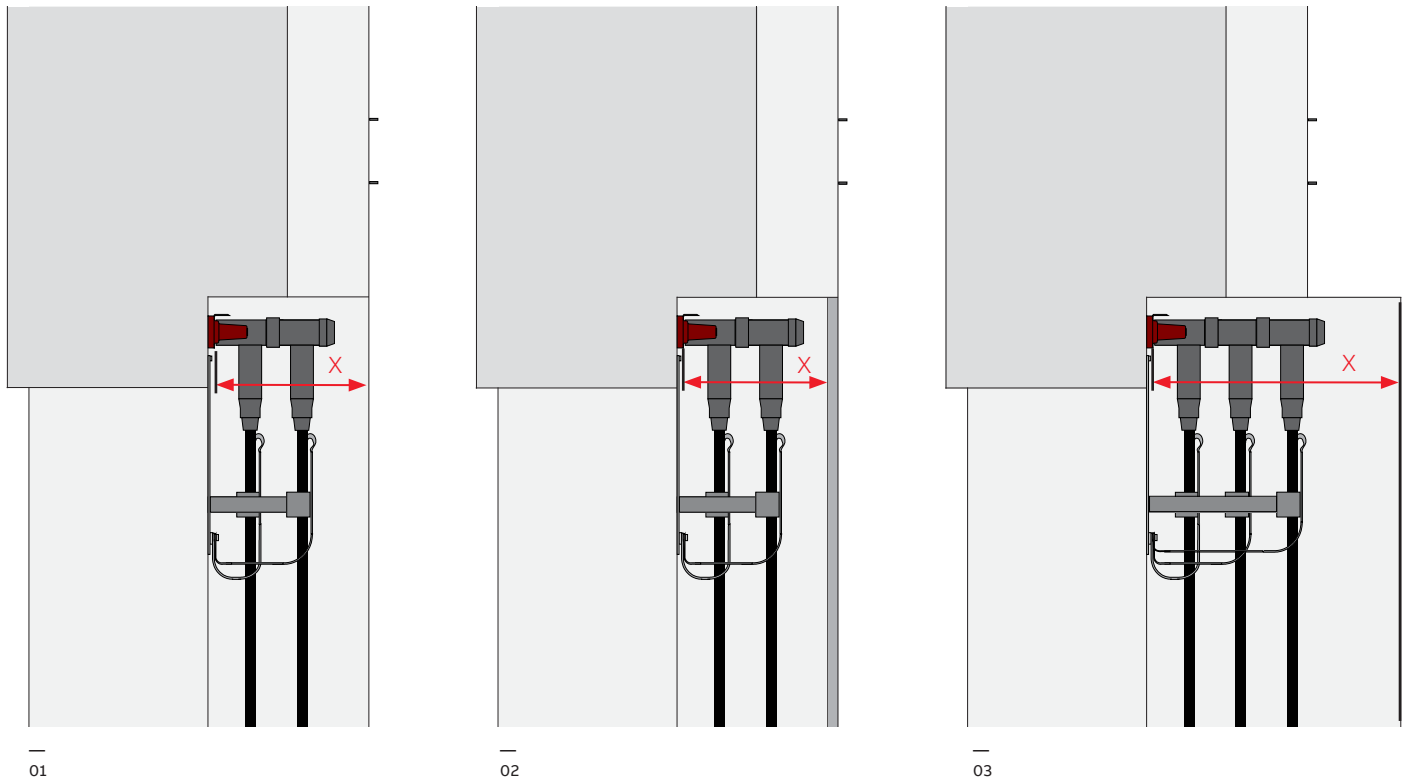
Important: Where cables are not connected, the grounding switch must be locked in closed position or the bushings must be fitted with dead end receptacles before the unit is energized.

# Cable terminations

- 01 Standard cable cover
- 02 Arc proof cable cover
- 03 Expanded cable cover

All bushings are protected by cable compartment covers. The drawings below show typical arrangements with cable connectors.

The table below the drawings shows the distance X in millimeters/inches from cable bushing to the inner part of cable compartment cover.



Distance X	
Standard cable cover	360 mm/14.2 inches
Arc proof cable cover	343 mm/13.5 inches
Expanded cable covers	580 mm/22.8 inches

The following manufacturers of cable terminations are recommended:

- 3M
- Euromold/Elastimold
- Kabeldon
- nkt cables/Felten & Guillaume
- Tyco/Raychem

Cable terminations

—

01

Euromold 784TB

**Application area**

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

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

- 400 A: interface type B with plug-in Ø 14 mm
- 600 A: interface 13

**Standard**

Meets the requirements of:

- CENELEC, HD 629.1 S2
- IEEE standard 386



—

01

**Design**

Terminations are premolded and manufactured in rubber with three layers: a conductive inner layer, an insulation layer, and a conductive outer layer, that are vulcanized together for the best possible interface between the layers.

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

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

**Note:**

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

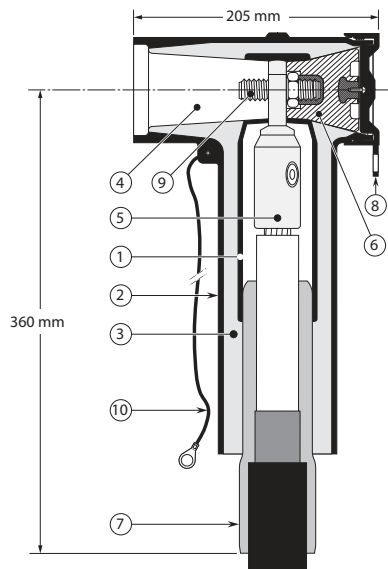
Contact your local supplier sales representative for more details.

Designation	XLPE/EPR Ø mm2	Rated current	Bushing type
TEE connector with capacitive test point, up to 42kV			
Euromold P784TB	16.0 - 56.0	600 A	Interface type E with bolt 5/8"
TEE connector with capacitive test point, up to 35kV			
3M System 5835 Series	16,3 - 49,9	600 A	Interface type E with bolt

# Cable terminations

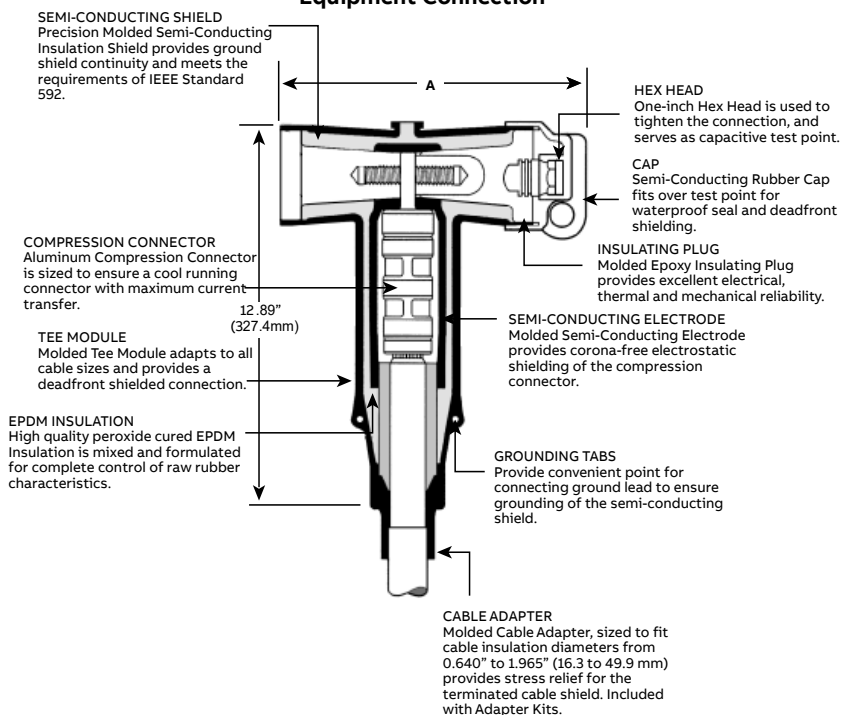
## Euromold

1. Conductive EPDM insert.
2. Conductive EPDM jacket.
3. Insulating EPDM layer moulded between the insert and the jacket.
4. Type E 5/8" interface as described by IEEE 386.
5. Conductor contact.
6. Basic insulating plug 858 BIPA (with VD point).
7. Cable reducer.
8. Conductive rubber cap.
9. Stud/nut/washer 5/8".
10. Earthing lead.



## 3M

### Equipment Connection





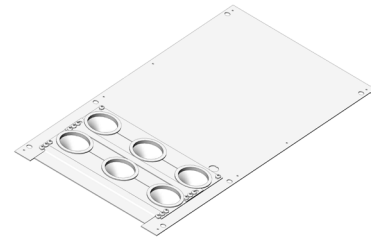
## Additional equipment

- 01  
Standard cable support bar for single cable connection.
- 02  
Adjustable cable support bar for single cable connection.
- 03  
Adjustable cable support bar for double cable connection.
- 04  
Adjustable cable support bar for single cable connection with Grounding bar for surge arrester.

### Gland plates

Gland plates may be placed either at the bottom of the switchgear or at the bottom of the base frame. They prevent access of reptiles and small animals into the cable compartment.

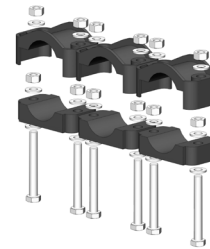
Gland plates are available for double and single sets of cables.



### Cable clamps

Cable clamps are used to support the cable and the cable connection. They are available in three different sizes (Outer cable diameter):

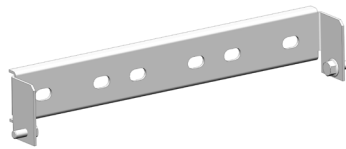
- 24-38 mm
- 25-54 mm
- 66-90 mm (available on request)



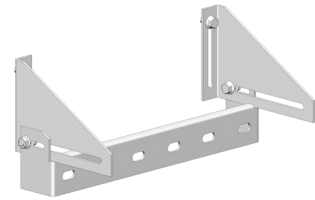
Not supporting the cables may put an unacceptable strain on the bushings and ultimately result in gas leakage or other damage.

### Cable support bars

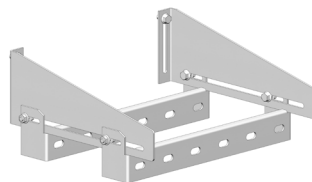
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01



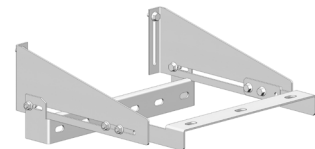
—  
02



—  
03



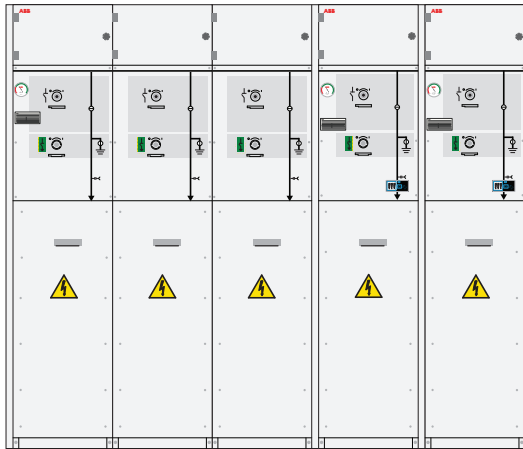
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04



## Side extension

01  
SafePlus with a fully modular design.

02  
The installation of the external busbars has to be done on site, see separate installation instructions, 1VDD006146 GB.



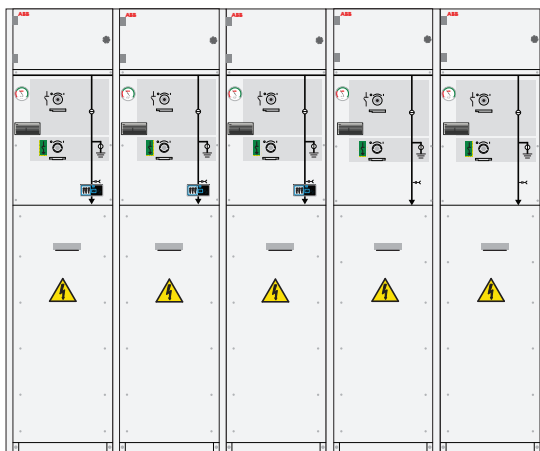
01

As an option, SafePlus can be provided with bushings for side extension on one or both sides.

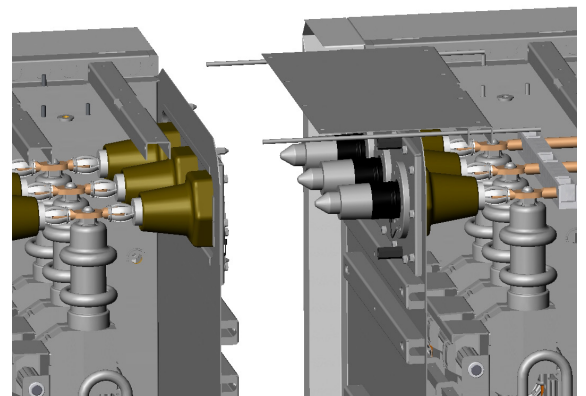
For a SafePlus switchgear consisting of only one module, bushings on both sides are necessary if future extension is required.

Since a maximum of four panels can be included in a single, common SF<sub>6</sub>-tank, the side extension and busbar kit are required for configurations that require additional panels.

For practical handling of modules on site, the switchgear can be extended by 1- or 2-way units. No gas handling is required on site during installation of extended modules.



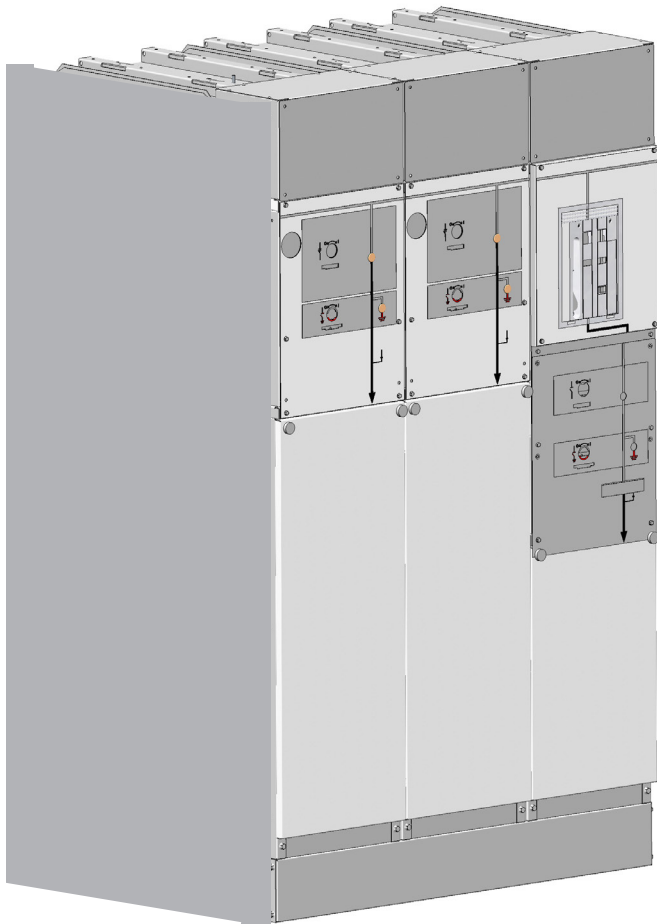
02



# Optional equipment

## Base frame

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01  
SafePlus 36 CCV.  
—  
02  
The baseframe as  
seen from the rear

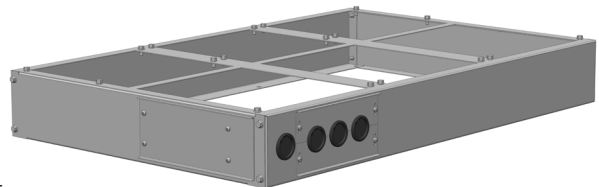


01

If SafePlus is placed directly on the floor, the height from the floor to the center of the cable bushings is 615 mm/24,25 inches (V-module), or 1034mm/40,7 inches (C-module).

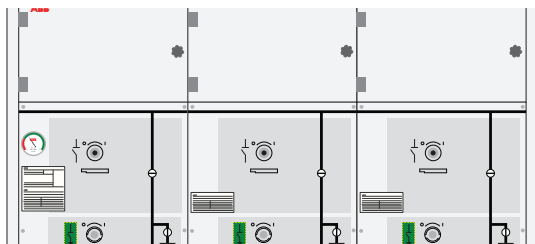
If there is no cable trench, this height might not be sufficient for proper installation of cables. It is then possible to place the switchgear on an additional base frame. Base frame are available in three different heights: 160, 350 and 495 mm/6, 14 and 19,5 inches. The 160mm/6 inches base frame has openings for cable entrance from the bottom, rear, right hand side.

The 350mm and 495mm/14 and 19,5 inches base frame have openings for cable entrance from the bottom and rear side.



02

## Low Voltage Compartment

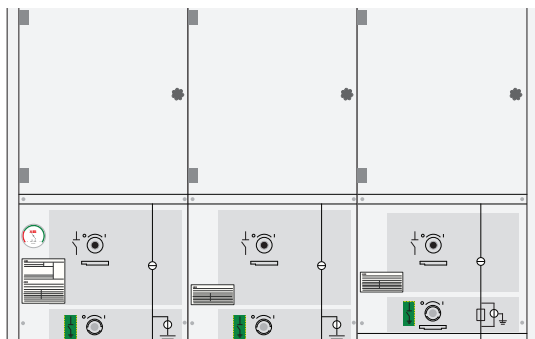


When motor operation, coils, auxiliary switches, or other relevant components are mounted on a SafePlus 36 module, the auxiliary relays, MCB / fuses, and terminals are located in the low voltage compartment on the top of the switchgear.

The low voltage compartment allows entrance of the customer's low voltage cables on either side or on the top left or top right of the switchgear. Also, the low voltage compartment allows for the installation of instruments and other components.

As an option, the standard LV-compartment can be delivered with a hinged door.

Height of standard version: 284 mm/11,2 inches.



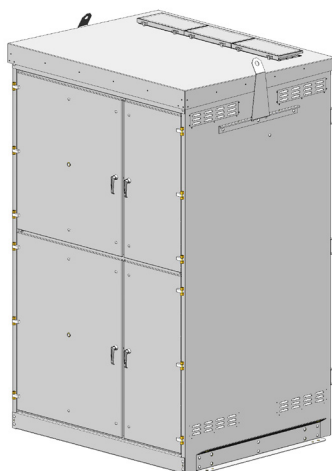
Additionally, all SafePlus switchgears can be supplied with a high low voltage compartment.

This compartment can be equipped with protection relays, meters, terminal blocks, etc.

This compartment also allows entrance of low voltage cable from the rear side.

Height of high version: 534 mm/21 inches.

## Outdoor enclosure

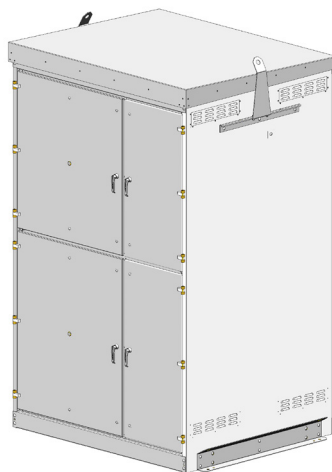


### Arc proof version

An outdoor enclosure is a water-resistant cabinet which protects the switchgear from outdoor conditions. Note that the outdoor enclosure may be installed in restricted areas only. Every offer needs to be discussed with an ABB sales representative.

Basic parameters for setup:

- Available for 2-4 way units
- IAC AFLR 25kA 1s
- IP 54
- If there is a roof above the enclosure the minimum distance to the roof is:  
600 mm/24 inches
- Minimum distance to sidewall:  
100 mm/4 inches
- Minimum distance to backwall:  
800 mm/32 inches



### Non-arc proof version

Basic parameters for setup:

- Available for 2-4 way units
- IP 54

**NEMA 3R enclosures are available upon request. Speak with your ABB representative for more information.**

# Motor operation and coils

Closing and opening of load-break switches and charging mechanism springs for vacuum circuit breaker mechanisms can all be performed by motor operation.

All motor devices require DC voltage. If control voltage is either 110 or 220 VAC, a rectifier is integrated in the control unit.

The operating cycle for motor operation for C-module is CO - 3 min (i.e. it can be operated with a frequency of up to one close and one open operation every third minute). The operating sequence for Vacuum circuit-breaker is O-0,3s-CO-3min-CO.

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

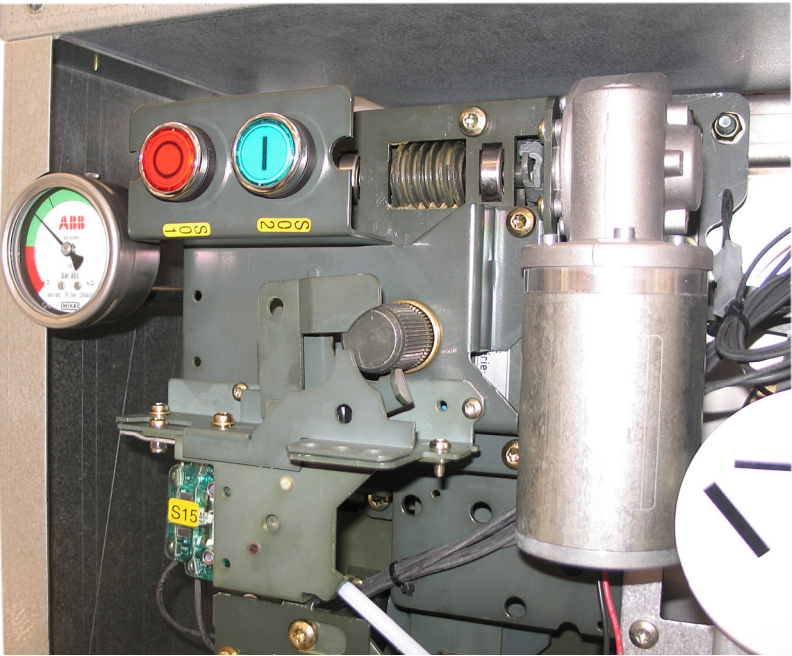
Characteristics of motor operation for C-module					
Rated voltage (V)	Power consumption [W] or [VA]	Operating times		Peak start current (A)	Fuse
		Closing time (s)	Opening time (s)		
24	130	6-10	6-10	19	F 6,3 A
48	150	4 - 7	4 - 7	13	F 4 A
60	90	6 - 9	6 - 9	7	F 4 A
110	90	6 - 9	6 - 9	3	F 2 A
220	90	6 - 9	6 - 9	1,7	F 1 A

Characteristics of motor operation for V-module					
Rated voltage (V)	Power consumption [W] or [VA]	Charge time (s)	Current (A)	Peak start current (A)	Fuse
24	350	7-15	15	38	F 10 A
48	350	7-15	7	19	F 6,3 A
60	350	7-15	6	15	F 6,3 A
110	350	7-15	3	8	F 4 A
220	350	7-15	1,5	4	F 2 A



Characteristics of shunt trip-, closing- and opening coils <sup>1)</sup>				
Rated voltage (V)	Power consumption - Launch [W] or [VA]	Power consumption - Hold [W] or [VA]	Operating times	
			Closing time (ms)	Opening time (ms)
24 V DC	100	1,5	50 - 90	40 - 80
48 V DC	100	1,5	50 - 90	40 - 80
60 V DC	100	1,5	50 - 90	40 - 80
110 V DC	100	1,5	50 - 90	40 - 80
220 V DC	100	1,5	50 - 90	40 - 80
110 V AC	100	1,5	50 - 90	40 - 80
220 V AC	100	1,5	50 - 90	40 - 80

<sup>1)</sup> Smart Coil

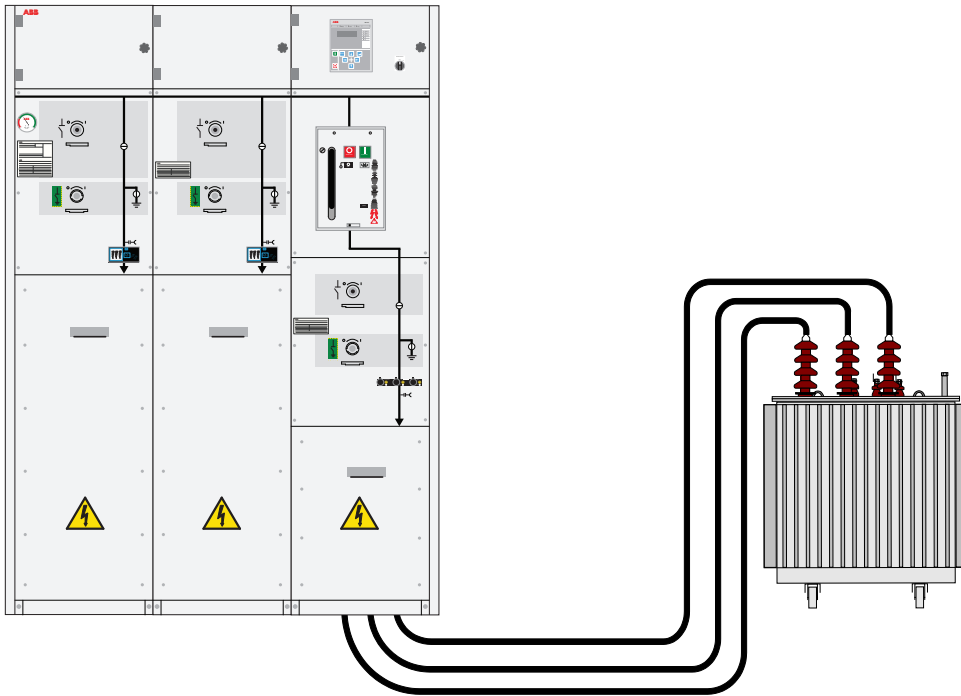


Auxiliary equipment like motor drives, operation coils, and auxiliary switches are all located behind the upper front covers.

Electrical control units for motor operation and the internal wiring in general are connected to the terminals located in the low voltage compartments.



# Transformer protection



SafePlus offers protection of the transformer by means of circuit-breaker in combination with a protection relay.

The circuit breaker panel offers optimal protection against short-circuit currents as well as low over-currents. It is always recommended for higher rated transformers.

SafePlus V-modules are delivered with 600A rating. For SafePlus, the relay is self-powered utilizing the energy from the current transformers under a fault situation for energizing the trip coil.

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

Additional options, such as protection by switch-fuse combination, are available according to IEC standards.

## Important features V-module:

- Relay in low voltage box (for the self-powered relays used for transformer protection)

## Typical for vacuum circuit-breaker protection:

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



# Relays



The V-module for SafePlus 36kV includes a 600A vacuum circuit-breaker. This chapter describes the different choices of protection relays and feeder terminals that can be used in SafePlus. Standard test procedure includes functional testing of protection relay trip circuits.

All customer settings must be done on site. ABB feeder terminals are configured according to customer specification for protection functions. Special control requirements can be delivered on request. The V-module can also be delivered prepared for protection relays in one of two ways:

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

This is applicable for relays delivered complete from our factory or if we have received necessary documentation on the relay. Other types of relays are available on request.

ABB delivers three main types of relays:

- Feeder protection relays
  - Self-powered protection relays
  - Feeder terminal relays
- A. Feeder protection relays  
ABB offers a wide range of feeder protection relays. After many years on the market these relays have an excellent reputation for reliability and secure operation. These relays have either 18-80VDC or 80-265VAC/DC auxiliary supplies and are connected to conventional CTs and VTs.
  - B. Self-powered protection relays  
Self-powered relays are suitable for rough conditions and places without possibility of auxiliary supply. SafeRing and SafePlus can be delivered with ABB REJ603 to fulfill all relevant needs in a distribution network.
  - C. Feeder terminal relays  
ABB feeder terminals provide cost-effective solutions for different protection, monitoring, and control applications. SafePlus can be delivered with REF630.

# Feeder protection

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01  
REF601/REJ601  
—  
02  
REJ603

## Feeder protection

The power protection applications can be roughly 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 fulfill 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 nondirectional/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 undervoltage 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 loadshedding schemes.

These are just a few examples of the major power protection for power feeders.



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02

## Powered relays



### REF601/REJ 601

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 and REJ601 are members of ABB's Relion® product family and part of its 605 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 and 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 provides mainly 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 grounded.

### REF630

REF630 is a comprehensive feeder management IED for protection, control, measurement and supervision of utility and industrial distribution substations.

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

REF630 incorporates local and remote control functions. The IED offers a number of freely assignable binary inputs/outputs and logic circuits for establishing bay control and interlocking functions for circuit-breakers and motor operated switch-disconnectors.



Technical functions powered relays		Powered relays					
Functionality groups	IEC61850	IEC60617	REF601	REF611	REF615	REF620	REF630
<b>Overcurrent functions</b>							
Three-phase transformer inrush detector	INROPHARI	3I2f>	X	X	X	X	X
Three-phase non-directional overcurrent protection, low stage	PHLPTOC	I>	X	X	X	X	X
Three-phase non-directional overcurrent protection, high stage	PHHPTOC	I>>	X	X	X	X	X
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC	I>>>	X	X	X	X	X
Three-phase directional overcurrent protection, low stage	DPHLPTOC	I>->			X	X	X
Three-phase directional overcurrent protection, high stage	DPHHPPTOC	I>>->			X	X	X
<b>Earth-fault functions</b>							
Non-directional earth-fault protection, low stage	EFLPTOC	Io>	X	X	X	X	X
Non-directional earth-fault protection, high stage	EFHPTOC	Io>>	X	X	X	X	X
Non-directional earth-fault protection, instantaneous stage	EFIPTOC	Io>>>			X	X	X
Directional earth-fault protection, low stage	DEFLPDEF	Io>->			X	X	X
Directional earth-fault protection, high stage	DEFHPDEF	Io>>->			X	X	X
<b>Over-/undervoltage</b>							
Three-phase overvoltage protection	PHPTOV	U>/>>/>>>			X	X	X
Three-phase undervoltage protection	PHPTUV	U</<</<<<			X	X	X
Residual overvoltage protection	ROVP TOV	Uo>		X	X	X	X
<b>Frequency protection function</b>							
	FRPFRQ	f>/f<,df/dt			X	X	X
<b>Thermal protection function</b>							
Three-phase thermal protection	T1PTTR	3Ith>F	X	X	X	X	X
<b>Arc protection function</b>							
Arc protection	ARCSARC	ARC			X	X	X
<b>Advanced protection functions</b>							
Auto-reclosing	DARREC	O->I	X	X	X	X	X
Fault locator	SCEFRFLO	FLOC			X		X
Distance protection	DSTPDIS	Z<					X
Synchro check	SYNCRSYN	SYNC			X	X	X
<b>Measuring functions</b>							
Three-phase current measurement	CMMXU	3I		X	X	X	X
Voltage	VMMXU	3U			X	X	X
Power and energy measurement (S,P,Q,PF)	PEMMXU	P,E			X	X	X
Frequency	FMMXU	f			X	X	X
Disturbance recorder	RDRE	DR		X	X	X	X
Residual current measurement	RESCMMXU	Io		X	X	X	X
Residual voltage measurement	RESVMMXU	Uo		X	X	X	X
Load profile recorder	LDPMSTA	LOADPROF			X	X	
<b>Communication functions</b>							
103			X		X	X	X
IEC61850				X	X	X	X
Modbus			X	X	X	X	

## Self-powered relays



### REJ603

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

### WIB1

All available versions of the WIB1 relay offer high-tech and cost-optimized protection for medium voltage switchgears. Specifically in compact switchgears, the WIB12PE and WIB12FE protection system in combination with a circuit-breaker can replace the combination of load break switch with HV fuses, thereby improving the overload protection of the attached unit. When power distribution networks are extended more and more high powered transformers are used. In this situation, HV fuses are unacceptable. For such applications the WIB1 protection system is an optimal replacement.

### WIC1

All available versions of the WIC1 relay offer high-tech and cost-optimized protection for medium voltage switchgears. Specifically in compact switchgears, the WIC1 protection system in combination with a circuit breaker can replace the combination of load break switch with HV fuses, thereby improving the overload protection of the attached unit. When power distribution networks are extended more and more high powered transformers are used. In this situation, HV fuses are inadmissible. For such applications the WIC1 protection system is an optimal replacement.

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

<sup>1)</sup> - 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

<sup>3)</sup> 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

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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 either with IEC 61958 standard for voltage presence indication system (VPIS) or IEC 61243-5 standard for voltage detection system (VDS).

### Voltage indicators VPIS

VPIS indicators only display the 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 according to IEC 61243-5. The VDS system delivered by ABB can be either based on the Low Resistance (LRM) or the High Resistance (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) according to IEC 61243-5. 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-61243-5.



01



02



03



04



05



06

Technical functions capacitive voltage indicators								
Manufacturer	Maxeta	Anda	Maxeta	Horstmann	Horstmann	Horstmann	Kries	Kries
Model	VPIS	DNX5	HR module	WEGA 1.2C (45 deg)	WEGA 2.2C (45 deg)	WEGA 1.2C Vario	Capdis S1+(R4)	Capdis S2+(R4)
Type	VPIS	VPIS	VDS	VDS	VDS	VDS	VDS	VDS
Standard	62271-206	62271-206	61243-5	61243-5	61243-5	61243-5	61243-5	61243-5
Capacity variable sec.	no	no	no	no	no	yes	yes	yes
Voltage range	9-15kV 15-24kV 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

## Short-circuit indicators



Compass B



IKI-50

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.

A fault passage indicator offers different functionalities including 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	Horstmann	Kries	Kries	Kries	Kries	Kries	Kries	Kries	Kries	Anda
Model	Sigma	Sigma F+E3	Sigma D	Sigma D+	Compass B	Compass B CS1	Compass B	IKI-50	IKI-50-PULS-EW	IKI-20	IKI-20PULS	IKI-20C	IKI-20C PULS	IKI-22	EKL-7	
Dedicated volt. ind.	-	-	Wega 1.2C/ Wega 1.2 Wega 2.2C vario/ Wega 2.2C	Wega 1.2C/ Wega 1.2 vario/ Wega 2.2C	Wega 1.2C/ Wega 1.2 Wega 2.2C vario/ Wega 2.2C	ABB Combi-sensor	Capdis S1/S2- R4	Capdis S1/S2- R4	Capdis S1/S2- R4	IKI-50-PULS-EW	IKI-20	IKI-20PULS	IKI-20C	IKI-20C PULS	Capdis S1	
STC fault ind.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Directional ind.	-	-	X	X	X	X	X	X	X	-	-	-	-	-	X	-
Directly grounded neutral	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Isolated neutral - Wattmetric (sin)	-	-	-	X	X	X	X	-	-	-	-	-	-	-	X	-
Compensated neutral - Wattmetric (cos)	-	-	-	X	X (with Sum-Sensor) IE>10A	X (IE>10A)	X	X	X	-	-	-	-	-	X	-
Compensated neutral - transient	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	-
Compensated neutral - puls	-	-	-	X	X	-	X	-	X	-	X	-	X	-	-	-
Monitoring	X	X	-	-	X	X	X	X	X	X	X	-	-	-	X	-
Trip current short-circuit	100-1000A	200-2000A	50-2000A	50-2000A	50-2000A	200-2000A	200-2000A	100-1000A	100-1000A	100-2000A	100-2000A	400-1000A	400-1000A	400-1000A	100-2000A	400,600,800,1000A
Response time short-circuit	40-80ms	40/80/200/300ms	40ms-60s	40ms-60s	40ms-60s	40ms-60s	40ms-60s	60-1600ms	60-1600ms	60-200ms	60-200ms	100ms	100ms	100ms	60-200ms	40,60,80,100ms
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) + transient methode	40-200A + 4-30A (cosphi methode) + transient methode	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	-	60/80/200/300ms	40ms-60s	40ms-60s	40ms-60s	40ms-60s (low imp. network), 200ms-60s (wattmetric)	40ms-60s (low imp. network), 200ms-60s (wattmetric)	60-1600ms	60-1600ms	60-200ms	Appr. 9s after detecting pulsating current	100ms	100ms	100ms	60-200ms	80, 120, 160, 200ms
Remote test/reset	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Automatic reset time	1,2,4,8h	2,4,8,24h	1 min - 24h	1 min - 24h	1 min - 24h	1 min - 24h	1 min - 24h	1,8h or automatic after load current is recovered	1,8h or automatic after load current is recovered	2,4h	2,4h	2,4h	2,4h	2,4h	2,4h	1,2,4,8h
Supply	Long life lithium cell	Long life lithium cell	CT powered	CT powered, aux.supply possible: 24V AC, 24-60V DC	24-230V AC/DC (ext)	24-230V AC/DC (ext)	24-230V AC/DC (ext)	24-230V AC/DC	24-230V AC/DC	3 options: Aux. (ext), capacitor buffered, dep. on version	2 options: Aux. (ext), capacitor buffered, dep. on version	Self-powered + capacitor	Self-powered + capacitor	Self-powered + capacitor	24-230V AC/DC, only for sensitive earth-fault function + battery	230V AC/DC (ext), 3,6V battery (int)
Life time of battery	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	20 years (batteries)	-	-	17 years (batteries)	12h for cap. buffering	4h for capacitor	4h for capacitor	4h for capacitor	15 years (batteries)	10 years (batteries)
No. of relay contacts	1	3	4	4	4	4	4	4	4	1-3 dep. on version	2 dep. on version	2	2	2	1-3	2
Comm. protocole	-	-	-	-	Modbus	Modbus	Modbus	Modbus	Modbus	Modbus	Modbus	-	-	-	-	-
Configuration	DIP	DIP	DIP/SW	DIP/SW	Menu/SW	Menu/SW	Menu/SW	Menu nav.	Menu nav.	DIP	DIP	DIP	DIP	DIP	DIP	DIP

---

## Manometer / pressure indicators

SafePlus switchgears are sealed systems, designed and tested according to IEC 62271-200 as a maintenance free switchgear for lifetime (30 years). The switchgear does not require any gas handling.

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 gas-tightness and a gas-pressure better than 1.35 bar\* throughout its designed lifespan. This pressure value is still within a good margin from the pressure used during the type tests, which is 1.3 bar\*.

\*) at 20°C.



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

In case of need of remote indication, manometers can be equipped with signalling contacts. Detailed description of manometer functions are described in the table on next page.

### Altitude

Maximum height above sea level for installation without reducing gas pressure is 1500 meters. For installation above 1500 meters, please contact ABB for instructions.



Producer	Model	Insulation medium	Temp. compensation	Accuracy	Scale range (Absolute)	Appearance (Absolute)	Marking of scale (Absolute)	Over-pressure ind.	Signalling contact	Threshold pressure	Connection to the tank
 Wika with signal contact	2RAA017583P0001	SF6	X	+/- 1% (20 deg.)	0...2,2 bar	red zone 0...1,2 bar green zone 1,2 bar...	mark at 1,2 bar	-	1x NO	1,2 bar	solid
	NHP 304769P0001	SF6	X	+/- 1% (20 deg.) +/- 2,5% (-20...+60 deg.)	1...2 bar	red zone 1,0...1,2 bar green zone 1,2...2,0 bar	mark at 1,4 bar	-	-	-	solid
 Wika with overpressure indicator	2RAA014075P0001	SF6	X	+/- 1% (20 deg.) +/- 2,5% (-20...+60 deg.)	1...2 bar	red zone 1,0...1,2 bar green zone 1,2...2,0 bar	mark at 1,4 bar	X (yellow indication)	-	-	solid
	Density switch GMD1	SF6	X	+/- 2% (-25...+70 deg.)	-	-	-	-	X	1,15/1,25 bar	solid

# Remote control

- 01  
Pendant control without  
indication lamps
- 02  
Pendant control with  
indication lamps

## Pendant control

It is possible to increase the safety of the personnel operating the switchgear by using pendant control for switching operations. With this pendant control it is possible to operate the switchgear up to a distance of 15 meters away.

Additional safety is added by connecting the on/off buttons through an enable button. The enable button must be pressed and held prior to operating the on or off buttons thus reducing the risk of accidental switch operation.

The cable is connected to the switchgear's

terminal blocks in the low voltage compartment.

## Basic features

Cable length: 15 meters (other lengths on request)

Cable connection to low voltage compartment via:

- Plug (as shown in picture)
- Direct connection to terminal blocks



01



02

SafePlus can be supplied with remote control and monitoring equipment. The switchgear can be fitted with different types of ABB remote terminal units: ARC600, REC615, RTU 540.

Being responsible for a whole network could put you in a situation in which some devices are brand new while others have been working for a very long time. As a gateway between IEDs and network control system (communication protocols and station bus) it is able to interpret information from all standard protocols.



### Benefits

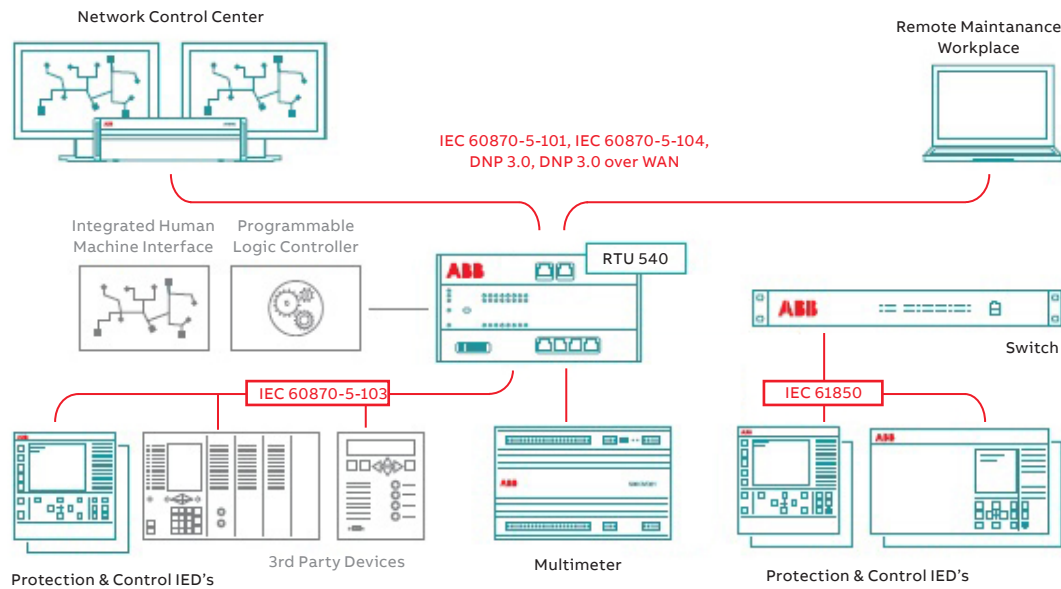
- Powerful protocol gateway to bridge old and new technologies in one system
- Intelligent device for automated load and voltage control
- Robust and compact housing for fan-less operation enables you to handle a complex network due to distributed intelligence
- Agile functionality allows easy adaption of automation based on changing system requirements
- Selective interpretation allows fast decision making in the network control center and saves primary equipment
- Communication redundancy for peace of mind and confidence in the network

### Application areas

- Gateway between IEDs and Network control system
- Interfacing of station level I/Os into station bus
- Integration of serial IEDs into station bus
- Transformer monitoring and control
- Voltage control

### Remote control terminal RTU 540

Auxiliary power	24 - 110V DC or 110 / 220V AC
Charger	60 watt
Battery	2 x 12V (24V), 20 Ah



# Battery back-up solutions

In case the auxiliary voltage should drop or disappear, it is possible to add batteries as back-up to ensure there is continuous voltage on critical components. The time the batteries will last depends on the components which are used in each configuration. It is possible to have a battery package of either 20 or 32 Ah.



## Battery charger

ADC 5000 Series:

- 60 watt (Usually used for Digital solutions)
- 125 watt (standard)
- Input voltage: 230/115 VAC
- Output voltage: 24 VDC
- Operating temp without power loss: -40 to 55°C



## Batteries:

- 24 (2x12) VDC
- 26 Ah
- Life time: 10 years

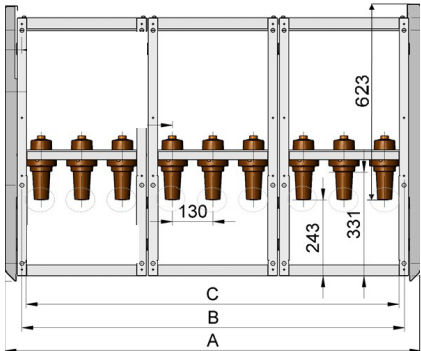
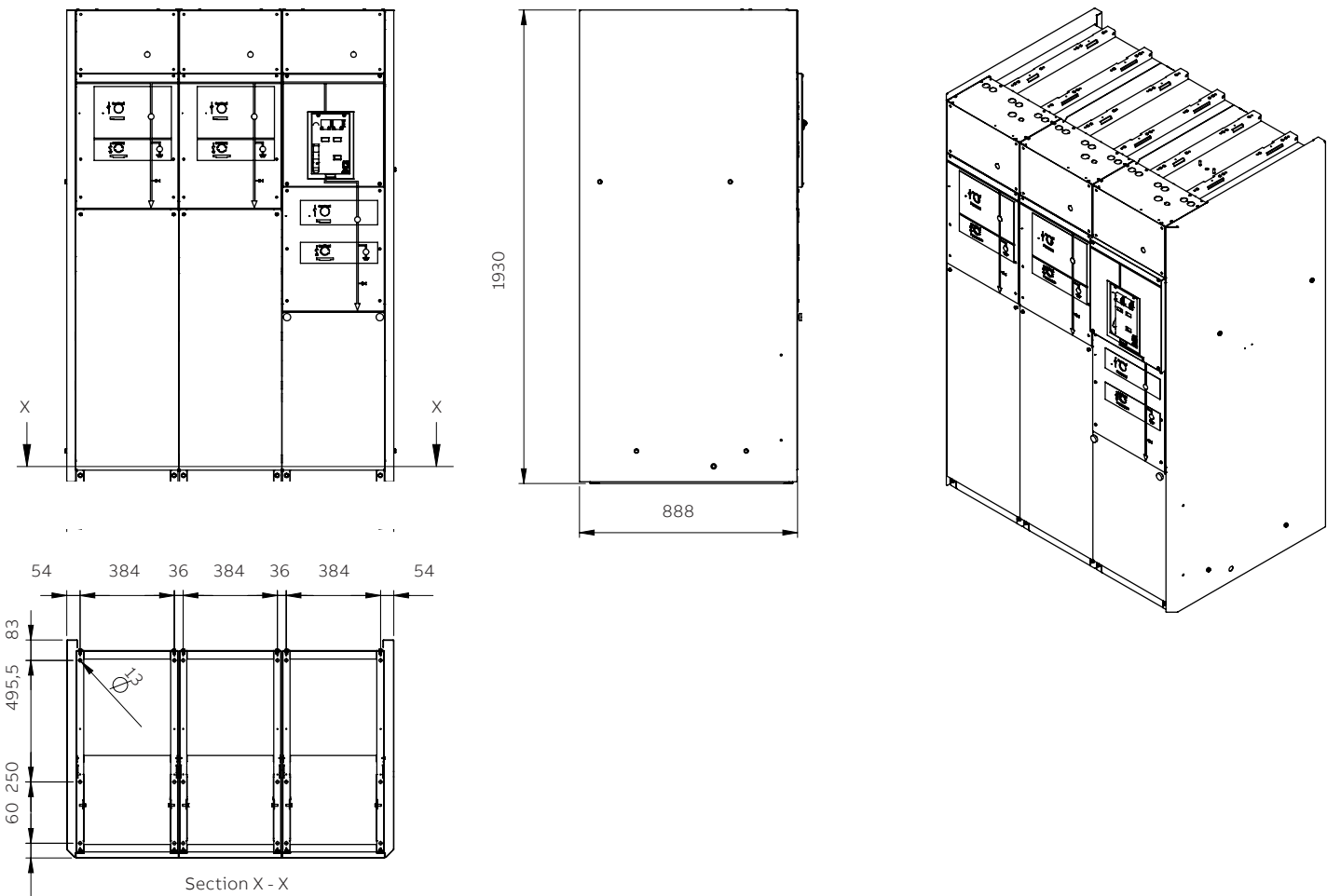






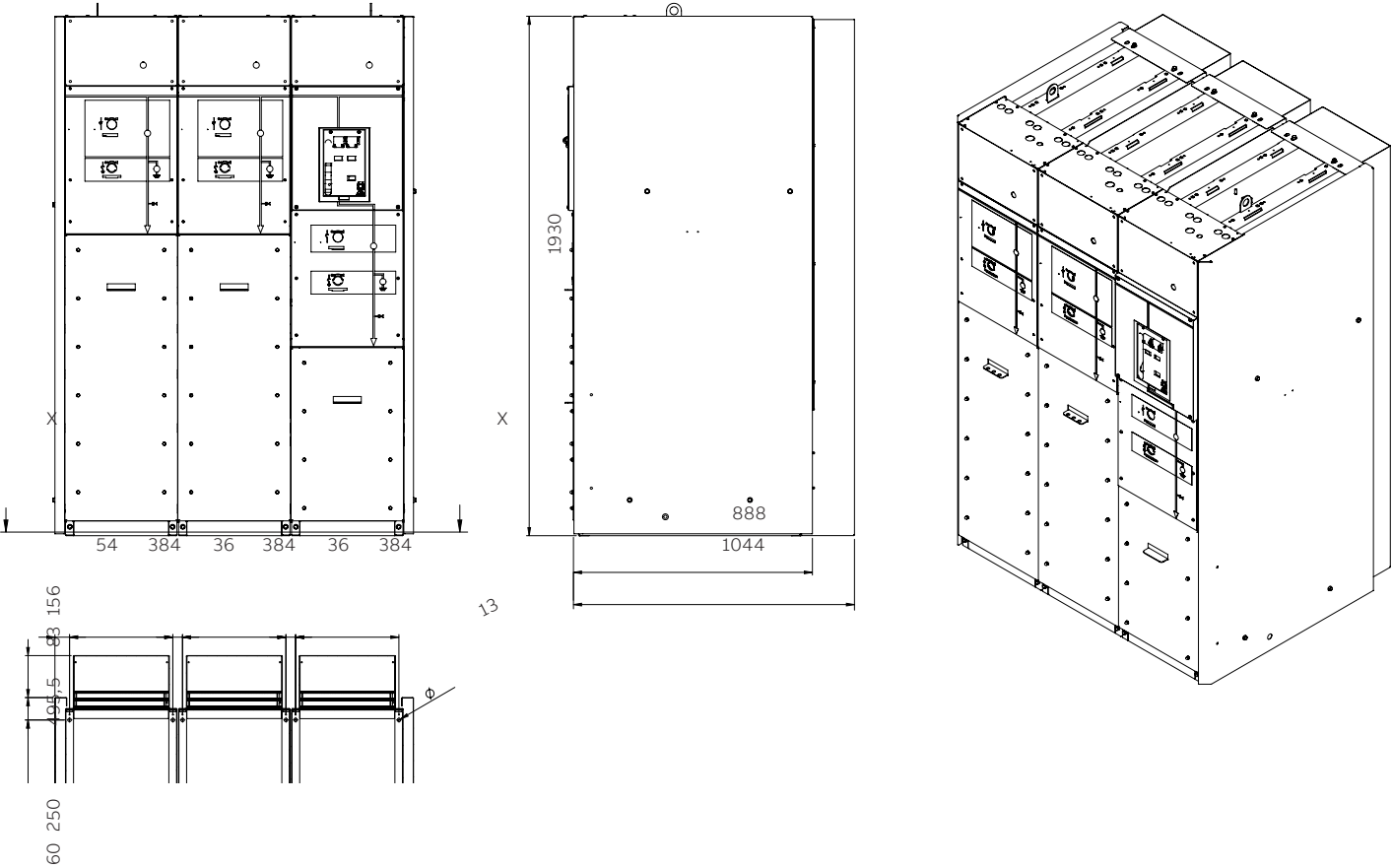
# Dimensions

## Standard switchgear

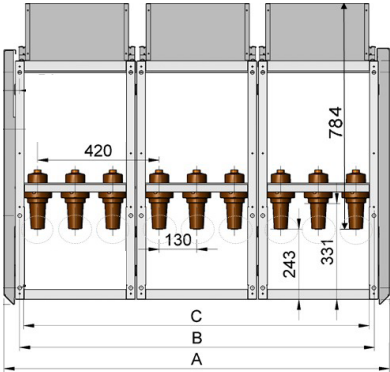


Module	A (mm/inch)	B (mm/inch)	C (mm/inch)
2-way	912/35.9	804/31.6	768/30.2
3-way	1332/52.4	1224/48.2	1188/46.8
4-way	1752/69	1644/64.7	1608/63.3

# Arc proof switchgear

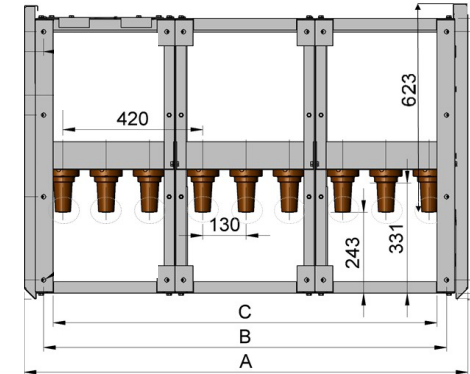
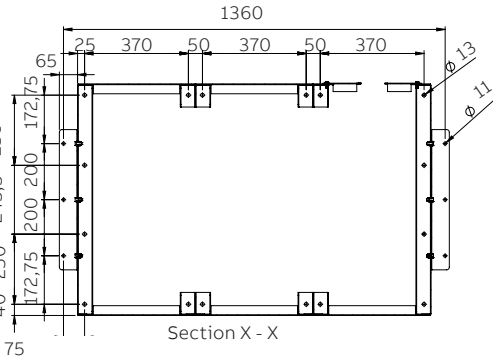
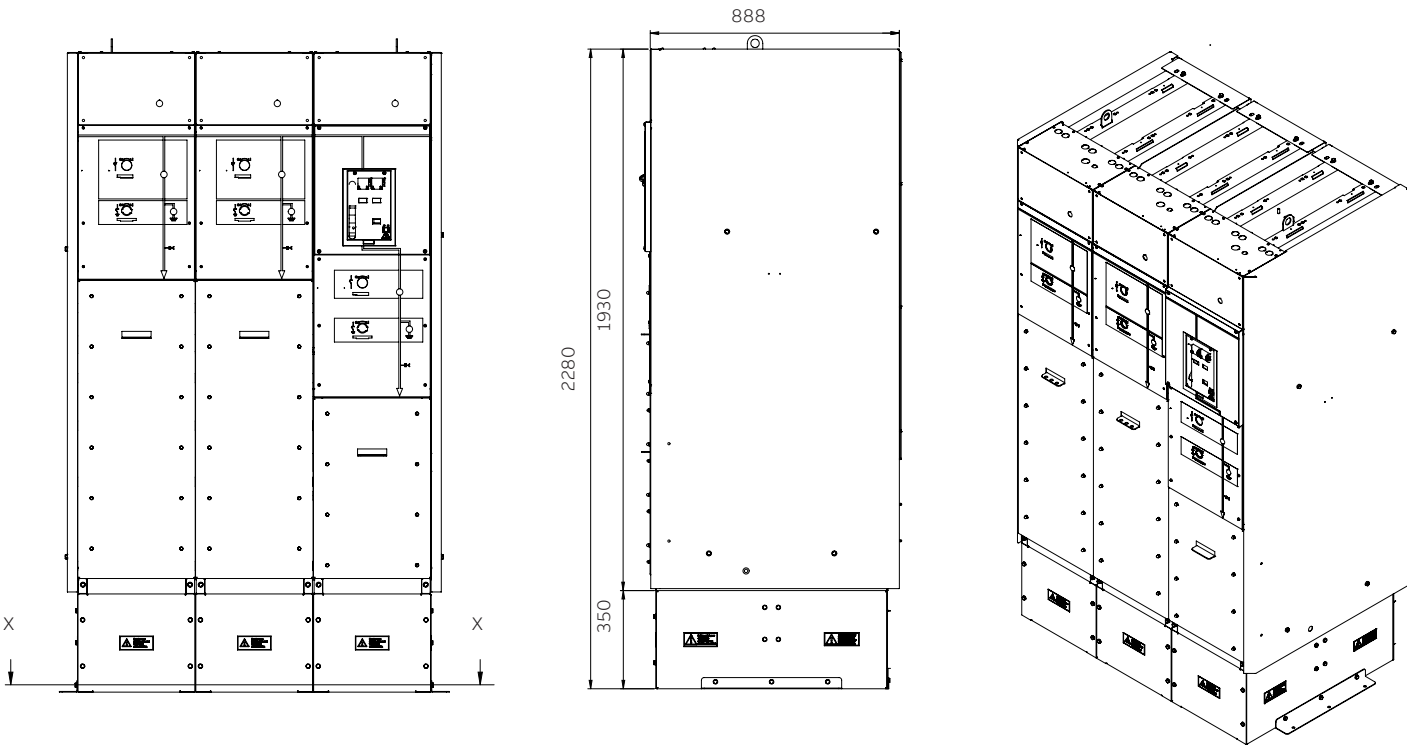


Section X - X



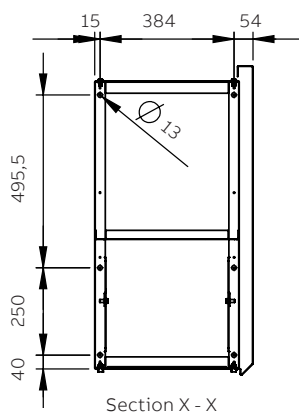
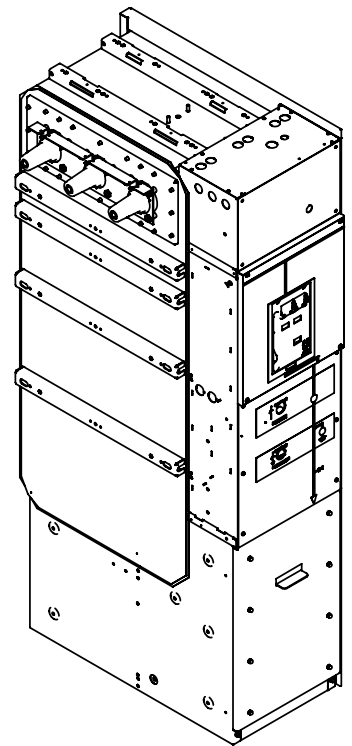
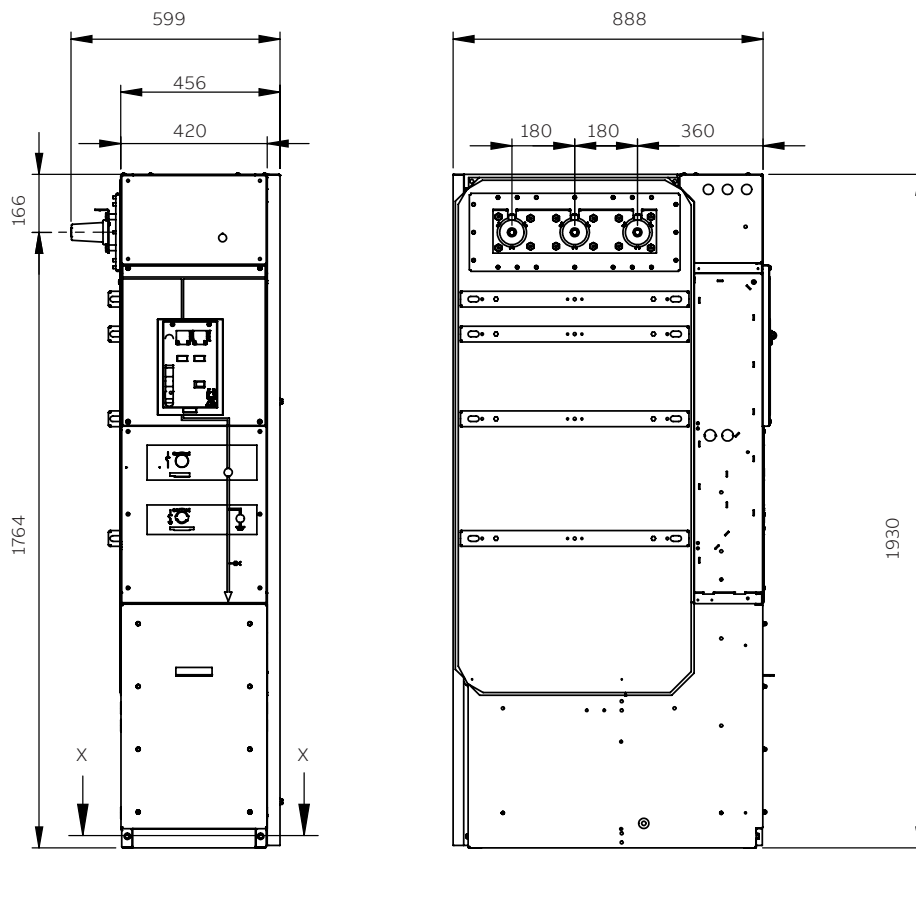
Module	A (mm/inch)	B (mm/inch)	C (mm/inch)
2-way	912/35.9	804/31.6	768/30.2
3-way	1332/52.4	1224/48.2	1188/46.8
4-way	1752/69	1644/64.7	1608/63.3

# Switchgear with baseframe

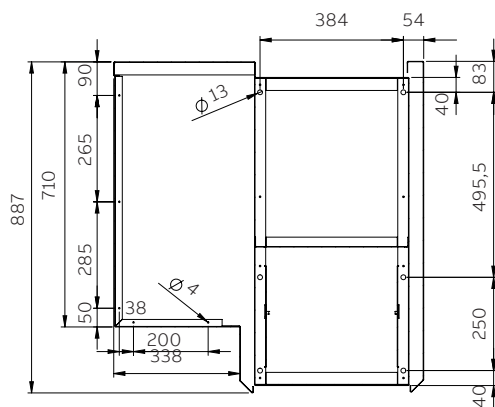
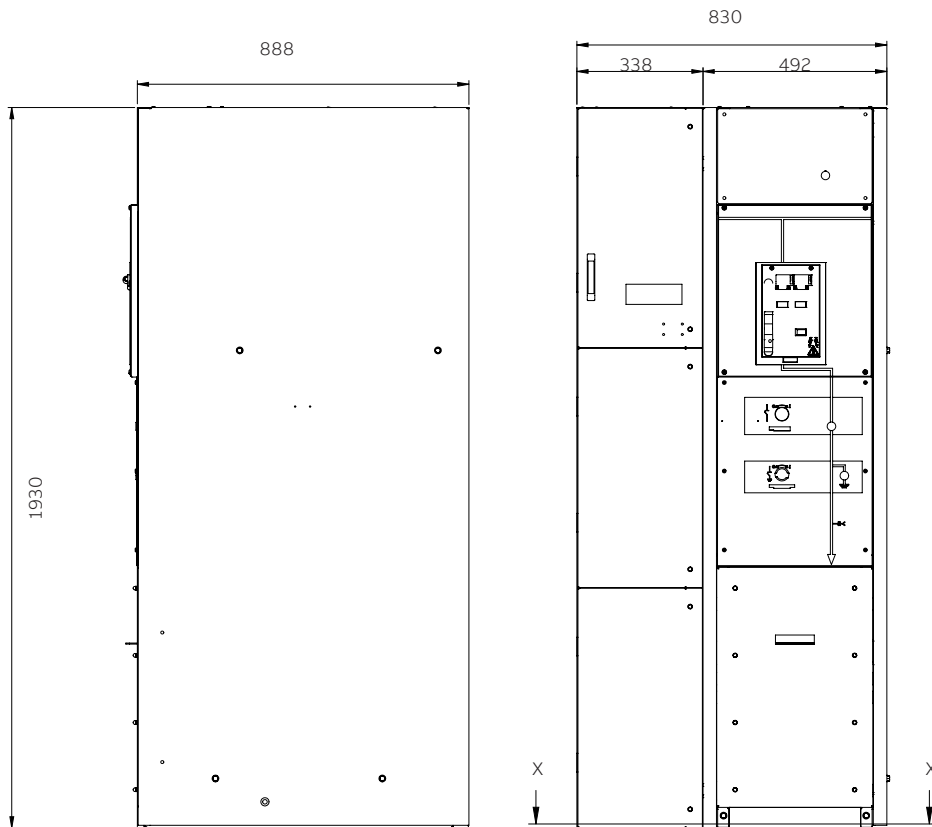


Module	A (mm/inch)	B (mm/inch)	C (mm/inch)
2-way	912/35.9	790/31.1	740/29.1
3-way	1332/52.4	1210/47.6	1160/45.7
4-way	1752/69	1630/64.2	1580/62.2

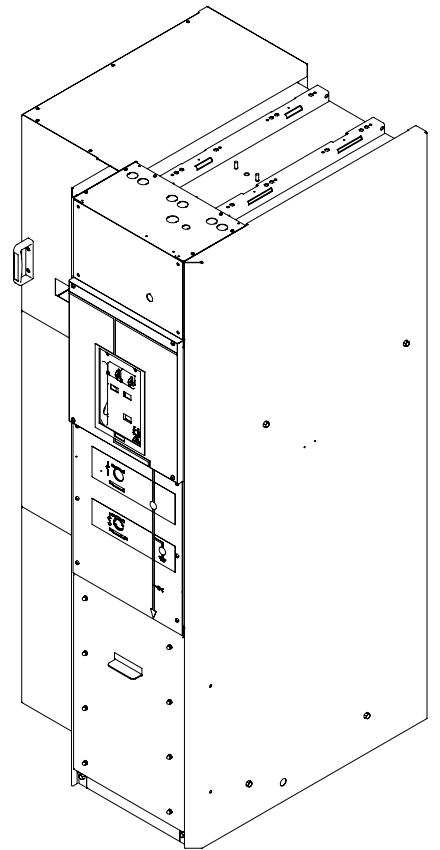
# 1-way with side connection



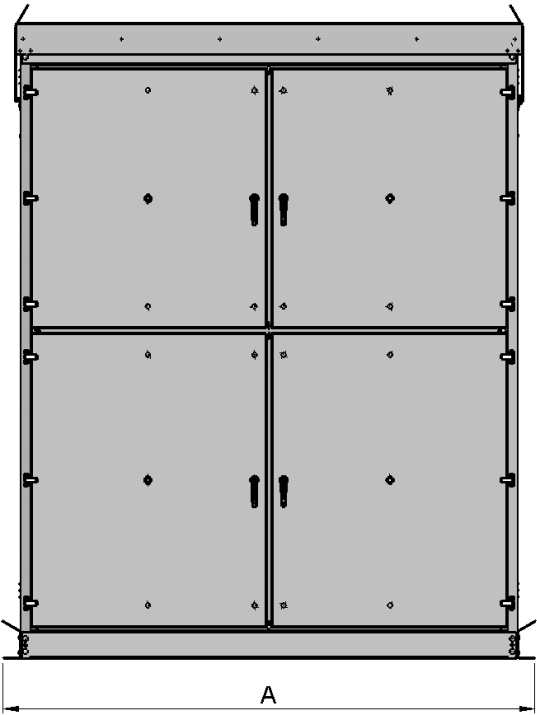
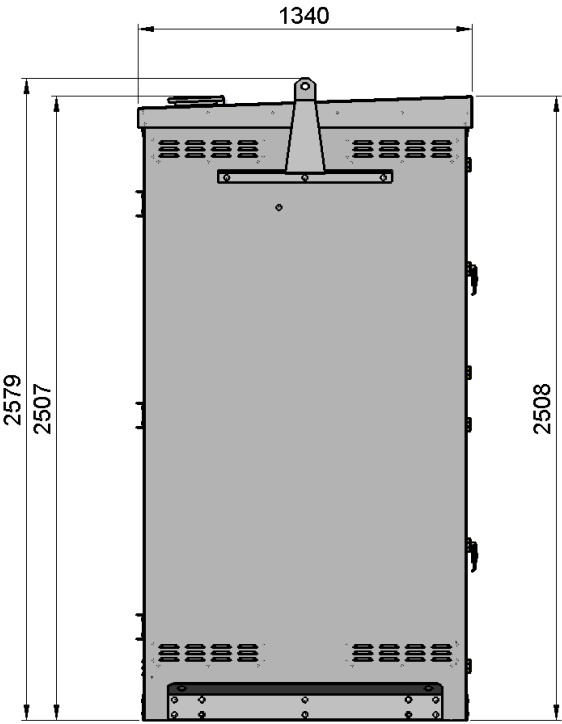
## 1-way with side cover



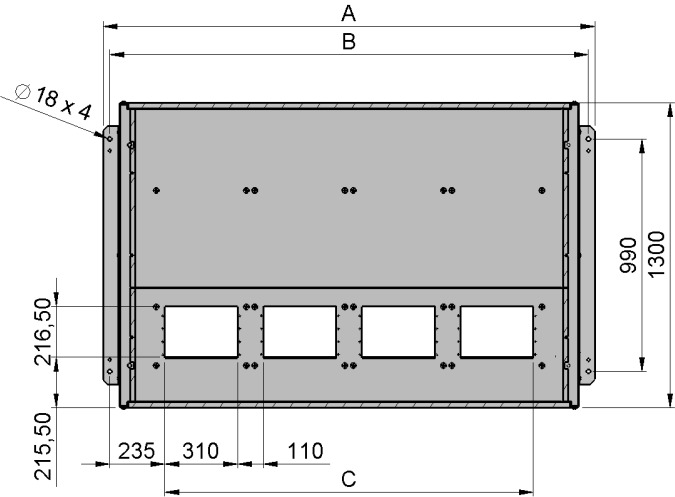
Section X - X



Outdoor enclosure



Footprint outdoor enclosure



Type of unit	A mm	B mm	C mm	Depth with open doors mm
2-way	1256	1200	774	1861
3-way	1676	1620	1150	2274
4-way	2096	2040	1570	2313

# Technical data

## Standards

IEC 62271-1	High-voltage switchgear and controlgear - Part 1: Common specifications
IEC 62271-100	High-voltage switchgear and controlgear - Part 100: High-voltage alternating-current circuit-breakers
IEC 62271-102	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and Grounding switches
IEC 62271-105	High-voltage switchgear and controlgear - Part 105: Alternating current switch-fuse combinations
IEC 62271-200	High-voltage switchgear and controlgear - Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-103	High-voltage switches- Part 1: Switches for rated voltages above 1 kV and less than 52 kV
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEEE C37.20.3	IEEE Standard for metal-enclosed interrupter switchgear (1kV - 38kV)
IEEE C37.54	For indoor Alternating Current High Voltage circuit breakers applied as removable elements in metal-enclosed switchgear - Conformance test procedures
IEEE C37.58	Switchgear - Indoor AC medium-voltage switches for use in metal-enclosed switchgear - Conformance test procedures



## Technical data - SafePlus modules

### Compact switchgear, electrical data (overview does not show rated values applicable for Metering modules)

1	Rated voltage	$U_r$	kV	36	38
2	Rated power frequency withstand voltage	$U_d$	kV	70	80
	- across disconnecter		kV	80	95
3	Rated lightning impulse withstand voltage	$U_p$	kV	170	170
	- across disconnecter		kV	195	210
4	Rated frequency	$f_r$	Hz	60	60
5	Rated normal current (busbars)	$I_r$	A	600	600
6	Rated short-time withstand current	$I_k$	kA	20	25
7	Rated duration of short-circuit	$t_k$	s	3	1
8	Rated peak withstand current	$I_p$	kA	52	65
9	Internal arc classification IAC AFL	$I_a/t_a$	kA/s	20/1	25/1
10	Internal arc classification IAC AFLR	$I_a/t_a$	kA/s	25/1	25/1
11	Loss of service continuity	LSC2-PM (for C-, D-, De- and V-module), LSC2A-PI (for F-module)			

### Making and breaking capacities C-module with switch-disconnector and Grounding switch

12	Rated normal current	$I_r$	A	600	600
13	Rated mainly active load breaking current	$I_{load}$	A	600	600
14	Number of operations for mainly active load breaking	$n$		100	10
15	Rated distribution line closed-loop breaking current	$I_{loop}$	A	600	600
16	Rated cable-charging breaking current	$I_{cc}$	A	-	-
17	Rated line-charging breaking current	$I_{lc}$	A	-	-
18	Rated earth-fault breaking current	$I_{ef1}$	A	-	-
19	Rated cable- and line-charging breaking current under earth-fault conditions	$I_{ef2}$	A	-	-
20	Rated short-circuit making current	$I_{ma}$	kA	52	65
21	Rated mechanical endurance class (Grounding switch)			M0	M0
22	Rated short-circuit making capability class (Grounding switch)			E2	E1
23	Electrical and mechanical classes (switch-disconnector)			M1	M1

### Making and breaking capacities V-module with vacuum circuit-breaker, downstream disconnecter and Grounding switch

	Rated voltage			36	38
24	Rated short-circuit breaking current	$I_{sc}$	kA	20	20
25	DC time constant of the rated short-circuit breaking current	$\tau$	ms	45	45
26	DC component	$p_{cs}$	%	30	-
27	Rated first-pole-to-clear factor	$k_{pp}$		1,5	1,5
28	Rated short-circuit making current (circuit-breaker)		kA	52	65
29	Rated cable-charging breaking current	$I_c$	A	-	-
30	Rated line-charging breaking current	$I_{lc}$	A	-	-
31	Electrical and mechanical classes (circuit-breaker)			E1 <sup>2)</sup> , M1, S1	E1 <sup>2)</sup> , M1, S1
32	Rated out-of-phase breaking current	$I_d$	kA	-	-
33	First-pole-to-clear factor for out-of-phase conditions (system with effectively and non-effectively grounded neutral)			-	-
34	Rated short-circuit making current (Grounding switch)	$I_{ma}$	kA	20	25
35	Rated short-circuit making capability class (Grounding switch)			E2	E1
36	Rated mechanical endurance class (Grounding switch)			M0	M0
37	Rated mechanical endurance class (disconnecter)			M0	M0

### Making and breaking capacities Dc-module

38 Making and breaking capacities not applicable as the D-module has no switching devices. Rated values are listed in lines 1-11.

## General data

<b>General data</b>	
Type of Ring Main Unit	Metal enclosed
Number of phases	3
Whether RMU is type tested	Yes
Pressure test on equipment tank or containers	Until pressure relief device opens
Whether facility is provided with pressure relief device	Yes
Insulating gas	SF <sub>6</sub>
Nominal operating gas pressure	1,4 bar abs. at 20°C
Gas diffusion rate	less than 0,1 % p.a.
Expected operating lifetime	30 years
Whether facilities are provided for gas monitoring	Yes, temperature compensated manometer can be delivered
Material used in tank construction	Stainless steel sheet, 2 mm
Busbars	300 mm <sup>2</sup> Cu
Earth bar (external)	120 mm <sup>2</sup> Cu
Earth bar bolt dimension	M10
<b>Operations</b>	
Means of switch-disconnector operation	Separate handle
Means of fuse-switch-disconnector operation	Separate handle and push-buttons and/or opening and closing trip coils
Means of circuit-breaker operation	Integrated handle and push-buttons and/or opening and closing trip coils
Total opening time of circuit-breaker	approx. 40 - 80 ms
Closing time of circuit-breaker	approx. 50 - 90 ms
Mechanical operations of switch-disconnector	1000 CO (Class M1)
Mechanical operations of Grounding switch	1000 CO
Mechanical operations of circuit-breaker	2000 CO (Class M1)
Principle switch-disconnector	2 position puffer switch
Principle Grounding switch	2 position Grounding switch with downstream Grounding switch in F-modules
Principle circuit-breaker	Vacuum interrupter with axial magnetic field contacts
<b>Switch-disconnector</b>	
Rated making operations on short circuit current (class E3)	5
Rated making operations on short circuit current (class E2)	3
Rated operations mainly active load (class E3)	100
Rated operations mainly active load (class E2)	30
<b>Fuse-links</b>	
Length, D, of fuse-links to be used in fuse canister	537 mm
Contact diameter, ØA, of fuse-links to be used in fuse canister	45 mm
Maximum diameter, ØC, of fuse-links to be used in fuse canister	88 mm
Standard dimensions	According to IEC60282-1 type 1/DIN 43625/ANSI
Maximum fuse-link rated current	63 A

<b>Normal service conditions - indoor according to IEC 62271-1:2017 subclause 4.1.2</b>	
Maximum ambient air temperature	+ 40°C <sup>1)</sup>
Maximum ambient air temperature - average value measured over a period of 24 hours	+ 35°C <sup>1)</sup>
Minimum ambient air temperature ambient air temperature	- 25°C <sup>2)</sup>
Altitude for erection above sea level	...1500 m <sup>3)</sup>
Maximum relative humidity - average value measured over a period of 24 hours	95%
<b>Weight table</b>	
Maximum weights for SafeRing 36	
2-way DeV/DeF	550 kg
3-way CCV/CCF	800 kg
4-way CCCV/CCCF	1050 kg
4-way CCVV/CCFF	1100 kg
3-way CCC	750 kg
4-way CCCC	1000 kg
Maximum weights for SafePlus 36	
1-way (C-, D-, De-module)	250 kg
1-way (F-, V-module)	300 kg
2-, 3- and 4-way	as for SafeRing
M – metering module	600 kg
<b>Degree of protection</b>	
High voltage live parts, SF <sub>6</sub> tank	IP 67
Front covers / operating mechanisms	IP 2X
Cable covers	IP 3X
Fuse canisters	IP 67
<b>Colours</b>	
Front covers	RAL 7035
Side and cable covers	RAL 7035
Switch area	Medium Grey Pantone 429C

<sup>1)</sup> Derating allows for higher maximum temperatures.

<sup>2)</sup> For lower minimum air temperature, please contact ABB.

<sup>3)</sup> For higher altitude, please contact ABB.

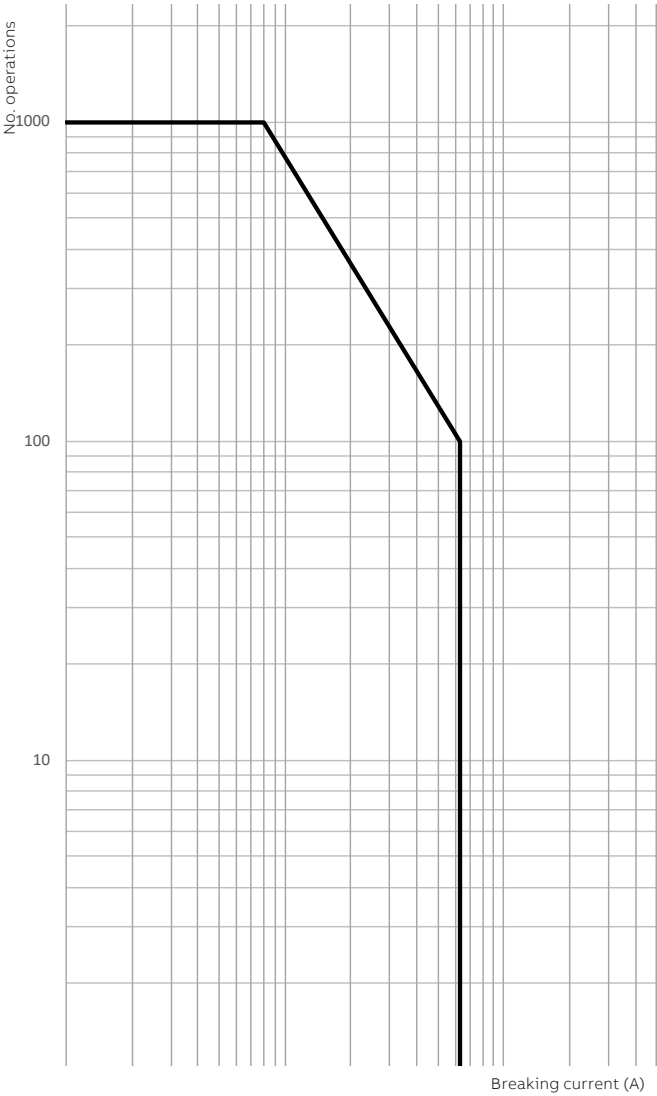
“ABB wishes to highlight that values of dimensions and weights provided herein are preliminary and may change after final design preparation, based on final scope of supply and installation details of the switchgear. As a consequence, provided values of dimensions and weights are NOT to be considered as final but only for standard reference purposes.

ACCORDINGLY, YOU EXPRESSLY ACKNOWLEDGE AND AGREE THAT VALUES OF DIMENSIONS AND WEIGHTS PROVIDED HEREIN ARE NEITHER FINAL NOR BINDING AND THAT THE RESULT OF THEIR USE IS NEITHER FEASIBLE NOR ACCURATE NOR ERROR FREE”.

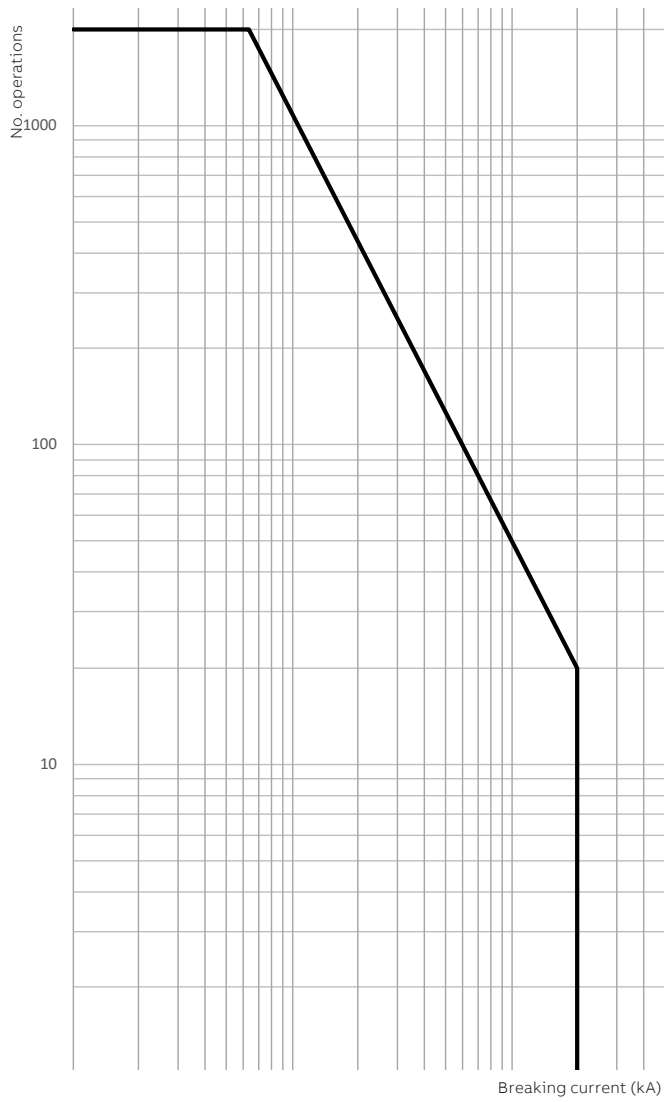
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# Number of operations

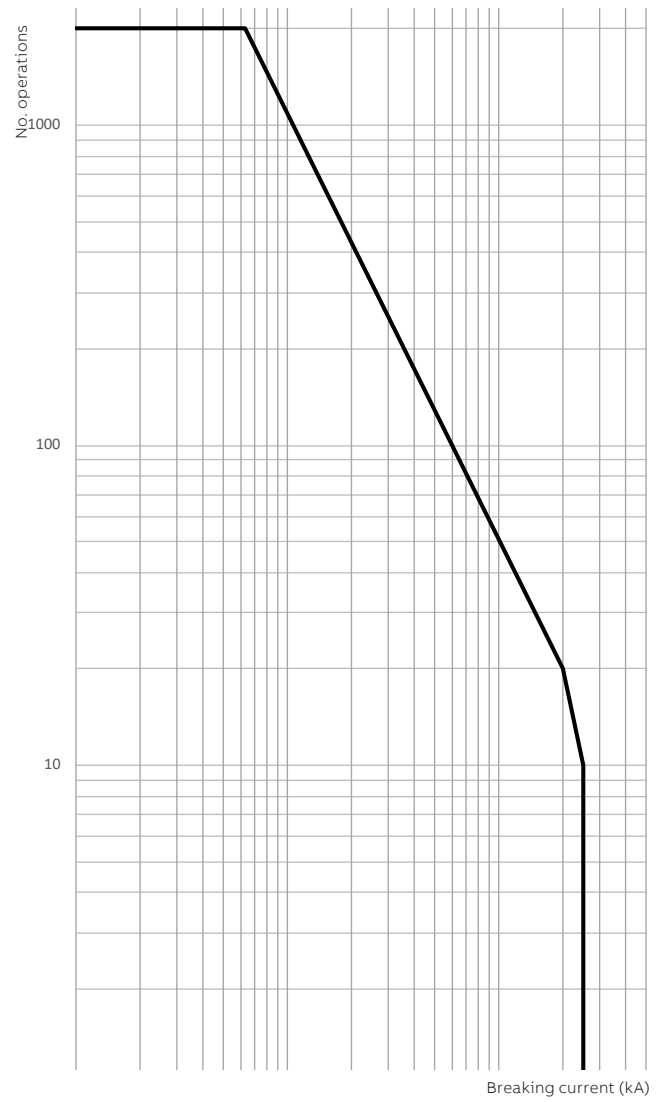
SafePlus C-module 36, 38,5 and 40,5kV



SafePlus 20kA V-module 36, 38,5 and 40,5kV



SafePlus 25kA V-module 36, 38,5 and 40,5kV



# Environmental certification for gas-insulated SafePlus

## Life expectancy of product

The product is developed in compliance with the requirements denoted by IEC 62271-200. The design incorporates a lifespan under indoor service conditions exceeding 30 years. The switchgear is gas-tight with an expected diffusion rate of less than 0.1 % per annum. Referring to the reference-pressure of 1.4 bar, the switchgear will maintain gas-tightness and a gas-pressure better than 1.3 bar at 20°C throughout its designed life span.

## Lifecycle concept for transport, installation, repair, service and disposal at end of life

ABB is committed to the protection of the environment and adheres to ISO 14001 standards. The unit contains no substances listed on the hazardous substances list. The unit contains SF<sub>6</sub> with 0,4 bar overpressure in a maintenance free and sealed unit. The unit is a sealed pressure system and restrictions for air transport exist.

Units damaged during transport must be returned to the manufacturer for inspection and possible repair.

SF<sub>6</sub> is a fluorinated greenhouse gas covered by the Kyoto Protocol and care must be taken not to cause emission of SF<sub>6</sub>. At end-of-life the greenhouse gas must be recovered. It is ABB's obligation to facilitate end-of-life recycling for our products. In the EU and EEA, the F-Gas Regulation must be followed. ABB's recycling service is according to IEC 61634 edition 1995 section 6: «End of life of SF<sub>6</sub> filled equipment» and in particular 6.5.2.a: «Low decomposition»: «No special action is required; non-recoverable parts can be disposed of normally according to local regulations.»

ABB AS, Electrification Division's manufacturing site in Skien is equipped to recover SF<sub>6</sub> gas from discarded switchgears.



Recycling capability					
Raw Material	Weight (kg)	% of total weight	Recycle	Environmental effects & recycle/reuse processes	
Iron	139,9	31,4	Yes	Separate, utilise in favour of new source (ore)	
Stainless steel	130,8	29,3	Yes	Separate, utilise in favour of new source (ore)	
Copper	71,9	16,1	Yes	Separate, utilise in favour of new source (ore)	
Brass	3,0	0,7	Yes	Separate, utilise in favour of new source (ore)	
Aluminium	1,0	0,2	Yes	Separate, utilise in favour of new source (ore)	
Zinc	5,1	1,1	Yes	Separate, utilise in favour of new source (ore)	
Silver	0,075	0,017	Yes	Electrolysis, utilise in favour of new source	
PBT	2,3	0,5	Yes	Make granulate, re-use or apply as energy	
PA6-6	5,3	1,2	Yes		
PC	0,8	0,2	Yes		
Other thermoplastic	0,1	0,0	Yes		
Packing foil	0,3	0,1	Yes	High-grade energy additive in refuse incineration	
SF <sub>6</sub> gas	7,14	1,6	Yes	ABB AS in Skien reclaims used SF <sub>6</sub> gas	
Dielectric oil	0,3	0,1	Yes	Collect / reclaim / regenerate	
Wooden pallet	27,8	6,2	Yes	Re-use	
<b>Total recycleables</b>	<b>395,8</b>	<b>88,8</b>			
Rubber	1,9	0,4	No	Incinerate energy in rubber	
Epoxy compounds	46,5	10,4	No	Contains 60 % quartz sand, incinerate energy in epoxy	
Unspecified	1,5	0,3	No	Stickers, film foils, powder coating, lubricates	
<b>Total non-recycleables</b>	<b>49,9</b>	<b>11,2</b>			
<b>Total weight *)</b>	<b>445,7</b>	<b>100 %</b>			

\*) All figures are collected from CCV 3-way unit.







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**ABB Electrification Norway AS**

Distribution Solutions  
P.O.Box 108, Sentrum  
N-3701 Skien  
Norway  
Phone: +47 35 58 20 00

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