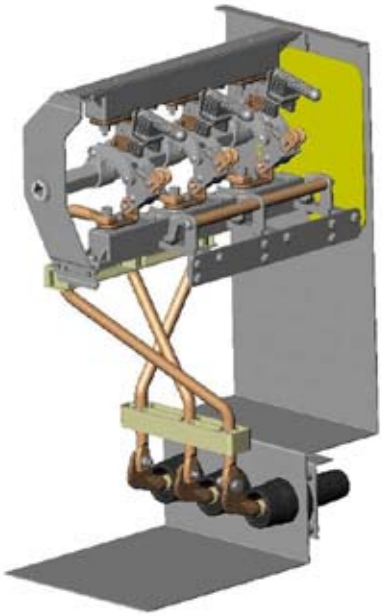
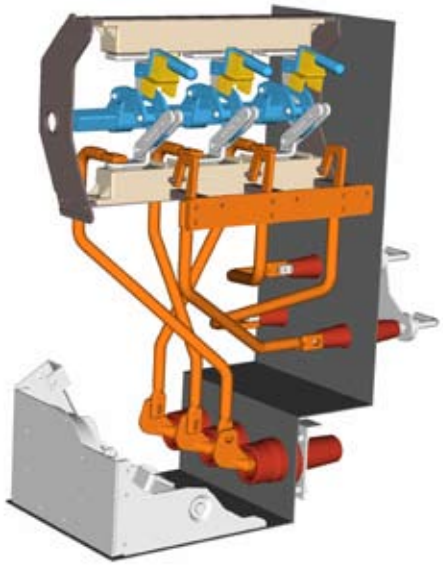
# 5.2 Cable switch module



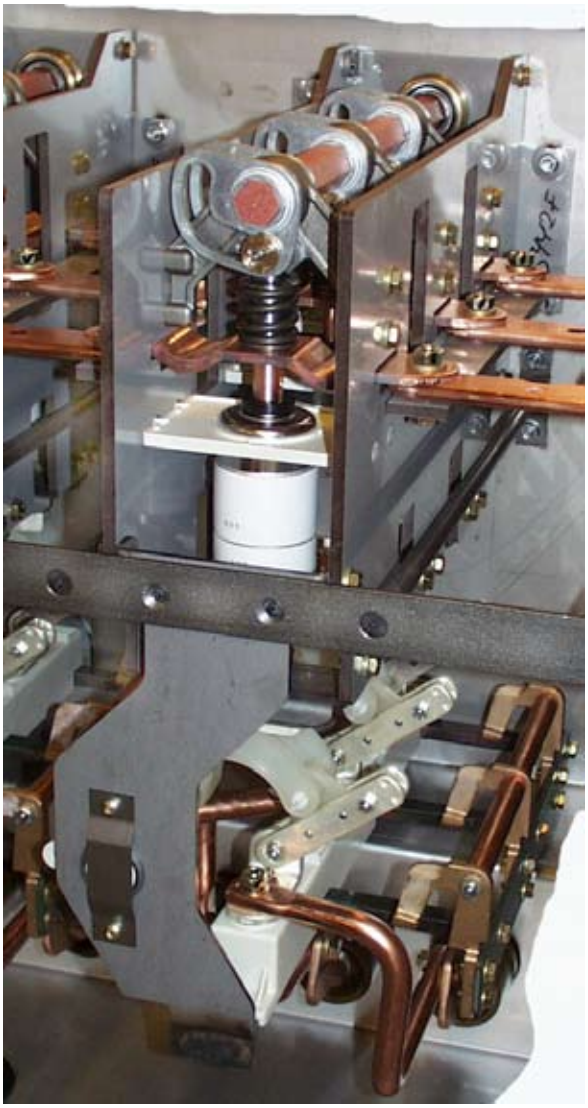
The cable switch (C-Module) is a three position switch-disconnector and earthing switch using $SF_6$ gas as an arc quenching medium.

The switch position is close - open - earthed. In the open position the switch satisfies the disconnector requirements.



C-module equipped with arc suppressor (optional equipment) and cable test bushings  (optional equipment).

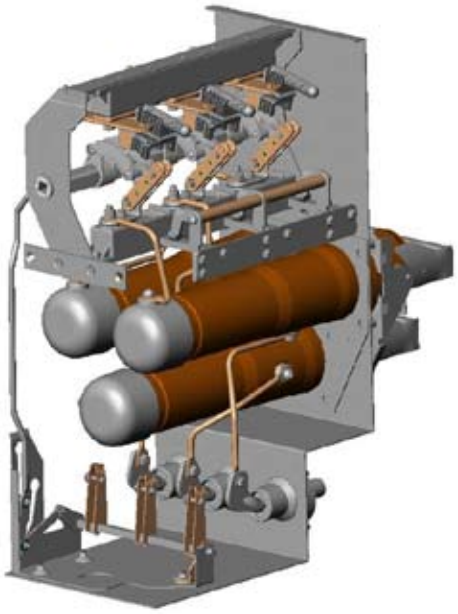
# 5.3 Vacuum circuit-breaker module



The vacuum circuit-breaker (V-module) has vacuum bottles as interrupters of the current.
In series with the circuit-breaker main circuit is connected a three-position disconnector / earthing switch.

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

# 5.4 Switch-fuse module

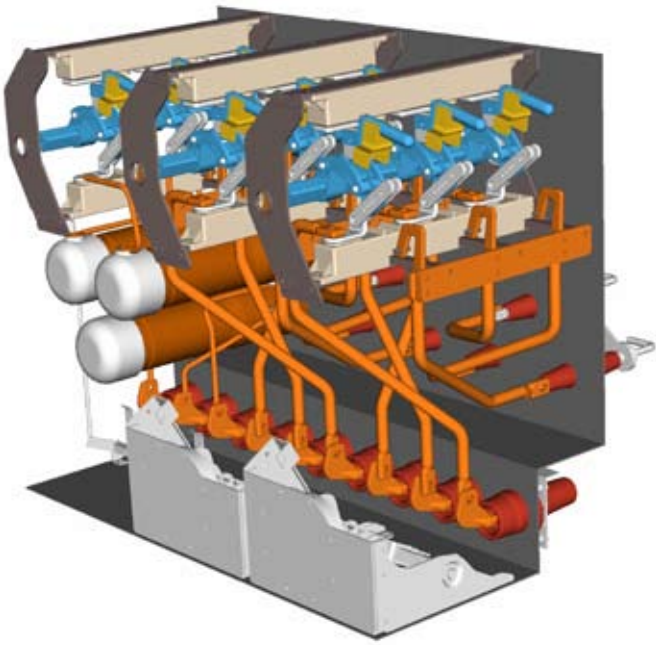


The switch-fuse (F-module) has a three position switch disconnector and earthing switch identical to the cable switch (C-module).

By means of the fuse tripping device it operates as a switch-fuse combination. There is a double earthing switch which in earthed position connects earth to both sides of the fuse-links simultaneously.

Both earthing switches are operated in one operation. Theswitch-fuse and earthing switch is mechanically interlocked to prevent hazardous access to the fuse-links.

The lower cover which gives access to the fuse-links is also mechanically interlocked with the earthing switch.



3-way unit consisting of two C-modules and one F-module. Both C-modules are equipped with arc suppressor (optional equipment) and cable test bushings (optional equipment)

# 5.5 Cable bushings

Interface C bushing (400 series bolted type) with terminal for capacitive voltage indication

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

ABB has produced bushings for $SF_6$ switchgear since 1985. Up to date production facilities and highly advanced robots and test equipment ensure the high quality required for each single device.

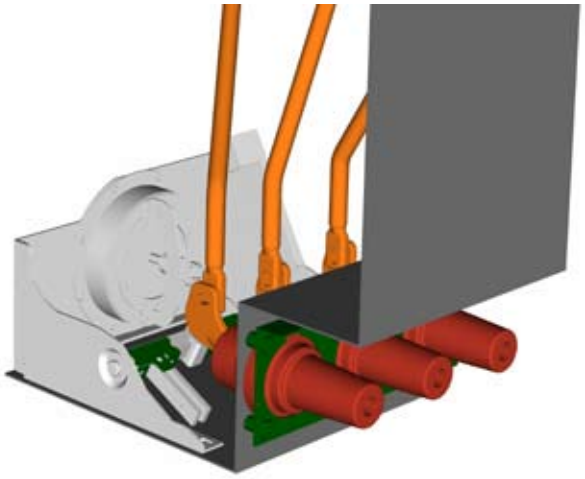
A very high number of units have been installed worldwide in distribution networks, power stations and industrial complexes.

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

There are 3 different cable bushings:
- Interface A (200 series with plug-in contact, In=200A)
- Interface C (400 series with M16 bolted contact, In=630A)
- Interface C (400 series with M16 bolted contact) and integrated voltage and current sensors (In=630A)

For more details, please see chapter 6.9

# 5.6 Arc suppressor



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 $SF_6$ tank of the SafeRing and SafePlus switchgear.

If an arc fault should occur inside the $SF_6$ tank the pressure-detector of the arc suppressor will automatically trip the short circuit device of the incoming feeder(s) within milliseconds, thereby transforming the arc fault into a bolted fault.
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 thereforeprevented, giving optimum reliability.

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

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

A signalling device (1NO) will indicate local or remote the tripping of one or more arc suppressors.

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 which has to be done after an internal arc fault when the release flap has opened, are reduced to zero.

# 5.7 Completely sealed system

SafeRing and SafePlus use $SF_6$–gas (Sulphur hexafluoride) as insulation and quenching medium.
The $SF_6$ is contained in a welded stainless steel tank, which is hermitically sealed.

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

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

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

All $SF_6$-tanks have to pass a leakage test, before gas filling. Leakage test and gas filling are done inside a vacuum chamber. The first step in the leakage test is to evacuate all air inside both $SF_6$-tank and vacuum chamber simultaneously. Then the $SF_6$-tank is filled with Helium.

Due to the characteristics of Helium this test will detect absolutely all possible leakages. If the $SF_6$-tank passes this test, the Helium will be evacuated and replaced by $SF_6$.

The $SF_6$-tank has a degree of protection of IP67, and can be immersed into water and still maintain all high voltage funtions in a satisfactory way.

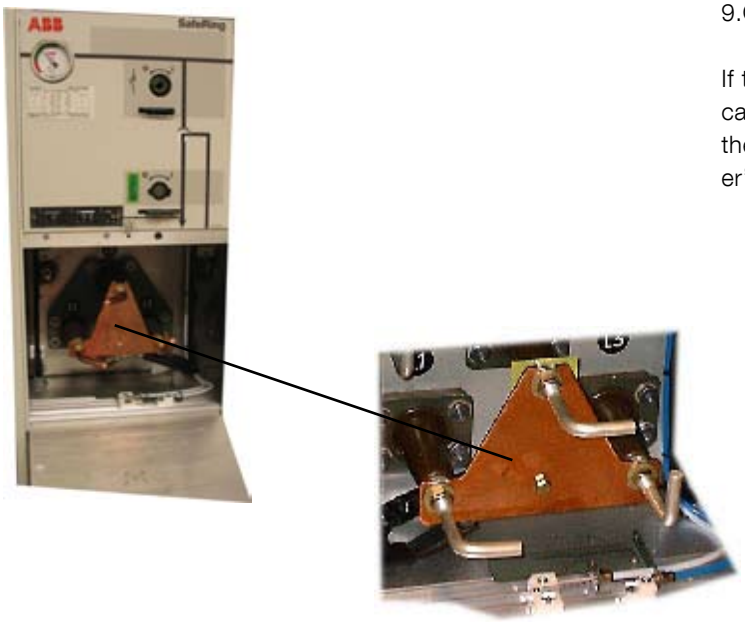
# 5.8 Cable test bushings


As an option, both C and De modules can be equipped with cable test bushings situated behind the lower front cover. This cover can be interlocked against the earthing switch to avoid access to the cable test compartment before earthing switch is in closed position.

When these bushings are mounted, cable insulation test can easily be done according to the following procedure:

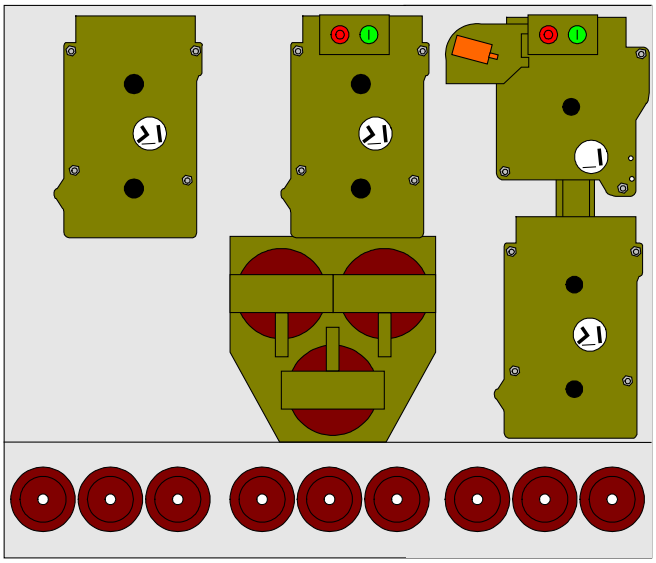
Principle sketch for testing:

1. Close the earthing switch after having checked the voltage indicators
2. Open compartment cover
3. Install the injection device onto the access terminals
4. Open the removable earthing bridge
5. Perform cable testing
6. Re-install the earthing bridge
7. Remove the injection device
8. Close compartment cover
9. Open the earthing switch




If the switchgear is not equipped with cable test bushings, cable testing is possible directly at the cable connectors if they are designed for this purpose, please follow the supplier's instruction.

# 5.9 Mechanisms and interlocks



Mechanisms front view.
$SF_6$ tank with operating mechanisms

All operating mechanisms are situated outside the $SF_6$-tank behind the front covers with degree of protection of IP2X.

This gives the opportunity of easy access to all operating mechanisms if retrofit or service should be required. The speed of operation of these mechanisms is independent of the operator.

To prevent access to cable compartment before earthing switch is in closed position, all mechanisms can as an option be supplied with mechanical interlocks which make it impossible to remove the cable compartment covers.
It will then also be impossible to operate load break / disconnector switch to open position before cable compartment cover is mounted properly.

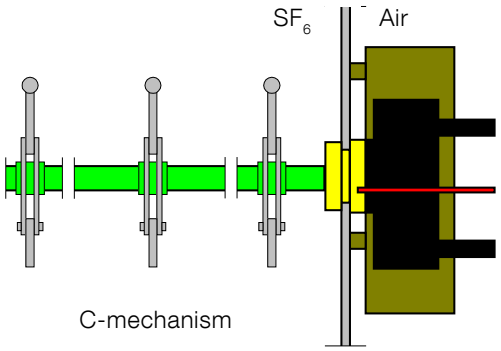
Each mechanism is equipped with a padlocking device. When adding a padlock to this device, the access to operate the mechanism will be impossible. This device has three holes with diameter 9 millimeter.

All operating mechanisms are equipped with position indicators for all switches. In order to achieve true indication, indicators are directly connected to the operating shafts of the switches inside the $SF_6$-tank, please see shafts shown with red colour on next page.

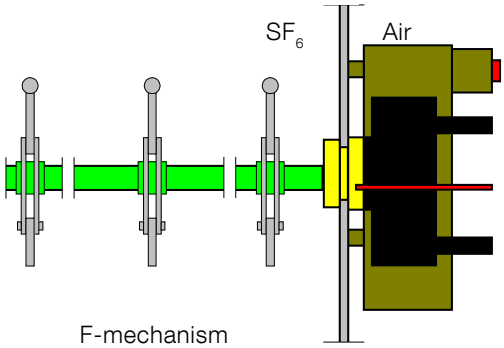
Operating handle has an anti-reflex system which prevents an immediate re-operation of the switch.

All steel parts have been electroplated with zinc and then olive chromated.

# 5.9 Mechanisms and interlocks




C-mechanism




F-mechanism

### Cable switch module and busbar sectionalizer with load break switch (C-mechanism)

The mechanism (3PKE) has two operating shafts; the upper one for the load break switch and the lower one for the earthing switch.
Both shafts are single spring operated and operate one common shaft which is directly connected to the three position switch (CFE-C) inside the $SF_6$-tank. When both load break switch and earthing switch are in open position, the switch satisfies the specifications of disconnector.

Due to the mechanical interlock between the upper and lower opera-ting shaft, it is impossible to operate the load break switch when earthing switch is in earthed position or operate the earthing switch when the load break switch is in closed position.

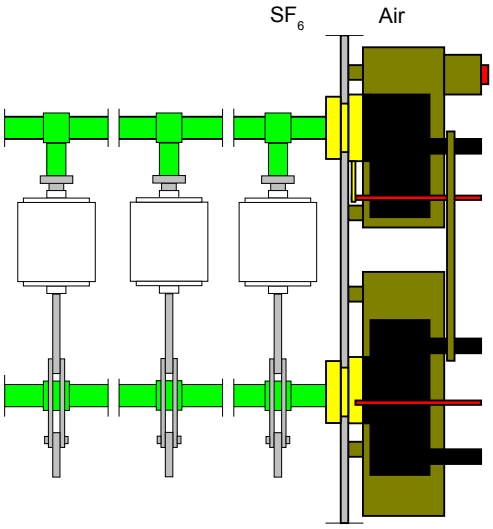
### Switch-fuse module (F-mechanism)

The mechanism (3PAE) has two operating shafts; the upper one for the load break switch and the lower one for the earthing switch.
The upper one operates two springs; one for closing and one for opening. Both springs are charged in one operation. By means of mechanical push buttons it is then possible to close and open the load break switch.
The opening spring is always charged when the load break switch is in closed position and will be ready to open the load break switch immediately if one of the HV-fuse-links blow.
The blown fuse-link(s) has/have to be replaced before the operator will be able to close the load break switch again.
According to IEC 60282-1, all three fuse links should be replaced, even if only one or two have operated.

The lower shaft is single spring operated. Both operating shafts operate one common shaft which is directly connected to the three position switch (CFE-F) inside the $SF_6$-tank.

Due to the mechanical interlock between the upper and lower operating shaft, it is impossible to operate the load break switch when earthing switch is in earthed position or operate the earthing switch when the load break switch is in closed position.
It will also be impossible to get access to the fuse compartment before earthing switch is in closed position.

# 5.9 Mechanisms and interlocks




## Vacuum circuit-breaker and busbar sectionalizer with circuit-breaker (V-mechanism)

These two modules have two mechanisms; the upper one (2PA) with one operating shaft is for circuit-breaker and the lower one (3PKE) with two operating shafts is for disconnector and earthing switch.

The upper mechanism has two operating springs; one for closing and one for opening.

Both springs are charged in one operation. By means of mechanical push buttons it is then 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.

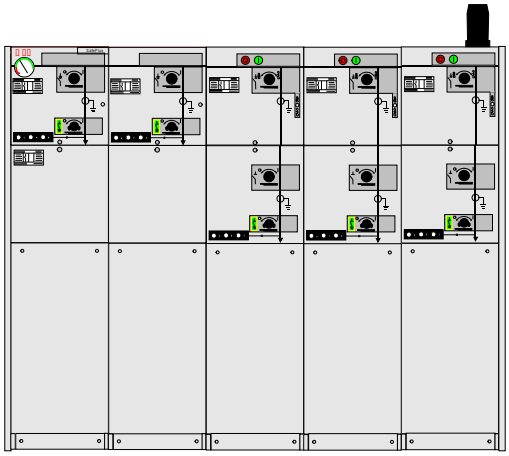
However a quick reclosing is not possible. If the mechanism is equipped with a motor operation a reclosing will take approx. 10 seconds.

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

There is a mechanical interlock between these two mechanisms which prevents operating of the disconnector and earthing switch when the circuit-breaker is in closed position.

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

# 5.10 External busbars on topa



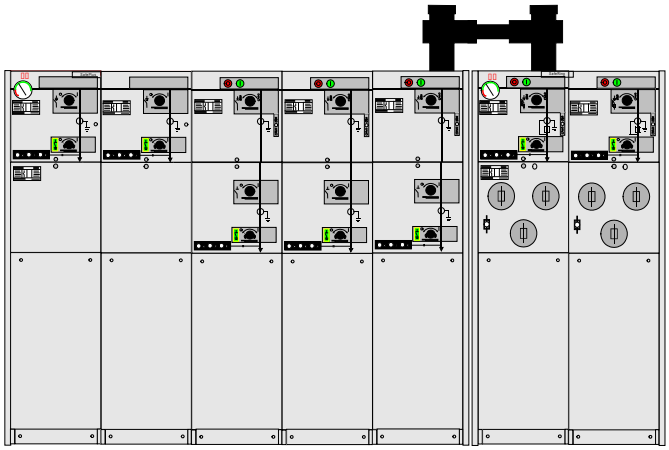
SafePlus prepared for future extension on right hand side

On the top of all SafeRing and SafePlus switchgear it is possible as an option to have bushings for connection of external busbars on the left and / or right side.

For a SafePlus switchgear consisting of only one module, only one set of bushings on the top is used.

When bushings are mounted on the top, you will have these possibilities:

1. When adding a dead end receptacle to each of these bushings, SafeRing/SafePlus will be prepared for future busbar extension.



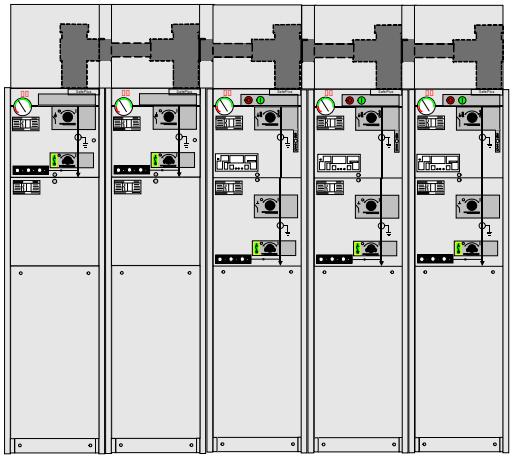
SafePlus consisting of two sections connected to each other by means of external busbar kit

2. With an external busbar kit, it is possible to connect two or more sections.

Normally, Since a 5-ways switchgear is the maximum size within one common $SF_6$-tank, the busbar kit allows a configuration with more than 5 modules.

Actually, the maximum size within one common $SF_6$-tank can content6 modules in some definite configuration, like CCCCCC.

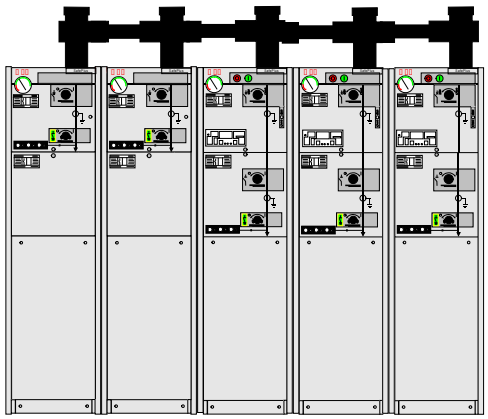
The installation of the external busbars has to de doneon site, see separate manual for installation instructions, 1VDD006006 GB.



SafePlus with external busbar cover

The complete extension kit and the dead end receptacles are fully screened, earthed and insualted with EPDM rubber. This makes a safe and reliable switchgear extension. In addition protection covers are available as an option.

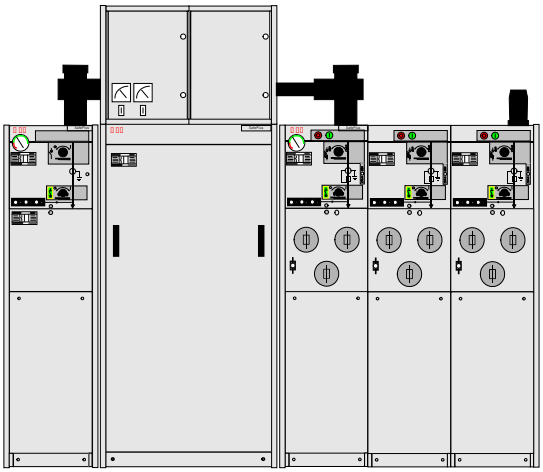
# 5.10 External busbars on topa



SafePlus with a fully modular design

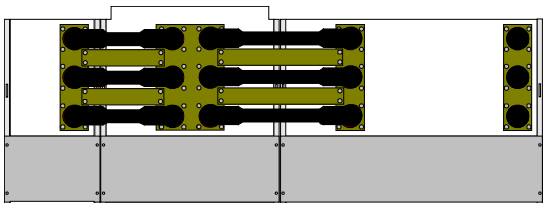
SafePlus switchgear can also be configured fully modular. This gives1250 A busbar rating.

The busbars between the modules and the end adaptersused on the left and right side are identical to the parts used in the previousexample. For the three modules in the middle a special cross adapteris used.

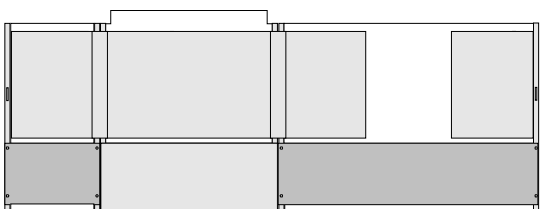


SafePlus with one incomer (C- module), one Metering moduleM-module) and three fused T-offs (F-modules), which are preparedfor future extension.

The length of the external busbars are dependant of the type ofmodules to be connected.

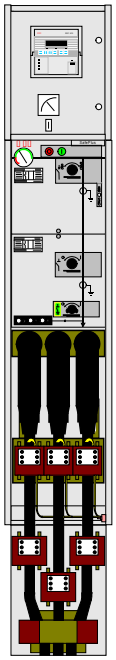


Top view

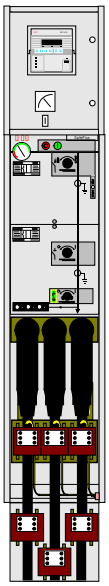


Top view with busbar cover mounted

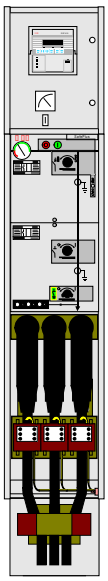
# 6. Accessories
# 6.1 Base frame



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



Base frame 290 mm with an extra set of current transformers



Base frame 290 mm with earth fault transformer

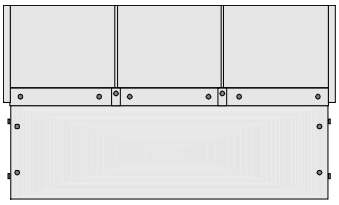
When SafeRing or SafePlus are placed directly on a floor, the height from the floor to the centre of the cable bushings is 595 millimeter.
If there is no cable trench, this height might not be sufficient for proper installation of cables. It is then possible to install the switchgear on an additional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

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

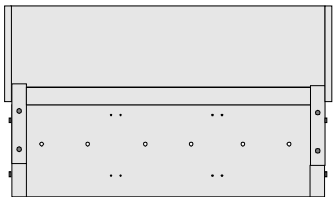
Inside the standard cable compartment for the vacuum circuit-breaker it will be enough space for three current transformers for protection relay.

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

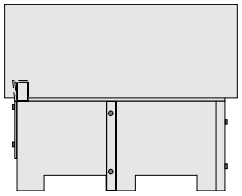
The base frame has openings for cable entrance from the bottom and from both sides. It is delivered as a kit and has to be assembled on site.



Front view

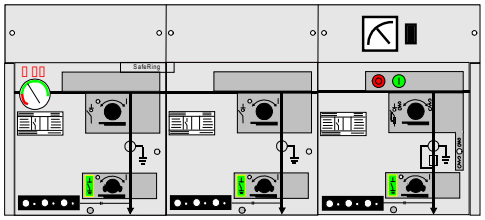


Rear view

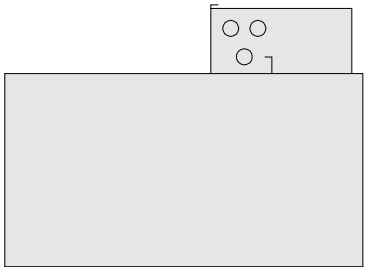


Side view

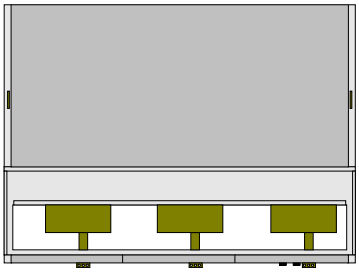
# 6.2 Low voltage compartment



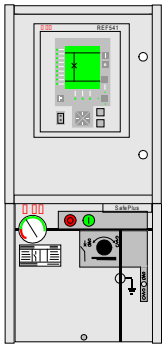
Top entry box with A-meter and selector switch



Side view



Top entry box seen from above when front / top cover has been removed



Low voltage compartment with REF 610 protection relay

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

However, an additional top entry box can be mounted on the top of all SafeRing and SafePlus switchgear. Since the top entry box is fixed to the side covers of the $SF_6$ tank, the total width of the switchgear must be covered.

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

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

Additionally all SafePlus switchgear can be supplied with low voltage compartment.
This compartment may be equipped with protection relays, meters, position switches, terminal blocks etc.

The compartment is fixed to the side covers of the $SF_6$ tank and must cover the total width of the switchgear.
However, each module has a separate hinged door, but there are no partition walls between the modules.

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

# 6.3 Motor operation

Closing and opening operations of load-break switches and charging of the springs of the mechanisms for the circuit-breaker and the switchfusecombination may be performed with a motor operation. Disconnector in the V-module and all earthing switches do not have this possibility.

All motors operate on DC voltage. If control voltage is either 110 or 220 VAC, a rectifier is integrated in the control unit. Operating cycle for motor operation is CO - 3 min (i.e. it may be operated with a frequency of up to one close and one open operation everythird minute). Motors and coils can easily be mounted to the mechanisms after delivery (retrofit).

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

Characteristics of motor operation for C-module

| Rated voltage (V) | Power consumption (W) or (VA) | Operation times | | Peak start current (A) | Fuse |
|---|---|---|---|---|---|
| | | Closing time(s) | Opening time(s) | | |
| 24 | 9zzzz0 | 6 - 9 | 6 - 9 | 14 | F 6,3 A |
| 48 | 150 | 4 - 7 | 4 - 7 | 13 | F 4 A |
| 60 | 90 | 6 - 9 | 6 - 9 | 7 | F 4 A |
| 110 | 90 | 6 - 9 | 6 - 9 | 3 | F 2 A |
| 220 | 90 | 6 - 9 | 6 - 9 | 1,7 | F 1 A |

Characteristics of motor operation for F-module

| Rated voltage (V) | Power consumption (W) or (VA) | Operation times | | Peak start current (A) | Fuse |
|---|---|---|---|---|---|
| | | Charge / Closing time(s) | Opening time (ms) | | |
| 24 | 160 | 9-14 | 40-60 | 14 | F 6,3 A |
| 48 | 200 | 5-9 | 40-60 | 13 | F 4 A |
| 60 | 140 | 8-13 | 40-60 | 7 | F 4 A |
| 110 | 140 | 8-13 | 40-60 | 3 | F 2 A |
| 220 | 140 | 8-13 | 40-60 | 1,7 | F 1 A |

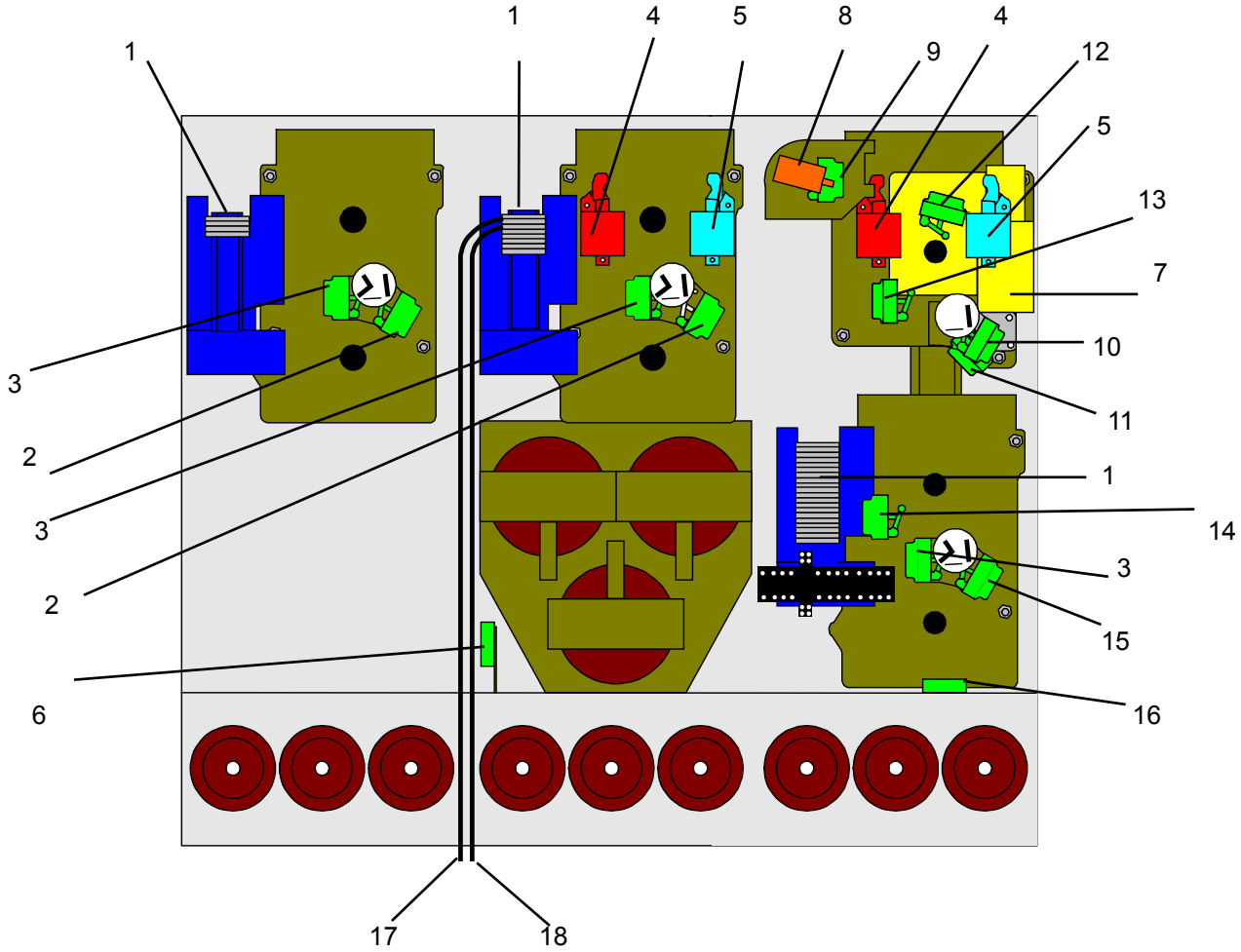
Characteristics of motor operation for V-module

| Rated voltage (V) | Power consumption (W) or (VA) | Operation times | | Peak start current (A) | Fuse |
|---|---|---|---|---|---|
| | | Charge / Closing time(s) | Opening time (ms) | | |
| 24 | 180 | 10-17 | 40-60 | 14 | F 6,3 A |
| 48 | 220 | 5-9 | 40-60 | 13 | F 4 A |
| 60 | 150 | 8-13 | 40-60 | 7 | F 4 A |
| 110 | 170 | 8-13 | 40-60 | 3 | F 2 A |
| 220 | 150 | 8-13 | 40-60 | 1,7 | F 1 A |

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

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

# 6.3 Motor operation

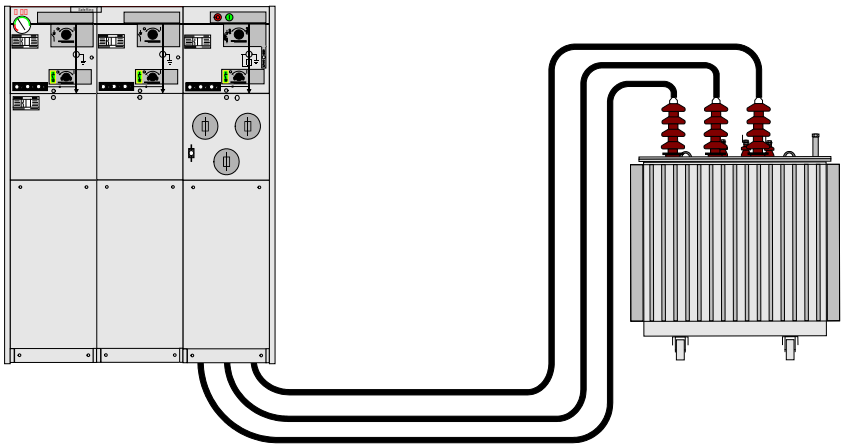



SafePlus CFV equipped with various auxiliary switches, coils and motor operation

1.Terminal blocks/control unit motor operation
2.Auxiliary switch S7, load break switch
3.Auxiliary switch S10, earthing switch
4.Opening coil Y1
5.Closing coil Y2
6.Auxiliary switch S9, fuse blown
7.Motor operation
8.Relay trip coil Y4 / Y5 /Y6*
9.Auxiliary switch S9, circuit-breaker tripped signal
10.Auxiliary switch S5, circuit-breaker
11.Auxiliary switch S6, mechanism latched
12.Auxiliary switch S8, spring charged
13.Auxiliary switch S14, operating handle, vacuum circuit-breaker
14.Auxiliary switch S15, operating handle, disconnector
15.Auxiliary switch S7, disconnector
16.Auxiliary switch S13, cable compartment cover
17.Auxiliary switch S20, arc suppressor
18.Auxiliary switch S19, $SF_6$ gas pressure

* Depending of the type of protection relay, the V module can only be delivered with one of the relay trip coils.

# 6.4 Transformer protection



SafeRing and SafePlus offer a choice between a switch-fuse combination or circuit-breaker in combination with relay for transformer protection.
The switch-fuse combination offers optimal protection against shortcircuitcurrents, while the circuit-breaker with relay offers better protection against low over-currents. Circuit-breaker with relay isalways recommended for higher rated transformers.

Both SafeRing and SafePlus V-module is delivered with a 630A rated current.

Both for SafeRing and SafePlus the relay is a self powered relay thatutilizes the energy from the CTs under a fault situation, for energizing the trip coil.
The self powered relay can also be used for cable protection andmore details on the different relays can be found in chapter 6.5.
Transformer protection with self powered relay.
Recommended types:
- ABB relay type REJ 603
- SACE PR512
- SEG WIC 1
- Circutor MPRB-06

Important features V-module:
- Relay behind cover. No need for additional low voltage box for theself powered relays used for transformer protection.

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

## SafeRing and SafePlus - Fuse-link selection

By selection of fuse-links for the protection of a transformer, it isimportant that requirements in IEC 62271-105 and in IEC 60787 arefulfilled. In particular Annex A in IEC 62271-105 gives a good exampleof the coordination of fuse-links, switch and transformer.

Correct selection of fuse-links for the protection of the transformer will give:
- Optimal protection of the transformer.
- No damage on the fuse-link's fuse-elements due to the magnetizinginrush current of the transformer.
- No overheating of the fuse-links, the switch-fuse combination or theswitchgear due to the full load current or the permissible periodicoverload current of the transformer.
- A transfer current of the combination which is as low as possible, andless that the rated transfer current of the switch-fuse combination.
- A situation where the fuse-links alone will deal with the condition of ashort-circuit on the transformer secondary terminals.
- Fuse-links that discriminates with the low-voltage fuse-links in theevent of phase-to-phase faults occurring downstream the low-voltagefuse-links.

By carefully checking that these rules are followed, fuse-links from anymanufacturer can be used in combination with SafeRing and SafePlusas long as the fuse-links are in accordance with the requirementsdescribed in chapter 6.5.

# 6.5 Fuse selection table

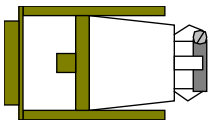
| 100% | Transformer rating (kVA) | | | | | | | | | | | | | | | | CEF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Un (kV) | 25 | 50 | 75 | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 | 630 | 800 | 1000 | 1250 | 1600 | |
| 3 | 16 | 25 | 25 | 40 | 40 | 50 | 50 | 80 | 100 | 125 | 160 | 160 | | | | | |
| 3,3 | 16 | 25 | 25 | 40 | 40 | 50 | 50 | 63 | 80 | 100 | 125 | 160 | | | | | |
| 4,15 | 10 | 16 | 25 | 25 | 40 | 40 | 50 | 50 | 63 | 80 | 100 | 125 | 160 | | | | |
| 5 | 10 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 50 | 63 | 80 | 100 | 160 | 160 | | | 7.2kV |
| 5,5 | 6 | 16 | 16 | 25 | 25 | 25 | 40 | 50 | 50 | 63 | 80 | 100 | 125 | 160 | | | |
| 6 | 6 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 50 | 80 | 100 | 125 | 160 | 160 | | |
| 6,6 | 6 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 50 | 63 | 80 | 100 | 125 | 160 | | |
| 10 | 6 | 10 | 10 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 50 | 80 | 80 | 125 | 125 | |
| 11 | 6 | 6 | 10 | 16 | 16 | 25 | 25 | 25 | 25 | 40 | 50 | 50 | 63 | 80 | 100 | 125 | 12kV |
| 12 | 6 | 6 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 100 | 125 | |
| 13,8 | 6 | 6 | 10 | 10 | 16 | 16 | 25 | 25 | 25 | 25 | 40 | 50 | 50 | 63 | 80 | 100 | |
| 15 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 100 | 17.5kV |
| 17,5 | 6 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 50 | 50 | 63 | 80 | |
| 20 | 6 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 63 | |
| 22 | 6 | 6 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 50 | 50 | 63 | 24kV |
| 24 | 6 | 6 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | |

- The table is based on using fuses type ABB CEF
- Normal operating consitions with no overload
- Ambient temperature -25°C - +40°C

| 120% | Transformer rating (kVA) | | | | | | | | | | | | | | | | CEF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Un (kV) | 25 | 50 | 75 | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 | 630 | 800 | 1000 | 1250 | 1600 | |
| 3 | 16 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 100 | 125 | 160 | | | | | | |
| 3,3 | 16 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 80 | 100 | 125 | | | | | | |
| 4,15 | 10 | 16 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 80 | 100 | 125 | | | | | |
| 5 | 10 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 80 | 125 | 160 | | | | 7.2kV |
| 5,5 | 6 | 16 | 16 | 25 | 25 | 25 | 40 | 50 | 50 | 80 | 80 | 100 | 125 | 160 | | | |
| 6 | 6 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 100 | 125 | 160 | | | |
| 6,6 | 6 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 80 | 100 | 125 | | | |
| 10 | 6 | 10 | 10 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 80 | 125 | | |
| 11 | 6 | 6 | 10 | 16 | 16 | 25 | 25 | 25 | 25 | 40 | 50 | 50 | 80 | 80 | 100 | 125 | 12kV |
| 12 | 6 | 6 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 100 | 125 | |
| 13,8 | 6 | 6 | 10 | 10 | 16 | 16 | 25 | 25 | 25 | 25 | 40 | 50 | 50 | 80 | 80 | 100 | |
| 15 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | 100 | 17.5kV |
| 17,5 | 6 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 50 | 50 | 63 | 80 | |
| 20 | 6 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | 80 | |
| 22 | 6 | 6 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 50 | 50 | 63 | 24kV |
| 24 | 6 | 6 | 6 | 6 | 10 | 10 | 16 | 16 | 16 | 25 | 25 | 25 | 40 | 40 | 50 | 63 | |

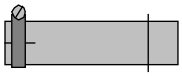
- The table is based on using fuses type ABB CEF
- Normal operating consitions with 20% overload
- Ambient temperature -25°C - +40°C

# 6.6 Fuse-links



Fuse holder

Fuse-link



Fuse adapter

SafeRing and SafePlus are designed and tested for fuse-links according to IEC 60282-1.

The dimensions of the fuse-links have to be in accordance with IEC 60282-1, Annex D. The fuse-links have to be type I with terminal diameter equal to + 45 mm and body length (D) equal to 442 mm.

The dimensions of the fuse-links can also be in accordance with DIN 43625 and the length of the fuse canister is based on the use of fuse-links with length 442 mm. For installation of shorter fuses, (<24kV) a fuse adapter will be needed. SafeRing and SafePlus are designed for fuse-links with striker in accordance with IEC 60282-1. The striker must be of type "Medium" with an energy of 1 J and a travel of minimum 20 mm. The start force of the striker should be minimum 40 N.

Please note: When inserting the fuse-link into the canister, the striker-pin must always face outwards against the fuse holder. Fuse adapter has to be fixed to the fuse-link contact which faces inwards in the fuse canister.

1600 kVA is the maximum size of distribution transformer which can be fed from a SafeRing/ SafePlus switch-fuse module. For higher rated transformers, we recommend our vacuum circuit-breaker module with CT's and protection relay.

The below table shows CEF fuse-links for use in SafeRing/ SafePlus. For more technical data, please refer to separate catalogue for ABB CEF fuse-links.

In order to find the correct fuse-link compared to the transformer rating in kVA, please see the selection table on previous page.

| Type | Rated voltage kV | Rated current A | e / D mm | Type | Rated voltage kV | Rated current A | e / D mm |
|---|---|---|---|---|---|---|---|
| CEF | 3,6/7,2 | 6 | 192/65 | CEF | 17,5 | 6 | 292/65 |
| CEF | 3,6/7,2 | 10 | 192/65 | CEF | 17,5 | 10 | 292/65 |
| CEF | 3,6/7,2 | 16 | 192/65 | CEF | 17,5 | 16 | 292/65 |
| CEF | 3,6/7,2 | 25 | 192/65 | CEF | 17,5 | 25 | 292/65 |
| CEF | 3,6/7,2 | 40 | 192/65 | CEF | 17,5 | 40 | 292/87 |
| CEF | 3,6/7,2 | 50 | 192/65 | CEF | 17,5 | 50 | 292/87 |
| CEF | 3,6/7,2 | 63 | 192/65 | CEF | 17,5 | 63 | 292/87 |
| CEF | 3,6/7,2 | 80 | 192/87 | CEF | 17,5 | 80 | 442/87 |
| CEF | 3,6/7,2 | 100 | 192/87 | CEF | 17,5 | 100 | 442/87 |
| CEF | 3,6/7,2 | 125 | 292/87 | | | | |
| CEF | 3,6/7,2 | 160 | 292/87 | | | | |
| CEF | 12 | 6 | 292/65 | CEF | 24 | 6 | 442/65 |
| CEF | 12 | 10 | 292/65 | CEF | 24 | 10 | 442/65 |
| CEF | 12 | 16 | 292/65 | CEF | 24 | 16 | 442/65 |
| CEF | 12 | 25 | 292/65 | CEF | 24 | 25 | 442/65 |
| CEF | 12 | 40 | 292/65 | CEF | 24 | 40 | 442/65 |
| CEF | 12 | 50 | 292/65 | CEF | 24 | 50 | 442/87 |
| CEF | 12 | 63 | 292/65 | CEF | 24 | 63 | 442/87 |
| CEF | 12 | 80 | 292/87 | | | | |
| CEF | 12 | 100 | 292/87 | | | | |
| CEF | 12 | 125 | 442/87 | | | | |

# 6.7 Relays

SafePlus can be delivered with a V-module with 630A vacuum circuitbreaker.This chapter describes the different choices of protectionrelays and feeder terminals that can be used in SafePlus. Theserelays require an additional low voltage compartment.

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

REF type feeder terminals are configured according to customerspecification for protection functions. Special control requirements onrequest only.

The V-module can also be delivered prepared for protection relays.

This is defined in two types:
1. Trip coil and auxiliary contact.
2. Cut out in LV-compartment, trip coil, aux contact, wiring and drawings.

This is applicable for relays delivered complete from our factory or ifwe have received necessary documentation on the relay.

Other types of relays on request.
There are three main groups of relays delivered:

A) ABB feeder protection relays
B) Self powered relays
C) ABB feeder terminals type REF 54x

A) ABB offers a wide range of feeder protection relays.These relays have been sold for a long period and have anexcellent reputation for reliability and secure operation. These relays have either 18-80VDC or 80-265VAC/DC auxiliarysupplies and are connected to conventional CTs and VTs.

B) Self powered relays are suitable for rough conditions and placeswithout possibility of auxiliary supply.SafeRing and SafePlus can be delivered with different types tofulfil all relevant needs in a distribution network.

C) ABB feeder terminals, type REF 54x provides cost-effectivesolutions for different protection, monitoring and controlapplications.

The terminals enable the use of accurate and reliable current andvoltage sensors as well as conventional CTs and VTs.

# 6.7 Relays

Ring core current transformers and earth fault transformer

| | | |
|---|---|---|
| MPRB 06 transformer protection and cable protection kit (self powered) | Ring core current transformer type | Current range |
| Transformer type | CT1 | 15 - 112 A |
| | CT2 | 64 - 448 A |
| SEG WIC1 transformer protection and cable protection kit (self powered) | Ring core current transformer type | Current range |
| Transformer type | W2 | 16 - 56 A |
| (Thermal load capacity: | W3 | 32 - 112 A |
| permanently: 2,5 x highest rated current) | W4 | 64 - 224 A |
| | W5 | 128 - 448 A |
| PR512 transformer protection and cable protection kit (self powered) | | Ratio |
| Transformer type | | 40/1 A |
| | | 80/1 A |
| | | 250/1 A |
| REJ603 transformer protection and cable protection kit (self powered) | Ring core current transformer type | Current range |
| Transformer type | CT1 | 8 - 28 A |
| | CT2 | 16 - 56 A |
| | CT3 | 32 - 112 A |
| | CT4 | 64 - 224 A |
| | CT5 | 128 - 448 A |
| Protection relay standard CT's typical | Ring core current transformer type | Ratio - burden |
| Transformer type: class 10P10 | SVA100-100-45 | 50-100-200/1 A 1,5/3/6 VA |
| Transformer type: class 5P10 | SVA100-100-45 | 150/1 A 4 VA |
| Transformer type: class 5P10 | SVA100-100-45 | 100-200/1 A 4 - 7 VA |
| Transformer type: class 5P10 | SVA100-100-45 | 300 - 600/1 A 4 - 7 VA |
| Transformer type: class 5P10 | SVA100-100-45 | 400 - 600/1 A 4 - 7 VA |
| Earth fault transformer | | |
| Earth fault transformer, class 10P10, burden 0,5 – 15VA dependent on selected ratio | KOLMA 06A1 (90 mm) | Multi-tap secondary: 50-150/1 A or 50-750/5A |
| Earth fault transformer, class 10P10, burden 0,5 – 15VA dependent on selected ratio | KOLMA 06D1 (180 mm) | Multi-tap secondary: 50-150/1 A or 50-750/5A |

# 6.7 Relays

ABB feeder protection relays

| Protection and measurement | | | | Relay | | | | |
|---|---|---|---|---|---|---|---|---|
| Type of faults | IEEE device no. | IEC symbol | Protection function | SPAJ 140C | SPAA 341C | SPAA 120C | REF 610 | REX 521 1) |
| Short circuits | 51 | 3 I > | Non-directional overcurrent, low-set stage | X | X | | X | X |
| | 50/51/51B | 3 I >> | Non-directional overcurrent, high-set stage | X | X | | X | X |
| | 50/51B | 3 I >>> | Non-directional overcurrent instantaneous stage/blockable | | X | | X | X |
| | 51 | 2 I > | Two-phase non-directional overcurrent, low-set stage | | | X | | |
| | 50/51 | 2 I >> | Two-phase non-directional overcurrent, high-set stage | | | X | | |
| | 51N | Io > | Non-directional earth fault, low-set stage | X | X | | X | X |
| | 51N | Io >/SEF | Non-directional earth fault, low-set stage sensitive | | | | | |
| | 50N/51N | Io >>/Io-o> | Non-directional earth fault, high-set stage | X | X | | X | X |
| Earth fault | 67N | Io >-->/SEF | Directional earth fault, sensitive, In=1A and 5A | | X | X | | X |
| | 67N | Io >-->/SEF | Directional earth fault, sensitive, In=0,2A and 1A | | | | | |
| | 67N | Io >> --> | Directional earth fault, high-set stage | | X | X | | X |
| | 59N | Uo > | Residual overvoltage (SPAA 341 also high-set/instantaneous) | | X | X | | X |
| Additional | 46 | Δ I > | Phase discontinuity | | X | | | X |
| functions | 62BF | CBFP | Circuit-breaker failure | X | X | X | X | X |
| Type of | | 31/21 | Three-phase / two-phase current | X | X | X | X | X |
| measurements | | Io | Neutral current | X | X | X | X | X |
| current | | Δ I | Degree of unbalance | | | | | |
| | | Uo | Residual voltage | | X | X | | X |
| Auto-reclosing | 79 | | | | | X | X | X |

1) Available protection functions dependant of version

Self powered relays

| Functionality | | | Relay | | | |
|---|---|---|---|---|---|---|
| Features | Description | IEEE device no. | REJ 603 | WIC1 | MPRB-06 | PR512/P |
| | Phase overdurrent (multi-characteristic) | 50/51 | X | X | X | X |
| | Short-curcuit protection | 50/51 | X | X | X | X |
| Protection | Number of overcurrent elements | 50/51B | 2 | 2 | 2 | 2 |
| FUNCTIONS | Earth fault current | 50N/51N | X | X | X | X |
| | Number of earth fault elements | | 2 | 1 | 1 | 2 |
| Characteristic | Overcurrent element | | DEFT,INV 1) | DEFT,INV 1) | DEFT,INV 2) | DEFT,INV 2) |
| curves | Earth fault current | | DEFT,INV 1) | DEFT | DEFT | DEFT,INV 2) |
| | Trip indication | | X | X (option) | X | X |
| Additional | Electro-impulse | | X | X | X | X |
| functions | input remote tripping (voltage) | | X | 115 VAC/230VAC | 230 VAC | 24VDC |
| | Auxiliary power, voltage (option) | | | | 230 VAC | 24 VDC |
| | Rated secondary current | | wide range | wide range | wide range | 40/80/250 |
| Measuring circuit | | | special CT | special CT | special CT | 1A secondary |
| | Measuring range, start current I> (A) | | 7,2 | 14,4 | 13,5 | 8 |
| Climatic withstand | Storage temperature (°C) | | -40 ...+85 | -40 ...+85 | -40 ...+85 | -40 ...+90 |
| | Operating temperature (°C) | | -40 ...+85 | -40 ...+85 | -40 ...+85 | -5 ...+40 |

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

1) - Resistance inverse timeovercurrent (RINV)
- Characteristics of high voltage fuse-link (HV-FUSE)
- Characteristics of full range fuse (FR-FUSE)

2) - Definite time overcurrent
- Inverse characteristics, please contact us for further information

# 6.7 Relays

## ABB feeder terminals type REF 54x

SafePlus can be delivered with two different REF series feeder terminals:

REF 541 which is installed in the door of the low voltage compartment.

REF542plus with integrated web-interface is a leader in the development of feeder terminals. REF 542 plus has a separate display unit and does not need a build out frame.

Both REF units are configured according to customer specification for protection functions. Other configurations on request only.

### Typical configuration of V-module:

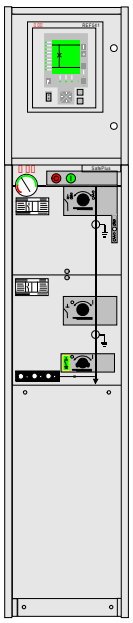
### Primary equipment, standard

- 630A vacuum circuit-breaker
- Disconnector
- Earthing switch

### Additional equipment

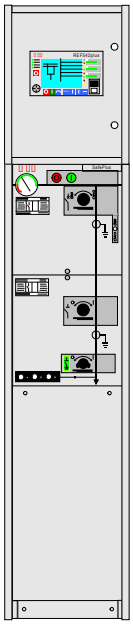
- Trip coil (Y4)
- HR voltage indication
- Combisensors with 400 series interface
- Low voltage compartment
- REF 542 plus or REF 541
- Motor operation
- Earth fault transformer (sensitive earth fault)

# 6.7 Relays



REF 541

Depth 765 mm
Width: 325 mm
Height: 1806 mm



REF 542plus

Depth 765 mm
Width: 325 mm
Height: 1806 mm

Technology summary REF 541 and REF542plus:
(configurable functions)

Protection:
- non-directional overcurrent protection, 3 stages
- directional overcurrent protection, 3 stages
- non-directional earth-fault protection
- directional earth-fault protection
- residual overvoltage protection
- 3-phase thermal overload
- 3-phase overvoltage protection
- 3-phase undervoltage protection
- Under- or overfrequenzy incl. rate of change, 5 stages

Optional functionality:
- Capacitor bank protection
- Capacitor bank control
- Power quality

Measurement:
- 3-phase current
- neutral current
- 3-phase voltage
- residual voltage
- 3-phase power and energy incl. cos phi
- transient disturbance recorder

# 6.8 Combisensor


The combi sensor is a Interface C bushing (400 series bolted) with three integrated sensors. It is installed instead of the normal bushing. The three sensors are one “ROGOWSKI” coil for current measurement and two capacitive voltage dividers for voltage measurement and indication.

### Technical specification, general

| | |
|---|---|
| Insulation level | 24/50/125 kV |
| Rated short-time thermal current | 25 kA 1s |
| Rated dynamic current (Idyn) | 62,5 kA (peak) |
| Rated continuous thermal current | 630 A |
| Cable length | 2,2 m (supplied for the current and voltage sensors) |
| Cable terminal | Twin-BNC (TWB 1111K1-NP3G Goldflash) |

### Technical specification, current sensor

| | |
|---|---|
| Principle | ROGOWSKI coil |
| Rated primary current (Ipr) | 80 A |
| Accuracy limit factor | 60 |
| Rated primary current factor | 10 |
| Rated secondary voltage (Usr) | 0,150 V (0,180 V at 60 Hz) |
| Rated burden | ≥ 4 MΩ |
| Accuracy | Class 5 – using calibration factor Class 3 /10P60 |

### Technical specification, voltage sensor

| | |
|---|---|
| Principle | Capacitive voltage divider |
| Rated primary voltage (Upr) | 20:√3 kV |
| Rated secondary voltage (Usr) | 2,0:√3 kV |
| Rated burden | ≥ 4 MΩ |
| Division ratio | 10 000:1 |
| Accuracy class | Class 6P |

### Technical specification, voltage indication

| | |
|---|---|
| Principle | Capacitive voltage divider |
| Capacitance C1 | 8 – 12 pF |
| Stray Capacitance C2 | 15 – 40 pF |
| Connection | Cable with BNC plug |
| Over-voltage protection | Surge arrester or additional parallel capacitor is excluded |