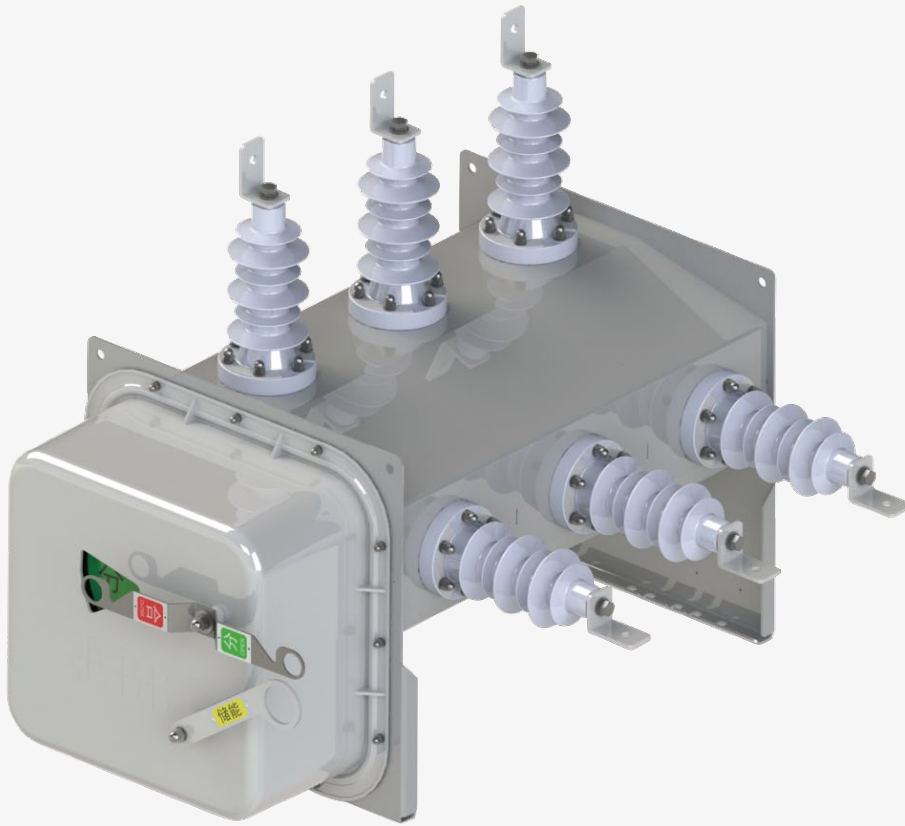


PRODUCT BROCHURE

# PVB-S outdoor vacuum circuit breaker



• New generation SMART outdoor VCB



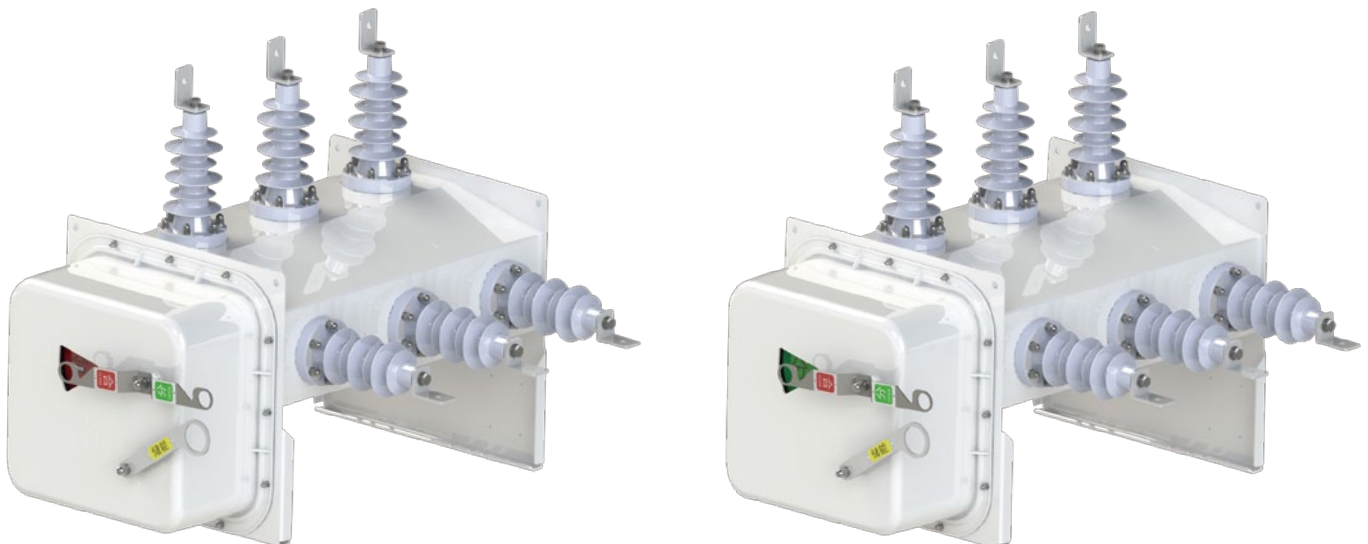
---

# Contents

<b>004</b>	<b>1</b>	<b>Overview</b>
<b>005</b>	<b>2</b>	<b>Product feature</b>
<b>006</b>	<b>3</b>	<b>Standards</b>
<b>006</b>	<b>4</b>	<b>Application condition</b>
<b>007</b>	<b>5</b>	<b>PVB-S technical parameters</b>
<b>007 – 011</b>	<b>6</b>	<b>Structure and functions</b>
<b>012 – 014</b>	<b>7</b>	<b>Distribution automation</b>
<b>015</b>	<b>8</b>	<b>Intelligent FTU</b>
<b>016 – 017</b>	<b>9</b>	<b>Electrical circuit diagram</b>
<b>018</b>	<b>10</b>	<b>Structure and installation</b>
<b>019</b>	<b>11</b>	<b>Ordering requirements</b>

# 1 Overview

PVB-S outdoor vacuum circuit breaker (hereinafter referred to PVB-S) is pole mounted switch equipment of ABB vacuum circuit breaker series, rated voltage is 12 kV, applied to the overhead lines. ABB's PVB-S is one of the most flexible devices for smart grid application, and also provides maximum functionality and mounting flexibility suitable for a variety of applications. This is especially true of our feeder automation product, where years of knowledge and modular manufacturing technique allow PVB-S outdoor circuit breaker to meet any need and schedule. PVB-S outdoor vacuum circuit breakers can meet various protections requirements under the situation with power electricity, including making and breaking short-circuit current. PVB-S has a very good performance on frequent operation occasions, and PVB-S can fully meet the requirements of automatic re-closing with high reliability and electrical service lifetime.



## 2 Product feature

PVB-S is perfect synthesis of ABB's affirmed technology in designing and constructing vacuum interrupter and manufacturing technology, and also is combination of advanced EL operating mechanism.

### 2.1 Vacuum interrupter

PVB-S is a circuit breaker that can be installed under a harsh environment with vacuum interruption and SF<sub>6</sub> gas insulation. It has a very strong fault breaking and closing capacity.

In any case, on separation of the contacts, an electric arc is generated made up exclusively of molten and vaporized contact material. The electric arc supported by the external energy only remains until the current is cancelled by passing through natural zero. At that instant, the rapid reduction in the load density carried and the fast condensation of the metallic vapour lead to extremely rapid recovery of the dielectric properties. The vacuum interrupter therefore recovers the insulating capacity which withstand the transient recovery voltage, definitively the arc is extinguished. Since high dielectric strength can be reached in vacuum, even with minimum distances, interruption of the circuit is also guaranteed when separation of the contacts takes place a few milliseconds before passage of the current through natural zero.

The special geometry of the contacts and the material used, together with the limited duration and low voltage of the arc guarantee minimum contact wear and long life. Furthermore, the vacuum prevents their oxidation and contamination.

### 2.2 Product feature

- Suitable for DA application
- Contacts in vacuum environment to avoid oxidation and contamination
- High quality, 3 mm stainless steel tank designed for maximum robustness and minimum welding line to minimize corrosion
- Advanced laser cutting, CNC bending and robot welding to ensure high reliability on sealing
- ABB globally recognized vacuum interrupter
- Modularized and reliable spring mechanism minimizes operating energy and ensures longer mechanical life
- Status indicators visible from distance
- Offers reliable maintenance free operation even in the most demanding climatic conditions including salt laden atmospheres, corrosive industrial pollution, snow and ice
- The motor drive device can easily be retrofitted on site to manually operated units

## 3 Standards

- IEC 60694-2002 Common specifications for high-voltage switchgear and controlgear standards
- IEC 62271-100 High-voltage switchgear and controlgear
- GB/T 11022-2011 Common specifications for high-voltage switchgear and controlgear standards
- GB/T 1984 High-voltage alternating-current circuit-breakers
- GB/T 311.1 Insulation coordination for high voltage transmission and distribution equipment
- DL/T 402-2007 Specification of high-voltage alternating-current circuit-breakers
- DL/T 403-2000 HV vacuum circuit-breaker for rated voltage 12 kV to 40.5 kV
- DL/T 593-2006 Common specifications for high-voltage switchgear and controlgear standards

## 4 Application condition

### General condition

Ambient temperature high limit	+55°C
Average temperature limit in 24 hours	+35°C
Ambient temperature low limit	-40°C
Installation altitude high limit	2000 m*

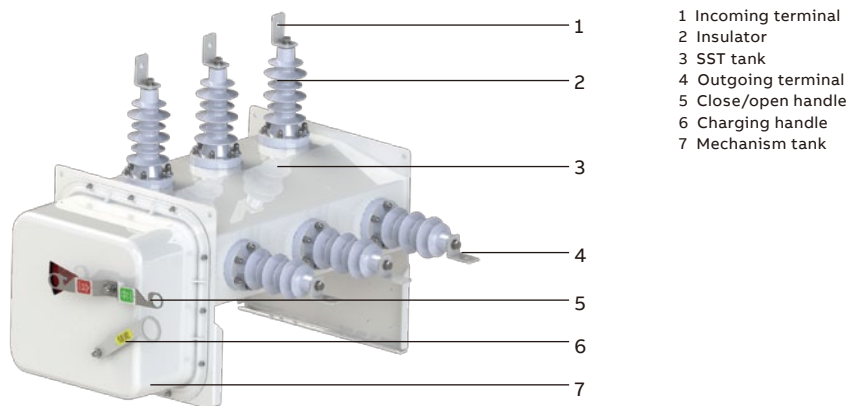
\* If you need higher altitude products, please contact the manufacturer.

## 5 PVB-S technical parameters

Parameters		Unit	Values
Rated voltage		kV	12
Dielectric test	Lightning impulse withstand voltage	kV	85/96
	Power frequency withstand voltage	kV	48/55
Rated frequency		Hz	50
Rated current		A	630
Filling pressure		kPa	101
Short-circuit breaking current		kA	25
Short time withstand current duration (4 s)		kA	25
Peak withstand current		kA	63
Short-circuit making current (peak)		kA	63
Short-circuit breaking current/operations		n	30
Mechanical endurance		CO	10,000
Rated operating sequence			O-0.3 s-CO-180 s-CO

## 6 Structure and functions

### 6.1 PVB-S structure



- 1 Incoming terminal
- 2 Insulator
- 3 SST tank
- 4 Outgoing terminal
- 5 Close/open handle
- 6 Charging handle
- 7 Mechanism tank

## 6 Structure and functions

### 6.2 Interruption principle of ABB interrupter

ABB has been developing and manufacturing vacuum interrupters since the early 1980 s. Worldwide, more than five million ABB vacuum interrupters are in service. ABB's vacuum interrupter facility uses the latest technologies in high quality mass production to produce the next generation of vacuum interrupters. This new generation vacuum interrupter is robust for universal application.

#### Advantages

- Maximum reliability
- Superior contact wear
- Long life: 10,000 full load operations
- Minimal maintenance
- Environmentally friendly

In a vacuum interrupter, separation of current-carrying contacts initiates the vacuum arc and this is maintained until the current zero and can be influenced by magnetic fields.

#### Diffuse or contracted vacuum arcs

Following contact separation, single melting points form on the surface of the cathode, producing metal vapours which support the arc.

The diffuse vacuum arc is characterised by expansion over the contact surface and by an even distribution of the thermal stress.

At the rated current of the vacuum interrupter, the electric arc is always of the diffuse type. Contact erosion is negligible, and the number of current interruptions very high.

As the interrupted current value increases (above the rated value), the electric arc tends to be transformed from the diffuse into the contracted type, due to the Hall effect.

Starting at the anode, the arc contracts and as the current rises further it tends to become sharply defined.

Near the area involved there is an increase in temperature with consequent thermal stress on the contact. To prevent overheating and erosion of the contacts, the arc is kept rotating. With arc rotation it becomes similar to a moving conductor which the current passes through.

#### The spiral geometry of ABB vacuum interrupter contacts

The special geometry of the spiral contacts generates a radial magnetic field in all areas of the arc column, concentrated over the contact circumferences.

An electromagnetic force is self-generated and this acts tangentially, causing rapid arc rotation around the contact axis.

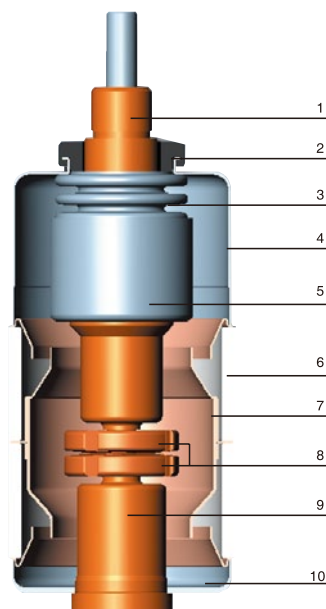
This means the arc is forced to rotate and to involve a wider surface than that of a fixed contracted arc.

Apart from minimising thermal stress on the contacts, all this makes contact erosion negligible and, above all, allows the interruption process even with very high short-circuits.

ABB vacuum interrupters are zero-current interrupters and are free of any re-striking.

Rapid reduction in the current charge and rapid condensation of the metal vapours simultaneously with the zero-current, means maximum dielectric strength can be restored between the interrupter contacts within microseconds.

- Vacuum interrupter
- 1 Stem/terminal
  - 2 Twist protection
  - 3 Bellows
  - 4 Interrupter housing
  - 5 Shield
  - 6 Ceramic insulator
  - 7 Shield
  - 8 Contacts
  - 9 Terminal
  - 10 Interrupter housing





**6.3 Operating mechanism**

PVB-S uses EL-mechanical operation, and the optional secondary accessories can be installed easily and quickly, and EL mechanical operation is spring operated mechanism.

**6.3.1 EL operating mechanism**

The mechanical operating mechanism of PVB-S circuit-breaker is of simple concept and use, and can be customized with a wide range of easily and rapidly installed accessories.

This simplicity translates into greater reliability of circuit breaker. The EL operating mechanism is of the stored energy type with the anti-pumping device mounted as standard to prevent incorrect operations.

**6.3.2 Close/open indication**

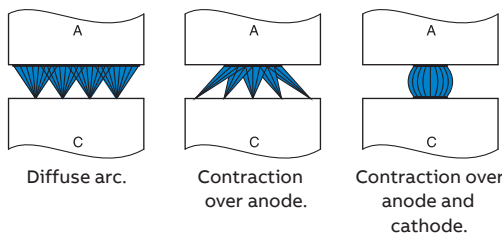
Position of open or closed, and charging status are visible from the indication windows which are at the bottom of PVB-S tank (please find the dimension of the windows in detail shown below).

**6.4 Manual operating PVB-S**

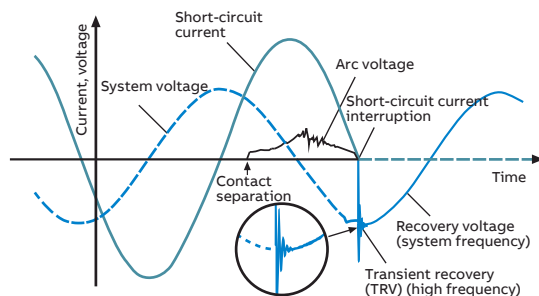
Spring operating mechanism of PVB-S can be charged manually via charging rod simply and reliably. After the spring operating mechanism being charged, PVB-S can be closed via operation handle, if closed, PVB-S can be opened by operation handle without charging the spring operating mechanism again!

**6.4.1 Protection functions of manual operating PVB-S**

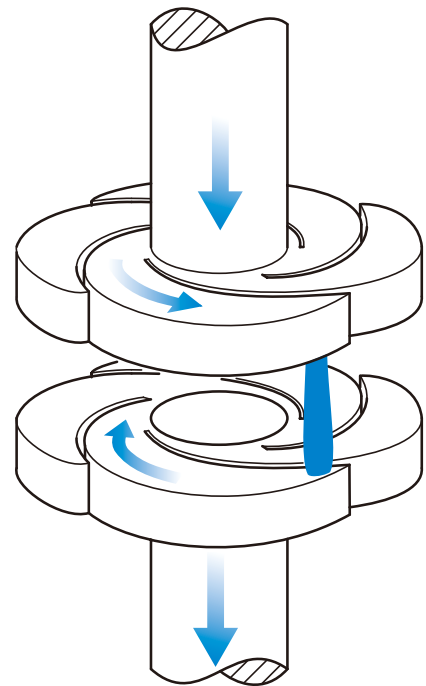
Protection elements of manual operating PVB-S are CT, MFC protection control device and overcurrent release. When the overhead lines have overloaded current or fault current, CT will sense the current and secondary current of CT will increase accordingly, thus the current into the MFC protection control will over the setting value to drive the overcurrent release to trip.



Schematic diagram of the transition from a diffuse arc to a contracted arc in a vacuum interrupter.



Development of current and voltage trends during a single phase vacuum interruption process.



Radial magnetic field contact arrangement with a rotating vacuum arc.

- 01 EL operating mechanism
- 02 Overcurrent release
- 03 MFC protection control device

**6.4.2 Current transformer**

Rated ratio	Accuracy	Insulation level (rated voltage/PFW/BIL)	Pollution level
630/5	5P10	12/42/75 kV	IV
400/5	5P10	12/42/75 kV	IV
630-400/5	5P10	12/42/75 kV	IV

**6.4.3 Capacitor voltage divider**

Rated Primary Voltage	Rated Secondary Voltage	Ratio	Accuracy
10/ $\sqrt{3}$ kV	1/ $\sqrt{3}$ V	10000:1	3P

**6.4.4 MFC protection control device**

- Cold load time for Inrush current, time delay setting has four options: 0, 200 ms, 400 ms, 600 ms
- Time overcurrent, its delay time can be set from 40 ms to 3 s with 16 options
- Multiplier of rated current (CT secondary value) for instantaneous overcurrent protection can be set: 2, 3, 4, and 5
- Time delay for Instantaneous overcurrent can be set: 0, 40 ms, 80 ms, and 120 ms
- Power loss of MFC is less than 0.5 W at normal work condition
- Ambient temperature: -40°C~+85°C
- Protection function is achieved through phase A and phase C, which controlled by two independent CPU

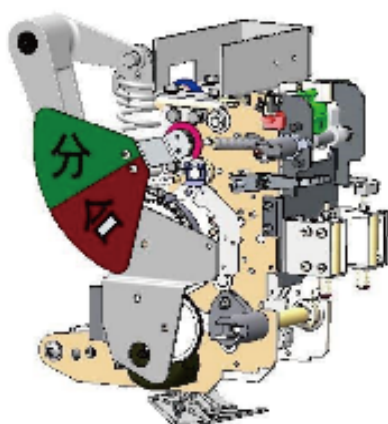
**6.4.5 Overcurrent release**

- Rated current: 5 A, DC
- Insulation level: E
- Power frequent withstand voltage: 2000 V/1 min

**6.5 Motor operating PVB-S with simple protection functions**

In order to operate the circuit breaker safely and use less effort, meanwhile ready for DA, manual PVB-S can be upgraded to motor operating mechanism PVB-S by adding motor operator and control cabinet which is installed below the Pole to fulfill protection function.

Note: One (1) potential transformer at least is needed to supply power for control cabinet.



01



02



03

- 04 Motor operator
- 05 Opening and closing release
- 06 Auxiliary switch

**6.5.1 Motor operator**

This carries out automatic charging of the circuit-breaker operating mechanism closing springs. After circuit-breaker closing, the geared motor immediately recharges the closing springs. In the case of a power cut or during maintenance work, the closing springs can be charged manually in any case (by means of the special crank handle incorporated in the operating mechanism).

Parameters	Values
Rated voltage Un	DC 24, 48, 110, 220 V AC (50, 60 Hz) 110, 220 V
Operating limits	85~110% Un
Power on inrush (Ps)	DC: 500 W; AC=500 VA
Rated power (Pn)	DC: 200 W; AC=200 VA
Inrush duration	0.2 s
Charging time	4~7 s
Insulation voltage	2500 V 50 Hz (1 min)

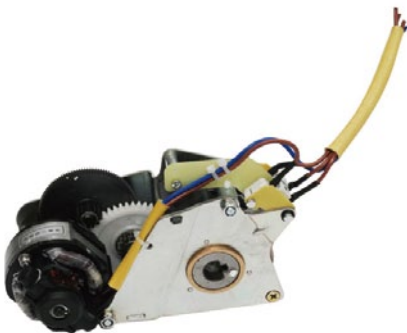
**6.5.2 Opening and closing release**

This allows remote control of the PVB-S. The release can operate both in direct and alternating current. This release is suitable for both instantaneous and permanent service. In the case of instantaneous service, the minimum current impulse time must be 100 ms.

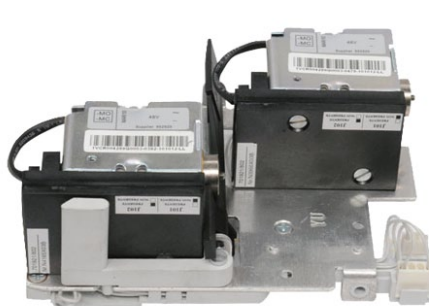
Parameters	Values
Rated voltage Un	DC 24, 48, 110, 220 V AC (50, 60 Hz) 110, 220 V
Operating limits	65~120% Un
Power on inrush (Ps)	DC: 200 W; AC: 200 VA
Rated power (Pn)	DC: 5 W; AC: 5 VA
Inrush duration	100 ms
Closing time	35~80 ms
Opening time	45~80 ms
Insulation voltage	2500 V 50 Hz (1 min)

**6.5.3 Auxiliary switch**

Parameters	Values
Rated voltage Un	DC 220 V
Rated frequency	50 Hz
Rated current	3 A



04



05



06

## 7 Distribution automation

According to statistics, 80%-90% of fault in the medium voltage overhead line belongs to the transient fault, which exists only few cycles or seconds, and then disappeared. With the combination of circuit breaker and load breaker switch, the ABB advanced distribution network automation scheme can distinguish between instantaneous and permanent faults in the switch user area. The fault will be isolated automatically if was permanent. The distribution automation scheme is mainly divided into two types: demarcation circuit breaker and intelligent distributed solution based on GOOSE communication.

### 7.1 demarcation circuit breaker

Demarcation circuit breaker usually installed on branches or end-user lines, isolated fault area immediately and avoid short time power off on main network.

Main function as follow:

- Earth fault detection and isolation
- Over-current fault detection and isolation

In the non-solid grounding system, the detection accuracy of earth fault can be increased to 99% by using the ABB multi-frequency admittance technique.

Additional, demarcation circuit breaker has reclose function as well, and restore network quickly when transient fault happened.

Fault type	Fault location	Soution
Earth fault	Isolated neutral system, downstream of fault point	Trip or alarm
	Arc suppression coil grounding system, downstream of fault point	
	Isolated neutral system, upstream of fault point	No action
	Arc suppression coil grounding system, upstream of fault point	
	Solid grounding system, downstream of fault point	Trip or alarm
	Solid grounding system, upstream of fault point	No action
Over-current fault	Downstream of fault point	Trip or alarm
	Upstream of fault point	No action

## 7.2 Intelligent distributed solution based on GOOSE communication

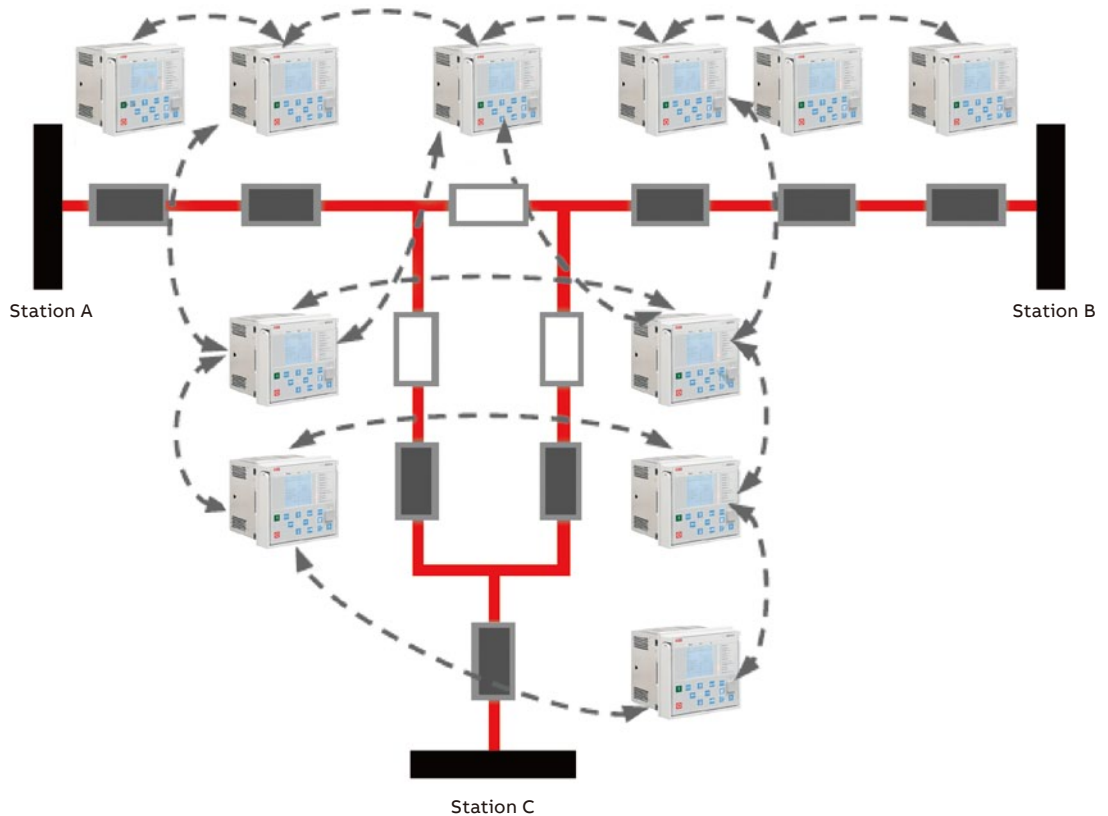
ABB has developed intelligent distributed solution based on GOOSE communication. The scheme is achieved by the intelligent controller REC615 and communication network, and supports all kinds of distribution topology networks, effectively reducing the complexity and cost of the system, and improving the performance and reliability.

GOOSE (Generic Object Oriented Substation Event) is used to meet the fast message demand of substation automation system in IEC 61850 standard. It is used to carry out information transmission between multi IED (Intelligent Electronic Device), including transmission switching signal (command), and has high transmission probability. GOOSE network can be realized transmission of real-time information such as switch position, blocking signal and trip commands which instead of traditional hard wiring.

Intelligent distributed solution based on GOOSE communication can be applied in any kind of network. The scheme also supports two consecutive failures in different locations. During the process of GOOSE program, if there is an abnormality, the controller of the feeder will be blocked, and the circuit breaker will remain open.

### Abnormal condition

- Refuse control (remote control return error)
- Switch misoperation
- Communication disconnect between IED
- Communication disconnect between FTU
- Communication disconnect during process
- Received total fault signal during process
- Predict overload in the process of restoring power supply



All circuit breakers are PVB-S in above solution based on GOOSE communication. The solution meet selective requirement without protective gradation coordination, realize feeder automation based on GOOSE high speed signal, trip two switches close to fault area directly, improve reliability in network.

**Benefits**

- Advanced technology, real-time GOOSE signals transmit between controllers, complete feeder automation individual without substation
- Fast speed of fault location and isolation (less than 500 ms), restore non-fault plant
- The fault isolation and non-fault region recovery is completed once, without reclosing and reduce the impact of the power grid
- It supports any type of complex topology structure, and network expansion and modification, which need to modify the configuration between local neighbors only, and does not need to change all configuration, so as to greatly shorten the engineering commissioning time
- Support to isolate upstream switch automatically if refused trip fault current, Reduce the power outage in the non fault area and greatly improve the reliability of the power supply
- Support any change on topology, dynamic identify contact points
- Self healing fiber ring network without any extra communication device, so that reduce system expense and improve reliability in network
- Fast communication interruption detection and alarm, reliable feeder automatic locking processing
- Support independent network channel access subsystem master station system, support standard IEC101/104 protocol access substation

## 8 Intelligent FTU

08 REC615/REF615

In order to match the different needs of different customers in different distribution networks, ABB develops a variety of controllers to choose.



08

Type	REC615	REF615
Distribution automation	Supporting: Demarcation circuit breaker GOOSE distributed automation	Supporting: Demarcation circuit breaker GOOSE distributed automation Multi-frequency admittance solution
Protection		
OC/EF protection	✓	✓
Reclose	0-5 cycles	0-5 cycles
DEF protection	✓	✓
Neutral voltage	Option	Option
Thermal overload	✓	✓
Over/under voltage	Option	Option
Block second reclose	✓	✓
Post acceleration	✓	✓
Measurement	✓	✓
Three phase current and voltage	✓	✓
Active/inactive power	Option	Option
Neutral current	RS232/485, RJ45, Fiber	RS232/485, RJ45, Fiber
Communication Port Protocol	IEC 61850, IEC 101/104, DNP3.0 or Modbus	IEC 61850, IEC 103, DNP3.0 or Modbus

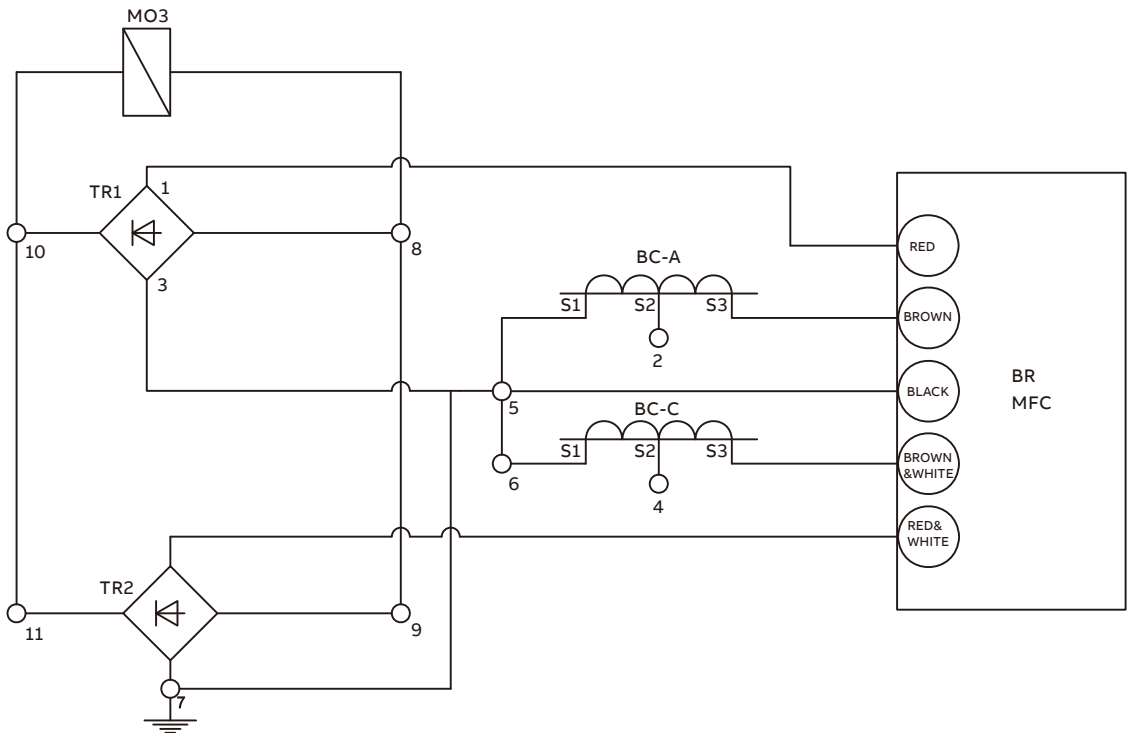
# 9 Electrical circuit diagram

## 9.1 Manual operation

### Electrical principle description

The primary current flows through A,C current transformer, secondary current flows into MFC.

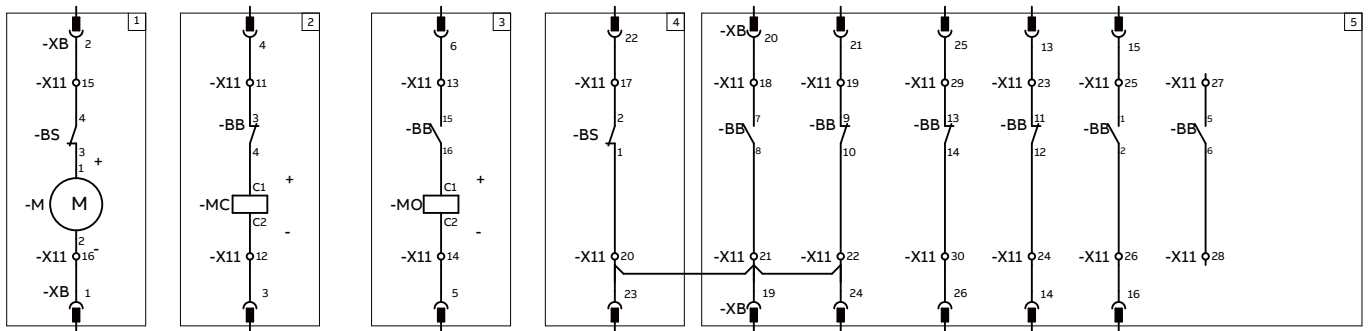
After internal logic checking, MFC only sends out the protection trip instruction according to the set time when there is a fault. After receiving instruction, MFC outputs current, and flows into the over current tripping coil, the circuit breaker will trip after tripping coil action.



BC-A	CT
BC-C	CT
MO3	Overcurrent coil
BR	MFC
TR1	Rectified block
TR2	Rectified block



## 9.2 Motor operation



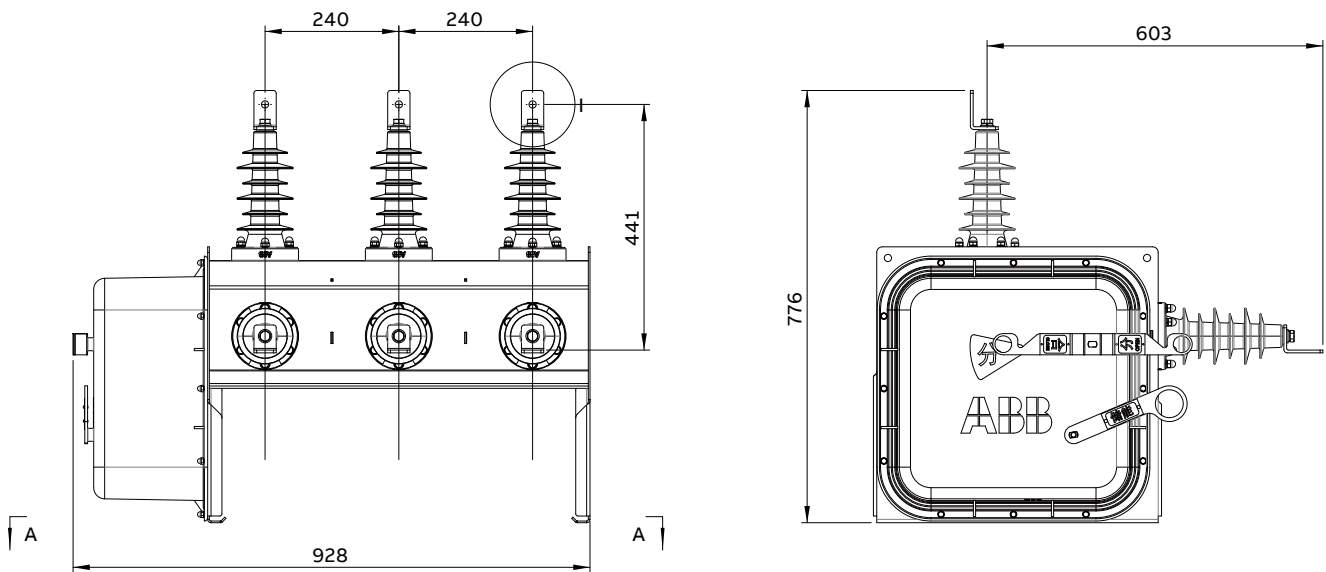
The diagram indication when CB in following status:

- CB in open position
- Close spring discharged

Symbol description		Schematic description	
Name	Description	Fig. 1	Motor circuit for spring charge
XB	26 pin plug	Fig. 2	Close circuit
BB	Aux. Contacts	Fig. 3	Open circuit
BS	Limit switch for motor	Fig. 4	Spring discharged signal
M	Motor	Fig. 5	CB aux. Contacts
MC	Close coiling		
MO	Open coiling		

# 10 Structure and installation

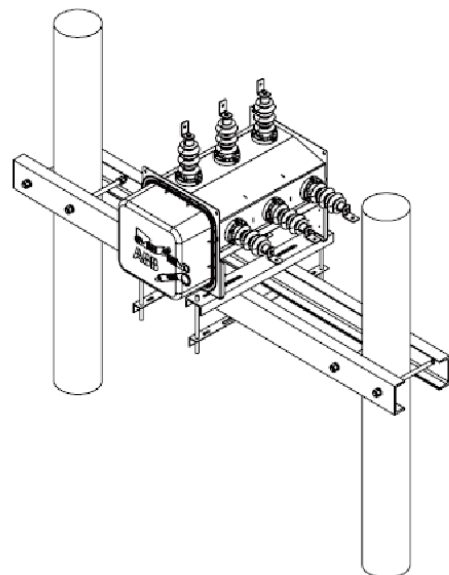
## 10.1 Overall structure



## 10.2 Installation

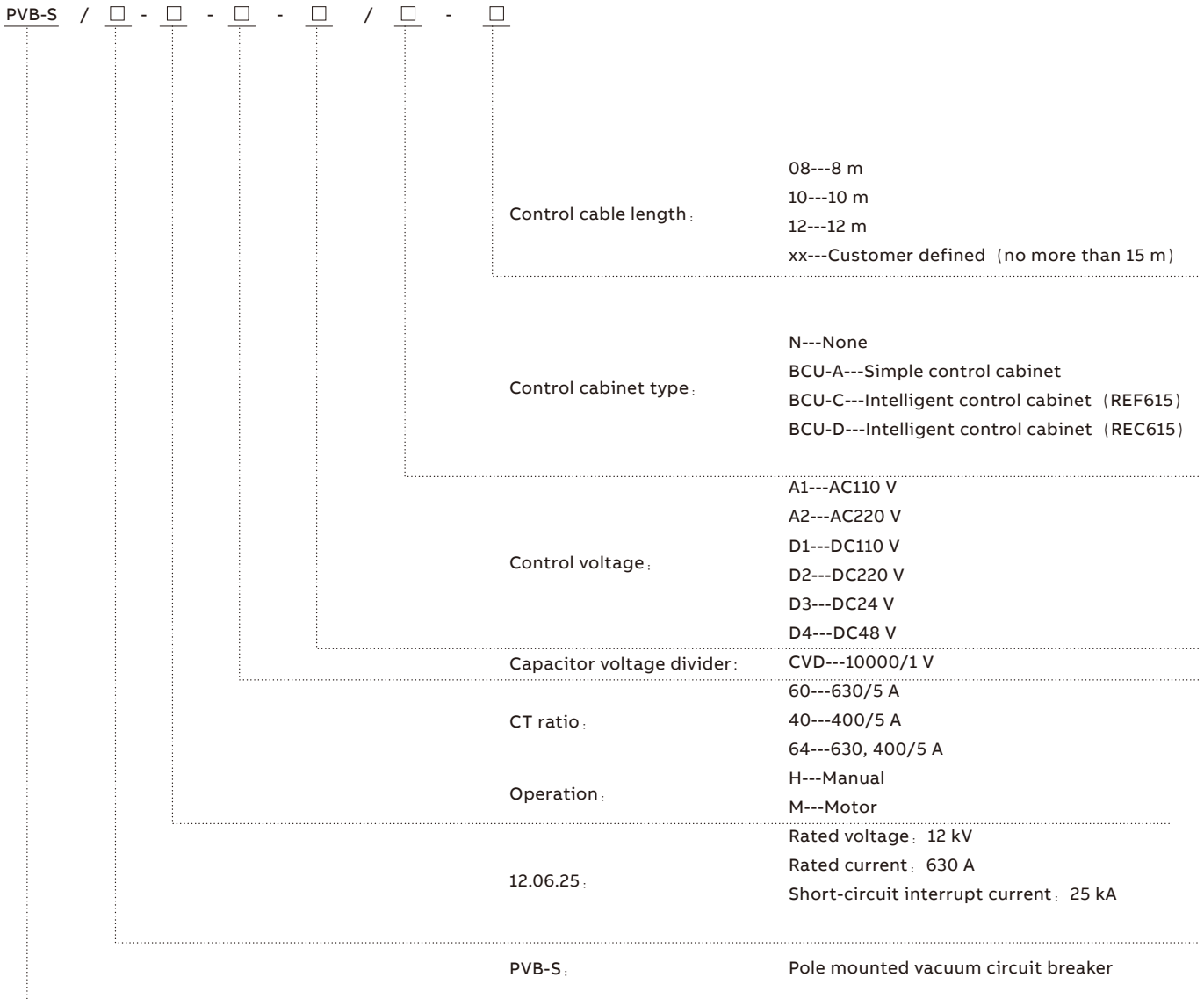


Single pole installation



Double poles installation

# 11 Ordering requirements



Example: PVB-S/12.06.25-M60-D4/BCU-D-08  
 Pole mounted vacuum circuit breaker  
 Rated voltage 12 kV  
 Rated current 630 A  
 Short-circuit interrupt current 25 kA  
 Motor operation  
 CT ratio: 630/5 A  
 Control voltage: DC48 V  
 Control cabinet: REC615  
 Control cable length: 8 m



---

**ABB Xiamen Switchgear Co., Ltd.**

No.885, FangShanXiEr Road, Xiang'an District,  
Xiamen, Fujian, 361101

Tel: 0592 602 6033

Fax: 0592 603 0505

**ABB China Customer Service Hot Line**

TEL: 800-820-9696 / 400-820-9696

mail: cn-ep-hotline@abb.com

**[www.abb.com](http://www.abb.com)**