




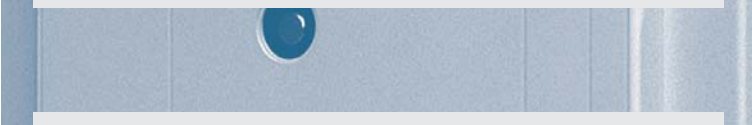
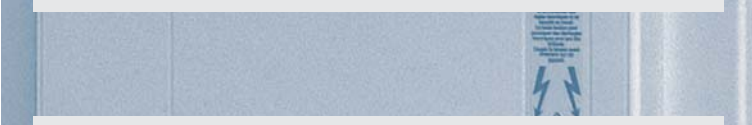
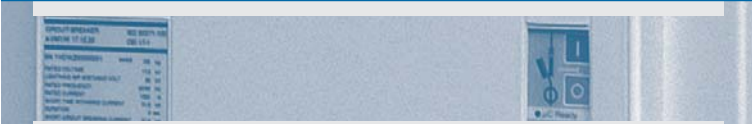

Medium Voltage Products

eVM1

Medium voltage vacuum circuit-breakers
with integrated magnetic actuator,
sensors, protections and control
12...17.5 kV - 630...1250 A - 16...31.5 kA

Power and productivity
for a better world™



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DESCRIPTION

General

The eVM1 circuit-breaker is a complete protection system of medium voltage electrical installations and, apart from the medium voltage vacuum circuit-breaker with magnetic drive, it consists of the following electronic devices for:

- protection
- control
- measurement
- monitoring
- watchdog.

The current sensors mounted at the rear of the circuit-breaker poles are also part of the system, thereby carrying out, in medium voltage, the concept of an automatic low voltage circuit-breaker in the standard solution, also widely used in medium voltage secondary distribution.

The eVM1 circuit-breakers use vacuum interrupters embedded in resin poles. The interrupters embedded in the resin make the circuit-breaker poles particularly sturdy and are effectively protected from shocks, deposits of dust and humidity. Each interrupter houses the contacts and makes up the quenching chamber. Activation of the interrupter contacts is entrusted to a single magnetic drive controlled by position sensors and by an electronic module. The energy needed for the operation is provided by capacitors which ensure an adequate reserve of energy. Thanks to these details, eVM1 circuit-breakers guarantee sturdiness, reliability, long life and are maintenance-free.



The eVM1 circuit-breakers are provided with current sensors on the pole terminals and the secondary circuit is cabled directly to the electronic control and protection module on board the circuit-breaker. A single type of sensor covers the whole range of rated currents.

The electronic module controls all the functions of the circuit-breaker: operation of the drive, protections, state of the whole switchgear panel and its integrity. Since most of the panel functions are on board the circuit-breaker, the use of eVM1 circuit-breakers allows cabling to be drastically reduced.

The configuration software allows display and/or modification of the protection, control and general setting parameters and makes complete supervision of the state of the panel possible.

The electronic control card at all times checks efficiency of the magnetic drive coils, correct charging of the capacitor for the opening – closing – opening cycle, incorrect positions or incongruent states of the circuit-breaker and of the panel isolators and efficiency of the microprocessor, making up an advanced watchdog system for the circuit-breaker, whose state is communicated to the operator either by means of signalling on the local HMI (human machine interface) or by means of the binary outputs, in order to allow intervention and to be able to solve the problem without discovering it at the last moment when the circuit-breaker has to operate.

Compared with a traditional medium voltage circuit-breaker, the integrated eVM1 circuit-breaker offers considerable advantages both in the installation stage and during service:

- simplified preparation of the specifications and of ordering procedures, leading to more rapid delivery times

- full factory testing and commissioning of operation of the circuit-breaker and of the other components mounted in the panel
- drastic reduction in cabling and in the risk of errors
- more rapid installation and putting into service of the substation
- improved service safety and reliability
- all the documentation regarding the system is available right from the beginning of the project.

The control circuit is characterised by:

- high electromagnetic immunity
- self-diagnosis of the charge of the capacitors and of continuity of the coils, controller watchdog with fault signalling
- wide range of auxiliary power supply in direct and alternating current
- low consumption for maintaining the charge of the capacitors
- detection of the circuit-breaker state by means of proximity sensors
- monitoring of all the quenching functions
- protection functions in accordance with IEC 60255-3 and IEC 60255-8 Standards:

basic series

- 51 Overcurrent IDMT (NI, VI, EI, LI)
- 51 Overcurrent DT1
- 50 Overcurrent DT2
- 51N Earth fault IDMT
- 51N Earth fault DT1
- 50N Earth fault DT2

complete series (also includes)

- 51MS Motor starting protection
- 66 Number of start-ups
- 51LR Locked rotor
- 49 Thermal overload
- 46 Unbalanced load.

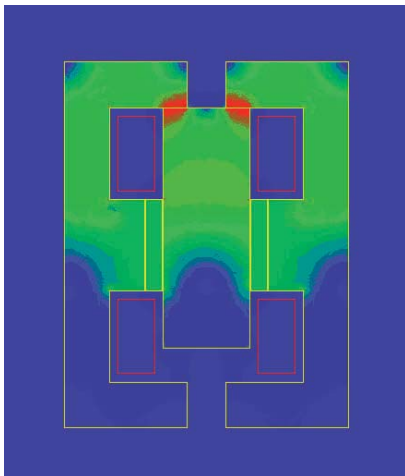
(1) For availability, please contact us.

DESCRIPTION

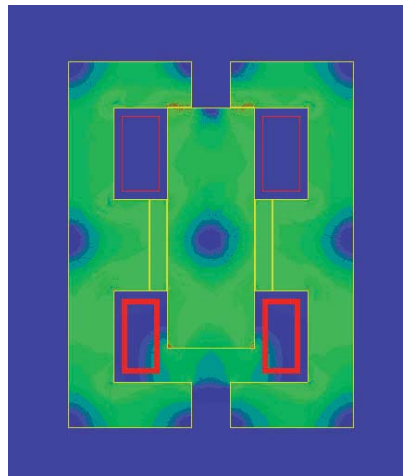
Magnetic drive technology

The magnetic drive used in the eVM1 circuit-breakers generates the stroke required to activate the moving contact in the interrupters and integrates all the functions of a traditional drive. The magnetic drive is a bistable system where the end-of-run positions of the moving armature are reached by means of magnetic fields generated by two coils (one for closing and one for opening). The moving armature is kept in position by permanent magnets. The circuit-breaker operations are obtained by energising the opening or closing coil respectively. The magnetic field generated by each coil attracts the moving armature and thereby moves it from one of the permanent magnet latching points to the other.

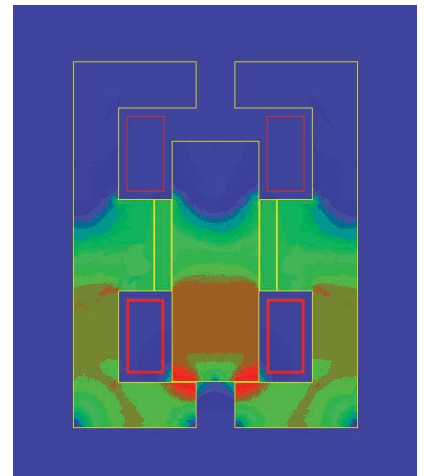
Capacitors are provided in the control circuit which allow the circuit-breaker to be operated, with a time limit of two minutes, even when there is a drop in the auxiliary voltage. In case of emergency, the circuit-breaker can in any case be opened by means of a special lever acting directly on the moving armature of the drive. Compared with a traditional drive, the magnetic drive has few moving parts and drastically reduced wear even after a high number of closing and opening cycles. These characteristics make it practically maintenance-free.



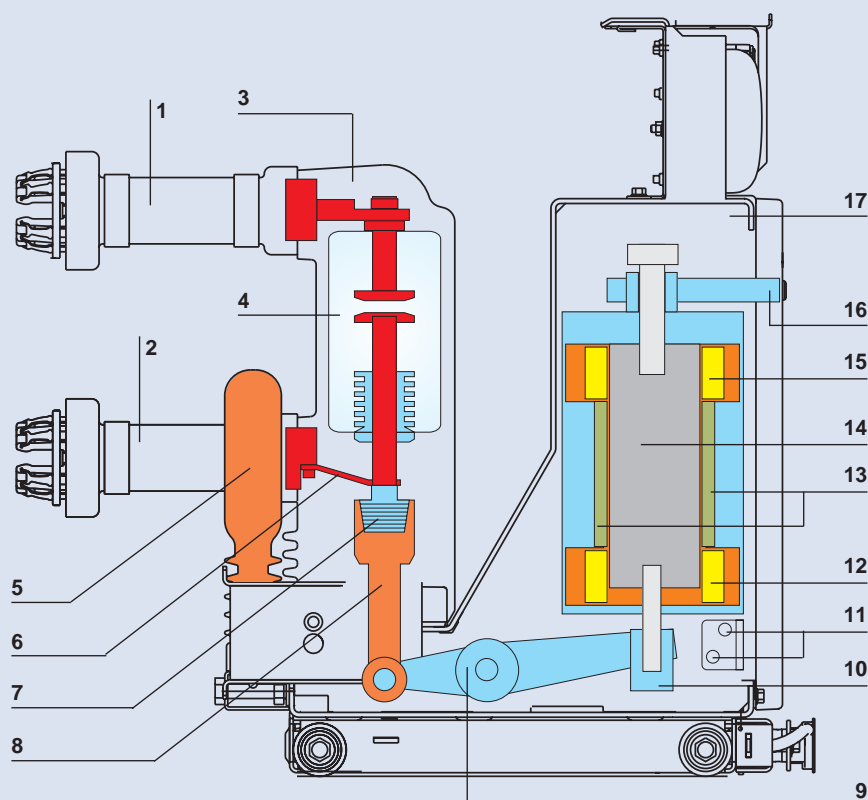
Magnetic latching in end-of-run position.



Magnetic latching and magnetic field action of a coil.



Moving armature in opposing position and end-of-run magnetic latching.



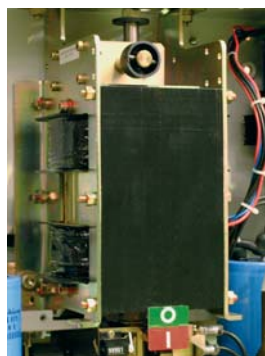
- 1 Top terminal
- 2 Bottom terminal
- 3 Pole in resin
- 4 Vacuum interrupter
- 5 Current sensor
- 6 Flexible connection
- 7 Contact pressure spring
- 8 Insulating push-rod
- 9 Drive shaft

- 10 Run regulator
- 11 Position sensors
- 12 Closing coil
- 13 Permanent magnets
- 14 Moving armature
- 15 Opening coil
- 16 Manual emergency opening device
- 17 Supporting structure

DESCRIPTION

Structure

The magnetic actuator and the poles with the current sensors are fixed to a metal frame that provides strength and reliability from a mechanical aspect. Both fixed and removable versions are available. The fixed version includes a cord and plug for connecting to the auxiliary circuits and current sensors. Besides the isolating contacts and the cord with plug for connecting to the auxiliary circuits, the removable version also has a withdrawable trolley that allows it to be moved in and out of the panel or holder with the doors closed, and current sensors. The precision class of the current sensors (Rogowski coils) is 1.



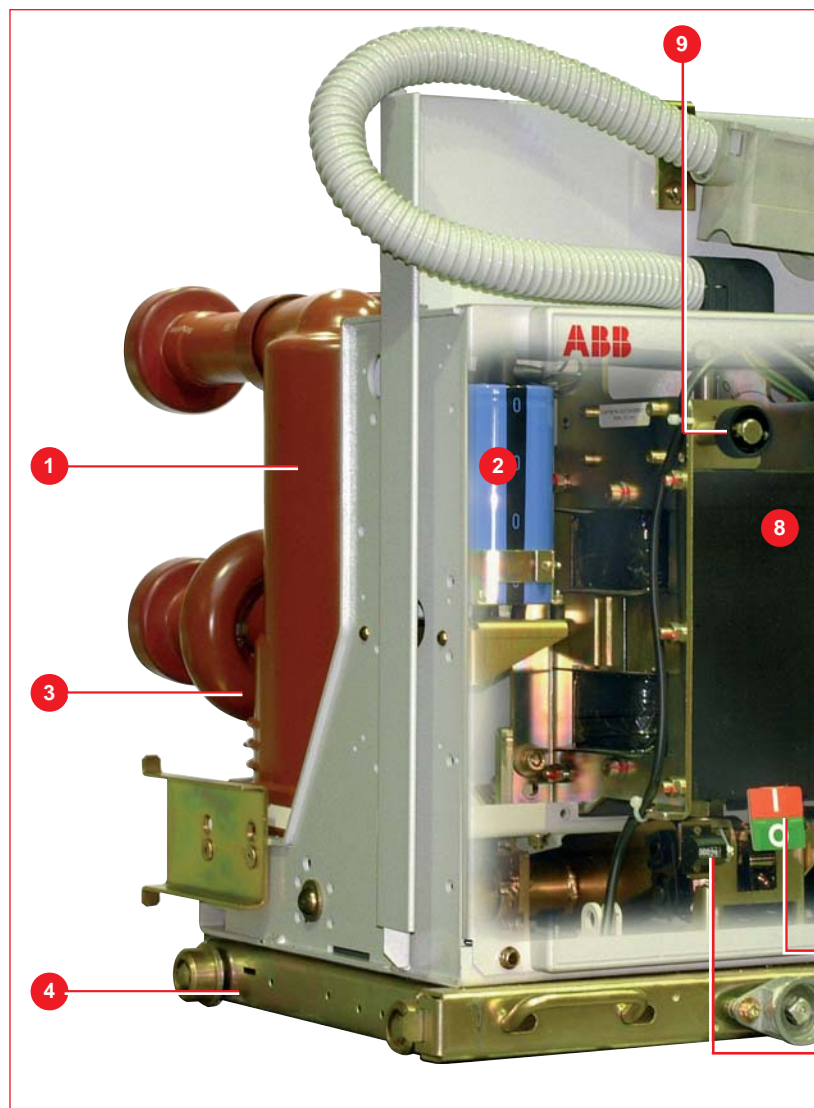
Magnetic drive

This consists of a laminar pack, two permanent magnets, two coils and a moving armature. The moving element is attracted by the magnetic field generated by one of the windings and, by means of a special kinematics device, allows the interrupter contacts to be operated on opening and closing.



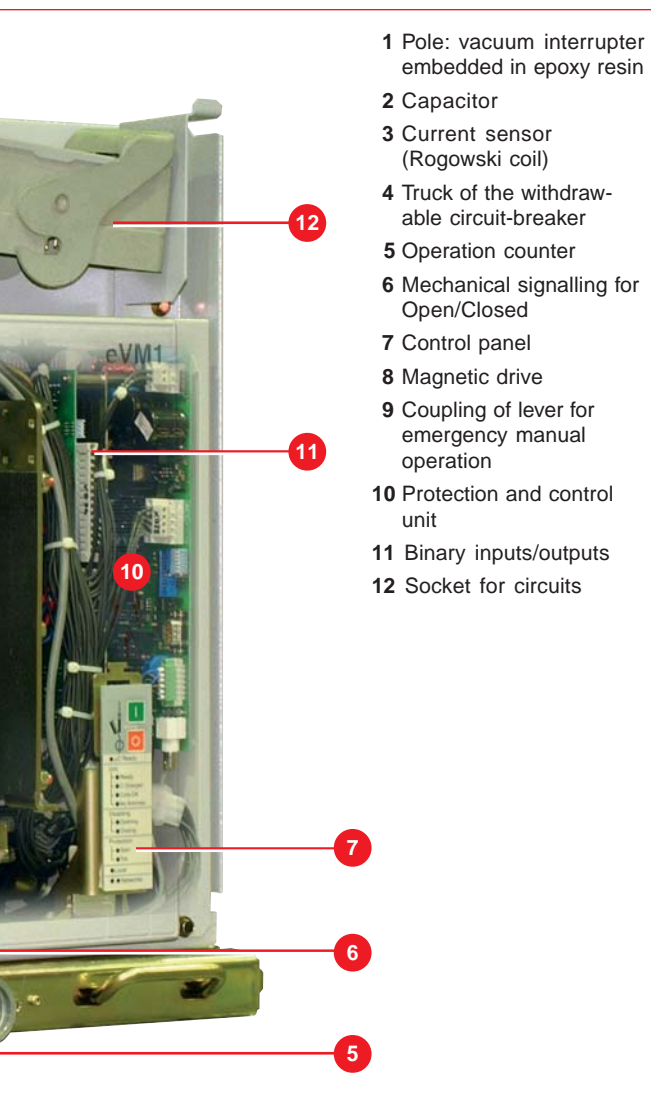
Local control and signalling interface

The local on-board circuit-breaker unit allows local opening and closing operations (if enabled) to be carried out and to display the state of the circuit-breaker by means of small luminous mimic diagram. Special LEDs display any anomalies, locking of opening and closing operations, activation and trip of the protection, and the type of operation set (local/remote).



Electronic module

The electronic module controls all the circuit-breaker functions, receives and sends command and control signals by means of binary inputs (logical) and isolated signalling contacts. It also carries out the protection functions which are available in two versions (basic and complete).



- Vacuum quenching technique
- Embedded vacuum interrupters
- Contacts protected against oxidation and contamination
- Operation under different climatic conditions
- Mechanical compatibility with the VD4 and VM1 series
- Possibility of use in all types of plants
- Magnetic drive
- Limited number of components
- Inductive position sensors
- Limited power consumption
- Sealed-for-life poles
- High reliability and sturdiness
- Long electrical and mechanical life
- Maintenance-free
- Circuit-breaker racking-out and racking-in with door closed
- Incorrect and hazardous operations prevented by special locks in the drive and in the truck and by the electronic control module
- High electromagnetic and environmental compatibility
- Emergency mechanical opening operation
- Control of the state of the circuit-breaker
- Control of continuity of the coils
- Control of capacitor charge
- Watchdog function
- Protection functions
- Current sensors (Rogowski coils)
- Programmable digital inputs/outputs
- Configuration and supervision programme for PC
- Panel interface module (HMI) with ammeter (on request)
- Drastic reduction in cabling and in the risk of connection errors
- More rapid installation and putting into service of the substation
- Rapid modification on site of the control and protection functions with the circuit-breaker already installed or in service
- Improved safety and reliability of service
- Availability of all the documentation regarding the system right from the beginning of the project



Position sensors

The sensors have the function of determining the exact mechanical position of the circuit-breaker (open or closed). The signal is sent to the electronic control module.



Capacitors

The capacitors have the function of storing the energy required for a complete cycle: opening - closing - opening. When there is no auxiliary power supply, the capacitors are able to maintain circuit efficiency for about 30 s.

DESCRIPTION

Vacuum current quenching

The eVM1 circuit-breaker exploits the dielectric characteristics of a vacuum and does not require an interrupting and insulating medium. In fact, the interrupter does not contain any ionisable gas. In any case, on separation of the contacts an electric arc is generated made up exclusively of melted and vaporised contact material. The electric arc only remains supported by the external energy until the current is cancelled by near natural zero.

At that instant, the rapid reduction in the load density carried and rapid condensation of the metallic vapour, leads to extremely rapid recovery of the dielectric properties.

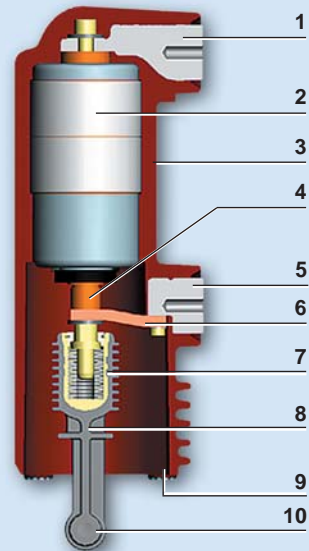
The vacuum interrupter therefore recovers its insulating capacity and the capacity to withstand the transient recovery voltage, definitively extinguishing the arc.

Since high dielectric strength can be reached in the 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.

Characteristics of the vacuum interrupter embedded in the resin pole

- Vacuum quenching technique
- Contacts protected against oxidation and contamination
- Vacuum interrupter embedded in resin poles
- Interrupter protected against shocks, dust and humidity
- Operation under different climatic conditions
- Limited operating energy
- Compact dimensions
- Sealed-for-life poles
- Sturdiness and reliability
- Maintenance-free
- High environmental compatibility



- | | |
|------------------------------|----------------------------|
| 1 Top terminal | 7 Tie-rod spring fork |
| 2 Vacuum interrupter | 8 Tie-rod |
| 3 Resin housing | 9 Pole fixing |
| 4 Stem of the moving contact | 10 Connection to the drive |
| 5 Bottom terminal | |
| 6 Flexible connection | |

Quenching principle of ABB interrupters

In a vacuum interrupter, the electric arc starts the moment the contacts separate, is maintained until zero current and can be affected by the magnetic field.

Diffuse or contracted vacuum arc

Following contact separation, single melting points form on the surface of the cathode. This causes formation of metallic vapours which support the arc itself.

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

At the rated current of the vacuum interrupter, the electric arc is always of the diffuse type.

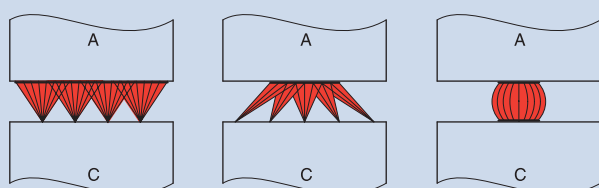
Contact erosion is very limited, and the number of current interruptions very high.

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 from the anode, the arc contracts and as the current rises it tends to concentrate.

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. When the arc rotates it becomes similar to a moving conductor which the current passes through.

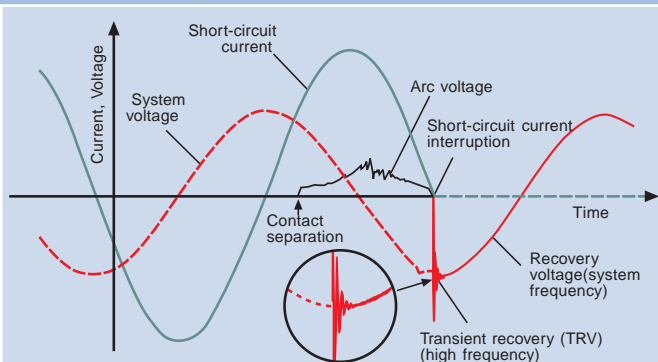


Diffuse arc.

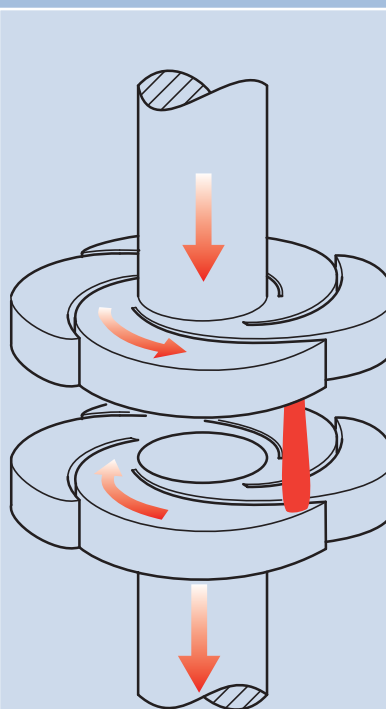
Contraction on the anode.

Contraction on the anode and on the cathode.

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

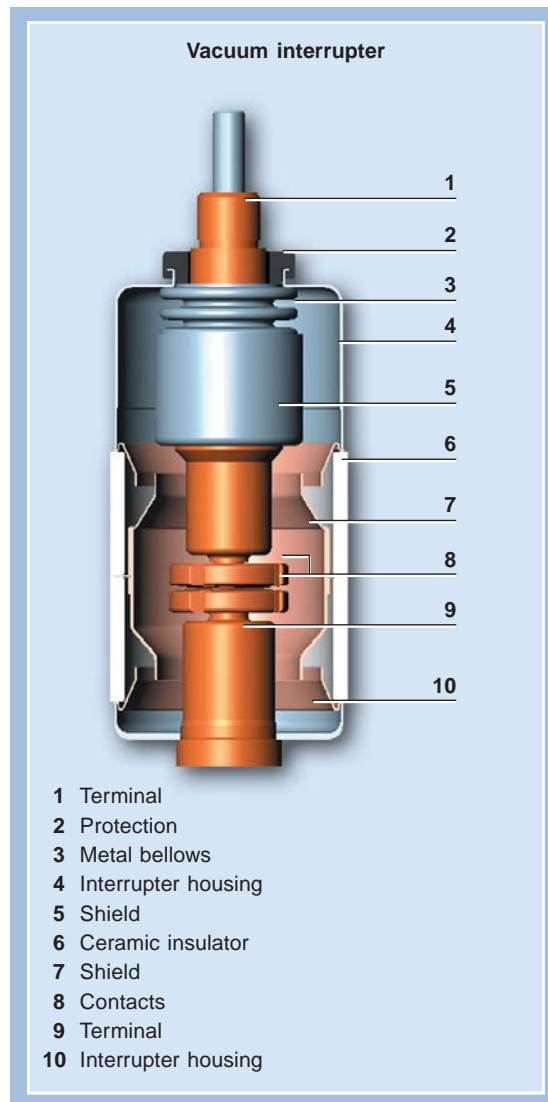


Development of current and voltage trends in a single phase during vacuum quenching.



Geometry of the contact with radial magnetic field with an arc rotating in a vacuum.

DESCRIPTION



The spiral geometry of ABB vacuum interrupter contacts

The particular spiral geometry of the 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 quenching process to be controlled even with very high short-circuits currents.

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

Rapid reduction in the current density and rapid condensation of the metallic vapours simultaneously with the moment of zero current means maximum dielectric strength can be restored between the interrupter contacts within a few thousandths of a second.

Versions available

The eVM1 circuit-breakers are available in the fixed and withdrawable version for UniGear switchgear and PowerCube modules. The eVM1 circuit-breakers are mechanically interchangeable with the circuit-breakers in the VD4 and VM1 series which use the same vacuum interrupters embedded in resin poles.

Fields of application

Thanks to integration of the current sensors and to the current protection functions, eVM1 circuit-breakers feature great versatility of use, typically for power supply lines for transformers, motors, power factor correction capacitor banks and for all applications where voltmetric type protections are not required.

Standards and approvals

The eVM1 circuit-breakers comply with the IEC 62271-100, CEI 17-1 file 1375 Standards and with those of the major industrialised countries. The eVM1 circuit-breakers have undergone the tests indicated below and guarantee the safety and reliability of the apparatus in service in any installation.

- **Type tests:** heating, withstand insulation at power frequency, withstand insulation at lightning impulse, short-time and peak withstand current, mechanical life, short-circuit current making and breaking capacity, and no-load cable interruption.
- **Individual tests:** insulation of the main circuits with voltage at power frequency, auxiliary and control circuit insulation, measurement of the main circuit resistance, mechanical and electrical operation.
- **Electromagnetic compatibility tests:** in accordance with what is defined by the IEC 60694, IEC 61000 and EN 50263 Standards.

Service safety

Thanks to the complete range of both mechanical and electrical software locks, safe distribution switchgear can be constructed with eVM1 circuit-breakers.

The locking devices have been studied to prevent incorrect operations and to allow inspection of the installations guaranteeing maximum operator safety.

The racking-out device with the door closed only allows the circuit-breaker to be racked into or out of the switchgear with the door closed.

DESCRIPTION

Technical documentation

To go into technical and application aspects of the eVM1 circuit-breakers in depth, ask for the following publications:

– PowerCube modules	Code 1VCP000091
– UniGear switchgear	Code 1VCP000138

Quality System

Complies with ISO 9001 Standards, certified by an independent organisation.

Test Laboratory

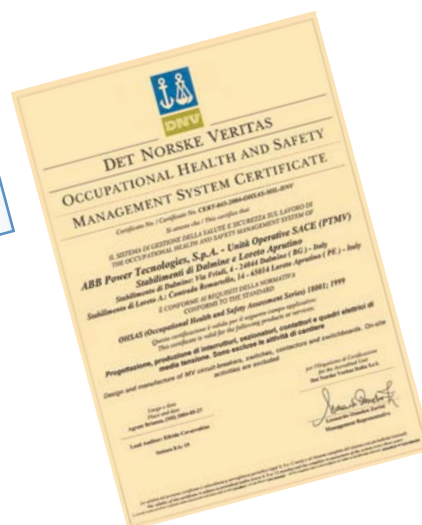
Complies with UNI CEI EN ISO/IEC 17025 Standards, accredited by an independent organisation.

Environmental Management System

Complies with ISO 14001 Standards, certified by an independent organisation.

Health and Safety Management System

Complies with OHSAS 18001 Standards, certified by an independent organisation.

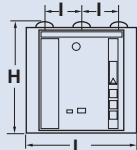


CIRCUIT-BREAKER SELECTION AND ORDERING

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CIRCUIT-BREAKER SELECTION AND ORDERING

Fixed circuit-breakers

Circuit-breaker			eVM1 12		eVM1 17		
Standards	IEC 60694 - 62271-100	■			■		
	CEI 17-1 (File 1375)	■			■		
Rated voltage	Ur [kV]	12			17		
Rated insulation voltage	Us [kV]	12			17		
Withstand voltage at 50 Hz	Ud (1 min) [kV]	28			38		
Impulse withstand voltage	Up [kV]	75			95		
Power frequency	fr [Hz]	50-60			50-60		
Rated normal current (40 °C)	(1) Ir [A]	630	1250		630	1250	
Rated breaking capacity (rated symmetrical short-circuit current)	Isc [kA]	16	16		16	16	
		20	20		20	20	
		25	25		25	25	
		31.5	31.5		31.5	31.5	
Rated short-time withstand current (3 s)	Ik [kA]	16	16		16	16	
		20	20		20	20	
		25	25		25	25	
		31.5	31.5		31.5	31.5	
Making capacity	Ip [kA]	40	40		40	40	
		50	50		50	50	
		63	63		63	63	
		80	80		80	80	
Operation sequence	[O-0,3s-CO-15s-CO]	■			■		
Opening time	[ms]	33			33		
Arc time	[ms]	10...15			10...15		
Total quenching time	[ms]	43...48			43...48		
Closing time	[ms]	50			50		
Mechanical operations (cycles)	Actuator	[N.]	... 100,000		... 100,000		
	Interrupters	[N.]	... 30,000		... 30,000		
Electrical operations (cycles)	Rated current	[N.]	... 30,000		... 30,000		
	Under short-circuit	[N.]	... 100		... 100		
Maximum overall dimensions		H [mm]	461	461	461	461	
		L [mm]	450	570	700	450	570
		P [mm]	464	464	464	464	464
		I [mm]	150	210	275	150	210
Pole centre distance		A [mm]	205	205	205	205	
Bottom/top terminal distance							
Weight	[kg]	106 ...117		106 ...117			
Power consumption at rest	[W]	≤ 15		≤ 15			
Power consumption after a self-pumping cycle	[W]	≤ 110		≤ 110			
Service temperature	[°C]	− 5 ... + 40		− 5 ... + 40			
Electromagnetic compatibility	IEC 61000	■			■		
	IEC 60255	■			■		

(1) Rated uninterrupted currents guaranteed with withdrawable circuit-breaker installed in UniGear ZS1 type switchgear with air temperature of 40 °C.

Types of fixed circuit-breakers

Ur	Ir (40°C)	Isc	Dimensions			Circuit-breaker type
[kV]	[A]	[kA]	L [mm]	I [mm]	A [mm]	
12	630	16	450	150	205	eVM1 12.06.16 p150
	630	20	450	150	205	eVM1 12.06.20 p150
	630	25	450	150	205	eVM1 12.06.25 p150
	630	31.5	450	150	205	eVM1 12.06.32 p150
	1250	16	450	150	205	eVM1 12.12.16 p150
	1250	20	450	150	205	eVM1 12.12.20 p150
	1250	25	450	150	205	eVM1 12.12.25 p150
	1250	31.5	450	150	205	eVM1 12.12.32 p150
12	630	16	570	210	205	eVM1 12.06.16 p210
	630	20	570	210	205	eVM1 12.06.20 p210
	630	25	570	210	205	eVM1 12.06.25 p210
	630	31.5	570	210	205	eVM1 12.06.32 p210
	1250	16	570	210	205	eVM1 12.12.16 p210
	1250	20	570	210	205	eVM1 12.12.20 p210
	1250	25	570	210	205	eVM1 12.12.25 p210
	1250	31.5	570	210	205	eVM1 12.12.32 p210
12	630	16	700	275	205	eVM1 12.06.16 p275
	630	20	700	275	205	eVM1 12.06.20 p275
	630	25	700	275	205	eVM1 12.06.25 p275
	630	31.5	700	275	205	eVM1 12.06.32 p275
	1250	16	700	275	205	eVM1 12.12.16 p275
	1250	20	700	275	205	eVM1 12.12.20 p275
	1250	25	700	275	205	eVM1 12.12.25 p275
	1250	31.5	700	275	205	eVM1 12.12.32 p275
17.5	630	16	450	150	205	eVM1 17.06.16 p150
	630	20	450	150	205	eVM1 17.06.20 p150
	630	25	450	150	205	eVM1 17.06.25 p150
	630	31.5	450	150	205	eVM1 17.06.32 p150
	1250	16	450	150	205	eVM1 17.12.16 p150
	1250	20	450	150	205	eVM1 17.12.20 p150
	1250	25	450	150	205	eVM1 17.12.25 p150
	1250	31.5	450	150	205	eVM1 17.12.32 p150
17.5	630	16	570	210	205	eVM1 17.06.16 p210
	630	20	570	210	205	eVM1 17.06.20 p210
	630	25	570	210	205	eVM1 17.06.25 p210
	630	31.5	570	210	205	eVM1 17.06.32 p210
	1250	16	570	210	205	eVM1 17.12.16 p210
	1250	20	570	210	205	eVM1 17.12.20 p210
	1250	25	570	210	205	eVM1 17.12.25 p210
	1250	31.5	570	210	205	eVM1 17.12.32 p210
17.5	630	16	700	275	205	eVM1 17.06.16 p275
	630	20	700	275	205	eVM1 17.06.20 p275
	630	25	700	275	205	eVM1 17.06.25 p275
	630	31.5	700	275	205	eVM1 17.06.32 p275
	1250	16	700	275	205	eVM1 17.12.16 p275
	1250	20	700	275	205	eVM1 17.12.20 p275
	1250	25	700	275	205	eVM1 17.12.25 p275
	1250	31.5	700	275	205	eVM1 17.12.32 p275



Notes

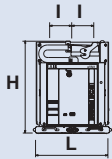
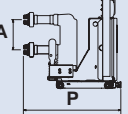
L = Width of the circuit-breaker.

I = Horizontal centre distance between poles.

A = Distance between bottom and top terminal.

CIRCUIT-BREAKER SELECTION AND ORDERING

Withdrawable circuit-breakers for UniGear switchgear and PowerCube modules

Circuit-breaker		eVM1 12		eVM1 17	
Standards	IEC 60694 - 62271-100	■		■	
	CEI 17-1 (File 1375)	■		■	
Rated voltage	Ur [kV]	12		17	
Rated insulation voltage	Us [kV]	12		17	
Withstand voltage at 50 Hz	Ud (1 min) [kV]	28		38	
Impulse withstand voltage	Up [kV]	75		95	
Power frequency	fr [Hz]	50-60		50-60	
Rated normal current (40 °C)	(1) Ir [A]	630	1250	630	1250
Rated breaking capacity (rated symmetrical short-circuit current)	Isc [kA]	16	16	16	16
		20	20	20	20
		25	25	25	25
		31.5	31.5	31.5	31.5
Rated short-time withstand current (3 s)	Ik [kA]	16	16	16	16
		20	20	20	20
		25	25	25	25
		31.5	31.5	31.5	31.5
Making capacity	Ip [kA]	40	40	40	40
		50	50	50	50
		63	63	63	63
		80	80	80	80
Operation sequence	[O-0,3s-CO-15s-CO]	■		■	
Opening time	[ms]	33		33	
Arc time	[ms]	10...15		10...15	
Total quenching time	[ms]	43...48		43...48	
Closing time	[ms]	50		50	
Mechanical operations (cycles)	Actuator [N.]	... 100,000		... 100,000	
	Interrupters [N.]	... 30,000		... 30,000	
Electrical operations (cycles)	Rated current [N.]	... 30,000		... 30,000	
	Under short-circuit [N.]	... 100		... 100	
Maximum overall dimensions		H [mm]	628	628	628
		L [mm]	503	503	503
		P [mm]	662	662	662
		I [mm]	150	150	150
Pole centre distance		A [mm]	205	205	205
Bottom/top terminal distance					
Weight	[kg]	126 ...137		126 ...137	
Power consumption at rest	[W]	≤ 15		≤ 15	
Power consumption after a self-pumping cycle	[W]	≤ 110		≤ 110	
Service temperature	[°C]	- 5 ... + 40		- 5 ... + 40	
Electromagnetic compatibility	IEC 61000	■		■	
	IEC 60255	■		■	

(1) Rated uninterrupted currents guaranteed with withdrawable circuit-breaker installed in UniGear ZS1 type switchgear with air temperature of 40 °C.

Types of withdrawable circuit-breakers for UniGear switchgear and PowerCube modules

Ur	Isc	Rated uninterrupted current (40°C) [A]	
kV	kA	L = 650 I = 150 u/I = 205 ø = 35	Type of circuit-breaker
12	16	630	eVM1/P 12.06.16 p150
	20	630	eVM1/P 12.06.20 p150
	25	630	eVM1/P 12.06.25 p150
	31.5	630	eVM1/P 12.06.32 p150
	16	1250	eVM1/P 12.12.16 p150
	20	1250	eVM1/P 12.12.20 p150
	25	1250	eVM1/P 12.12.25 p150
	31.5	1250	eVM1/P 12.12.32 p150
17.5	16	630	eVM1/P 17.06.16 p150
	20	630	eVM1/P 17.06.20 p150
	25	630	eVM1/P 17.06.25 p150
	31.5	630	eVM1/P 17.06.32 p150
	16	1250	eVM1/P 17.12.16 p150
	20	1250	eVM1/P 17.12.20 p150
	25	1250	eVM1/P 17.12.25 p150
	31.5	1250	eVM1/P 17.12.32 p150



Notes

- L = Width of the UniGear switchgear.
 I = Horizontal centre distance between poles.
 u/I = Distance between bottom and top terminal.
 ø = Diameter of isolating contact.

CIRCUIT-BREAKER SELECTION AND ORDERING

Control circuit power supply

The energy for operation of the circuit-breaker is provided by one or more capacitors which are kept charged by a feeder which also sees to the power supply of the electronic circuit. This guarantees correct operation even if the auxiliary power supply does not reach the rated value.

Thanks to the use of low consumption components, the feeder absorption is about 15 watt with the circuit-breaker closed or open.

After each operation the feeder absorbs about 110 watt for a few seconds to restore the optimal charge level of the capacitors.

The charging condition of the capacitors is constantly monitored by the electronic module which also provides to the functions of opening, closing, signalling, etc.

Two feeders are available:

- **type 1:** 24...48 V a.c. / 24...60 V d.c.
- **type 2:** 100...240 V a.c. / 110...250 V d.c.

Standard fittings

The basic versions of the withdrawable circuit-breakers are three-pole and fitted with:

- closing button (built into the control panel –PI1)
- opening button (built into the control panel –PI1)
- mechanical operation counter
- mechanical signalling device for circuit-breaker open/closed
- emergency manual opening device
- lever for manual emergency opening (the quantity must be defined according to the number of pieces of apparatus ordered)
- “READY” for operation signal, together with a further 11 luminous diagnostic signals on the local interface of the circuit-breaker
- one or more capacitors for energy storage for the operation
- mobile connector for direct connection to the sockets of the electronic module, for cabling the auxiliary circuits
- basic version control module with protections I> - I>> - Io> - Io>> (51-50-51N-50N)
- software for configuration of the protections, control and display of the state
- transmitted contacts in the trolley (-BT1; -BT2).

Basic version of monitoring module

The monitoring module has 16 inputs and 16 outputs of the digital type, the majority of which can be freely programmed via the configuration software to suit the requirements of the system.

Consult schematic drawings 1VCD400060 for all the application meanings of the switch.

Amongst the fixed, non-programmable inputs:

- input for the minimum voltage function
- remote opening and closing controls
- disabling of the opening manoeuvre
- second switch opening via hardware only, to provide the utmost reliability.

Amongst the fixed, non-programmable outputs:

- switch closed and open
- signal that unit is ready for –RL2 (locking magnet on carriage)
- monitoring signal.

All the remaining inputs and outputs are mapped according to pre-defined meanings if one of the four default application layouts is selected (switch removable, removable with grounding switch, fixed, fixed with grounding switch) by means of the software configurator, while all the available meanings can be allocated to the digital inputs/outputs by ticking off the ‘free’ layout (consult the Input / Output Mapping chapter).

For example:

- grounding switch position, open and closed
- functional interlocks
- local – remote control enabling keys
- protection activation reset
- local switch closing and opening command.

(1) For the characteristics of the contacts without potential see chapter 3.

(2) With the circuit-breaker not supplied (without auxiliary power supply) these contacts are open, except for the contact for signalling circuit-breaker not ready for operation (DO16).

And for the outputs:

- switch in service or being tested
- protection activated
- functional interlocks
- protections in timed mode (start)
- switch opened by protection opening commands (transitory contact made for 100 ms)
- opening and closing manoeuvres disabled.

The meanings of the outputs can be programmed several times with the same function. For example, three outputs to indicate the switch open position.

The binary inputs can be powered in the following way:

- 24 ... 240 V AC (– 15% ... + 10% tolerance)
- 24 ... 250 V DC (– 30% ... + 10% tolerance).

To be considered valid, the pulse must last at least 5 10 ms, approx.

The monitoring module carries out the following functions:

- auto-opening after the switch not correct status has been detected
- auto-lock after a condenser charging threshold that is less than the minimum value required for the opening and closing manoeuvre; self-opening if the condition persists (Energy Failure Autotrip)
- antipumping relay function
- trip-free condenser charging voltage monitoring function with power supplier auto-switch-off if the maximum charge level is exceeded
- opening for minimum voltage condition with nominal reference voltage selection and the ability to delay opening from 0 to 5 s (-SO4)
- auto-protection of the electronic power circuit with power supplier auto-switch-off in the event of overtemperature and/or overcurrent
- opening and closing coil continuity monitoring
- watchdog (DO16).

Accessories on request



1 Interface for panel (HMI)

The interface allows the control and protection device incorporated in the eVM1 circuit-breaker to be managed from the low voltage compartment door of the unit.

2 Extended set of protections

The extended set of protections makes available, apart from the following basic protections (ref. IEC 60255-3 and IEC 60225-8):

- 51 Overcurrent IDMT (NI, VI, EI, LI)
- 51 Overcurrent DT1
- 50 Overcurrent DT2
- 51N Earth fault IDMT
- 51N Earth fault DT1
- 50N Earth fault DT2

the following additional protections:

- 51MS Motor starting protection
- 66 Number of start-ups
- 51LR Locked rotor
- 49 Thermal overload
- 46 Unbalanced load.

The protections can be enabled/disabled locally by means of an RS485 port (local) or by the panel interface with IRDA connector by means of the configuration software.

CIRCUIT-BREAKER SELECTION AND ORDERING



3 Fast capacitor discharging device (CFD)

Device which allows the circuit-breaker capacities to be discharged rapidly and safely.



4 Cable for configuring eVM1 by means of HMI with USB/RS 232 - Irda connection

Cable which allows the personal computer to be connected to the interface for the HMI panel to configure the eVM1.



5 Connection cable Kit for configuring the eVM1 when there is no HMI

Kit which makes it possible to have an RS485 port in the low voltage compartment of the panel to connect the personal computer to in those cases where there is no HMI.



6 eVM1 RS232/USB - RS485 configuration cable

Cable which allows the personal computer to be connected to the RS485 port prepared in the low voltage compartment of the panel to configure the eVM1.

SPECIFIC PRODUCT CHARACTERISTICS

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SPECIFIC PRODUCT CHARACTERISTICS



Resistance to vibrations

The eVM1 circuit-breakers are unaffected by mechanically generated vibrations. Please contact us for the versions approved by shipping registers.

Tropicalisation

The eVM1 circuit-breakers are manufactured in compliance with the strictest regulations for use in hot-humid-saline climates.

All the most important metal parts are treated against corrosive factors according to UNI 3564-65 Standards environmental class C. Galvanisation is carried out in accordance with UNI ISO 2081 Standards, classification code Fe/Zn 12, with a thickness of 12×10^{-6} m, protected by a conversion layer mainly consisting of chromates in compliance with the UNI ISO 4520 Standards. These construction characteristics mean that all the eVM1 series of apparatus and their accessories comply with climate graph 8 of the IEC 60721-2-1 and IEC 60068-2-2 (Test B: Dry Heat).



Altitude

The insulating property of air decreases as the altitude increases, therefore this phenomenon must be taken into account for external insulation of the apparatus (the internal insulation of the interrupters does not undergo any variations as it is guaranteed by the vacuum).

The phenomenon must always be taken into account during the design stage of the insulating components of apparatus to be installed over 1000 m above sea level.

In this case a correction coefficient must be considered, which can be taken from the graph on the following page, built up on the basis of the indications in the IEC 60694 Standards.

The following example gives a clear interpretation of the indications given above.

Graph for determining the K_a correction factor according to the altitude

H = altitude in metres;

m = value referred to power frequency and to the lightning impulse withstand and between phase voltages.

Example

- Installation altitude: 2000 m
- Rated service voltage of 12 kV
- Industrial frequency withstand voltage: 28 kV rms
- Impulse withstand voltage: 75 kVp
- K_a factor, which can be taken from the graph = 1.13.

Considering the above parameters, the apparatus must withstand (under test at zero altitude, i.e. at sea level):

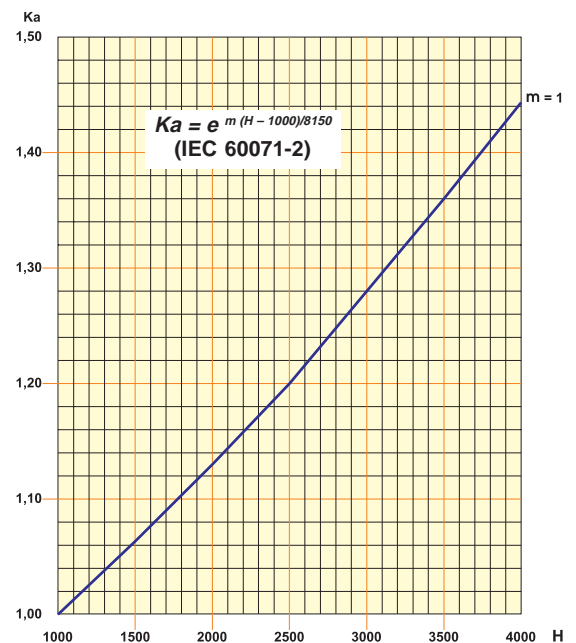
– power frequency withstand voltage:

$$28 \times 1.13 = 31.6 \text{ kVrms}$$

– impulse withstand voltage:

$$75 \times 1.13 = 84.7 \text{ kVp.}$$

From the above, it can be deduced that for installations at an altitude of 2000 m above sea level, with 12 kV service voltage, the apparatus must be provided with 17.5 kV rated voltage, characterised by insulation levels at industrial frequency of 38 kVrms with 95 kVp impulse withstand voltage.



Characteristics of the contacts without potential

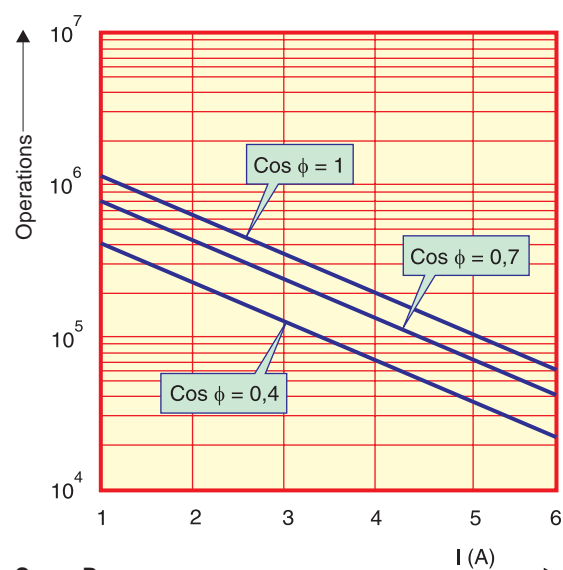
The contacts without potential are provided with special relays.

For the characteristics of the contacts, please see the table and curves given below.

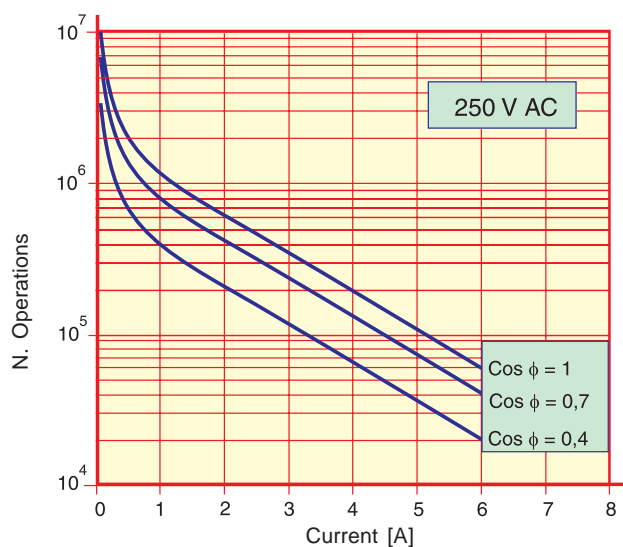
Notes

- In the case of inductive loads, the contacts must be protected against overvoltages by means of varistors.
- For the other characteristics, please refer to the IEC 60694.5.4.4.5.4 (Ed. 2.2), Class 3 Standards.

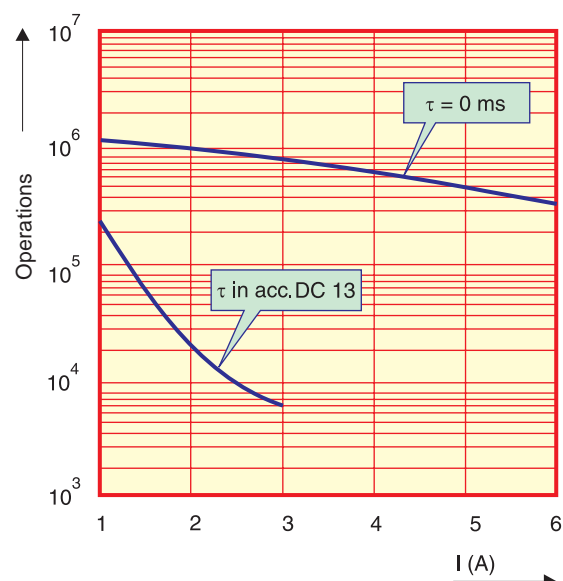
Rated voltage (range of operation)	0 ... 264 V~ 50/60 Hz 0 ... 280 V–
Maximum power applicable	1500 VA (V a.c. on resistive load) (V d.c. on resistive load - curves A)
Maximum voltage applicable	400 V~ 50/60 Hz 300 V–
Maximum current applicable	6 A
Rated current	6 A (250 V~ 50/60 Hz -resistive load)
Maximum contact resistance	≤ 100 mohm (measured at 6 V– / 1 A)
Maximum capacity	≤ 1.5 pF
Maximum closing time	≤ 5 ms
Maximum opening time	≤ 3 ms
Insulation between contacts and coil	4000 Vrms (50 Hz / 1 min)
Resistance with contacts open	Min. 10^3 Mohm (measured at 500 V–)
Operating temperature	- 40 °C ... + 85 °C
Storage temperature	- 40 °C ... + 100 °C
Mechanical life	500,000 operations (at 250 V~ 50/60 Hz - 180 operations/min)
Electrical life	50,000 operations (at 6 A / 277 V~ 50/60 Hz - resistive load - see curves B and C)



Curve B
Electrical life of the contacts at 250 V a.c.



Curve A
Maximum power applicable (V d.c./a.c. on resistive load).



Curve C
Electrical life of the contacts at 24 V d.c.

SPECIFIC PRODUCT CHARACTERISTICS

Monitoring and protecting electronics

All the functions described are provided by two modules.

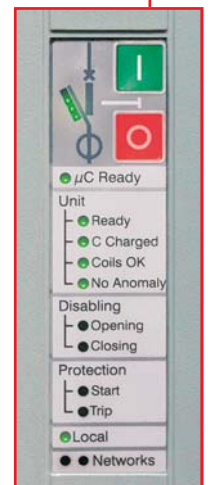
1. Main processing module with integrated feeder: this has the function of charging the capacitors for operation of the magnetic drive. It also sees to acquiring the analog signals and to analog-digital conversion of the signals coming from the Rogowski coils (current sensors). The analog signals are sampled and the current values are calculated by means of a digital Fourier transform (DFT) at the network frequency. By means of the control unit, it carries out current measurement, activates the protections, monitoring, signalling and watchdog. The information is exchanged with the binary I/O card. The card incorporates an RS485 port for communication with the configuration software and the HMI.

2. Binary I/O module: this includes 16 insulated binary inputs with wide range and 16 outputs with relay contacts for cabling the circuit-breaker and the switchgear.

Operation of the circuit-breaker

Operation of the eVM1 is very similar to operation of a traditional circuit-breaker. "Remote" or "local" operation can be enabled either by means of a circuit-breaker with key integrated in the interface placed in the low voltage compartment door of the switchgear panel or by means of a binary input. Red and green LEDs indicate the true positions of the circuit-breaker, of the isolating truck and of the earthing switch.

The circuit-breaker can be seen through the inspection widow of its own compartment. The door can only be opened with the circuit-breaker isolated and the earthing switch closed. Under these conditions, the circuit-breaker can be operated locally by means of its own control and signalling interface.

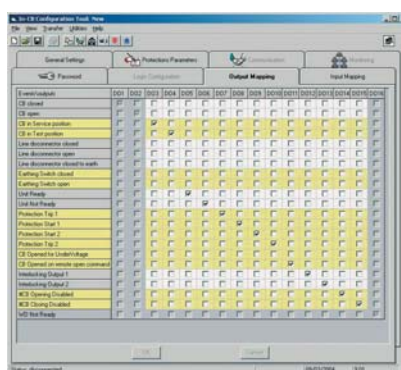


Software for configuration of the protections, control and display of state

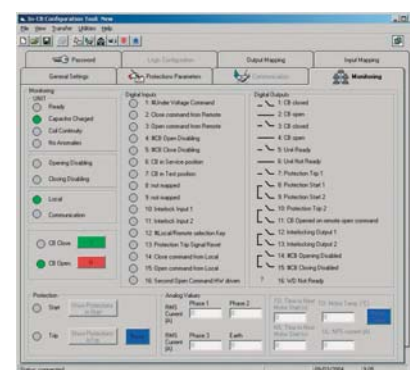
The interface located on the low voltage compartment door has a port with infrared rays. With the help of a laptop computer, the proper cable and the configuration software, it is possible to access all the information regarding the states of the operating devices and of the eVM1 circuit-breaker. Readout of all the phase currents and of the earth fault current is possible. Thanks to the software, the circuit-breaker can be completely configured (general settings and assignment of inputs and outputs). When a protection function trips, the circuit-breaker must be reset before attempting closing. To reset it, you can work using the configuration software or by means of the interface located in the low voltage compartment of the panel. Should this not be available, an alternative is to press the circuit-breaker opening pushbutton "O" for 5 s.

The switch can reclose in the blocked status caused by the relay having tripped when the respective function is enabled. This is useful when the switch is used in auto-reclosing cycles. The configuration software can also be used to select, parameterise and display the state of the protection. The basic protection functions cover the following applications for feeder protections: inverse time fault (IDMT) and definite time (DT) phase and earth fault. Furthermore, the extended version allows a series of motor protection functions: start-up, locked rotor and number of start-ups, unbalanced load and thermal overload protection functions.

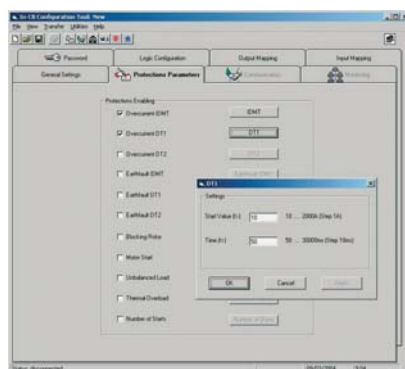
The protections, together with display of the values measured can also be enabled and configured directly from the front of the circuit-breaker in the test position and with the shield removed, by means of an RS485 cable with 9-pole connector.



Input/output configuration page:
- flexible mapping of logical events on I/O.



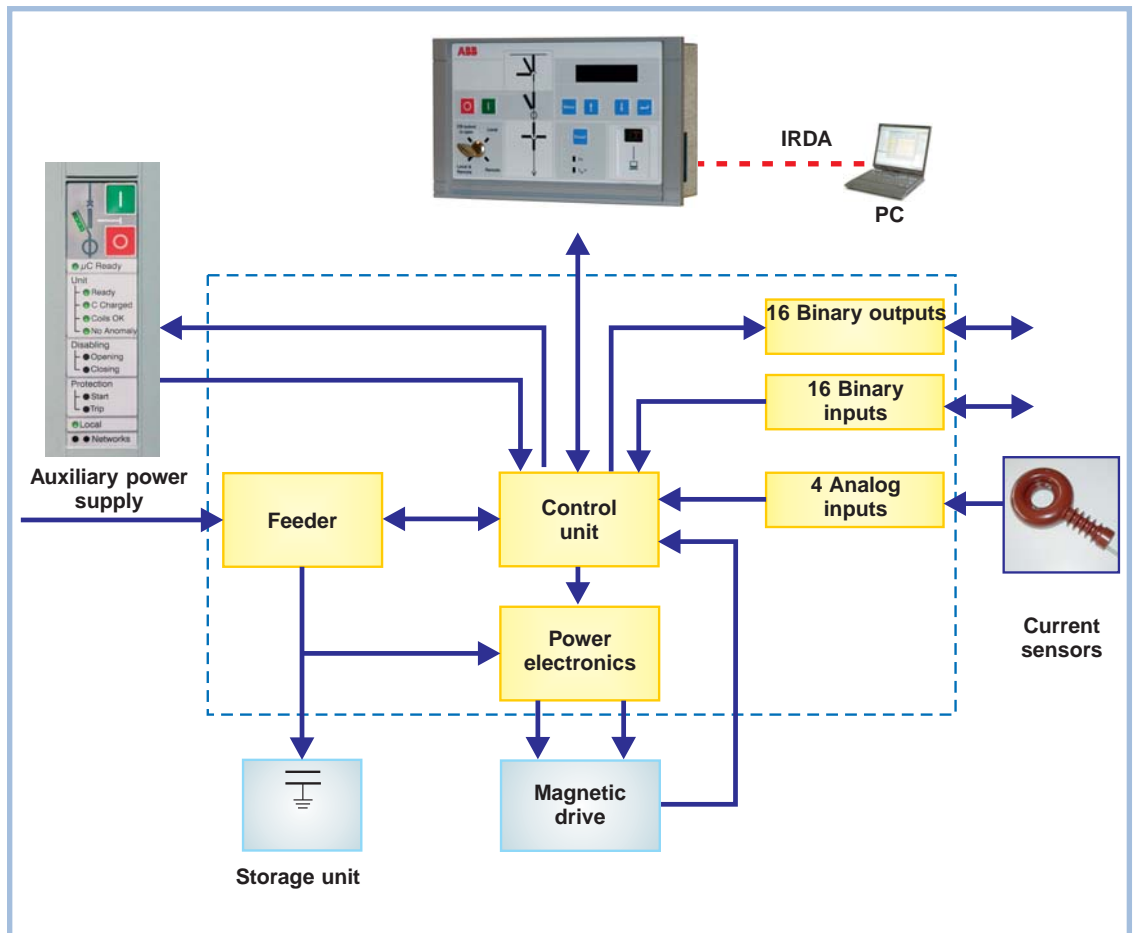
Monitoring page:
- complete indication of the state of the panel
- all the logical indications
- readout of the analog values
- circuit-breaker opening/closing commands
- protection start-up/trip/resetting.



Protection page:
- selection of protection
- configuration setting.

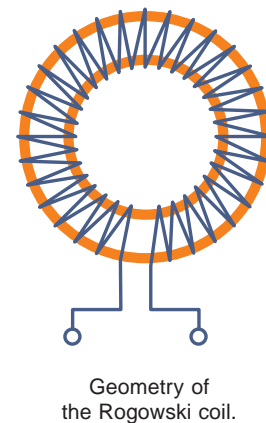
SPECIFIC PRODUCT CHARACTERISTICS

Architecture of the electronic control and information management module of the eVM1 circuit-breaker



The current sensor

The Rogowski coil consists of a solenoid wound over a non-magnetic core whose ends are accessible (see figure), destined to supply the measuring instrument with power. The operating principle it is based on is mainly that of a mutual inductor linked to the magnetic field produced by the currents subject to measurement and is therefore, by its nature, a transducer aimed at detecting currents variable over time. The Rogowski coil bases its operation on application of the Ampere theorem on the basis of which the integral of the magnetic field vector along a



closed line equals the sum of the currents which pass across the surface subtended by this line.

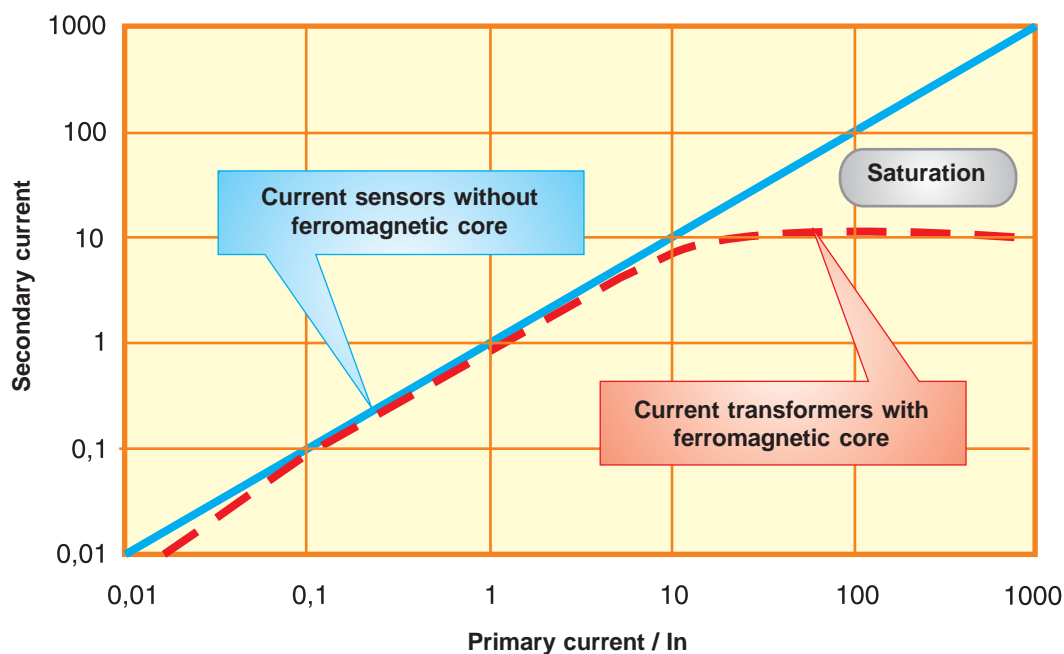
There are various advantages obtained by using the Rogowski coil, among which:

- absolute linearity of the output signal as a function of the one measured
- no saturation
- no currents magnetising the metallic core – important at low values for the current transformers
- no hysteresis phenomena.

When switch eVM1 was designed, the characteristics described above allowed a single size of sensor to be used with class 1 accuracy, able to cover all the current ratings from 50 to 1250 A and to protect against short circuits up to 31.5 kA.



Current sensor used in eVM1 circuit-breakers.



Comparison of the response characteristic of the Rogowski coil with that of a current transformer.

SPECIFIC PRODUCT CHARACTERISTICS

Panel interface: HMI

In order to be able to manage the protection and control system incorporated in the eVM1 easily, an interface is available (HMI Human Machine Interface) located on the low voltage compartment door of the panel.

This interface has the following functions:

- it allows control of the circuit-breaker by means of the opening and closing pushbuttons
- it shows the mimic diagram of the single-line panel diagram by using very bright green and red LEDs
- it contains a two-line display which normally shows the maximum phase current and the earth current (ammeter function), which, by means of the navigation pushbuttons, allows navigation around the eVM1 menu

- it allows the protection to be reset after a trip
- it shows the state of the protections by means of two LEDs, one for the phase fault and one for the earth fault
- it allows connection to a personal computer by means of the IrDA port
- by means of a 4-position key, it allows local or remote control of the circuit-breaker, or both, or circuit-breaker locking in the open position.

The HMI is connected to the electronics on board the circuit-breaker by means of two bushing conductors using the plug socket of the circuit-breaker itself. The HMI has a universal power supply.

In fact, it can be supplied with direct voltages from 24 to 250 Vdc or with alternating voltages at 50 and 60 Hz from 24 to 240 Vac.



Environmental protection programme

The eVM1 circuit-breakers are manufactured in accordance with the ISO 14000 Standards (Guidelines for environmental management). The production processes are carried out in compliance with the Standards for environmental protection in terms of reduction in energy consumption as well as in raw materials and production of waste materials. All this is thanks to the medium voltage apparatus manufacturing facility environmental management system. Assessment of the environmental impact of the life cycle of the product, obtained by minimising energy consumption and overall raw materials of the product, became a concrete matter during the design stage by means of targeted selection of the materials, processes and packing. This is to allow maximum recycling at the end of the useful life cycle of the apparatus.

Spare parts and ordering

- Position sensors
- Position contact of the withdrawable truck
- Contacts signalling connected/isolated
- Isolation interlock with the door
- HMI
- Local control panel
- 1MRS050698 A1 infrared cable for configuration
- RS232/RS485 or USB/RS485 converter.

For availability and to order spare parts, please contact our Service department, specifying the circuit-breaker serial number.

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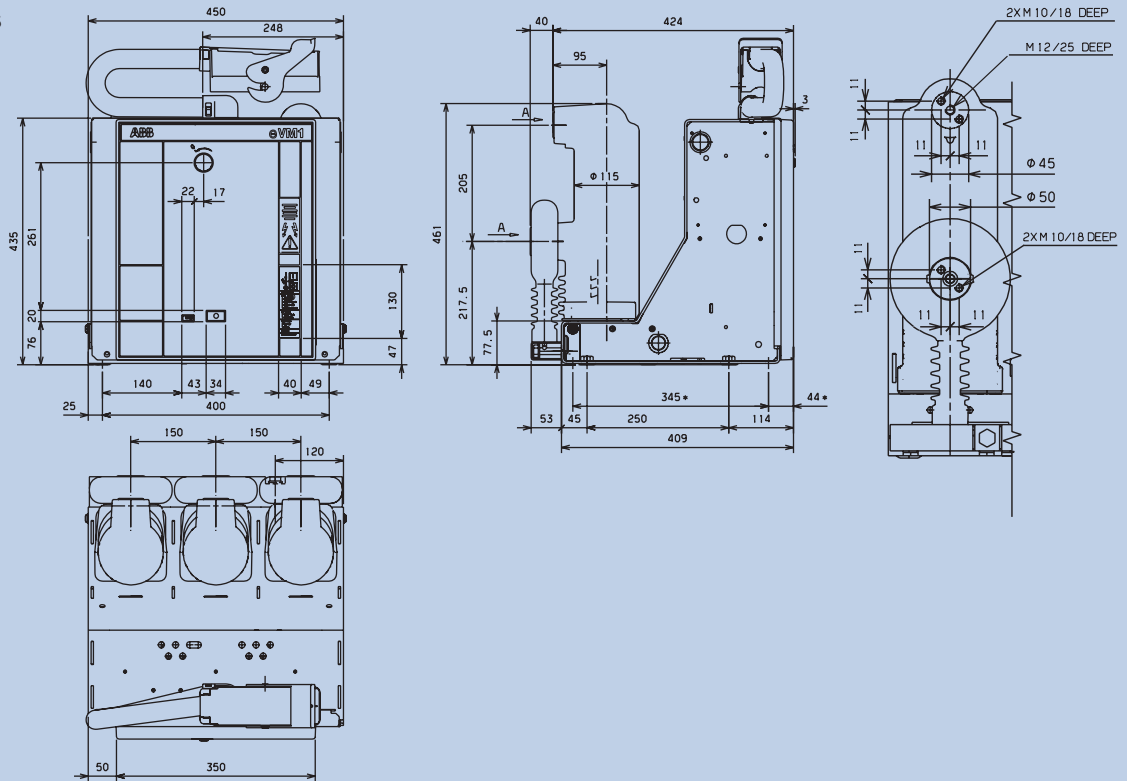
OVERALL DIMENSIONS

Fixed circuit-breakers

eVM1

TN 1VCD000096

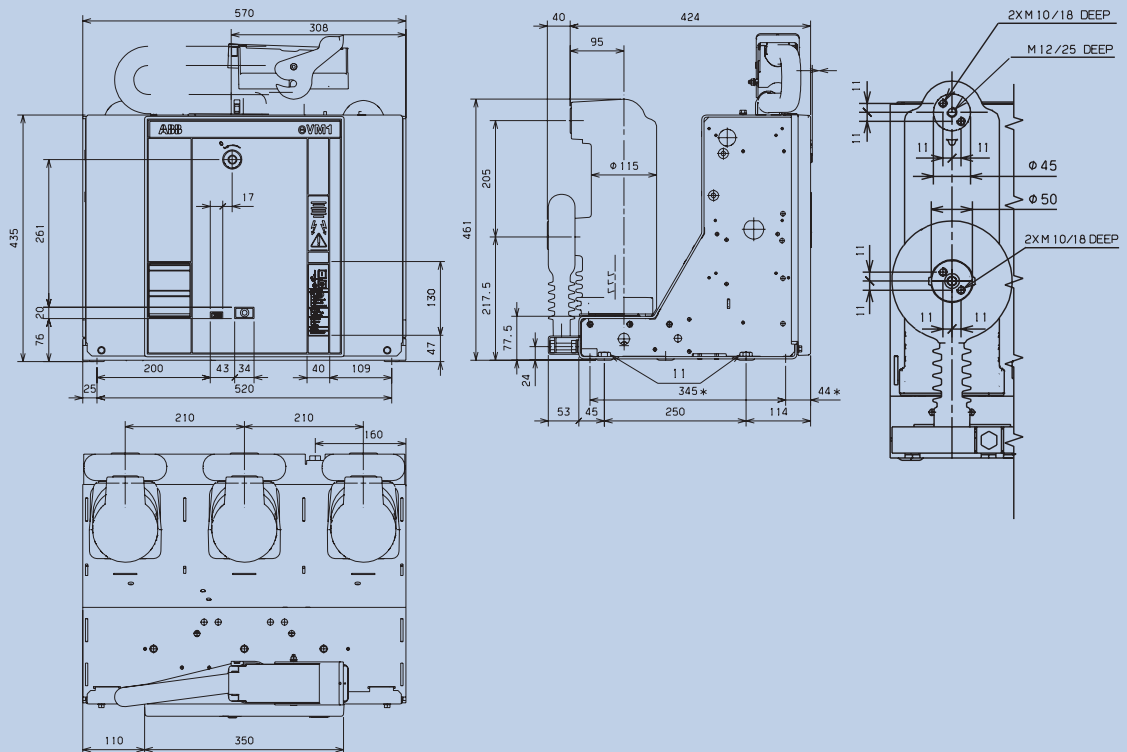
Ur	12 kV
	17.5 kV
Ir	630 A
	1250 A
Isc	16 kA
	20 kA
	25 kA
	31.5 kA



eVM1

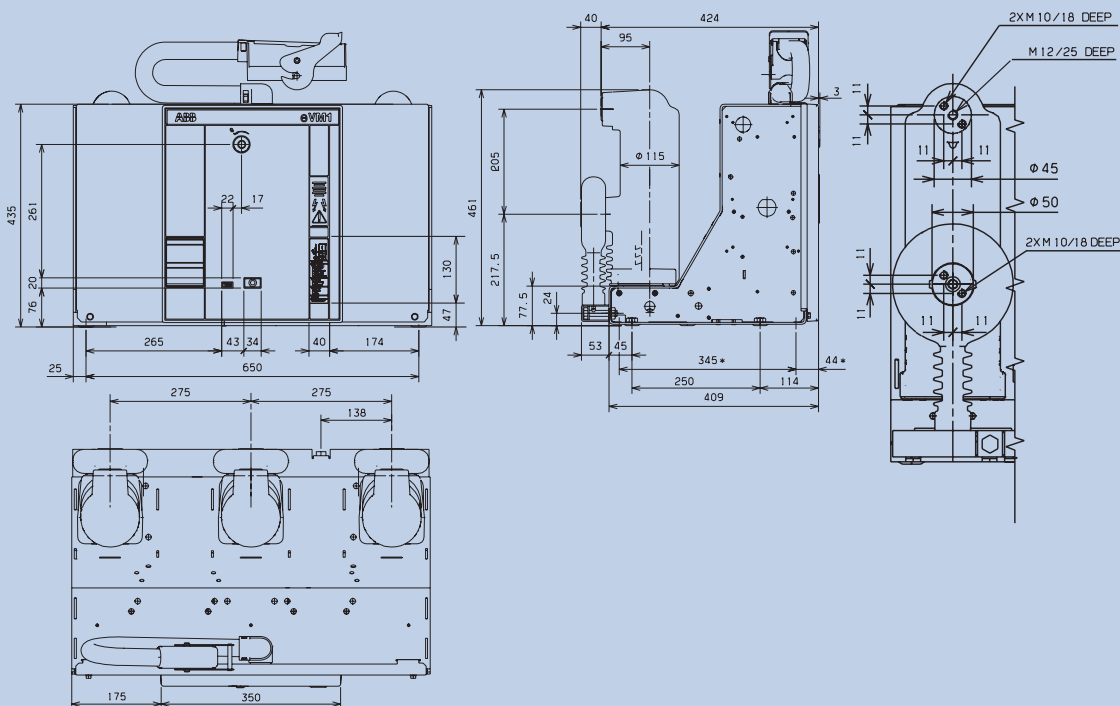
TN 1VCD000097

Ur	12 kV
	17.5 kV
Ir	630 A
	1250 A
Isc	16 kA
	20 kA
	25 kA
	31.5 kA



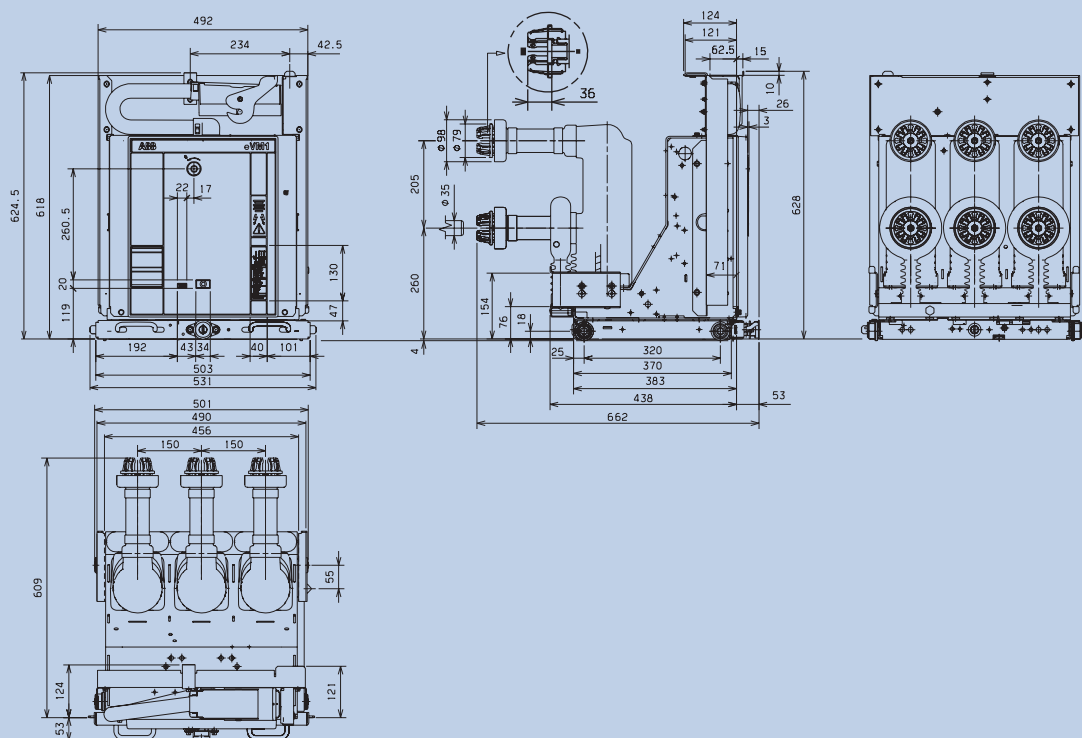
eVM1

Ur	12 kV
	17.5 kV
Ir	630 A
	1250A
Isc	16 kA
	20kA
	25 kA
	31.5 kA



eVM1/P

Ur	12 kV
	17.5 kV
Ir	630 A
	1250A
Isc	16 kA
	20kA
	25 kA
	31.5 kA



Technical drawing of the ABB iB7000 drive, showing front, side, and bottom views with dimensions in mm.

Front View Dimensions:

- Overall width: 250
- Overall height: 149.4
- Top mounting flange thickness: 6
- Bottom mounting flange thickness: 6
- Internal width (excluding flanges): 239
- Internal height (excluding flanges): 138.4

Side View Dimensions:

- Overall depth: 48
- Top flange thickness: 5.5
- Bottom flange thickness: 5.5

Bottom View Dimensions:

- Overall width: 240
- Overall height: 140
- Left mounting flange thickness: 5.5
- Right mounting flange thickness: 5.5
- Internal width (excluding flanges): 239
- Internal height (excluding flanges): 138.4

Internal Features and Labels:

- ABB** logo
- Terminal block with labels: **CB locked in open**, **Local**, **Local & Remote**, **Remote**
- Control panel with buttons: **Menu**, **↓**, **↑**, **↶**, **Reset**, **▶**, **▶**
- Door cut-out dimensions: 240 (width) x 140 (height)

Door cut-out

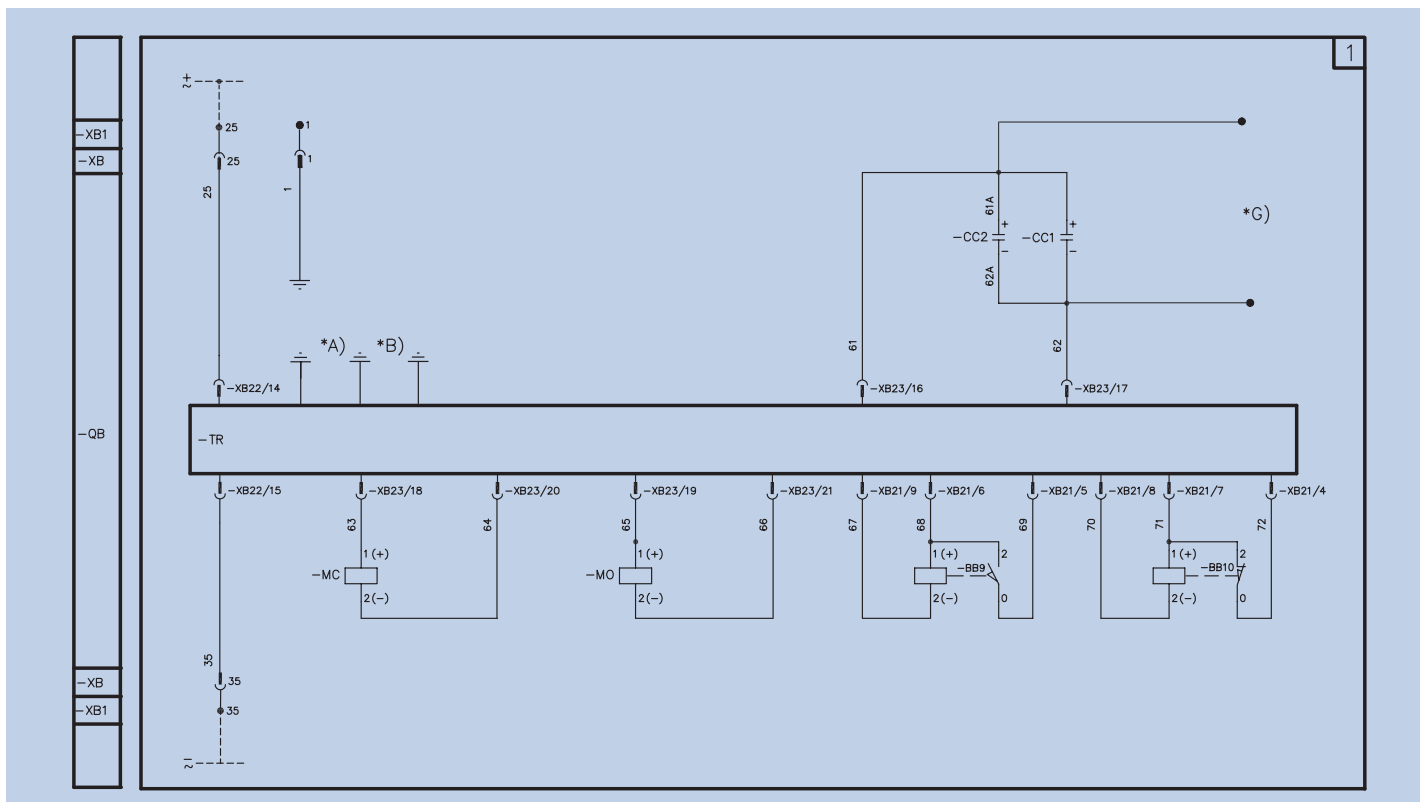
ELECTRIC CIRCUIT DIAGRAM

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ELECTRIC CIRCUIT DIAGRAM

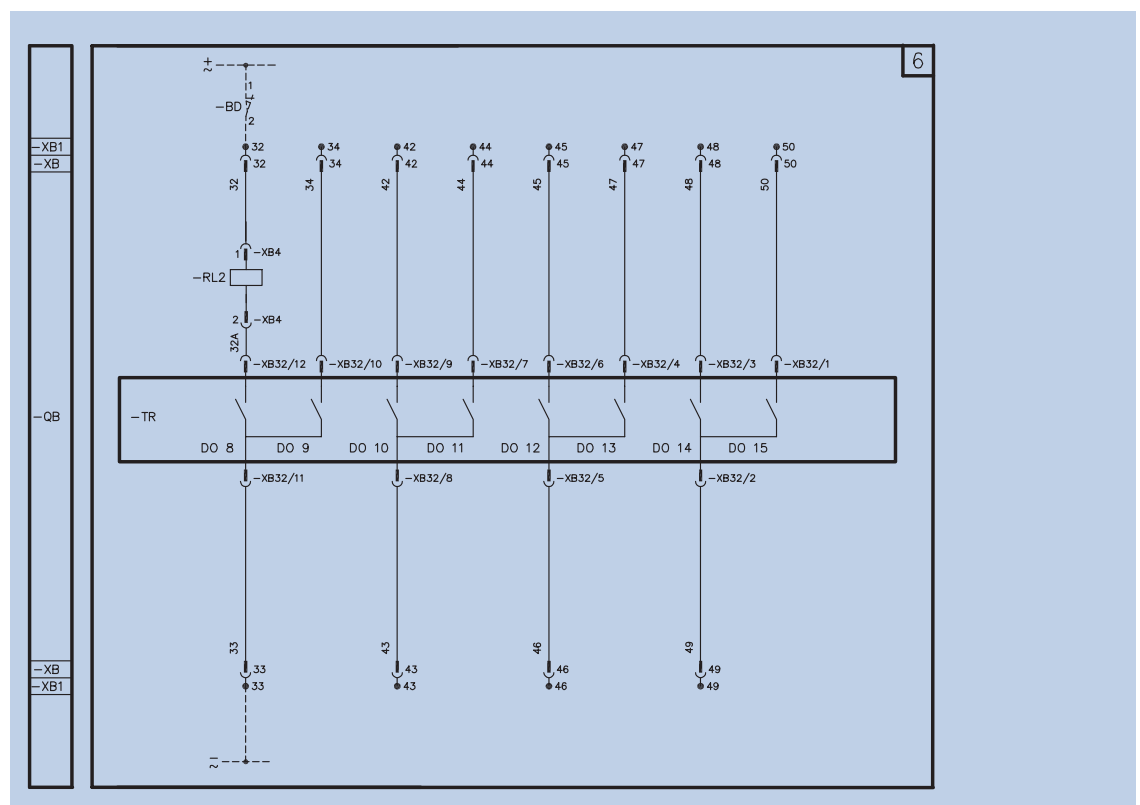
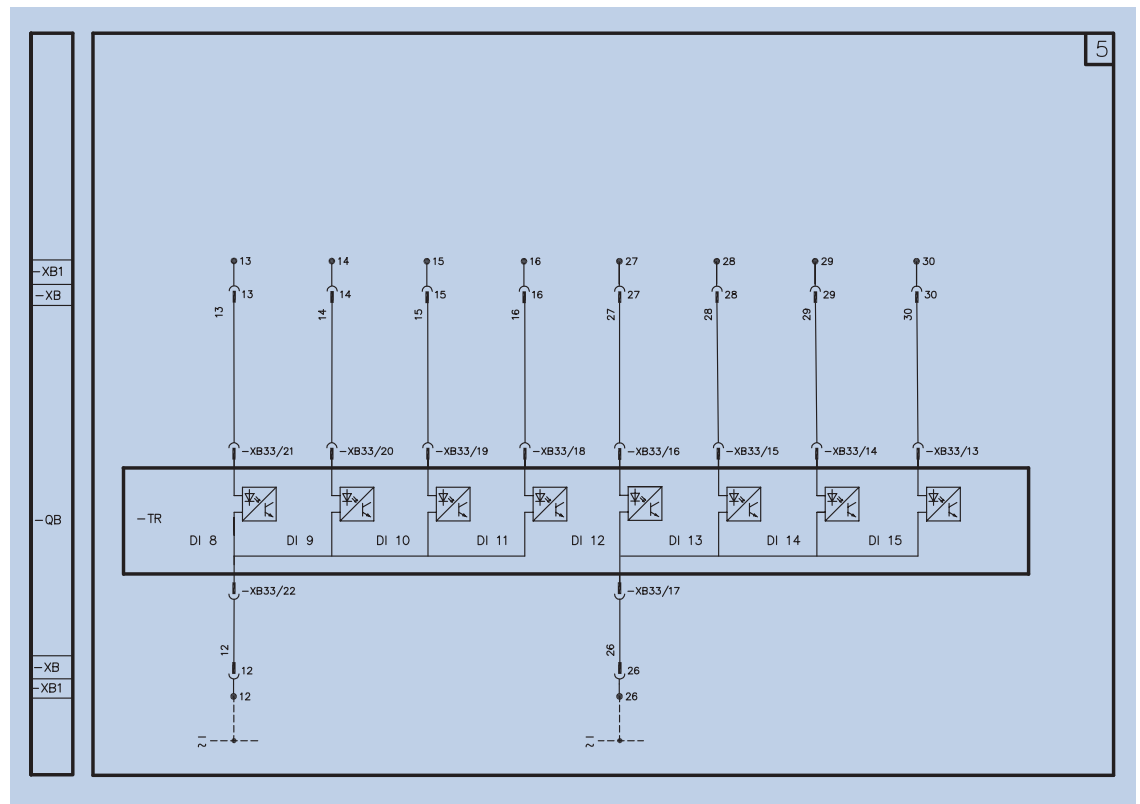
Application layouts

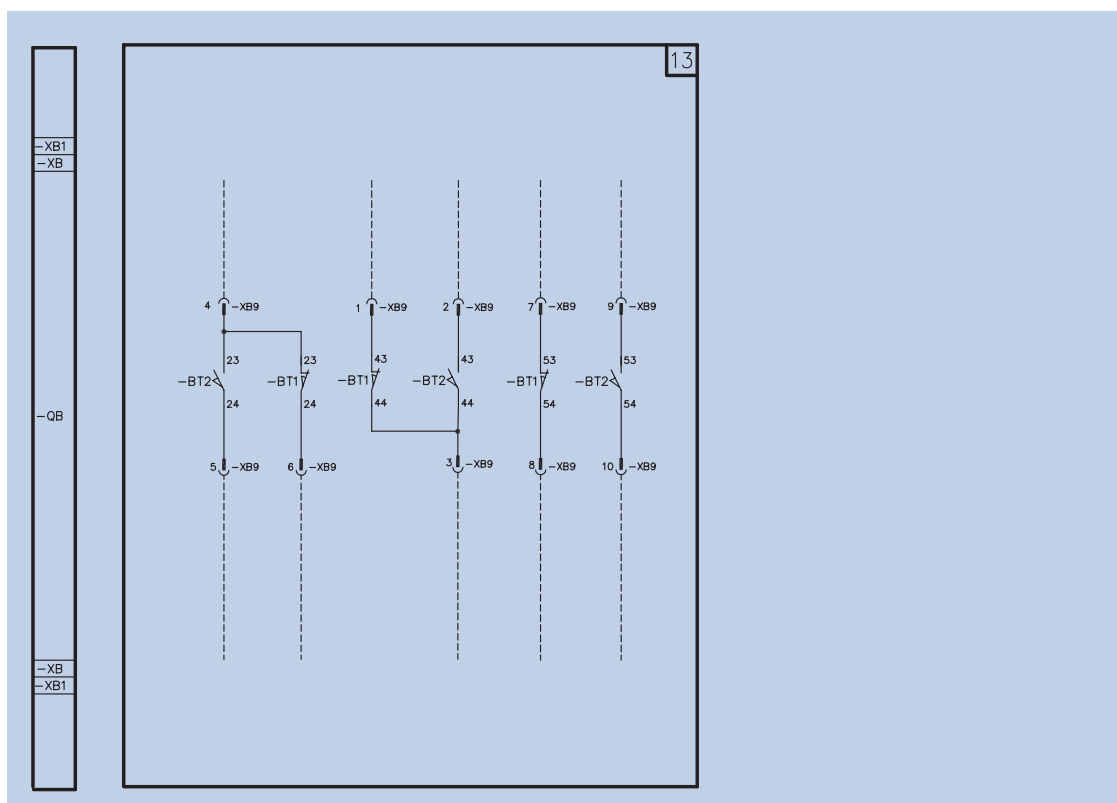
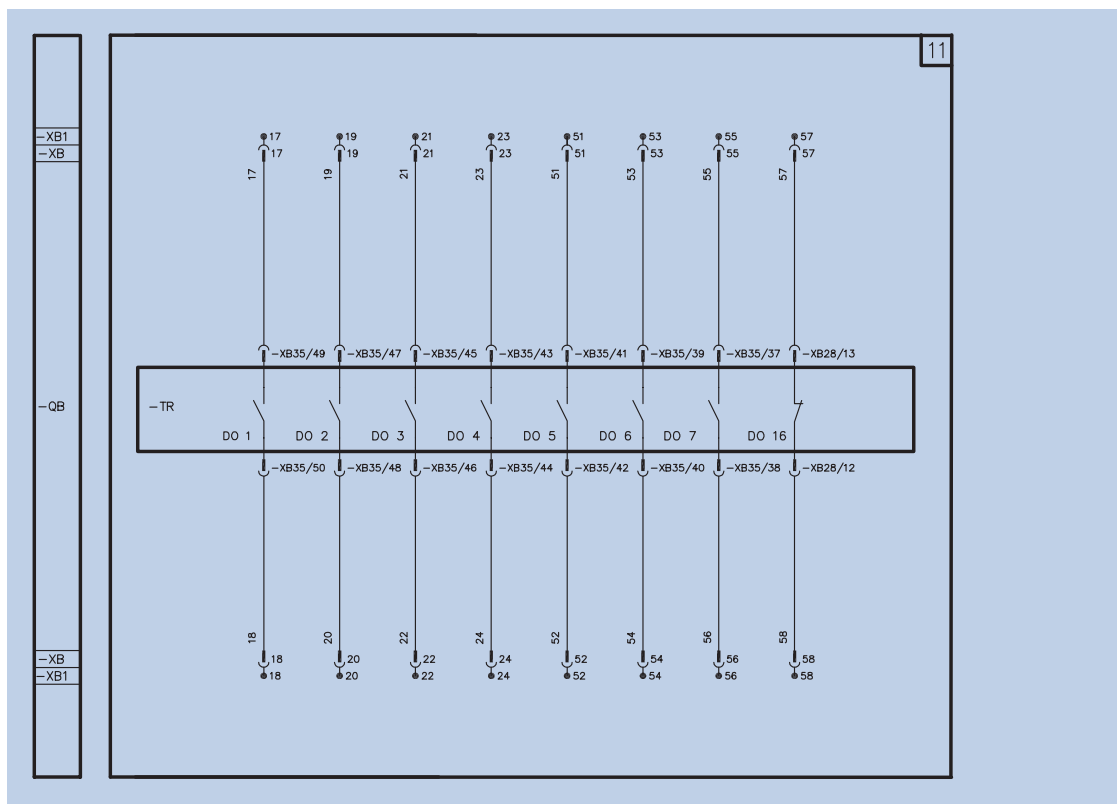
The following layout 1VCD400060 depicts the circuits of removable switches eVM1/P consigned to the customer by means of connector "-XB1". Refer to layout 1VCD 400089 for the fixed switches. However, to keep up to date with product developments, it is always advisable to refer to the circuitry layout supplied with each switch.





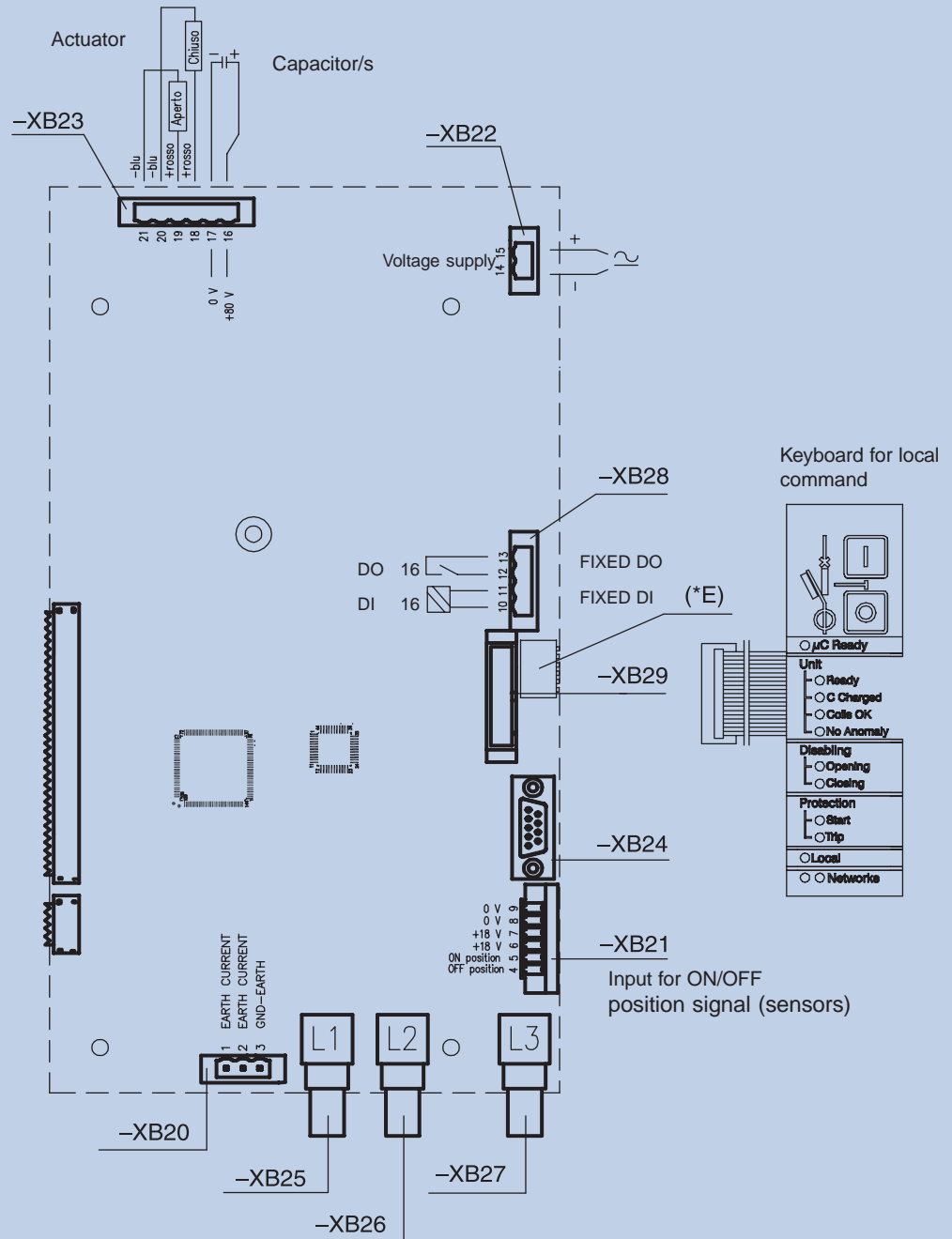
ELECTRIC CIRCUIT DIAGRAM



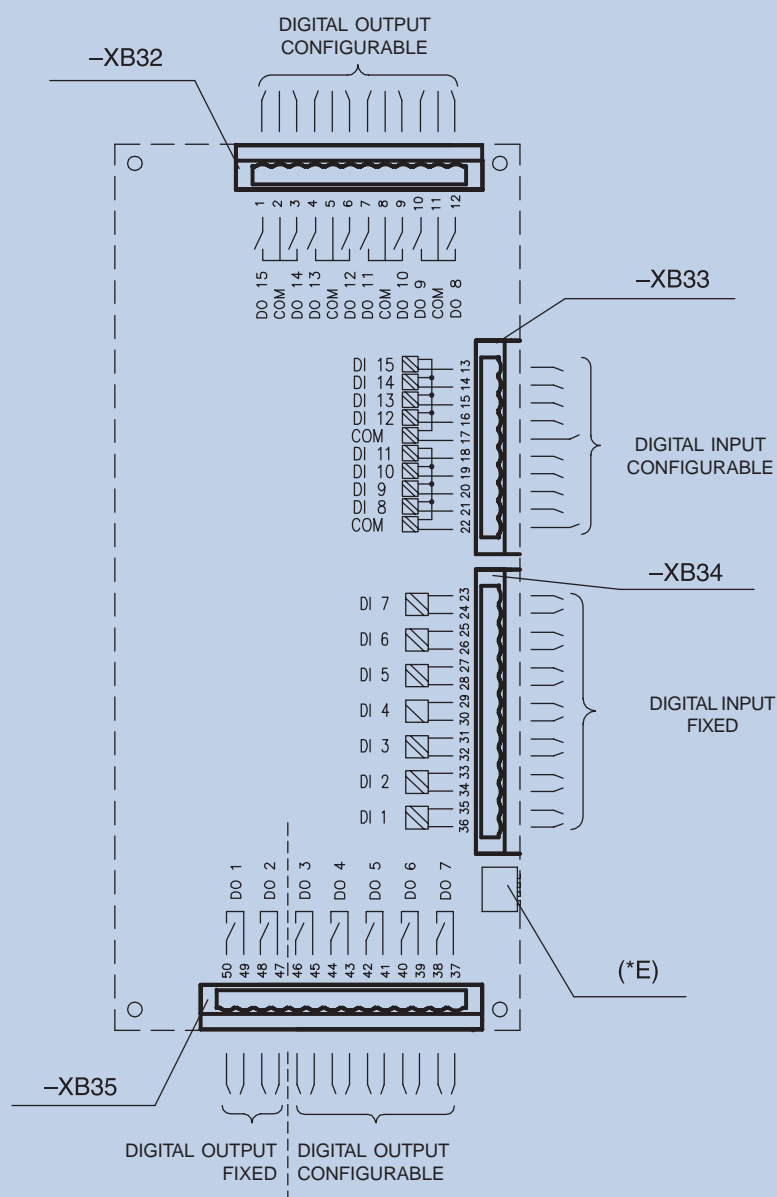


ELECTRIC CIRCUIT DIAGRAM

MOTHERBOARD



I/O BOARD



ELECTRIC CIRCUIT DIAGRAM

State of operation shown

The diagram is shown under the following conditions:

- circuit-breaker open and connected
- circuits de-energised

Caption

- = Number of diagram figure
- * n) = See the note indicated by the letter
- QB = Circuit-breaker applications
- OBI = Medium voltage circuit-breaker
- L1 = Phase L1
- L2 = Phase L2
- L3 = Phase L3
- PI1 = Human Machine Interface keypad with opening and closing pushbuttons and signals
- BC1 = Current sensor (Rogowski) phase L1
- BC2 = Current sensor (Rogowski) phase L2
- BC3 = Current sensor (Rogowski) phase L3
- TR = Electrical control and actuation unit
- BN = Earth current transformer
- BB9 = Position contact for signalling circuit-breaker closed (limit switch with auxiliary power supply)
- BB10 = Position contact for signalling circuit-breaker open (limit switch with auxiliary power supply)
- BD = Position contact of the door
- BT1 = Auxiliary truck contacts of the for electrical signalling of circuit-breaker connected
- BT2 = Auxiliary truck contacts of the for electrical signalling of circuit-breaker isolated
- CC1-CC2 = Capacitors
- MC = Closing coil
- MO = Opening coil
- RL2 = Locking magnetic on the truck
- SC2 = Pushbutton or contact for remote circuit-breaker closing
- SL1 = Circuit for locking circuit-breaker closing (with contact closed, closing is enabled)
- SL2 = Contact for locking circuit-breaker opening circuit-breaker (with contact closed, opening is enabled)
- S02 = Pushbutton or contact for remote circuit-breaker opening
- S03 = Auxiliary opening and safety contact
- S04 = Pushbutton or contact for opening with no circuit-breaker power (contact closed with voltage present)
- WS = Interfaccia seriale per operazioni di servizio (interfaccia RS 485)
- XB = Serial interface for service operations (RS 485 interface)
- XB1 = Connector of the circuit-breaker circuits
- XB8 = Connector of the switchgear circuits
- XB9 = Auxiliary contact connected and isolated connector

- XB20 = Earth current sensor connector
- XB21 = Connector for position sensors –BS3 and –BS4
- XB22 = Connector for the auxiliary power supply
- XB23 = Connector for the actuator and for the capacitor/s
- XB24 = Connector for serial interface (RS 485 interface)
- XB25 = Analog input connector phase L3
- XB26 = Analog input connector phase L2
- XB27 = Analog input connector phase L1
- XB28 = Motherboard digital input connector
- XB29 = Connector for the local pushbutton panel
- XB32 = Configurable digital output connector
- XB33 = Configurable digital input connector
- XB34 = Fixed digital input connector
- XB35 = Configurable fixed digital output connector

Description of figures

- Fig. 1 = Basic circuits of the circuit-breaker and of the eVM1 magnetic drive
- Fig. 2 = Keypad for local controls
- Fig. 3 = Analog inputs for eVM1 circuit-breaker
- Fig. 4 = Fixed digital inputs for eVM1 circuit-breaker
- Fig. 5 = Configurable digital inputs for eVM1 circuit-breaker
- Fig. 6 = Fixed digital outputs for eVM1 circuit-breaker
- Fig.11 = Configurable digital outputs for eVM1 circuit-breaker
- Fig. 13 = Auxiliary contacts of the truck available but not cabled in plug -XB

Notes

- A) Fix the copper strips for the earthing connection under the vibrostop in the unpainted area.
- B) For insulation tests, disconnect the copper strip for the earthing connection under the vibrostop in the unpainted area.
- C) If the earthing toroid is not present, short-circuit pin –XB/38 with –XB/39
- D) Serial interface for service operations (RS485 interface) and connection with the HMI
- E) To set the DIP switches, please see the Instruction Manual
- F) The circuit-breaker is only fitted with the applications specified in the order acknowledgement.
- G) CFD (Capacitor Fast Discharge) connector.
Attention: consult the instruction manual.

DEFAULT CONFIGURATION TABLE **DIGITAL INPUTS**

Event: Inputs	Withdrawable Circuit-breaker	Withdrawable Circuit-breaker with HMI	Withdrawable Circuit-breaker with earthing switch	Withdrawable Circuit-breaker with earthing switch and HMI	Free Configuration
Under voltage / Negate Open command	DI 1	DI 1	DI 1	DI 1	DI 1
Close command from remote	DI 2	DI 2	DI 2	DI 2	DI 2
Open command from remote	DI 3	DI 3	DI 3	DI 3	DI 3
# Circuit-breaker Open disabling	DI 4	DI 4	DI 4	DI 4	DI 4
# Circuit-breaker Closed disabling	DI 5	DI 5	DI 5	DI 5	
Circuit-breaker in Service position	DI 6	DI 6	DI 6	DI 6	
Circuit-breaker in Test position	DI 7	DI 7	DI 7	DI 7	
Line disconnector Closed					
Line disconnector Open					
Line disconnector Closed to earth					
Line disconnector operating rod inserted					
Earthing switch Open			DI 4	DI 4	
Earthing switch Closed			DI 5	DI 5	
Earthing switch operating road inserted					
Interlock Input 1	DI 8	DI 8	DI 8	DI 8	
Interlock Input 2	DI 9	DI 9	DI 9	DI 9	
# Local / Remote selection Key	DI 10	on HMI	DI 10	on HMI	
Trip Signal and Anomaly Reset	DI 11	on HMI and DI 11	DI 11	on HMI and DI 11	
Closed command from local	DI 12	on HMI	DI 12	on HMI	
Open command from local	DI 13	on HMI	DI 13	on HMI	
Auxiliary Supply Monitoring					
Second Safety Open circuit-breaker command (Hardware only)	DI 16	DI 16	DI 16	DI 16	DI 16

DI...

Prefixed
Not modifiable

Not available



Configurable




























Only without **HMI**

= Active low level (not supplied)

ELECTRIC CIRCUIT DIAGRAM

DEFAULT CONFIGURATION TABLE DIGITAL OUTPUTS					
Events: Outputs	Withdrawable Circuit-breaker	Withdrawable Circuit-breaker with HMI	Withdrawable Circuit-breaker with earthing switch	Withdrawable Circuit-breaker with earthing switch and HMI	Free Configuration
Closed circuit-breaker	DO 1	DO 1	DO 1	DO 1	DO 1
Open circuit-breaker	DO 2	DO 2	DO 2	DO 2	DO 2
Circuit-breaker in Service position	DO 3	DO 3	DO 3	DO 3	
Circuit-breaker in Test position	DO 4	DO 4	DO 4	DO 4	
Line disconnector closed					
Line disconnector open					
Line disconnector closed to earth					
Earthing switch closed					
Earthing switch open					
Unit ready	DO 5	DO 5	DO 5	DO 5	
Unit not ready	DO 6	DO 6	DO 6	DO 6	
Anomaly	DO 7	DO 7	DO 7	DO 7	
Output for truck locking magnet -RL2	DO 8	DO 8	DO 8	DO 8	DO 8
Protection trip 1	DO 9	DO 9	DO 9	DO 9	
Protection start 1	DO 10	DO 10	DO 10	DO 10	
Protection start 2	DO 11	DO 11	DO 11	DO 11	
Protection trip 2	DO 12	DO 12	DO 12	DO 12	
Circuit-breaker Opened for under voltage					
Circuit-breaker Opened transient contact	DO 13	DO 13	DO 13	DO 13	
Interlocking Output 1	DO 14	DO 14	DO 14	DO 14	
Interlocking Output 2	DO 15	DO 15	DO 15	DO 15	
# Circuit-breaker opening disabled					
# Circuit-breaker closing disabled					
Local mode					
Remote mode					
Auxiliary Supply Monitoring					
WD not ready	DO 16	DO 16	DO 16	DO 16	DO 16
DO... Prefixed Not modifiable					
	Not available		Configurable		Only if relative DI (Digital Input) is selected
# = Active low level (not supplied) WD = Microprocessor operation					

Graphic symbols for electric diagrams (Standards IEC 60617 and CEI 3-14 ... 3-26)

	Thermal effect		Capacitor (general symbol)		Conductors in screened cable (two conductors shown)		Make position contact (limit switch)
	Electromagnetic effect		Motor (general symbol)		Connection of conductors		Break position contact (limit switch)
	Timing		Rectifier with two half-waves (bridge)		Terminal or clamp		Power circuit-breaker with automatic opening
	Pushbutton control		Make contact		Socket and plug (female and male)		Control coil (general symbol)
	Key control		Break contact		Resistor (general symbol)		Lamp (general symbol)
	Earth (general symbol)		Changeover contact with momentary interruption		Delayed movement (in the direction of the arc movement towards its centre)		Insulated digital binary input
	Corded conductors or cables (two conductors shown)		Exposed conductive part, frame		Passing contact with momentary closing during release		

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