MEDIUM VOLTAGE PRODUCTS

VM1

Installation and service instructions
12 ... 24 kV - 630 ... 2500 A - 16 ... 31.5 kA

Table of Contents

For your safety!

- Make sure that the installation room (spaces, divisions and ambient) is suitable for the electrical apparatus.
- Check that all the installation, putting into service and maintenance operations are carried out by qualified personnel with suitable knowledge of the apparatus.
- Make sure that the standard and legal prescriptions are complied with during installation, putting into service and maintenance, so that installations according to the rules of good working practice and safety in the work place are constructed.
- Strictly follow the information given in this instruction manual.
- Check that the rated performance of the apparatus is not exceeded during service.
- Check that the personnel operating the apparatus have this instruction manual to hand as well as the necessary information for correct intervention.
- Pay special attention to the notes indicated in the manual by the following symbol:

Responsible behaviour safeguards your own and others' safety!
For any requests, please contact the ABB Assistance Service.

I. Introduction

This publication contains the information needed to install medium voltage VM1 circuit breakers and put them into service.
For correct use of the product, please read it carefully.
Like all the apparatus we manufacture, the VM1 circuit breakers are designed for different installation configurations.
However, they do allow further technical and construction modifications (at the customer's request) to adapt to special installation requirements.
For this reason, the information given below may sometimes not contain instructions concerning special configurations.
Apart from this manual, it is therefore always necessary to consult the latest technical documentation (circuit and wiring diagrams, assembly and installation drawings, any protection coordination studies, etc.), especially regarding any variants requested in relation to the standardised configurations.
Only use original spare parts for maintenance operations.
For further information, please also see the technical catalogue of the circuit breaker.

All the installation, putting into service, running and maintenance operations must be carried out by skilled personnel with in-depth knowledge of the apparatus.

II. Environmental protection programme

The VM1 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.

1. Packing and transport

The circuit breaker is shipped in special packing, in the open position.
Each piece of apparatus is protected by a plastic cover to prevent any infiltration of water during the loading and unloading stages and to keep the dust off during storage.

2. Checking on receipt

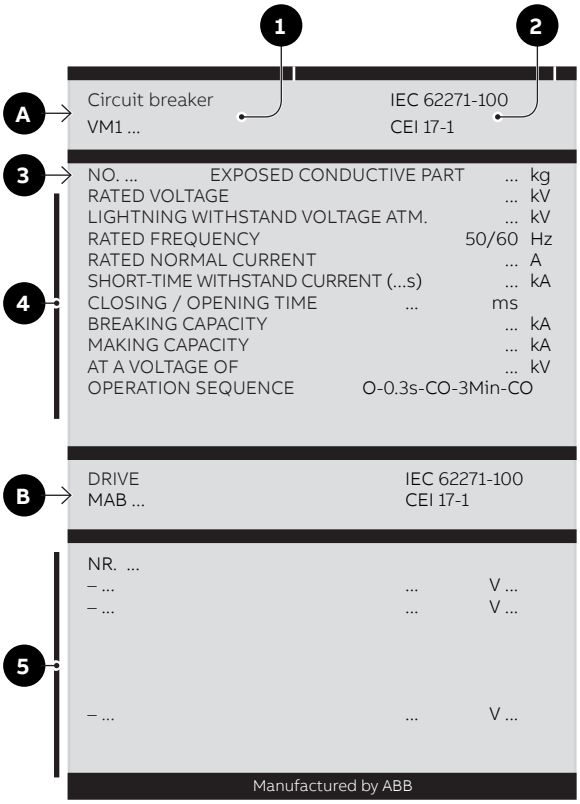
Before carrying out any operation, always make sure that the capacitors are discharged and that the apparatus is in the open position.

On receipt, check the state of the apparatus, integrity of the packing and correspondence with the nameplate data (see fig. 1) with what is specified in the order confirmation and in the accompanying shipping notes.
Also make sure that all the materials described in the shipping notes are included in the supply.
Should any damage or irregularity be noted in the supply on unpacking, notify ABB (directly or through the agent or supplier) as soon as possible and in any case within five days of receipt.
The apparatus is only supplied with the accessories specified at the time of ordering and validated in the order confirmation sent by ABB.
The accompanying documents inserted in the shipping packing are:

- instruction manual (this document)
- test certification
- identification label
- copy of the shipping documents
- electric wiring diagram.

Other documents which are sent prior to shipment of the apparatus are:

- order confirmation
- original shipping advice notesany drawings or documents referring to special configurations/ conditions.



Caption
A Circuit breaker rating plate.
B Drive rating plate.
1 Type of apparatus.
2 Symbols of compliance with Standards.
3 Serial number.
4 Circuit breaker characteristics.
5 Characteristics of the drive auxiliaries.

Fig. 1

3. Storage

When a period of storage is foreseen, our workshops can (on request) provide suitable packing for the specified storage conditions.
On receipt the apparatus must be carefully unpacked and checked as described in Checking on receipt (chap. 2).
If immediate installation is not possible, the packing must be replaced, using the original material supplied.
Insert special hygroscopic substances inside the packing, using at least one standard packet per piece of apparatus.
Should the original packing not be available and immediate installation is not possible, store in a covered, well-ventilated, dry, dust-free, non-corrosive ambient, away from any flammable materials and at a temperature between –5 °C and +45 °C.
In any case, avoid any accidental impacts or positioning which stresses the structure of the apparatus.

4. Handling

Before carrying out any operations, always make sure that the capacitors are discharged.
To lift and handle the circuit breaker, proceed as follows (fig. 2):

- use a special lifting tool (1) (not supplied) fitted with ropes with safety hooks (2);
- insert the hooks (2) in the supports (3) fixed to the frame of the circuit breaker and lift. Latch the hooks (2) into the support holes (3) according to the type of apparatus (see table);
- on completion of the operation (and in any case before putting into service) unhook the lifting tool (1) and dismantle the supports (3) from the frame.

During handling, take great care not to stress the insulating parts and the terminals of the circuit breaker.

The apparatus must not be handled by putting lifting devices directly under the apparatus itself. Should it be necessary to use this technique, put the circuit breaker onto a pallet or a sturdy supporting surface (see fig. 3). In any case, it is always advisable to carry out lifting using the supports (3).

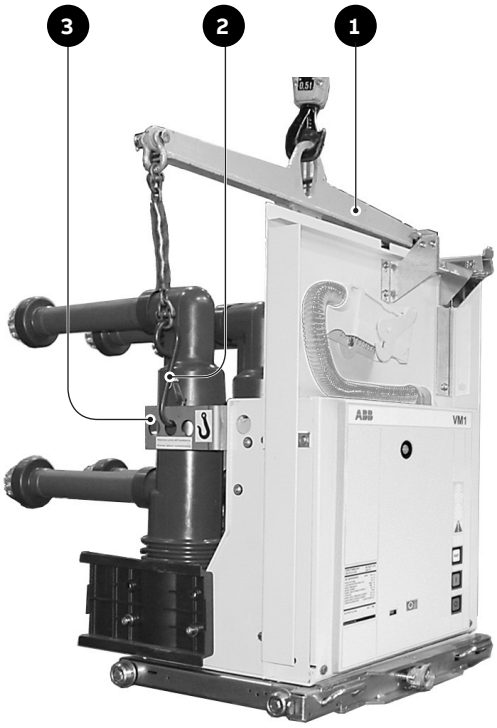


Fig. 2

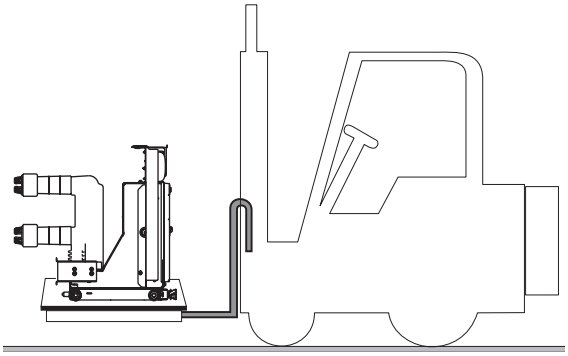
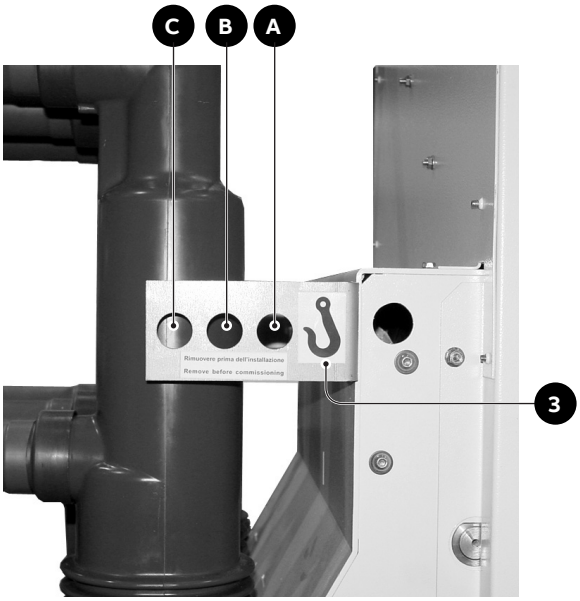


Fig. 3



Version	Pole centre distance	Rated current	Hole
Fixed	150-210 mm	up to 1250 A	A
Fixed	275 mm	from 1600 to 2500 A	A
Fixed	210 mm	from 1600 to 2000 A	A
Withdrawable	150 mm	up to 1250 A	A
Withdrawable	210 mm	up to 1250 A	C
Withdrawable	210 mm	from 1600 to 2500 A	B
Withdrawable	275 mm	up to 1250 A	B
Withdrawable	275 mm	from 1600 to 2500 A	C

5. Description

The VM1 type vacuum circuit breakers are designed for indoor installation in air-insulated switchgear.
In respect of the technical characteristics, VM1 circuit breakers are suitable for operation of electric circuits under normal and fault service conditions.
The vacuum circuit breakers have particular advantages when used in systems with a high frequency of operations and/or which lead to a certain number of short-circuit trips. The VM1 type vacuum circuit breakers stand out for their particularly high operating reliability, extremely long useful life expectancy and for being completely maintenance-free.
The VM1 type vacuum circuit breakers are available in the fixed and withdrawable version.
The basic structure is shown in the “Technical data” section.

5.1. Standards and regulations

5.1.1. Fabrication

The VM1 circuit breakers conform to the following Standards:

- VDE 0670, part 1000, and IEC 60694
- DIN VDE 0670, part 104, and IEC 62271-100
- DIN VDE 0847, part 4, and IEC 61000-4.

5.1.2. Installation and operation

For assembly and operation, please refer to the relative regulations, and in particular to:

- DIN VDE 0101, AC electrical plants with voltage higher than 1 kV
- DIN VDE 0100-410, Installation of electrical plants up to 1000 V, protective measures
- VDE 0105, Operation of electrical plants
- DIN VDE 0141, Earthing systems for special electrical plants with rated voltages higher than 1 kV
- Accident prevention regulations of insurance institutes against accidents at the workplace or of comparable organisations
- Safety directives for auxiliary and operating materials.

5.2. Service conditions

5.2.1. Normal service conditions

Follow the recommendations in the IEC 60694 and 62271-100 Standards. In more detail:

Ambient temperature	
Maximum	+ 40 °C
Average maximum over 24 hours	+ 35 °C
Minimum (according to class – 5), apparatus for indoor installatio	– 25 °C

Humidity
The average value of the relative humidity, measured for a period longer than 24 hours, must not exceed 95%.
The average value of the pressure of the water vapour without condensation, measured for a period longer than 24 hours, must not exceed 2.2 kPa.
The average value of the relative humidity, measured for a period longer than 1 month, must not exceed 90%..
The average value of the pressure of the water vapour, measured for a period longer than 1 month, must not exceed 1.8 kPa.

Altitude
< 1000 m above sea level.

5.2.2. Special service conditions

Installations over 1000 m a.s.l.
Possible within the limits permitted by reduction of the dielectric resistance of the air.

Increase in the ambient temperature
Reduction in the rated current.
Encourage heat dissipation with appropriate additional ventilation.

Climate
To avoid the risk of corrosion or other damage in areas:
• with a high level of humidity, and/or
• with rapid and large temperature variations, take appropriate steps (for example, by using suitable electric heaters) to prevent condensation phenomena.

For special installation requirements or other operating conditions, please contact ABB.

6. Structure

6.1. Drive structure

The drive is of the magnetic type and basically consists of the magnetic actuator (6) (fig. 4), the control module (5), the sensors (10), the capacitor/s (4) and the kinematics which transmit the movement to the circuit breaker poles.
The actuator (6) acts on the circuit breaker poles by means of special kinematics. The capacitor/s (4) provides/provide the energy required for the operation.
The mechanical operating positions of the circuit breaker are detected by two due sensors (10).
The basic version of the circuit breaker is fitted with the following controls and instruments:

- closing pushbutton “I” (8)
- opening pushbutton “O” (9)
- coupling for manual emergency operation (1)
- mechanical position indicator (2)
- mechanical operation counter (3)
- luminous signalling of the “ready” state (7) (READY).

It is also possible to install auxiliary open/closed position contacts (11) (accessory on request).

6.1.1. Structure of the control module

The control module (5) of the circuit breaker consists of:

- a microprocessor
- opto-electrical input couplers
- output relay
- electronic power system for controlling the actuator coils.

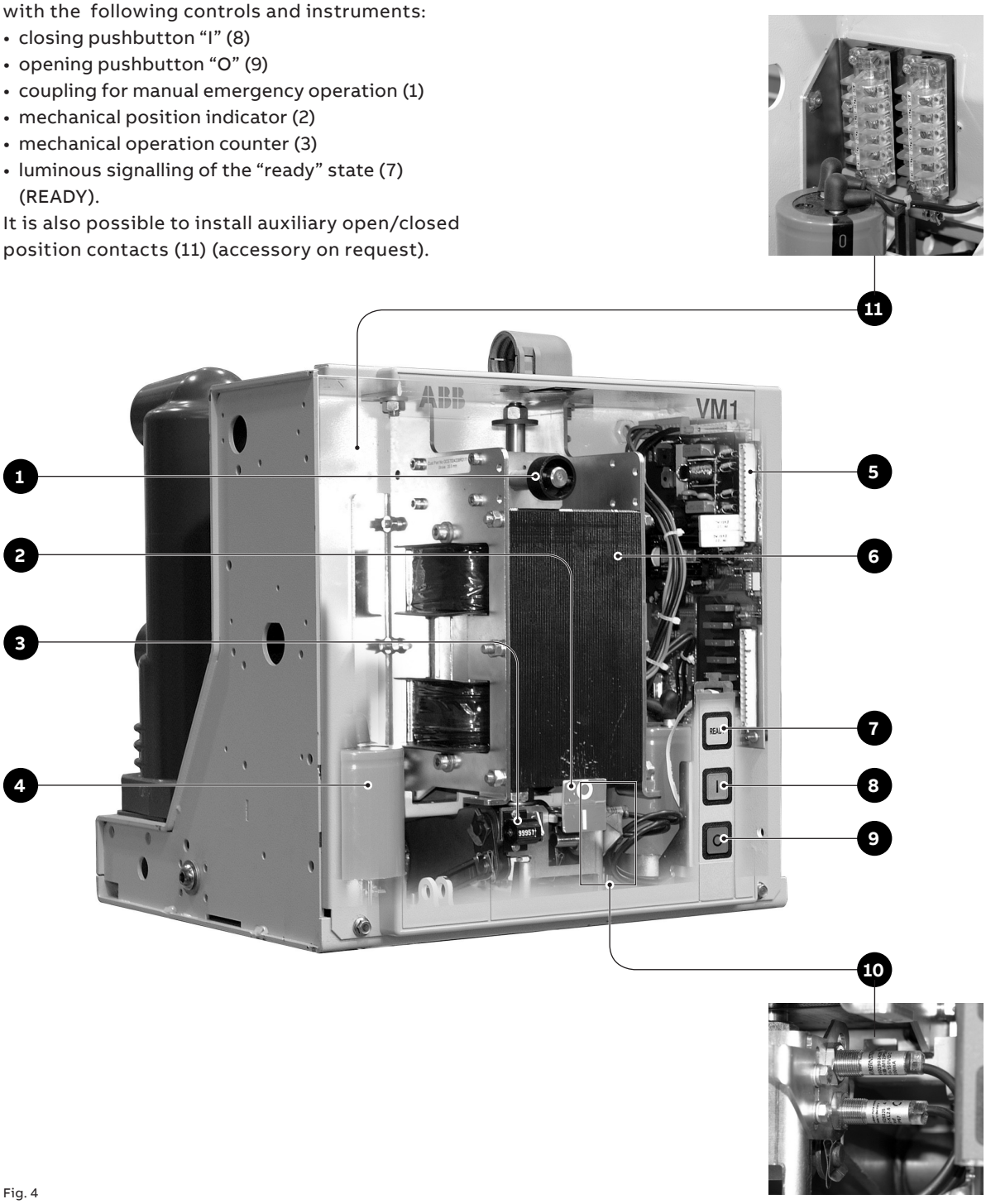


Fig. 4

6.1.2. Capacitor

The energy for operating the circuit breaker is stored in one or two capacitors according to the circuit breaker model (fig. 5).
The capacitors are designed so that the energy for an O-C-O operating cycle is supplied without the need for recharging.
The energy stored by the capacitor is constantly monitored by means of measuring the voltage of the capacitor.
The “READY” indication signals application of the power supply voltage and the “ready” state of the circuit breaker for the next operation.
The energy stored in the capacitors determines the position of the READY/NOT READY contacts and lighting up of the luminous “READY” signal according to the following criteria.

- Case 1: circuit breaker in the open position.
  - The energy available is sufficient for one closing and opening operation.
- Case 2: circuit breaker in the closed position.
  - The energy available is sufficient for one opening operation.
  - The energy available is sufficient for one opening operation within 60 s from interruption of the auxiliary power supply.

If the energy stored is not sufficient, the luminous “READY” signal is off, the “READY” contact is open and the “NOT READY” contact is closed to indicate that the circuit breaker is not ready for the operation.
When there is no auxiliary voltage, the capacitor is able to keep the circuit breaker operational for about 2 minutes.

6.1.3. Position sensors

The use of two inductive proximity sensors (fig. 6) allows the state of the circuit breaker (open - closed - anomalous intermediate position) to be determined without the use of auxiliary contacts, allowing continual monitoring of the system.
The signal of the two sensors is sent to the electronic control module.

Fig. 5

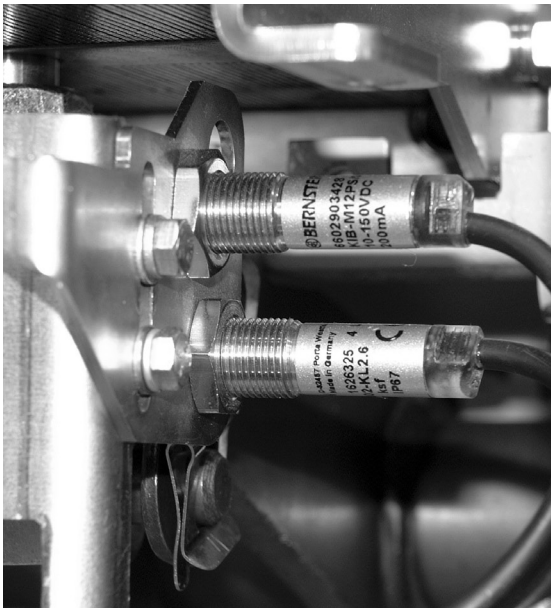


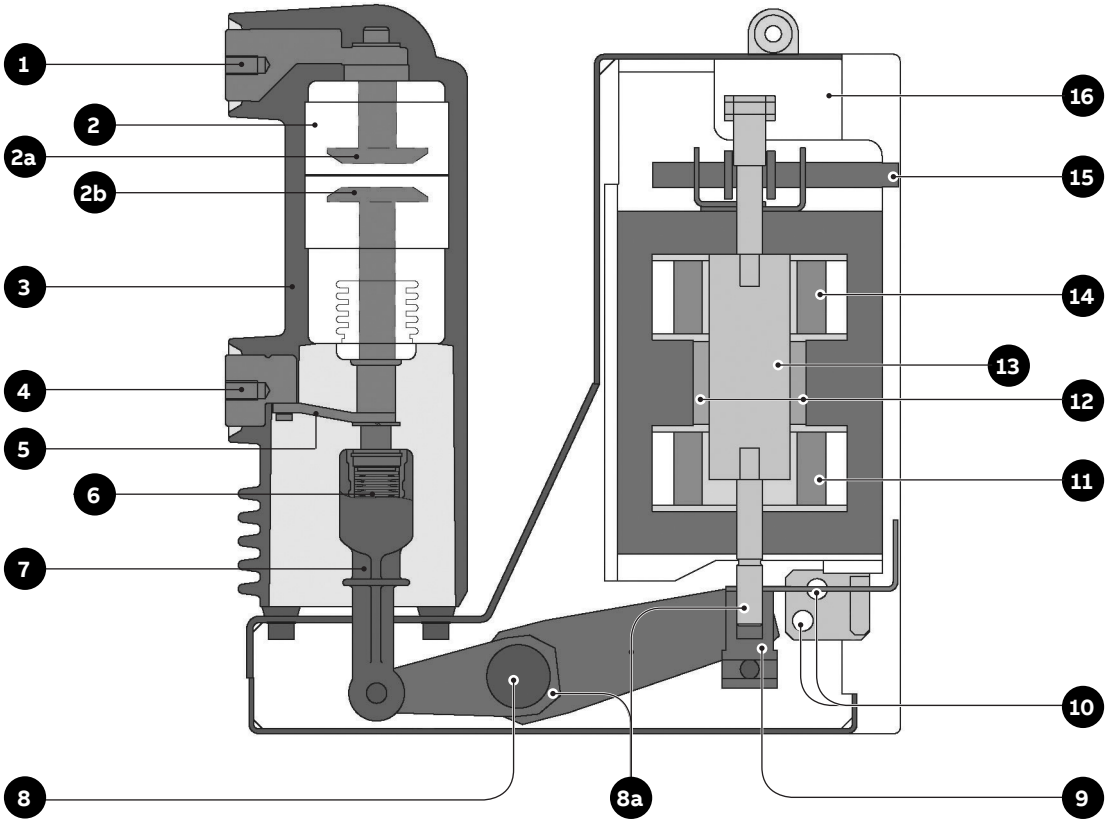
Fig. 6

6. Structure

6.2. Structure of the circuit breaker poles

The poles are installed in the rear part of the circuit breaker frame (fig. 7).
The active parts of the poles (vacuum interrupters) are embedded and protected against shocks and other external agents.

With the circuit breaker closed, the current flows from the top terminal (1) to the fixed contact (2a) in the vacuum interrupter (2), and then through the moving contact (2b) and the flexible connector (5) as far as the bottom terminal of the circuit breaker (4).
The movements of the moving contact are ensured by the insulating tie-rod (7) and by the kinematics (8a).



1 Terminale superiore
2 Ampolla in vuoto
2a Contatto fisso
2b Contatto mobile
3 Polo
4 Teminale inferiore
5 Connessione flessibile
6 Molla ammortizzatrice
7 Biella isolante
8 Albero di leva
8a Cinematismo di trasmissione del movimento del comando ai poli dell'interruttore
9 Regolatore della corsa
10 Sensori di posizione
11 Bobina di chiusura
12 Magneti permanenti
13 Ancora mobile
14 Bobina di apertura
15 Dispositivo manuale di apertura di emergenza
16 Struttura di supporto

Fig. 7

6.3. Basic structure of the withdrawable circuit breaker

The withdrawable truck (4) (fig. 8), either manual or motorised, consists of a steel sheet structure with wheels (3), on which the circuit breaker with the relative auxiliary components, the isolating contacts (2) for electrical connection with the switchgear and the multi-pole connector (1) for connection of the circuit breaker auxiliary circuits are installed.
After having been racked into the switchgear and hooked up, the withdrawable circuit breaker can take up the following positions: racked-out, isolated for test (with connector inserted) and racked-in. The racked-in circuit breaker is automatically earthed by means of the truck wheels. The magnetic actuator of the circuit breaker and the relative controls and indicators, are accessible from the front. Withdrawable circuit breakers of the same type and characteristics are interchangeable. However, the code of the connector prevents incorrect combinations between the circuit breaker and switchgear.

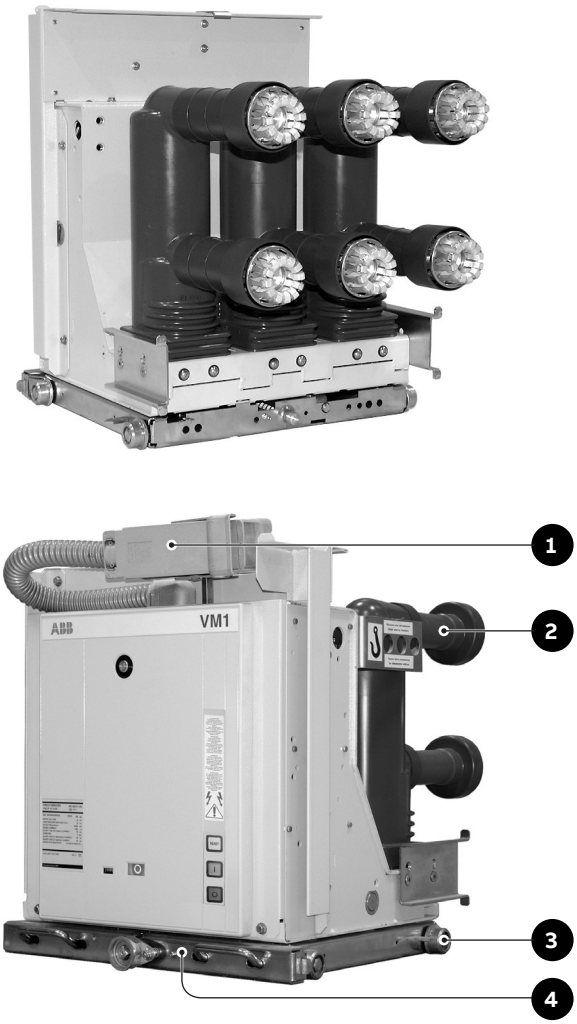


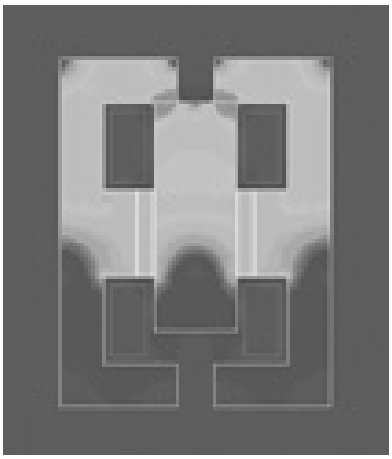
Fig. 8

7. Operation

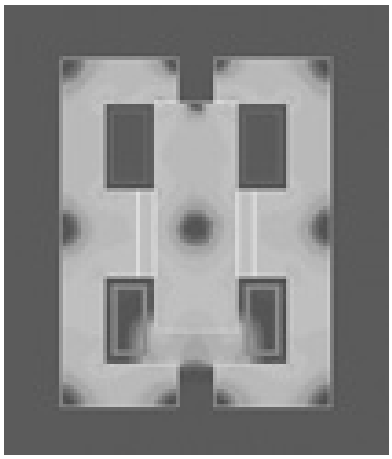
7.1. Operation of the circuit breaker drive

7.1.1. Magnetic actuator

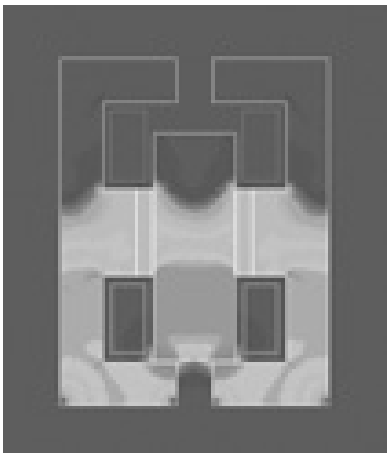
The magnetic actuator used in the VM1 circuit breakers generates the run required to operate the moving contacts of the interrupters and integrates all the functions of a traditional operating mechanism. The magnetic actuator is a bistable system where end-of-run positions of the moving armature are 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 means of energisation of 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 latching points of the permanent magnets to the other. The capacitors which allow circuit breaker operation, for a maximum time of two minutes, even in the case of a drop in the auxiliary voltage, are provided in the control circuit. In case of emergency, the circuit breaker can in any case be opened by means of a special crank handle which acts directly on the moving armature of the drive. Compared to a traditional operating mechanism, the magnetic actuator has few moving parts and greatly reduced wear even after a high number of closing and opening cycles.
These characteristics therefore make it practically maintenance-free.



Magnetic latching in end-of-run position.



Magnetic latching and action of the magnetic field of a coil.



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

Fig. 9

7.1.2. Opening and closing operations

The opening and closing operations can either be remotely controlled by means of the special inputs provided in the control module, or locally by pressing the pushbuttons (8 - 9) (fig. 4).
During the operations, the moving armature of the actuator acts directly on the moving contact by means of the kinematics (8a) (fig. 7).

7.1.3. Reclosing function

Thanks to the short duration of capacitor recharging, the drive is suitable for multiple reclosing operations with O-0,3s-CO-3min-CO cycle.

7.1.4. Control module

The control module is available in the standard version and in the full option version.

7.1.4.1. Functions of the control module - standard version

All the conditions for controlling the opening and closing commands given to the magnetic actuator are managed by a microprocessor:

- the power supply voltage must be applied to the AC/DC converter.
- the capacitor must be sufficiently charged for the next operation:

Circuit breaker position	Operations
Open	Closing and Opening
Closed	Opening

- the closing coil can only be activated when the circuit breaker is open
- the opening coil can only be activated when the circuit breaker is closed
- closing is disabled when an opening command is active at the same time
- de-activation of the opening or closing coil takes place when the relative limit position has been reached.
- WRONG POSITION (auto trip) function: if the final CLOSED (or OPEN) position is not reached within 70 ms during a closing (or opening) operation, an opening operation is immediately started to guarantee reaching a defined safe position in any case.
- The anti-pumping function ensures that only one closing-opening cycle is carried out when a closing command followed by an opening command is active. The active closing command must be cancelled and reset for the next closing operation.
- Activation of the input for the closing command can be locked by means of an external locking signal.
- The input for the “lock on closing” command must be energised to be able to close the circuit breaker (without power it inhibits closing).

7.1.4.2. Additional functions of the control module - full option version

When the “FULL OPTION” control module is requested, the following functions are also available:

- **Undervoltage function:** controls circuit breaker opening if the voltage applied drops below the limit of tolerance (established by the Standards). The rated voltage value to be monitored is set in the factory in conformity with the order specifications. To prevent the function intervening when the voltage drops below the specified level (e.g. in the case of motor starting), it is possible to set a trip time (see par. 7.1.7).
  If no voltage is applied to the undervoltage function input, it is impossible to close the circuit breaker.
  The undervoltage function can be disabled. In this case, it is possible to open and close the circuit breaker without applying voltage to the input of the function. It is also possible to select either the circuit breaker lock in the open state or permission to reclose the circuit breaker after an opening operation for undervoltage (see par. 7.1.7).
- **Monitoring function of the actuator closing and opening coil.** This function serves to monitor the continuity of the closing and opening coils of the magnetic actuator to detect any faults.
  If a fault is detected, the luminous “READY” signal on front of the circuit breaker turns off and the “READY/NOT READY” signalling contacts are activated.
- **Additional safety opening command function.** The second input of the control module for the opening function is designed so that an opening command is carried out directly even in the case of a fault in the microprocessor.

7. Operation

7.1.5. "READY" signalling

The luminous signal and relative "READY/NOT READY" contacts signal:

- capacitor/s charged
- detection of the correct "CLOSED" and "OPEN" positions by the position sensors
- watchdog (function only present on the FULL OPTION control module).

If the luminous "READY" signal is off or flashing, please refer to the table below to find the cause.

Note:
To carry out circuit breaker closing it is not sufficient for the luminous READY signal to be lit and the relative contact activated. It is indispensable to apply voltage to the logical "-SL1": 24 ... 240 V d.c. / a.c. input (input for commanding locking on closing; this function is the same as the one carried out by the locking electromagnet in the mechanical operating mechanism of the VD4 circuit breaker).

7.1.6. Truck locking magnet (compulsory device)

The locking magnet is inserted in withdrawable circuit breakers with manual movement and prevents traverse of the withdrawable truck when there is no power supply voltage.
It is always provided since it is an integral part of the safety interlock against racking-out with the apparatus closed due to any possible fault situation.

Meaning of the signals according to the charging state of the capacitor/s

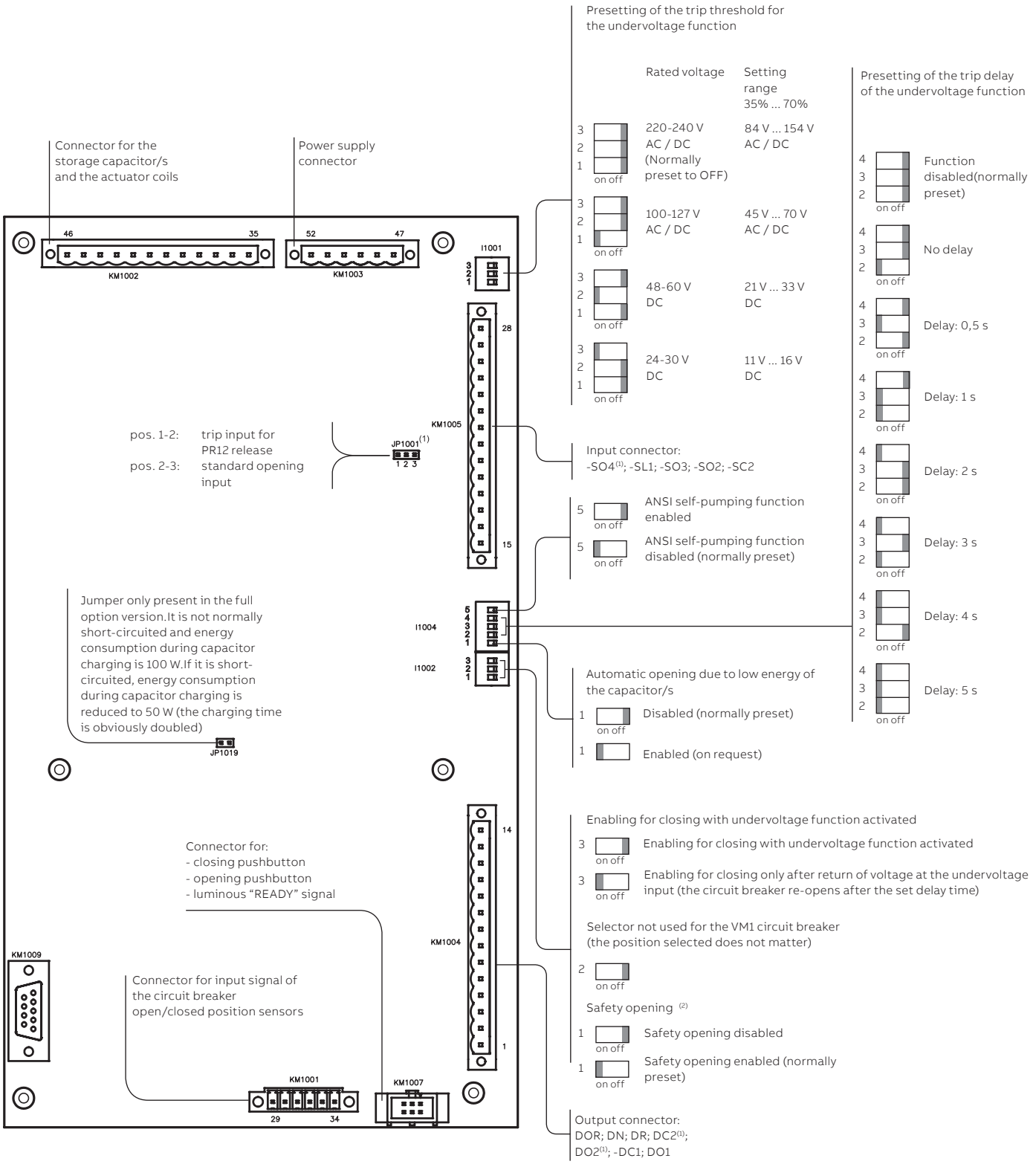
Circuit breaker closed	Circuit breaker open	Capacity of the capacitor/s
Ready signal: lit	Ready signal: lit	Sufficient energy for an O-C-O cycle
Ready contact: closed	Ready contact: closed	
Not Ready contact: open	Not Ready contact: open	
Ready signal: flashing	Ready signal: flashing	Sufficient energy for a C-O cycle
Ready contact: closed	Ready contact: closed	
Not Ready contact: open	Not Ready contact: open	
Ready signal: flashing	Ready signal: off	Sufficient energy for one opening
Ready contact: closed	Ready contact: open	
Not Ready contact: open	Not Ready contact: closed	
Ready signal: off	Ready signal off:	Insufficient energy for opening
Ready contact: open	Ready contact: open	
Not Ready contact: closed	Not Ready contact: closed	

Meaning of the signals according to the state of continuity of the coils

Circuit breaker closed	Circuit breaker open	State of the coils
Ready signal: flashing	Ready signal: off	No continuity the closing coil
Ready contact: closed	Ready contact: open in	
Not Ready contact: open	Not Ready Contact: closed	
Ready signal: off	Ready signal: off	No continuity in the opening coil
Ready contact: open	Ready contact: open	
Not Ready contact: closed	Not Ready contact: closed	

7.1.7. Circuit breaker control card

N.B. Changing the settings by means of dip-switches must be carried out with the control module de-energised and the capacitor discharged since the selections set and/or modified are acquired by the control electronics at the moment it is turned on.



(1) Full Option version.
(2) If enabled, the SO3 input behaves like a hardware input operation even when there is a fault in the microprocessor. If disabled, the –SO3 input behaves like a digital opening input processed by the microprocessor.

7. Operation

7.2. Principle of extinction of the vacuum interrupter

Given the relatively low static pressure of the interruption chamber (between 10^{-4} and 10^{-8} hPa), a relatively limited distance between the contacts is required to obtain high dielectric strength. The vacuum arc is extinguished on the first passage of the current through natural zero.
Considering the limited distance between the contacts, the high conductivity of the plasma of metallic vapours, the drop in voltage of the arc and, moreover, the short arcing time, the energy associated with the arc is extremely limited, therefore producing benefits for the useful life of the contacts obtained and, consequently, for the useful life of the vacuum interrupters.

7.3. Interlocks

7.3.1. Interlocks / protection against malfunction (for withdrawable circuit breakers for ABB switchgear)

A series of interlocks is provided to prevent incorrect operations and/or malfunctions. The interlocks are the following:

- the withdrawable truck can only be moved from the test/isolated position to the service position (and vice versa) if the circuit breaker is open (this means that first of all the circuit breaker must be opened).
- the circuit breaker can be closed if the withdrawable truck is exactly in the defined test position or in the service position (electric interlock).
- the circuit breaker can be opened manually in the service or test position when it is not powered, but it cannot be closed.
- the switchgear is provided with devices which only allow connection and disconnection of the plug connector (1) (fig. 10) in the test/isolation position.

Any detailed information regarding additional interlocks, e.g. in connection with the earthing switch operating mechanism, is given in the specific order documentation.

7.3.2. Interlocks in the case where ABB withdrawable trucks are used

1) The VM1 circuit breaker can only be closed by means of the logical input when a voltage of 24 V - 240 V AC/DC is applied (electric lock on closing).
2) The VM1 circuit breaker can only be closed when the withdrawable truck is in the test or service position. In intermediate positions the closing lock voltage is cut off by the auxiliary contacts.
3) A mechanical interlock positioned on the withdrawable truck prevents a closed circuit breaker from being moved from the test position to the service position.
4) MV1 circuit breaker can only be racked-in/ isolated if the locking electromagnet in the truck is supplied and the apparatus (as well as being open) is in the “READY” state.

Fig. 10

7.3.3. Interlock in the case where non-ABB withdrawable trucks are used

The VM1 circuit breakers mounted on non-ABB withdrawable trucks must be fitted with one or two additional auxiliary contacts interlocked with the mechanical interlocks. These contacts must cut off the input voltage directed to the electric closing lock.
Similarly to what takes place for the auxiliary contacts on the ABB withdrawable truck, additional electrical impulses cannot be received after the first half-turn of the spindle (2) (fig. 10). The electrical impulses can only be applied again after the last half-turn. This guarantees that it is impossible to close the circuit breaker when the withdrawable truck is in an intermediate position.
It is therefore necessary to implement a mechanical interlock to prevent movement of a closed circuit breaker. The slide locking device (1) (fig. 11) on the circuit breaker (optional accessory for fixed circuit breakers) can be used for this purpose: if the VM1 circuit-breaker is closed, the slide locking device is outside the base plate (2) (fig. 11).
Figure 11 shows the pawl (3) on the ABB withdrawable truck. If the circuit breaker is closed, the pawl (3) cannot be turned anticlockwise. This prevents movement of the withdrawable truck and therefore movement of the circuit breaker.

Note: any additional interlocks must not exert any force on the circuit breaker drive.
If the interlocking mechanism extends beyond the base of the circuit breaker housing, suitable measures must be taken to prevent the circuit breaker from resting on the interlock, for example during transport.

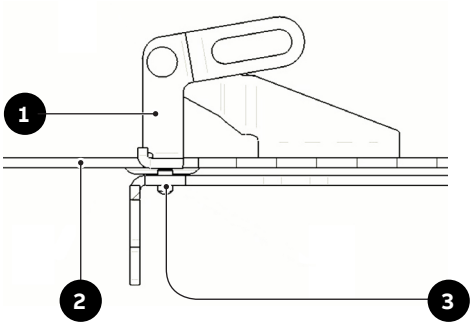


Fig. 11

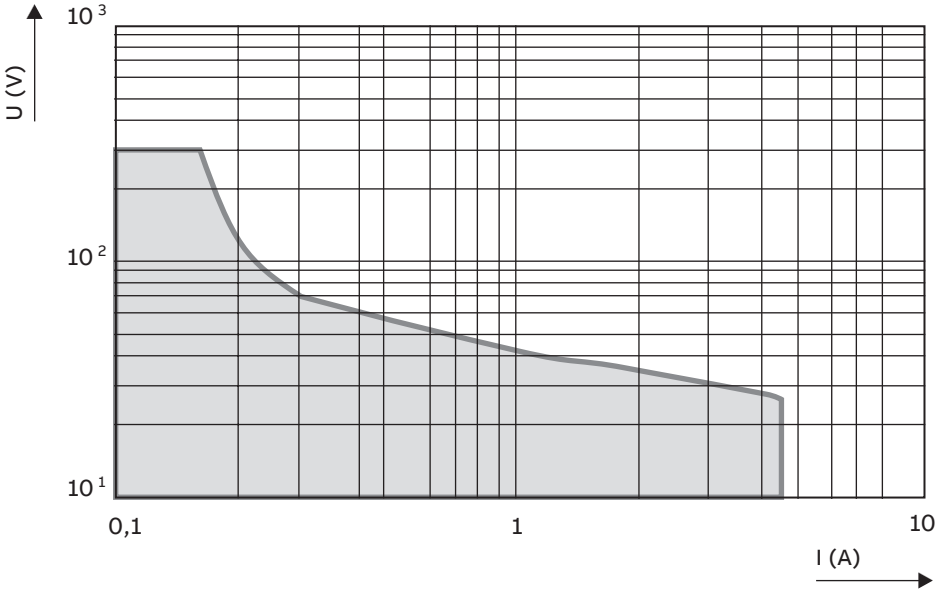
7. Operation

7.3.4. Characteristics of the control module contacts without potential

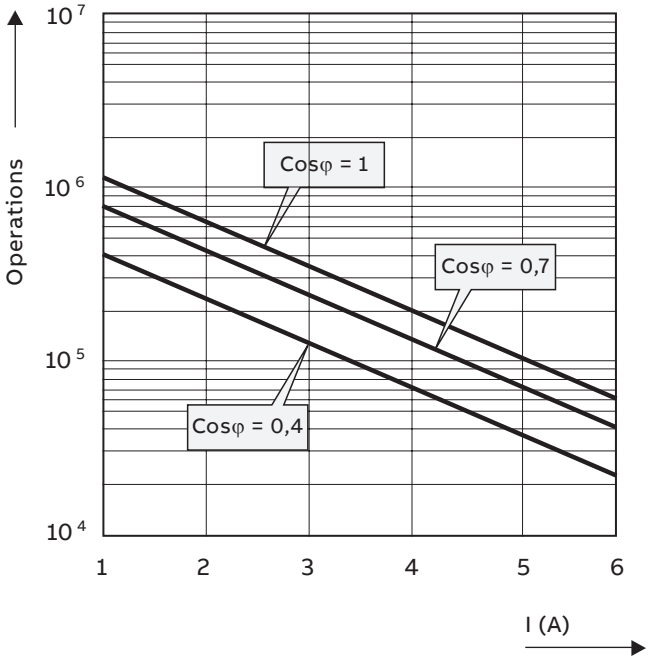
The contacts without potential are supplied with special relays.
For the characteristics of the contacts, please see the table and curves given below.

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.

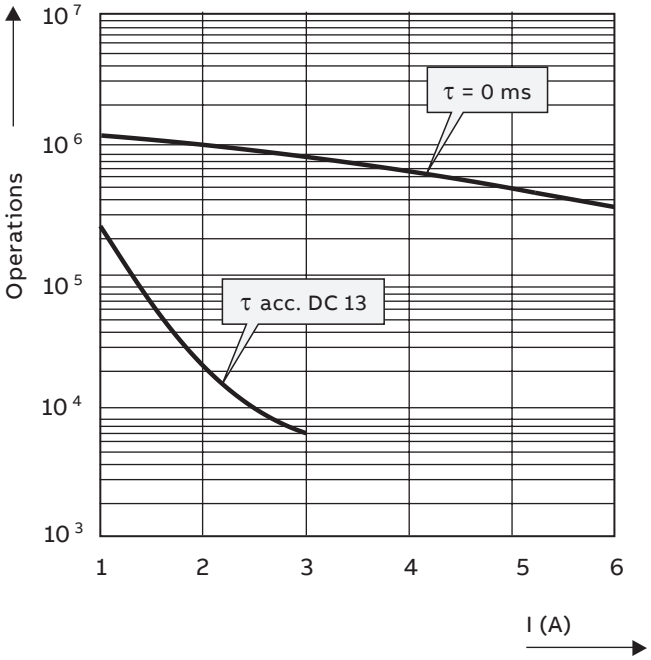
Rated voltage (operating range)	0 ... 264 V~ 50/60 Hz
	0 ... 280 V–
Maximum power applicable (see curves B and C)	1500 VA (V a.c. on resistive load)
	(V d.c. on resistive load - curve A)
Maximum voltage applicable	400 V~ 50/60 Hz
	300 V–
Maximum current applicable	6 A
Rated current	6 A (250 V~ 50/60 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	5.000,000 operations (at 180 operations/min)
Electrical life	N.O. 50,000 (at 6 operations/min)
	N.C. 30,000 (at 6 operations/min)



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



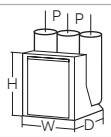
Curve B
Electrical life of the contacts at 250 V a.c.



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

8. Circuit breaker characteristics

8.1. General characteristics of fixed circuit breakers (12 – 17.5 - 24 kV)

Circuit breaker			VM1 12 (1)								
Standards		IEC 62271-100	•								
		CEI 17-1 (File 1375)	•								
Rated voltage		Ur [kV]	12								
Rated insulation voltage		Us [kV]	12								
Withstand voltage at 50 Hz		Ud (1 min) [kV]	28								
Impulse withstand voltage		Up [kV]	75								
Rated frequency		fr [Hz]	50-60								
Rated normal current (40 °C)		Ir [A]	630	630	1250	1250	1600	1600	2000	2000	2500
Rated breaking capacity (rated symmetrical short-circuit current)		Isc [kA]	16	16	16	16	–	–	–	–	–
			20	20	20	20	20	20	20	20	20
			25	25	25	25	25	25	25	25	25
			31.5	31.5	31.5	31.5	31.5	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	20	20	20	20	20
			25	25	25	25	25	25	25	25	25
			31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
Making capacity		Ip [kA]	40	40	40	40	–	–	–	–	–
			50	50	50	50	50	50	50	50	50
			63	63	63	63	63	63	63	63	63
			80	80	80	80	80	80	80	80	80
Operation sequence		[O-0.3s-CO-3min-CO]	•								
Opening time		[ms]	35...45								
Arcing time		[ms]	10...15								
Total interruption time		[ms]	45...60								
Closing time		[ms]	50...60								
Mechanical operations (cycles)		Actuator	... 100.000								
		Interrupters	... 30.000								
Electrical operations (cycles)		Rated current	... 30.000								
		Under short-circuit	... 100								
Maximum overall dimensions		H [mm]	475	475	475	475	599	599	599	599	616
		W [mm]	450	570	450	570	570	700	570	700	700
		D [mm]	424	424	424	424	424	424	424	424	424
Pole centre distance		P [mm]	150	210	150	210	210	275	210	275	275
Weight		≤ 25 kA [kg]	94	98	94	98	130	135	130	135	135
		31.5 kA [kg]	101	105	101	105	130	135	130	135	135
Standardised table of dimensions		1VCD	00001	00002	00001	00002	00003	00004	00003	00004	00004
Operating temperature		[°C]	– 25 ... + 40								
Tropicalisation		IEC: 60068-2-30	•								
		721-2-1	•								
Electromagnetic compatibility		IEC 60694	•								

(1) The circuit breakers up to 17.5 kV - 1250 A – 31.5 kA, are made with polyamide poles.

VM1 17 (1)									**VM1 24**						
•									•						
•									•						
17.5									24						
17.5									24						
38									50						
95									125						
50-60									50-60						
630	630	1250	1250	1600	1600	2000	2000	2500	630	630	1250	1250	1600	2000	2500
16	16	16	16	–	–	–	–	–	16	16	16	16	16	16	–
20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	–
25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	–	–	–	–	–	–	–
16	16	16	16	–	–	–	–	–	16	16	16	16	16	16	–
20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	–
25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	–	–	–	–	–	–	–
40	40	40	40	–	–	–	–	–	40	40	40	40	40	40	–
50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	–
63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
80	80	80	80	80	80	80	80	80	–	–	–	–	–	–	–
•									•						
35...45									35...45						
10...15									10...15						
45...60									45...60						
50...60									50...60						
... 100.000									... 100.000						
... 30.000									... 30.000						
... 30.000									... 30.000						
... 100									... 100						
475	475	475	475	599	599	599	599	616	631	631	631	631	642	642	661
450	570	450	570	570	700	570	700	700	570	700	570	700	700	700	700
424	424	424	424	424	424	424	424	424	424	424	424	424	424	424	424
150	210	150	210	210	275	210	275	275	210	275	210	275	275	275	275
94	98	94	98	130	135	130	135	135	108	115	108	115	137	137	137
101	105	101	105	130	135	130	135	135	–	–	–	–	–	–	–
00001	00002	00001	00002	00003	00004	00003	00004	00004	00005	00006	00005	00006	00007	00007	00007
– 25 ... + 40									– 25 ... + 40						
•									•						
•									•						
•									•						

8. Circuit breaker characteristics

8.1.1. Types of circuit breakers available in the fixed version

Complete the circuit breaker selected with the optional accessories indicated on the following pages.

VM1 fixed circuit breaker without bottom and top terminals

Ur	Isc	Rated normal current (40 °C) [A]									Type of circuit breaker
kV	kA	H = 461		H = 599		H = 616	H = 631		H = 642	H = 661	
		D = 424		D = 424		D = 424	D = 424		D = 424	D = 424	
		u/l = 205		u/l = 310		u/l = 310	u/l = 310		u/l = 310	u/l = 310	
		l/g = 217.5		l/g = 237.5		l/g =237.5	l/g = 282.5		l/g =82.5	l/g =282.5	
		P = 150	P = 210	P = 210	P = 275	P = 275	P = 210	P = 275	P = 275	P = 275	
		W = 450	W = 570	W = 570	W = 700	W = 700	W = 570	W = 700	W = 700	W = 700	
	16	630									VM1 12.06.16 p150
	20	630									VM1 12.06.20 p150
	25	630									VM1 12.06.25 p150
	31.5	630									VM1 12.06.32 p150
	16	1250									VM1 12.12.16 p150
	20	1250									VM1 12.12.20 p150
	25	1250									VM1 12.12.25 p150
	31,5	1250									VM1 12.12.32 p150
	16		630								VM1 12.06.16 p210
	20		630								VM1 12.06.20 p210
	25		630								VM1 12.06.25 p210
	31.5		630								VM1 12.06.32 p210
	16		1250								VM1 12.12.16 p210
	20		1250								VM1 12.12.20 p210
	25		1250								VM1 12.12.25 p210
12	31.5		1250								VM1 12.12.32 p210
	20			1600							VM1 12.16.20 p210
	25			1600							VM1 12.16.25 p210
	31.5			1600							VM1 12.16.32 p210
	20			2000							VM1 12.20.20 p210
	25			2000							VM1 12.20.25 p210
	31.5			2000							VM1 12.20.32 p210
	20				1600						VM1 12.16.20 p275
	25				1600						VM1 12.16.25 p275
	31.5				1600						VM1 12.16.32 p275
	20				2000						VM1 12.20.20 p275
	25				2000						VM1 12.20.25 p275
	31.5				2000						VM1 12.20.32 p275
	20					2500					VM1 12.25.20 p275
	25					2500					VM1 12.25.25 p275
	31.5					2500					VM1 12.25.32 p275

H = Height of the circuit breaker.
W = Width of the circuit breaker.
D = Distance between bottom and top terminal.
u/l = Distanza tra terminale inferiore e superiore.
l/g = Distance between the bottom terminal and the resting surface of the circuit breaker.
P = Pole horizontal centre distance.

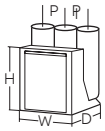
VM1 fixed circuit breaker without bottom and top terminals

Ur	Isc	Rated normal current (40 °C) [A]									Type of circuit breaker
kV	kA	H = 461		H = 599		H = 616	H = 631		H = 642	H = 661	
		D = 424		D = 424		D = 424	D = 424		D = 424	D = 424	
		u/l = 205		u/l = 310		u/l = 310	u/l = 310		u/l = 310	u/l = 310	
		l/g = 217.5		l/g = 237.5		l/g =237.5	l/g = 282.5		l/g =282.5	l/g =282.5	
		P = 150	P = 210	P = 210	P = 275	P = 275	P = 210	P = 275	P = 275	P = 275	
		W = 450	W = 570	W = 570	W = 700	W = 700	W = 570	W = 700	W = 700	W = 700	
	16	630									VM1 17.06.16 p150
	20	630									VM1 17.06.20 p150
	25	630									VM1 17.06.25 p150
	31.5	630									VM1 17.06.32 p150
	16	1250									VM1 17.12.16 p150
	20	1250									VM1 17.12.20 p150
	25	1250									VM1 17.12.25 p150
	31.5	1250									VM1 17.12.32 p150
	16		630								VM1 17.06.16 p210
	20		630								VM1 17.06.20 p210
	25		630								VM1 17.06.25 p210
	31.5		630								VM1 17.06.32 p210
	16		1250								VM1 17.12.16 p210
	20		1250								VM1 17.12.20 p210
	25		1250								VM1 17.12.25 p210
17.5	31.5		1250								VM1 17.12.32 p210
	20			1600							VM1 17.16.20 p210
	25			1600							VM1 17.16.25 p210
	31.5			1600							VM1 17.16.32 p210
	20			2000							VM1 17.20.20 p210
	25			2000							VM1 17.20.25 p210
	31.5			2000							VM1 17.20.32 p210
	20				1600						VM1 17.16.20 p275
	25				1600						VM1 17.16.25 p275
	31,5				1600						VM1 17.16.32 p275
	20				2000						VM1 17.20.20 p275
	25				2000						VM1 17.20.25 p275
	31.5				2000						VM1 17.20.32 p275
	20					2500					VM1 17.25.20 p275
	25					2500					VM1 17.25.25 p275
	31.5					2500					VM1 17.25.32 p275
	16						630				VM1 24.06.16 p210
	20						630				VM1 24.06.20 p210
	25						630				VM1 24.06.25 p210
	16						1250				VM1 24.12.16 p210
	20						1250				VM1 24.12.20 p210
	25						1250				VM1 24.12.25 p210
	16							630			VM1 24.06.16 p275
	20							630			VM1 24.06.20 p275
	25							630			VM1 24.06.25 p275
24	16							1250			VM1 24.12.16 p275
	20							1250			VM1 24.12.20 p275
	25							1250			VM1 24.12.25 p275
	16								1600		VM1 24.16.16 p275
	20								1600		VM1 24.16.20 p275
	25								1600		VM1 24.16.25 p275
	16								2000		VM1 24.20.16 p275
	20								2000		VM1 24.20.20 p275
	25								2000		VM1 24.20.25 p275
	25									2500	VM1 24.16.25 p275

H = Height of the circuit breaker.
W = Width of the circuit breaker.
D = Depth of the circuit breaker.
u/l = Distance between bottom and top terminal.
l/g = Distance between the bottom terminal and the resting surface of the circuit breaker.
p = Pole horizontal centre distance.

8. Circuit breaker characteristics

8.2. General characteristics of withdrawable circuit breakers for UniGear ZS1switchgear (12 – 17.5 - 24 kV)

Circuit breaker		**VM1/P 12 (3)**						
Standards	IEC 62271-100	•						
	CEI 17-1 (File 1375)	•						
Rated voltage	Ur [kV]	12						
Rated insulation voltage	Us [kV]	12						
Withstand voltage at 50 Hz	Ud (1 min) [kV]	28						
Impulse withstand voltage	Up [kV]	75						
Rated frequency	fr [Hz]	50-60						
Rated normal current (40 °C) (1)	Ir [A]	630	1250	1600	1600	2000	2000	2500
Rated breaking capacity (rated symmetrical short-circuit current)	Isc [kA]	16	16	–	–	–	–	–
		20	20	20	20	20	20	20
		25	25	25	25	25	25	25
		31.5	31.5	31.5	31.5	31.5	31.5	31.5
Rated short-time withstand current (3 s)	Ik [kA]	16	16	–	–	–	–	–
		20	20	20	20	20	20	20
		25	25	25	25	25	25	25
		31.5	31.5	31.5	31.5	31.5	31.5	31.5
Making capacity	Ip [kA]	40	40	–	–	–	–	–
		50	50	50	50	50	50	50
		63	63	63	63	63	63	63
		80	80	80	80	80	80	80
Operation sequence	[O-0.3s-CO-3min-CO]	•						
Opening time	[ms]	35...45						
Arcing time	[ms]	10...15						
Total interruption time	[ms]	45...60						
Closing time	[ms]	50...60						
Mechanical operations (cycles)	Actuator	... 100,000						
	Interrupters	... 30,000						
Electrical operations (cycles)	Rated current	... 30,000						
	Under short-circuit	... 100						
Maximum overall dimensions 	H [mm]	628	628	690	690	690	690	834
	W [mm]	503	503	653	853	653	853	853
	D [mm]	662	662	642	642	642	642	790
Pole centre distance	p [mm]	150	150	210	275	210	275	275
Weight	≤ 25 kA [kg]	137	137	192	196	192	196	255
	31.5 kA [kg]	144	144	192	196	192	196	255
Standardised table of dimensions	1VCD	00008	00008	00009	00010	00009	00010	00014
Operating temperature	[°C]	– 25 ... + 40						
Tropicalisation	IEC: 60068-2-30	•						
	721-2-1	•						
Electromagnetic compatibility	IEC 60694	•						

(1) Rated normal currents guaranteed with withdrawable circuit breaker installed in UniGear ZS1 switchgear with air temperature of 40 °C.
(2) The rated normal current of 2300 A is guaranteed with natural ventilation. The rated uninterrupted current of 2500 A is guaranteed with forced ventilation.
(3) The circuit breakers up to 17.5 kV - 1250 A – 31.5 kA, are made with polyamide poles.

VM1/P 17 (3)							**VM1/P 24**						
•							•						
•							•						
17.5							24						
17.5							24						
38							50						
95							125						
50-60							50-60						
630	1250	1600	1600	2000	2000	2500	630	630	1250	1250	1600	2000	2500 (2)
16	16	–	–	–	–	–	16	16	16	16	16	16	16
20	20	20	20	20	20	20	20	20	20	20	20	20	20
25	25	25	25	25	25	25	25	25	25	25	25	25	25
31.5	31.5	31.5	31.5	31.5	31.5	31.5	–	–	–	–	–	–	–
16	16	–	–	–	–	–	16	16	16	16	16	16	16
20	20	20	20	20	20	20	20	20	20	20	20	20	20
25	25	25	25	25	25	25	25	25	25	25	25	25	25
31.5	31.5	31.5	31.5	31.5	31.5	31.5	–	–	–	–	–	–	–
40	40	–	–	–	–	–	40	40	40	40	40	40	40
50	50	50	50	50	50	50	50	50	50	50	50	50	50
63	63	63	63	63	63	63	63	63	63	63	63	63	63
80	80	80	80	80	80	80	–	–	–	–	–	–	–
•							•						
35...45							35...45						
10...15							10...15						
45...60							45...60						
50...60							50...60						
... 100,000							... 100,000						
... 30,000							... 30,000						
... 30,000							... 30,000						
... 100							... 100						
628	628	690	690	690	690	834	790	790	790	790	834	834	834
503	503	653	853	653	853	853	653	853	653	853	853	853	853
662	662	642	642	642	642	790	802	802	802	802	790	790	790
150	150	210	275	210	275	275	210	275	210	275	275	275	275
137	137	192	196	192	196	255	148	152	148	152	255	255	255
144	144	192	196	192	196	255	–	–	–	–	–	–	–
00008	00008	00009	00010	00009	00010	00014	00012	00013	00012	00013	00014	00014	00014
– 25 ... + 40							– 25 ... + 40						
•							•						
•							•						
•							•						

8. Circuit breaker characteristics

8.2.1. Types of withdrawable circuit breakers available for UniGear switchgear

Complete the circuit breaker selected with the optional accessories indicated on the following pages.

VM1/P withdrawable circuit breaker for UniGear switchgear

Ur	Isc	Rated uninterrupted current (40 °C) [A]							
kV	kA	W = 650	W = 800	W = 1000	W = 1000	W = 800	W = 1000	W = 1000	
		P = 150	P = 210	P = 275	P = 275	P = 210	P = 275	P = 275	**Type of circuit breaker**
		u/l = 205	u/l = 310	u/l = 310	u/l = 310	u/l = 310	u/l = 310	u/l = 310	
		ø = 35	ø = 79	ø = 79	ø = 109	ø = 35	ø = 35	ø = 79	
	16	630							VM1/P 12.06.16 p150
	20	630							VM1/P 12.06.20 p150
	25	630							VM1/P 12.06.25 p150
	31.5	630							VM1/P 12.06.32 p150
	20		1600						VM1/P 12.16.20 p210
	25		1600						VM1/P 12.16.25 p210
	31.5		1600						VM1/P 12.16.32 p210
	20		2000						VM1/P 12.20.20 p210
	25		2000						VM1/P 12.20.25 p210
12	31.5		2000						VM1/P 12.20.32 p210
	20			1600					VM1/P 12.16.20 p275
	25			1600					VM1/P 12.16.25 p275
	31.5			1600					VM1/P 12.16.32 p275
	20			2000					VM1/P 12.20.20 p275
	25			2000					VM1/P 12.20.25 p275
	31.5			2000					VM1/P 12.20.32 p275
	20				2500				VM1/P 12.25.20 p275
	25				2500				VM1/P 12.25.25 p275
	31.5				2500				VM1/P 12.25.32 p275
	16	630							VM1/P 17.06.16 p150
	20	630							VM1/P 17.06.20 p150
	25	630							VM1/P 17.06.25 p150
	31.5	630							VM1/P 17.06.32 p150
	16	1250							VM1/P 17.12.16 p150
	20	1250							VM1/P 17.12.20 p150
	25	1250							VM1/P 17.12.25 p150
	31.5	1250							VM1/P 17.12.32 p150
	20		1600						VM1/P 17.16.20 p210
	25		1600						VM1/P 17.16.25 p210
	31.5		1600						VM1/P 17.16.32 p210
17.5	20		2000						VM1/P 17.20.20 p210
	25		2000						VM1/P 17.20.25 p210
	31.5		2000						VM1/P 17.20.32 p210
	20			1600					VM1/P 17.16.20 p275
	25			1600					VM1/P 17.16.25 p275
	31.5			1600					VM1/P 17.16.32 p275
	20			2000					VM1/P 17.20.20 p275
	25			2000					VM1/P 17.20.25 p275
	31.5			2000					VM1/P 17.20.32 p275
	20				2500				VM1/P 17.25.20 p275
	25				2500				VM1/P 17.25.25 p275
	31.5				2500				VM1/P 17.25.32 p275

W = Width of the switchgear.
p = Pole horizontal centre distance.
u/l = Distance between bottom and top terminal.
ø = Diameter of the isolating contact.

VM1/P withdrawable circuit breaker for UniGear switchgear

Ur	Isc	Rated uninterrupted current (40°C) [A]							
kV	kA	W = 650	W = 800	W = 1000	W = 1000	W = 800	W = 1000	W = 1000	
		P = 150	P = 210	P = 275	P = 275	P = 210	P = 275	P = 275	**Type of circuit breaker**
		u/l = 205	u/l = 310	u/l = 310	u/l = 310	u/l = 310	u/l = 310	u/l = 310	
		ø = 35	ø = 79	ø = 79	ø = 109	ø = 35	ø = 35	ø = 79	
24	16					630			VM1/P 24.06.16 p210
	20					630			VM1/P 24.06.20 p210
	25					630			VM1/P 24.06.25 p210
	16					1250			VM1/P 24.12.16 p210
	20					1250			VM1/P 24.12.20 p210
	25					1250			VM1/P 24.12.25 p210
	16						630		VM1/P 24.06.16 p275
	20						630		VM1/P 24.06.20 p275
	25						630		VM1/P 24.06.25 p275
	16						1250		VM1/P 24.12.16 p275
	20						1250		VM1/P 24.12.20 p275
	25						1250		VM1/P 24.12.25 p275
	16							1600	VM1/P 24.16.16 p275
	20							1600	VM1/P 24.16.20 p275
	25							1600	VM1/P 24.16.25 p275
	16							2000	VM1/P 24.20.16 p275
	20							2000	VM1/P 24.20.20 p275
	25							2000	VM1/P 24.20.25 p275
	16							2300	VM1/P 24.25.16 p275
	20							2300	VM1/P 24.25.20 p275
	25							2300	VM1/P 24.25.25 p275
	16							2500 (*)	VM1/P 24.25.16 p275
	20							2500 (*)	VM1/P 24.25.20 p275
	25							2500 (*)	VM1/P 24.25.25 p275

W = Width of the switchgear.
p = Pole horizontal centre distance.
u/l = Distance between bottom and top terminal.
ø = Diameter of the isolating contact.

8. Circuit breaker characteristics

8.3. General characteristics of withdrawable circuit breakers for PowerCube modules (12 – 17.5 - 24 kV)

Circuit breaker		**VM1/P 12**					**VM1/P 17**				
	PowerCube module	**PB1**	**PB1**	**PB2**	**PB2**	**PB3**	**PB1**	**PB1**	**PB2**	**PB2**	**PB3**
Standards	IEC 62271-100	•					•				
	CEI 17-1 (File 1375)	•					•				
Rated voltage	Ur [kV]	12					17.5				
Rated insulation voltage	Us [kV]	12					17.5				
Withstand voltage at 50 Hz	Ud (1 min) [kV]	28					38				
Impulse withstand voltage	Up [kV]	75					95				
Rated frequency	fr [Hz]	50-60					50-60				
Rated normal current (40 °C) (1)	Ir [A]	630	1250	1600	2000	2500	630	1250	1600	2000	2500
Rated breaking capacity (rated symmetrical short-circuit current)	Isc [kA]	16	16	–	–	–	16	16	–	–	–
		20	20	20	20	20	20	20	20	20	20
		25	25	25	25	25	25	25	25	25	25
		31.5	31.5	31.5	31.5	31.5	31.5	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	20	20	20	20	20	20
		25	25	25	25	25	25	25	25	25	25
		31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
Making capacity	Ip [kA]	40	40	–	–	–	40	40	–	–	–
		50	50	50	50	50	50	50	50	50	50
		63	63	63	63	63	63	63	63	63	63
		80	80	80	80	80	80	80	80	80	80
Operation sequence	[O-0.3s-CO-3min-CO]	•					•				
Opening time	[ms]	35...45					35...45				
Arcing time	[ms]	10...15					10...15				
Total interruption time	[ms]	45...60					45...60				
Closing time	[ms]	50...60					50...60				
Mechanical operations (cycles)	Actuator	... 100,000					... 100,000				
	Interrupters	... 30,000					... 30,000				
Electrical operations (cycles)	Rated current	... 30,000					... 30,000				
	Under short-circuit	... 100					... 100				
Maximum overall dimensions	H [mm]	628	628	690	690	690	628	628	690	690	690
	W [mm]	503	503	653	653	853	503	503	653	653	853
	D [mm]	662	662	642	642	642	662	662	642	642	642
Pole centre distance	P [mm]	150	150	210	210	275	150	150	210	210	275
Weight	≤ 25 kA [kg]	137	137	192	192	196	137	137	192	192	196
	31.5 kA [kg]	144	144	192	192	196	144	144	192	192	196
Standardised table of dimensions	1VCD	00008	00008	00009	00009	00011	00008	00008	00009	00009	00011
Operating temperature	[°C]	– 25 ... + 40					– 25 ... + 40				
Tropicalisation	IEC: 60068-2-30	•					•				
	721-2-1	•					•				
Electromagnetic compatibility	IEC 60694	•					•				

(1) Rated uninterrupted currents guaranteed with withdrawable circuit breaker installed with air temperature of 40 °C.
(2) The rated normal current of 2300 A is guaranteed with natural ventilation. The rated uninterrupted current of 2500 A is guaranteed with forced ventilation.
(3) The circuit breakers up to 17.5 kV - 1250 A – 31.5 kA, are made with polyamide poles.

VM1/P 24					VM1/W 12 (3)		VM1/W 17 (3)	
PB4	PB4	PB5	PB5	PB5	PB2	PB2	PB2	PB2
•					•		•	
•					•		•	
24					12		17.5	
24					12		17.5	
50					28		38	
125					75		95	
50-60					50-60		50-60	
630	1250	1600	2000	2500	630	1250	630	1250
16	16	16	16	16	16	16	16	16
20	20	20	20	20	20	20	20	20
25	25	25	25	25	25	25	25	25
–	–	–	–	–	31.5	31.5	31.5	31.5
16	16	16	16	16	16	16	16	16
20	20	20	20	20	20	20	20	20
25	25	25	25	25	25	25	25	25
–	–	–	–	–	31.5	31.5	31.5	31.5
40	40	40	40	40	40	40	40	40
50	50	50	50	50	50	50	50	50
63	63	63	63	63	63	63	63	63
–	–	–	–	–	80	80	80	80
•					•		•	
35...45					35...45		35...45	
10...15					10...15		10...15	
45...60					45...60		45...60	
50...60					50...60		50...60	
... 100,000					... 100,000		... 100,000	
... 30,000					... 30,000		... 30,000	
... 30,000					... 30,000		... 30,000	
... 100					... 100		... 100	
790	790	834	834	834	632	632	632	632
653	653	853	853	853	503	503	503	503
802	802	790	790	790	664	664	664	664
210	210	275	275	275	210	210	210	210
148	148	255	255	255	141	141	141	141
–	–	–	–	–	148	148	148	148
00012	00012	00014	00014	00014	00074	00074	00074	00074
– 25 ... + 40					– 25 ... + 40			
•					•			
•					•			
•					•			

8. Circuit breaker characteristics

8.3.1. Types of withdrawable circuit breakers available for PowerCube modules

Complete the circuit breaker selected with the optional accessories indicated on the following pages.

VM1/P withdrawable circuit breaker - VM1/W for PowerCube modules

Ur	Isc	Rated uninterrupted current (40°C) [A]						Type of circuit breaker
kV	kA	W = 600 P = 150 u/l = 205 ø = 35	W = 750 P = 210 u/l = 310 ø = 35	W = 750 P = 210 u/l = 310 ø = 79	W = 1000 P = 275 u/l = 310 ø = 109	W = 750 P = 210 u/l = 310 ø = 35	W = 1000 P = 275 u/l = 310 ø = 79	
PowerCube		**PB1**	**PB2**	**PB2**	**PB3**	**PB4**	**PB5**	
	16	630						VM1/P 12.06.16 p150
	20	630						VM1/P 12.06.20 p150
	25	630						VM1/P 12.06.25 p150
	31.5	630						VM1/P 12.06.32 p150
	16	1250						VM1/P 12.12.16 p150
	20	1250						VM1/P 12.12.20 p150
	25	1250						VM1/P 12.12.25 p150
	31.5	1250						VM1/P 12.12.32 p150
	16		630					VM1/W 12.06.16 p210
	20		630					VM1/W 12.06.20 p210
	25		630					VM1/W 12.06.25 p210
	31.5		630					VM1/W 12.06.32 p210
12	16		1250					VM1/W 12.12.16 p210
	20		1250					VM1/W 12.12.20 p210
	25		1250					VM1/W 12.12.25 p210
	31.5		1250					VM1/W 12.12.32 p210
	20			1600				VM1/P 12.16.20 p210
	25			1600				VM1/P 12.16.25 p210
	31.5			1600				VM1/P 12.16.32 p210
	20			2000				VM1/P 12.20.20 p210
	25			2000				VM1/P 12.20.25 p210
	31.5			2000				VM1/P 12.20.32 p210
	20				2500			VM1/P 12.25.20 p275
	25				2500			VM1/P 12.25.25 p275
	31.5				2500			VM1/P 12.25.32 p275

W = Width of the switchgear.
P = Pole horizontal centre distance.
u/l = Distance between bottom and top terminal.
ø = Diameter of the isolating contact.

Withdrawable circuit breaker VM1/P - VM1/W for PowerCube modules

Ur	Isc	Rated uninterrupted current (40 °C) [A]						Type of circuit breaker
		L = 600	L = 750	L = 750	L = 1000	L = 750	L = 1000	
kV	kA	I = 150	I = 210	I = 210	I = 275	I = 210	I = 275	
		u/I = 205	u/I = 310	u/I = 310	u/I = 310	u/I = 310	u/I = 310	
		ø = 35	ø = 35	ø = 79	ø = 109	ø = 35	ø = 79	
PowerCube		**PB1**	**PB2**	**PB2**	**PB3**	**PB4**	**PB5**	
	16	630						VM1/P 17.06.16 p150
	20	630						VM1/P 17.06.20 p150
	25	630						VM1/P 17.06.25 p150
	31.5	630						VM1/P 17.06.32 p150
	16	1250						VM1/P 17.12.16 p150
	20	1250						VM1/P 17.12.20 p150
	25	1250						VM1/P 17.12.25 p150
	31.5	1250						VM1/P 17.12.32 p150
	16		630					VM1/W 17.06.16 p210
	20		630					VM1/W 17.06.20 p210
	25		630					VM1/W 17.06.25 p210
	31.5		630					VM1/W 17.06.32 p210
17.5	16		1250					VM1/W 17.12.16 p210
	20		1250					VM1/W 17.12.20 p210
	25		1250					VM1/W 17.12.25 p210
	31.5		1250					VM1/W 17.12.32 p210
	20			1600				VM1/P 17.16.20 p210
	25			1600				VM1/P 17.16.25 p210
	31.5			1600				VM1/P 17.16.32 p210
	20			2000				VM1/P 17.20.20 p210
	25			2000				VM1/P 17.20.25 p210
	31.5			2000				VM1/P 17.20.32 p210
	20				2500			VM1/P 17.25.20 p275
	25				2500			VM1/P 17.25.25 p275
	31.5				2500			VM1/P 17.25.32 p275
	16					630		VM1/P 24.06.16 p210
	20					630		VM1/P 24.06.20 p210
	25					630		VM1/P 24.06.25 p210
	16					1250		VM1/P 24.12.16 p210
	20					1250		VM1/P 24.12.20 p210
	25					1250		VM1/P 24.12.25 p210
24	16						1600	VM1/P 24.16.16 p275
	20						1600	VM1/P 24.16.20 p275
	25						1600	VM1/P 24.16.25 p275
	16						2000	VM1/P 24.20.16 p275
	20						2000	VM1/P 24.20.20 p275
	25						2000	VM1/P 24.20.25 p275

W = Width of the switchgear.
P = Pole horizontal centre distance.
u/I = Distance between bottom and top terminal.
ø = Diameter of the isolating contact.

8. Circuit breaker characteristics

8.4. Standard fittings

8.4.1. Standard fittings for fixed version circuit breakers

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

- closing pushbutton (SC1)
- opening pushbutton (SO1)
- mechanical operation counter
- mechanical signalling device for circuit breaker open/closed
- device for manual emergency opening
- crank handle for manual emergency opening (the quantity must be defined according to the number of pieces of apparatus ordered)
- lamp signalling “READY” for the operation (PRDY)
- capacitor/s for storing energy for the operation
- mobile connector for direct connection to the sockets of the electronic module, to cable the auxiliary circuits
- ED2.0 basic version control module. Two types of feeders are available:
  - Type 1: 24 ... 48 V AC / 24 ... 60 V DC
  - Type 2: 100 ... 240 V AC / 110 ... 250 V DC

Preparation of the basic ED2.0 version control module

1) signalling contacts without potential, fitted with relays, with the following functions (for the characteristics of the contacts without potential see par. 8.5):
   - N. 1 contact signalling circuit breaker open (DO1)
   - N. 1 contact signalling circuit breaker closed (DC1)
   - N. 1 contact signalling circuit breaker ready for the operation (capacitors charged and state of the circuit breaker checked) (DR)
   - N. 1 contact signalling circuit breaker not ready for the operation (DN, normally closed)
   - N. 1 transient contact with momentary closing during the opening operation (DOR).

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

2) binary inputs (logical inputs) for remote control:
   - N. 1 input for closing command (-SC2) (top logical input activated)
   - N. 1 input for opening command (-SO2) (top logical input activated)
   - N. 1 input for additional opening command (-SO3) (top logical input activated)
   - N. 1 input for circuit breaker opening on direct command from the PR512 protection release (-SO5) (top logical input activated)
   - N. 1 input for lock on closing command (the same function as the one carried out by the locking electromagnet in the mechanical drive of the VM1 circuit breaker) (-SL1) (bottom logical input activated).

   Binary inputs can be powered as follows:
   - 24 ... 240 V AC (tolerance – 15% ... + 10%)
   - 24 ... 250 V DC (tolerance – 30% ... + 10%).

   The minimum impulse time for it to be considered valid is 20 ms.

The functions carried out by the control module are:

1) auto-trip following detection of wrong circuit breaker state (WRONG POSITION AUTO-TRIP)
2) auto-trip following lower capacitor charging threshold than the minimum value required for the opening operation (ENERGY FAILURE AUTO-TRIP)
3) anti-pumping relay function (ANTIPUMP)
4) priority opening function (TRIP-FREE)
5) checking the capacitor load voltage with auto-shutdown of the feeder when the maximum charging level is exceeded
6) reclosing function (RECLOSE)
7) management of No. 10 opening attempts (in the case of 10 unsuccessful attempts the control module blocks).

Some of these control module functions can be disabled by means of dip-switches present on the card (see par. 7.1.7).

8.4.2. Standard fittings for withdrawable version circuit breakers

The standard fittings are the same as those for the fixed version circuit breaker plus:

- isolating contacts
- cord with connector (plug only) for auxiliary circuits, with striker pin which does not allow the plug to be inserted in the socket if the rated current of the circuit breaker is different from the rated current of the panel (only for ABB UniGear type switchgear).
- racking-in/out lever (the quantity must be defined according to the number of pieces of apparatus ordered)
- truck locking electromagnet (only for ABB UniGear type switchgear)

8.5. Optional accessories

The accessories identified by the same number are alternative to each other.

8.5.1. ED2.0 Control module with full options

The full option ED2.0 control module is available on request as an alternative to the basic version ED2.0 control module and must be selected during the ordering stage since the possibility of replacing the basic module is not foreseen.
The full option ED2.0 control module is available with two types of feeders:

- Type 1: 24 ... 48 V AC / 24 ... 60 V DC
- Type 2: 100 ... 240 V AC / 110 ... 250 V DC

and provides the following signalling, control and operating functions:

1) signalling contacts without potential, fitted with relay, with the following functions (for the characteristics of the contacts without potential, see chapter 7.3.4.).
   - N. 2 contacts signalling circuit breaker open (DO1, DO2)
   - N. 2 contacts signalling circuit breaker closed (DC1, DC2)
   - N. 1 contact signalling circuit breaker ready for the operation (DR). This is a closed contact when the circuit breaker is ready for the operation, i.e. when the following conditions are met:
     - capacitor charged (the energy stored is sufficient to carry out one closing and opening operation if the circuit breaker is in the “open” state or one opening operation if the circuit breaker is in the “closed” state),
     - circuit breaker in a well-defined state (either “open” or “closed),
     - positive outcome of the opening and closing coil continuity of the magnetic actuator.
   - N. 1 contact signalling circuit breaker not ready for the operation (DN). This contact is of the normally closed type and therefore, even if there is no auxiliary voltage its indication “the circuit breaker is not ready for the operation” is always correct. The indication of circuit breaker not ready for operation is given when even only one of the following conditions occurs:
     - capacitor not charged (the energy stored is insufficient or there is no auxiliary voltage),
     - circuit breaker in an undefined state (neither “open” nor “closed”)
     - no continuity of the opening and closing coil of the magnetic actuator.
   - N. 1 transient contact with momentary closing (for 100 ms) during the opening operation (DOR). This contact has the same function as the one carried out by the –BB4 contact in the mechanical operating mechanism of the VD4 circuit breaker.

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

2) binary inputs (logical inputs) for remote control:
   - N. 1 input for closing command (-SC2) (top logical input activated)
   - N. 1 input for opening command (-SO2) (top logical input activated)
   - N. 1 input for additional and safety opening command (-SO3) (top logical input activated)
   - N. 1 input for circuit breaker opening on direct command from the PR512 protection release (-SO5) (top logical input activated)
   - N. 1 input for lock on closing command (the same function as the one carried out by the –RL1 locking electromagnet in the mechanical drive of the VD4 circuit breaker) (-SL1) (bottom logical input activated)
   - N. 1 input for undervoltage opening command (-S04):
   - The function can be excluded (bottom logical input activated).

N.B. The binary inputs can be supplied as follows:

- 24 ... 240 V a.c. (tolerance – 15% ... + 10%)
- 24 ... 250 V d.c. (tolerance – 30% ... + 10%).

A binary input is considered valid when the impulse applied lasts at least 20 ms.

8. Circuit breaker characteristics

3) The functions carried out by the control module are:
   - auto-trip following detection of wrong circuit breaker state after an operation attempt
   - auto-trip following lower capacitor charging threshold than the minimum value required for the opening and closing operation
   - anti-pumping relay function
   - priority opening function in the case of opening and closing commands being sent at the same time (TRIP-FREE)
   - checking the capacitor load voltage with auto-shutdown of the feeder when the maximum charging level is exceeded
   - opening for undervoltage. The rated voltage is set (values foreseen: 24-30 V AC, 48-60 V DC, 100-127 V AC/V DC 220-240 V AC/V DC) and opening can also be delayed (trip delays foreseen: 0-0.5-1-2-3-4-5 sec). The “lock in open” (the closing command is only accepted after the opening function for undervoltage has been reset) and “reclosing enabled” (the closing command is accepted even if the opening function for undervoltage is still active) can also be selected (-SO4)
   - watchdog of the electronic power circuit with feeder auto-shutdown in the case of overtemperature and/or overcurrent
   - slow capacitor charging function (the charging power passes from 100 watt to 40 watt, doubling the charging time. This function is useful when self-supply by means of a voltage transformer is to be made)
   - monitoring continuity of the opening and closing coils
   - management of opening attempts: after 10 unsuccessful opening attempts the control electronics block and the DR and EN signalling contacts are activated to indicate that the circuit breaker is not ready for the operation
   - reclosing function according to the ANSI standards (ANSI RECLOSE)
   - watchdog (DN)
   - limitation of the feeder connection current
   - serial RS232 for local connection (only to be used by ABB personnel).

N.B. Some of the control module functions can be excluded/set by means of special dip-switches on the card. Changing the dip-switch settings must always be carried out with the control module de-energised and capacitor/s discharged, both for safety of personnel and because the adjustments set are only detected by the control electronics when it is turned on.

8.5.2. Circuit breaker auxiliary contacts

It is possible to have electrical signalling of circuit breaker open/closed by means of make and break contacts. The following configurations are available.

For Fixed circuit breaker (-BB1; -BB2; -BB3; -BB8)
2A Set of 5 make contacts plus 5 break contacts
2B Set of 10 make contacts plus 10 break contacts

For withdrawable circuit breaker (-BB1; -BB2)
2C Set of 5 break contacts plus 5 make contacts.

Characteristics				
Un:	24 ... 250 V a.c.-d.c.			
Rated current:	Ith^2 = 10 A			
Insulation voltage:	2500 V 50 Hz (for 1 min)			
Electrical resistance:	3 mOhm			
Rated current and breaking capacity in category AC11 and DC11:				
Un	**Cosφ**	**T**	**In**	**Icu**
220 V ~	0.7	--	2.5 A	25 A
24 V –	--	15 ms	10 A	12 A
60 V –	--	15 ms	6 A	8 A
110 V –	--	15 ms	4 A	5 A
220 V –	--	15 ms	1 A	2 A

8.5.3. Transmitted contacts in the truck (-BT1; -BT2)

Transmitted contacts of the withdrawable circuit breaker (installed in the circuit breaker truck - only for withdrawable circuit breaker for UniGear ZS1 switchgear and for PowerCube enclosure).
These contacts are either in addition or as an alternative to the position contacts (for signalling circuit breaker racked-out) located in the unit. They also carry out the function of the position contact (-BT3).

8.5.4. Position contact (-BT3)

The position contact (-BT3) is used, together with binary input SL1, to prevent remote circuit breaker closing during traverse into the unit. It is only supplied for the withdrawable version circuit breaker when the transmitted contacts in the truck are not requested (-BT1; -BT2).

8.5.5. Motorised truck (-MT) (only for withdrawable version circuit breaker for UniGear switchgear)

This allows the circuit breaker to be racked-in/out of the switchgear remotely.

Characteristics	
Un:	110 - 220 V–
Operating limits:	85 ... 110% Un
Rated power (Pn):	40 W

8.5.6. Device for rapidly discharging the capacitor/s

Before accessing the circuits present in the control box, it is compulsory to make sure that the capacitor/s is/are discharged.
Even when there is no auxiliary power supply, more than ten minutes are needed to completely discharge the capacitor/s.
The rapid discharing device allows the waiting time to be reduced to one minute and guarantees safe access to the circuits which might be live.

9. Installation

9.1. General

Correct installation is of prime importance. The manufacturer's instructions must be carefully studied and followed. It is good practice to use gloves to handle the pieces during installation.
The areas involved by the passage of power conductors or conductors of auxiliary circuits must be protected against access of any animals which might cause damage or disservices.

9.2. Trip curves

The following graphs show the number of closing-opening cycles (No.) allowed, of the vacuum interrupters, according to the breaking capacity (Ia).

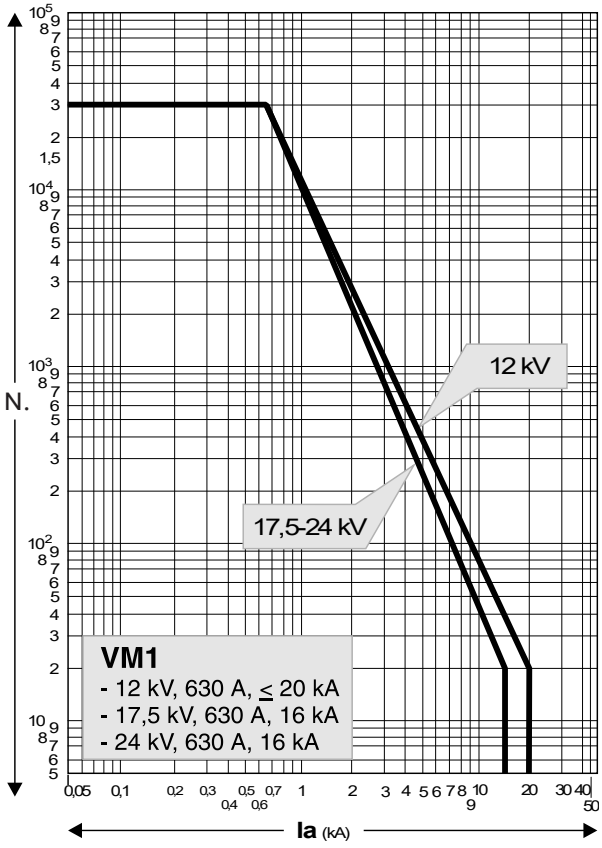


Fig. 12a

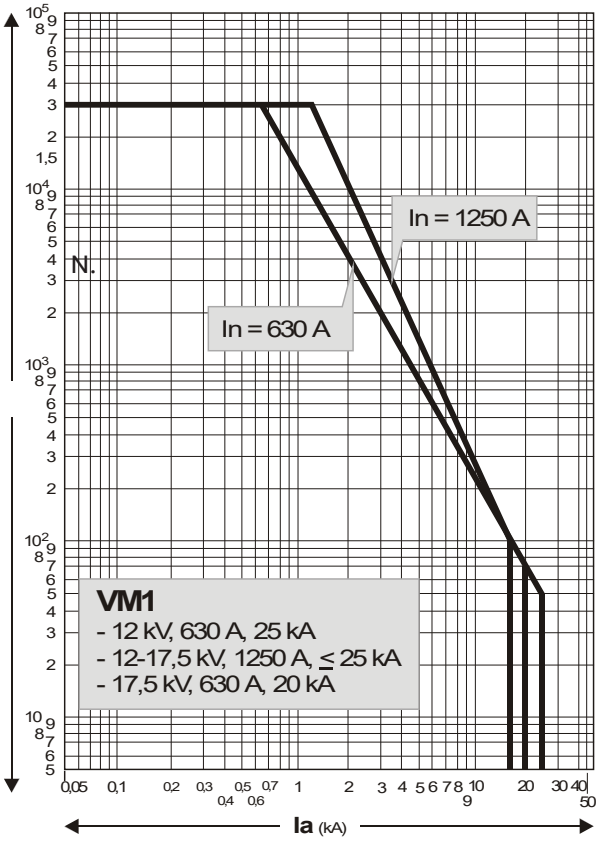


Fig. 12b

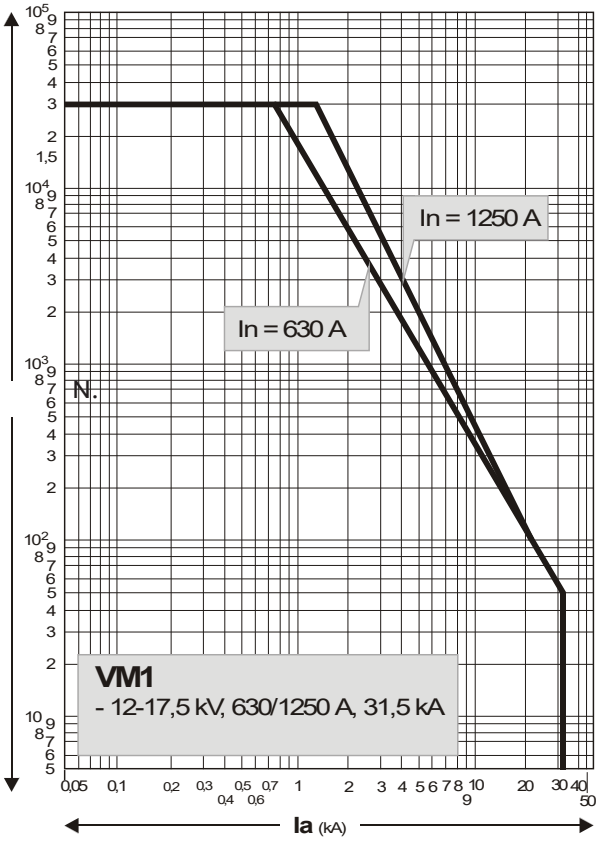


Fig. 12c

Caption
Nr. Number of closing-opening cycles allowed for the vacuum interrupters.
Ia Breaking capacity of the vacuum interrupters.

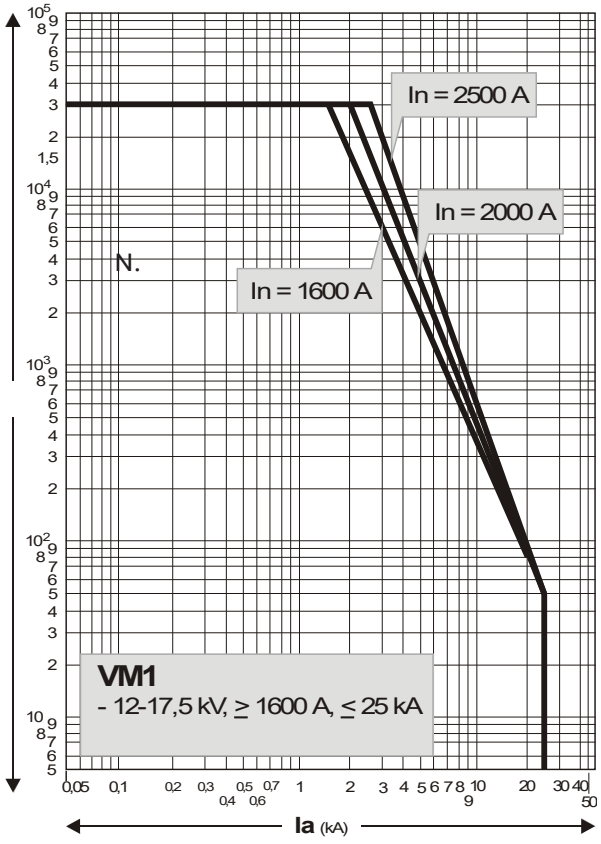


Fig. 12d

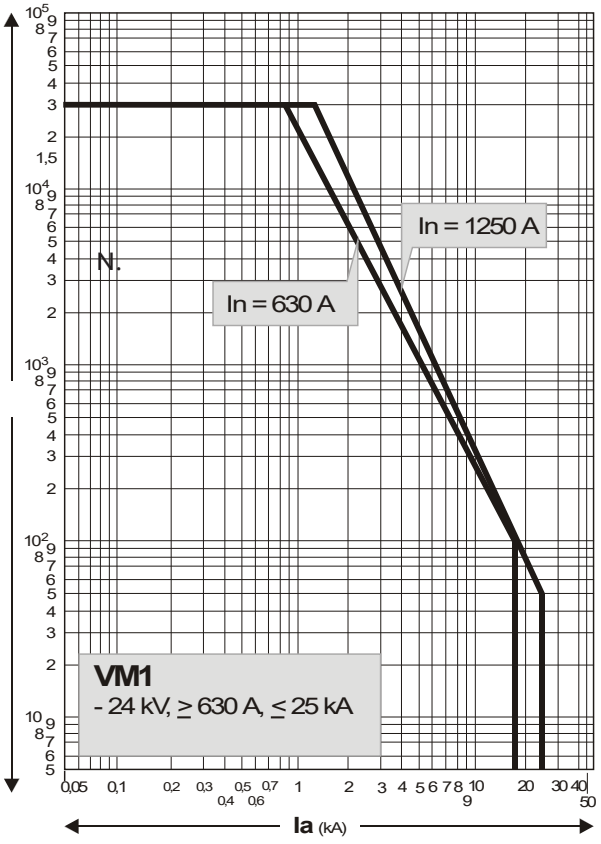


Fig. 12f

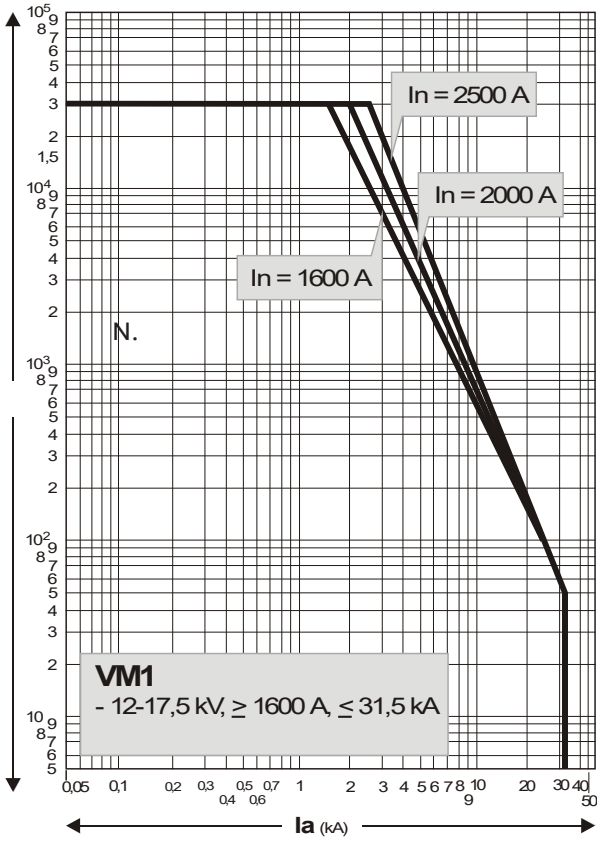


Fig. 12e

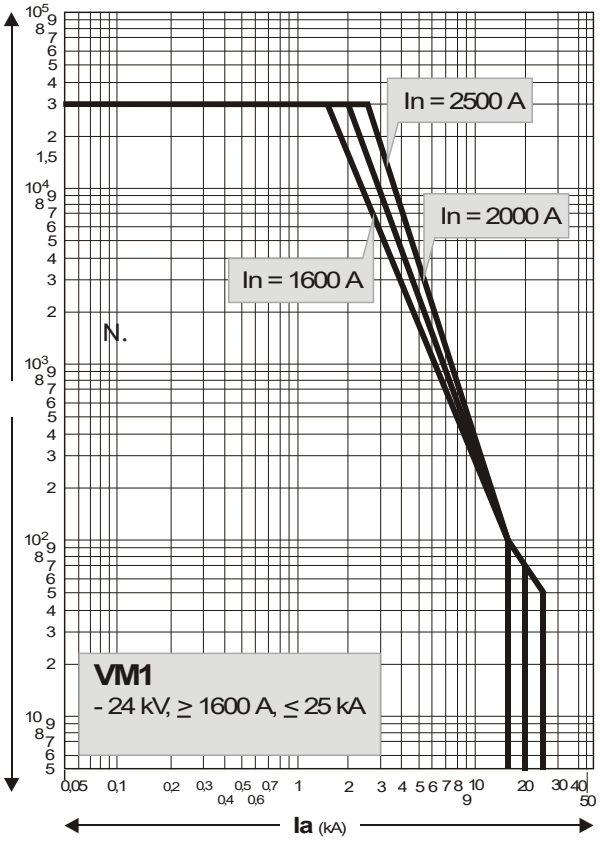


Fig. 12g

Caption
Nr. Number of closing-opening cycles allowed for the vacuum interrupters.
Ia Breaking capacity of the vacuum interrupters.

9. Installation

9.3. Preliminary operations

- Clean the insulating parts with clean dry cloths.
- Check that the top and bottom terminals are clean and free of any deformation caused by shocks received during transport or storage.

9.4. Installation of fixed circuit breakers

The circuit breaker can be mounted directly on supporting frames to be provided by the customer, or on a special supporting truck (available on request).
The circuit breaker, with supporting truck, must be suitably fixed to the floor of its own compartment by the customer. The floor surface in correspondence with the truck wheels must be carefully levelled.
A minimum degree of protection (IP2X) must be guaranteed from the front towards live parts.

9.5. Installation of withdrawable circuit breakers

The withdrawable circuit breakers are preset for use in UniGear switchgear or PowerCube modules. For racking-in/racking-out of the switchgear: connect the auxiliary circuits thereby supplying the locking electromagnet in the truck, fully insert the crank handle (1) (fig. 13) in the appropriate seat (2) and work it clockwise for racking-in, and anti-clockwise for racking-out, until the end-of-run positions are reached. Circuit breaker racking-in/-out must be carried out gradually to avoid shocks which may deform the mechanical interlocks and the end-of-runs.
The torque normally required to carry out racking-in and racking-out is $\leq$ 25 Nm.
This value must not be exceeded. If operations are prevented or difficult, do not force them and check that the operating sequence is correct.

Note
To complete the racking-in/out operation, about 20 turns of the crank handle are required for circuit breakers up to 17.5 kV, and about 30 turns for 24 kV circuit breakers.
When the circuit breaker has reached the isolated for test/isolated position it can be considered as racked into the switchgear and, at the same time, earthed by means of the truck wheels.
Withdrawable circuit breakers of the same version, and therefore with the same dimensions, are interchangeable.
For the circuit breaker installation operations, also refer to the technical documentation of the above-mentioned switchgear.

The racking-in/-out operations must always be carried out with the circuit breaker open.

9.5.1. Circuit breakers with withdrawable motorized truck

Carry out the racking-in/racking-out test of the motorized truck in the same way as for a manual truck, following the instructions below:

- Rack the circuit breaker into the switchgear in the open and isolated position, with the power supply to the motor circuit cut off and with the enclosure door closed.
- Insert the manual racking-in lever (1) in the special coupling (2) Fig. 13, and take the motorized truck to about half its run between the isolated for test and the connected position.
  The torque needed to carry out truck handling is $\leq$25 Nm.

In the case of accidental inversion of the truck motor power supply polarity, this operation allows a possible error in direction to be dealt with without any damage. Verification checks:

- a) motor rotation **clockwise** during circuit breaker racking-in.
- b) motor rotation **anticlockwise** during circuit breaker racking-out.
  - Remove the manual lever (1) from the coupling (2) Fig. 13
  - Supply the truck motor circuit and wait for the LED on the front of the circuit breaker signalling unit **“ready”** to come on permanently.
  - Activate the control for the electrical racking-in operation. When racking-in has taken place, check correct changeover of the relative auxiliary contact.
  - On completion, activate the control for the electrical racking-out operation. When racking-out has taken place, check correct changeover of the relative auxiliary contact.
  - In the case of a motor fault during a racking-in or racking-out operation, in an emergency the truck can be taken to the end of its run manually, after first cutting off the power supply to the motor power supply circuit and then, using the manual lever, work in the same way as with the manual truck.
  - In the case of a locking magnet –RL2 fault, in an emergency the truck can be racked out manually following the instructions below:
    - cut off the power supply to the motor circuit
    - open the enclosure door
    - remove the circuit-breaker front protection shield
    - using the manual lever, carry out an emergency racking-out operation, keeping the moving anchor of the locking magnet –RL2 pressed down by means of a screwdriver during the initial stage of racking-out (Fig. 13a).

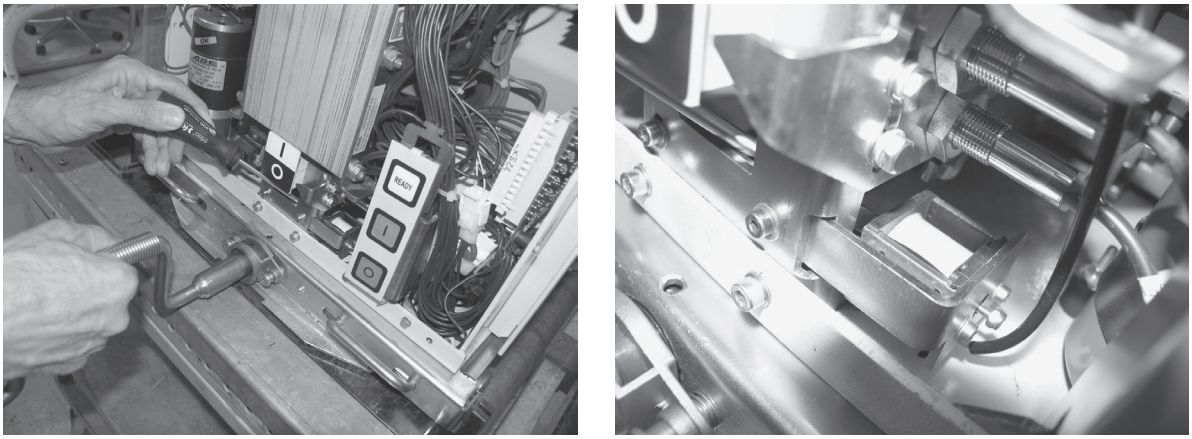


Fig. 13a

Note
By means of the transmission chain, truck handling carried out using the manual lever makes the truck motor armature rotate which, behaving like a generator, can cause inverse voltage at the connection terminals. This may damage the permanent magnet of the motor, therefore all the truck racking-in and racking-out operations carried out using the manual lever must be done without power supply in the motor circuit.

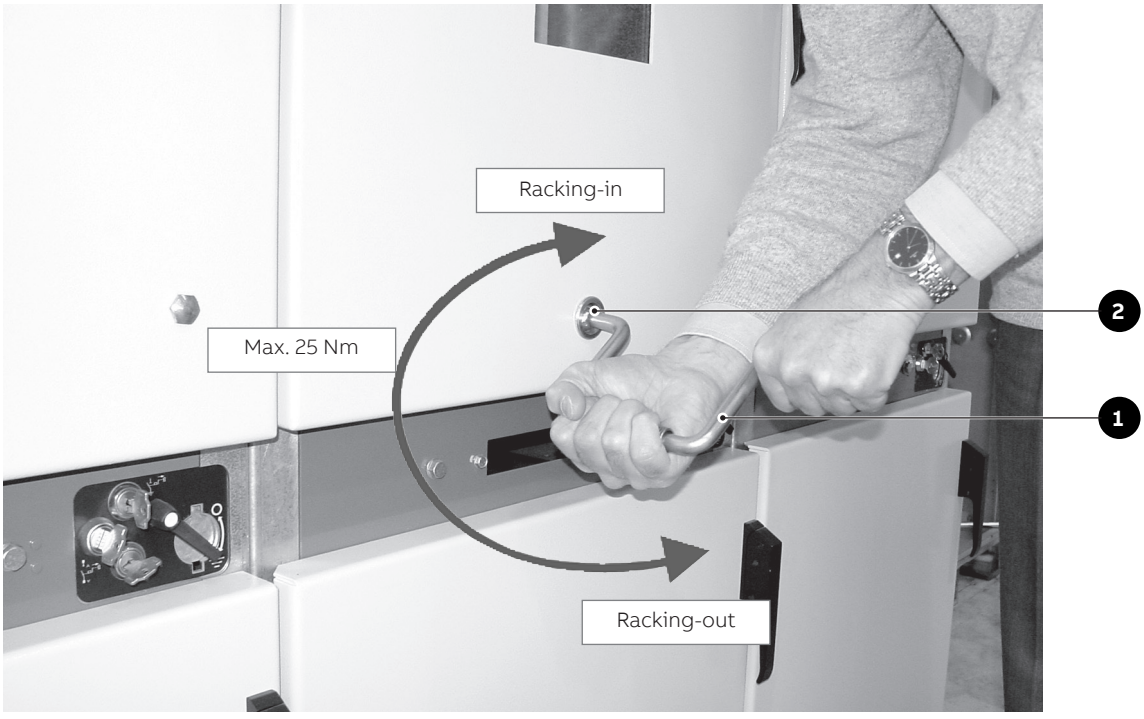


Fig. 13b

9. Installation

9.6. Power circuit connections of fixed circuit breakers

9.6.1. General recommendations

- Select the cross-section of the conductors according to the service current and the short-circuit current of the installation.
- Prepare special post insulators, near the terminals of the fixed circuit breaker or enclosure, sized according to the electrodynamic forces deriving from the short-circuit current of the installation.

9.6.2. Assembly of the connections

- Check that the contact surfaces of the connections are flat, and are free of any burrs, traces of oxidation or deformation caused by drilling or impacts received.
- According to the conductor material and the surface treatment used, carry out the operations indicated in table T1 on the contact surface of the conductor.

Assembly procedures

- Put the connections in contact with the circuit breaker terminals taking care to avoid mechanical stresses (traction / compression) on, for example, the conducting busbars on the terminals.
- Interpose a spring washer and a flat washer between the head of the bolt and the connection.
- It is advisable to use bolts according to DIN class 8.8 Standards, also referring to what is indicated in table T2.
- In the case of cable connections, strictly follow the manufacturer's instructions for making the terminals.

T1

Bare copper	Copper or silver-plated aluminium	Bare aluminium
• Clean with a fine file or emery cloth. • Tighten fully and cover the contact surfaces with 5RX Moly type grease.	• Clean with a rough dry cloth. • Only in the case of obstinate traces of oxidation, clean with a very fine grain emery cloth taking care not to remove the surface layer. • If necessary, restore the surface treatment.	• Clean with a metal brush or emery cloth. • Cover the contact surfaces again immediately with neutral grease. • Insert the copper-aluminium bimetal with surfaces shined (copper side in contact with the terminal; aluminium side in contact with the connection) between the aluminium connection and the copper terminal.

T2

Bolt	Recommended tightening torque (1)	
	Without lubricant	With lubricant (2)
M6	10.5 Nm	4.5 Nm
M8	26 Nm	10 Nm
M10	50 Nm	20 Nm
M12	86 Nm	40 Nm
M16	200 Nm	80 Nm

(1) The nominal tightening torque is based on a friction coefficient of the thread of 0.14 (distributed value the thread is subjected to which, in some cases, is not negligible). The nominal tightening torque with lubricant is according to the DIN 43673 Standards.
(2) Oil or grease. The thread and surfaces in contact with the lubricated heads.

Take into account the deviations from the general Standards table (for example, for contact systems or terminals) as foreseen in the specific technical documentation. The thread and surfaces in contact with the heads of bolts must be slightly oiled or greased, so as to obtain a correct nominal tightening torque.

9.7. Earthing

For the fixed version circuit breaker, carry out earthing by means of the special screw marked with the relative symbol. Clean and degrease the area around the screw to a diameter of about 30 mm and, on completion of assembly, cover the joint again with vaseline grease.
Use a conductor (busbar or braid) with a cross-section conforming to the Standards in force.

9.8. Connection of the auxiliary circuits

Note: the minimum cross-section of the wires used for the auxiliary circuits must not be less than the one used for the internal cabling. Furthermore, they must be insulated for 3 kV test.
It must also be remembered that the auxiliary circuit must be checked at the maximum voltage of 2 kV in accordance with the prescriptions of the standards.

9.8.1. Fixed circuit breaker

Connection of the circuit breaker auxiliary circuits must be made by means of the terminal boxes (1) (fig. 14) mounted inside the circuit breaker and the wires must pass through the connector (2). Outside the connector, the cables must pass through a suitable metal protective cover (pipe, wiring duct, etc.) which must be earthed.
To avoid the cabling wires outside the circuit breaker (provided by the customer) accidentally coming into contact with moving parts and therefore damaging the insulation, it is advisable to position and fix the wires as shown in the figure.

Before removing the drive cover to access the terminal box, check that the circuit breaker is open with the closing springs discharged.

9.8.2. Withdrawable circuit breakers

The auxiliary circuits of withdrawable circuit breakers are fully cabled in the factory as far as the connector (fig. 15).
For the external connections, refer to the electric wiring diagram of the switchgear.

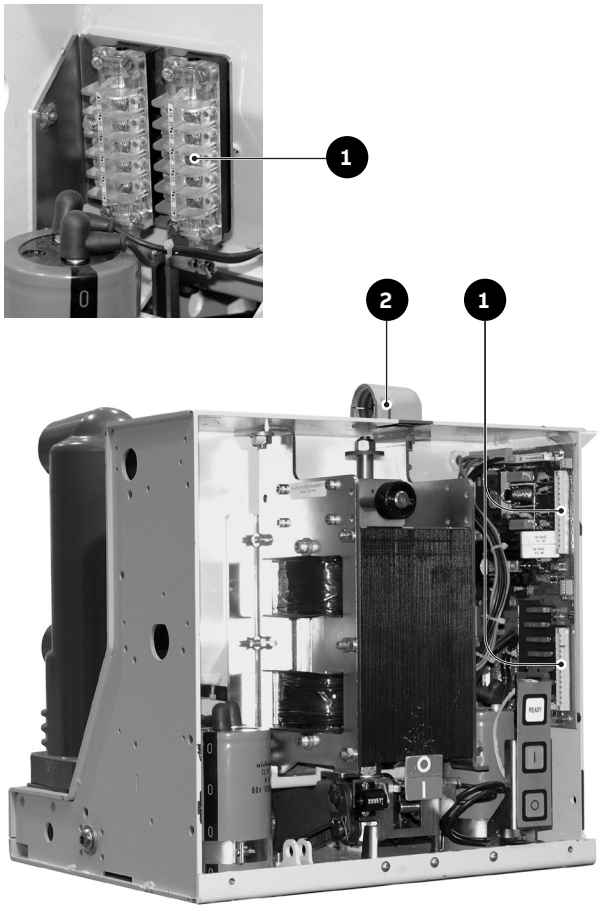


Fig. 14

Fig. 15

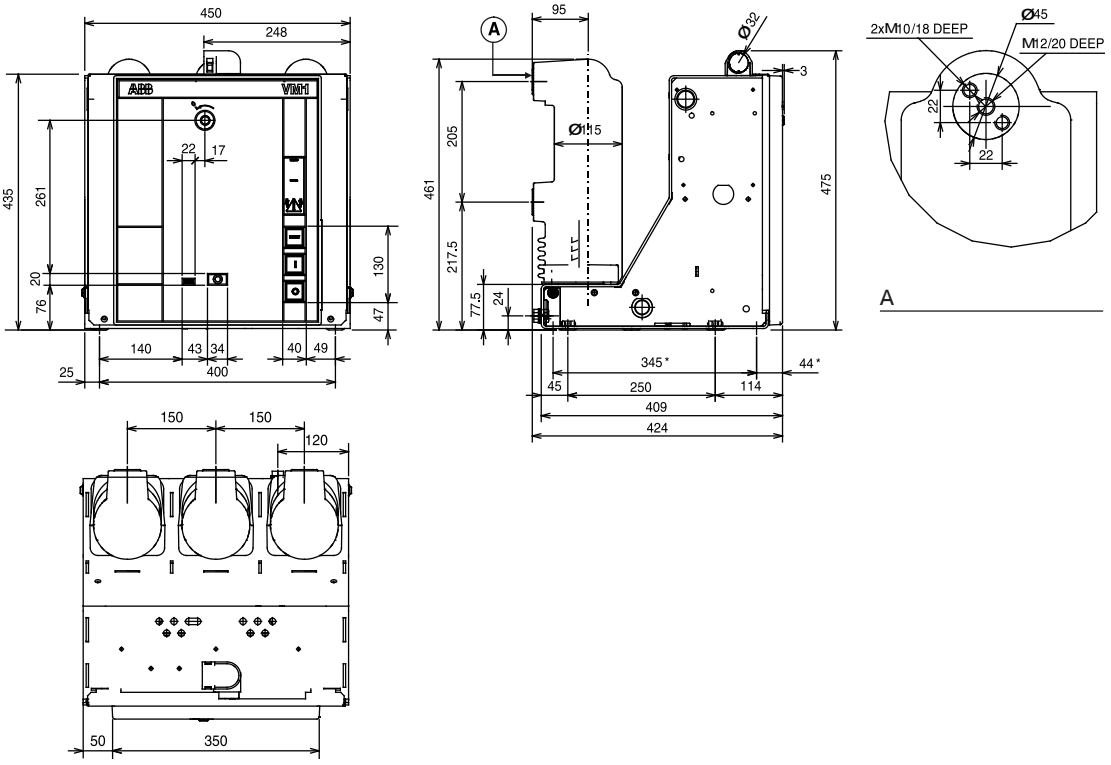
9. Installation

9.9. Overall dimensions

Fixed circuit breakers

VM1		
TN	1VCD00001 (E0148)	
Ur	12	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA

VM1		
TN	1VCD00001 (E0148)	
Ur	17.5	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA

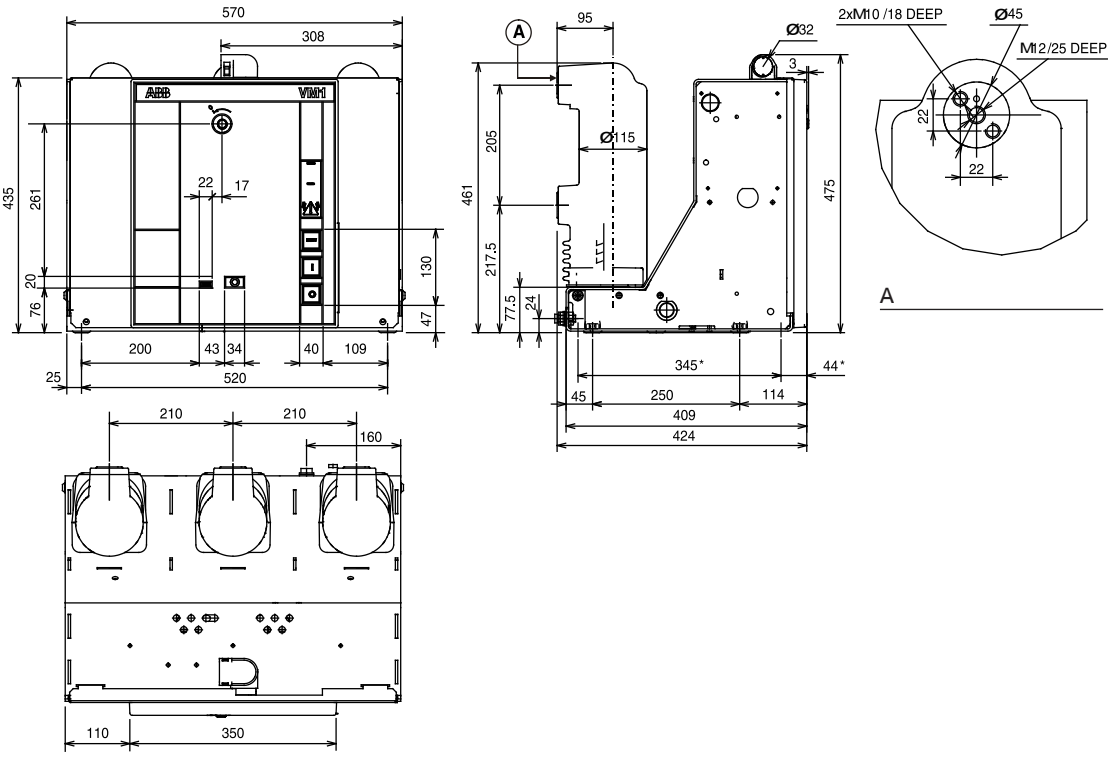


(*) Fixing interchangeable with the previous series (345 x 400).

Fixed circuit breakers

VM1		
TN	1VCD00002 (E0148)	
Ur	12	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA

VM1		
TN	1VCD00002 (E0148)	
Ur	17.5	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA

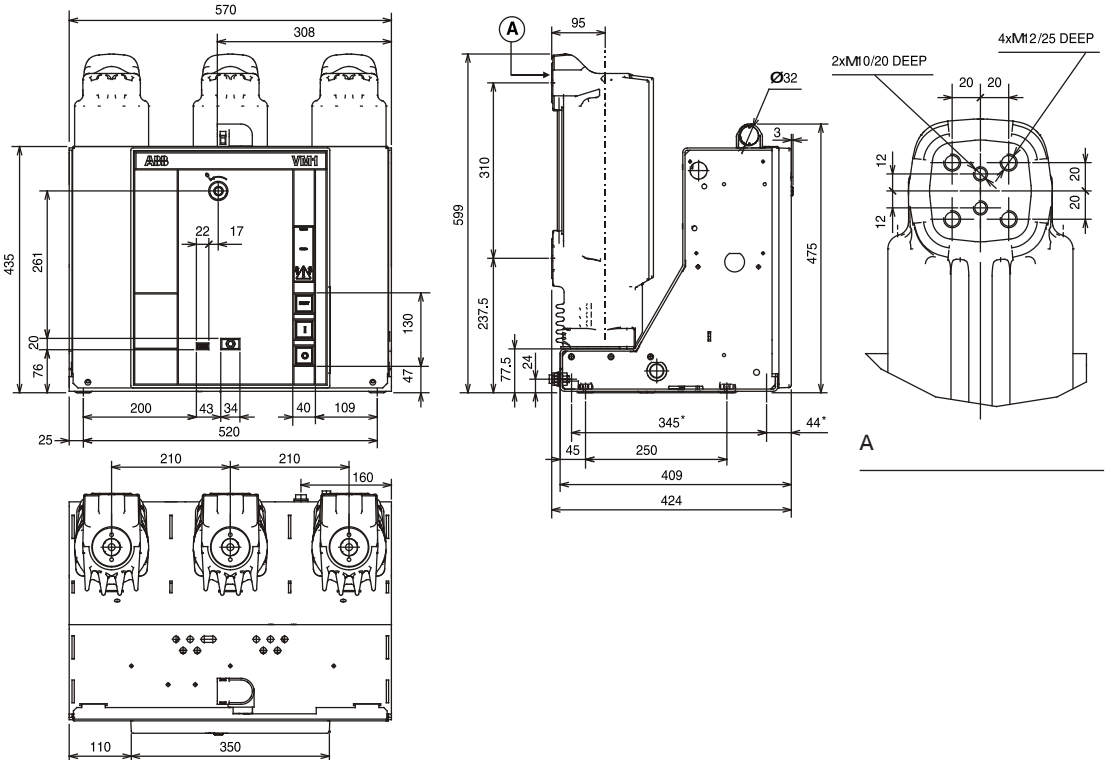


(*) Fixing interchangeable with the previous series (345 x 520).

Fixed circuit breakers

VM1		
TN	1VCD00003 (E0148)	
Ur	12	kV
Ir	1600	A
	2000	A
Isc	20	kA
	25	kA
	31.5	kA

VM1		
TN	1VCD00003 (E0148)	
Ur	17.5	kV
Ir	1600	A
	2000	A
Isc	20	kA
	25	kA
	31.5	kA

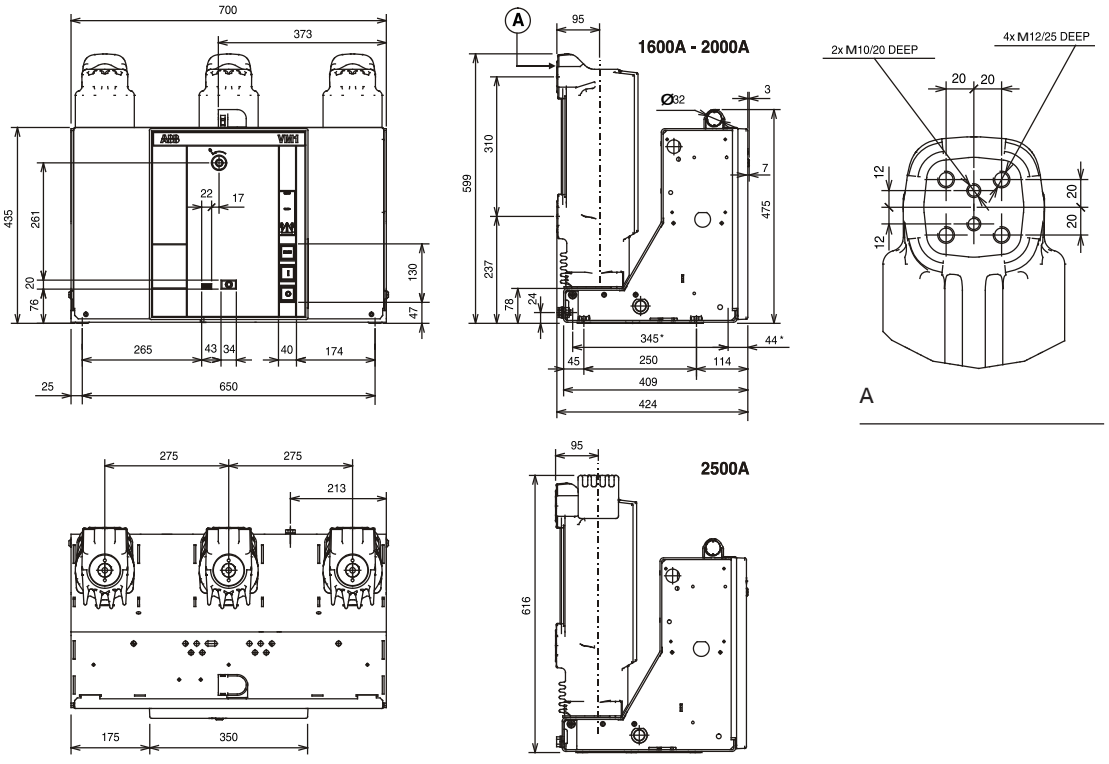


(*) Fixing interchangeable with the previous series (345 x 520).

Fixed circuit breakers

VM1		
TN	1VCD00004 (E0148)	
Ur	12	kV
Ir	1600	A
	2000	A
	2500	A
Isc	20	kA
	25	kA
	31.5	kA

VM1		
TN	1VCD00004 (E0148)	
Ur	17.5	kV
Ir	1600	A
	2000	A
	2500	A
Isc	20	kA
	25	kA
	31.5	kA

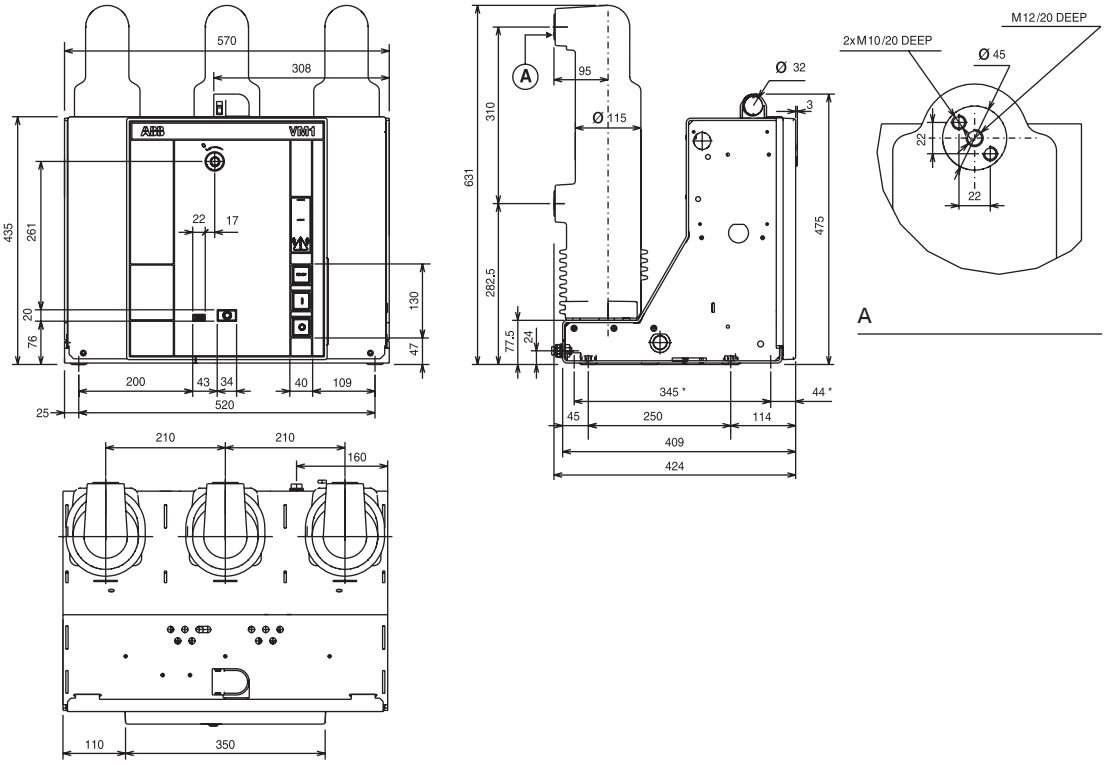


(*) Fixing interchangeable with the previous series (345 x 650).

9. Installation

Fixed circuit breakers

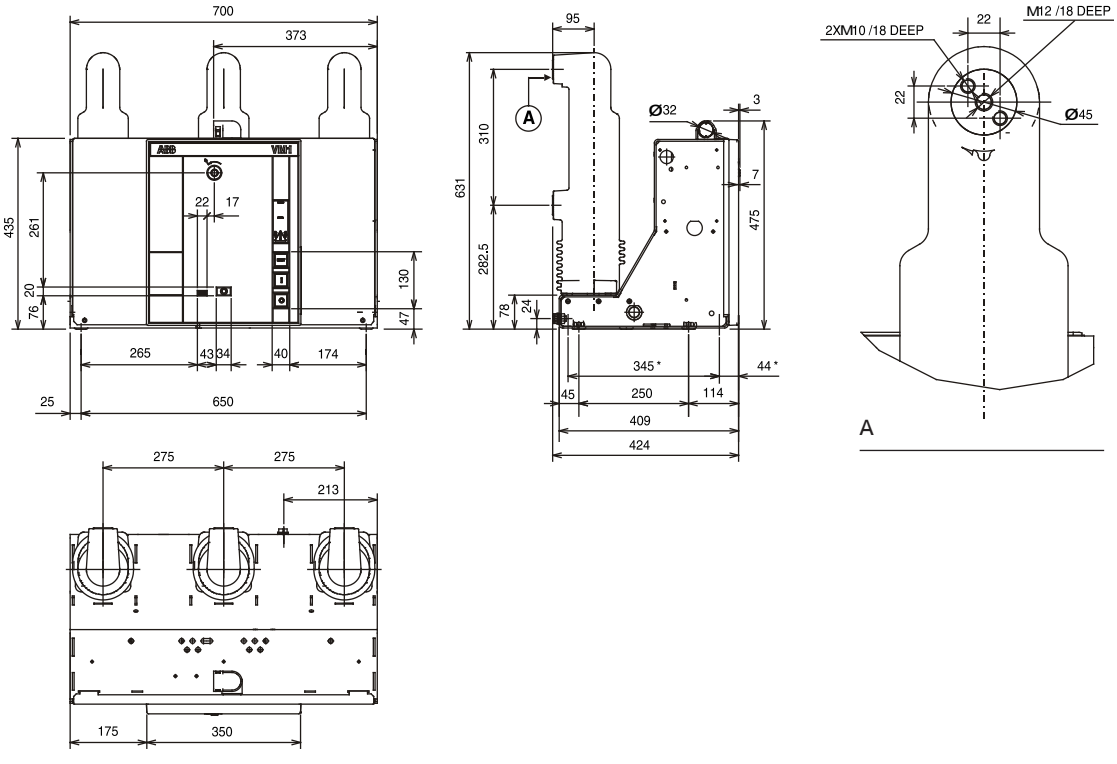
VM1		
TN	1VCD00005 (E0148)	
Ur	24	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA



(*) Fixing interchangeable with the previous series (345 x 520).

Fixed circuit breakers

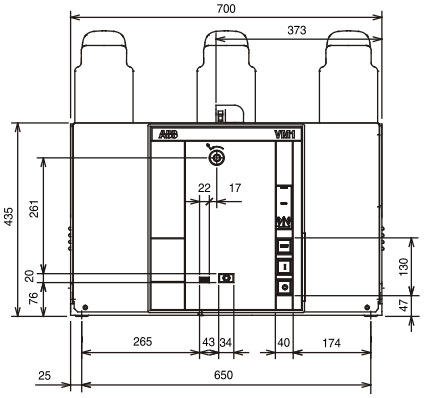
VM1		
TN	1VCD00006 (E0148)	
Ur	24	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA

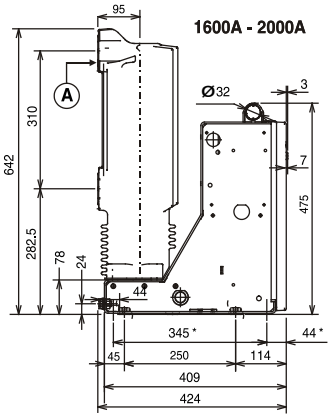


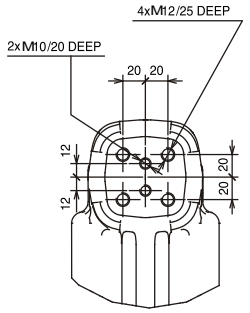
(*) Fixing interchangeable with the previous series (345 x 650).

Fixed circuit breakers

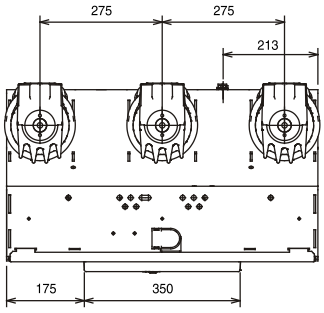
VM1		
TN	1VCD00007 (E0148)	
Ur	24	kV
Ir	1600	A
	2000	A
	2500	A
Isc	16	kA
	20	kA
	25	kA

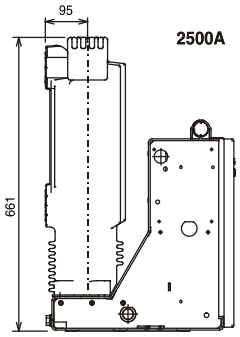






A





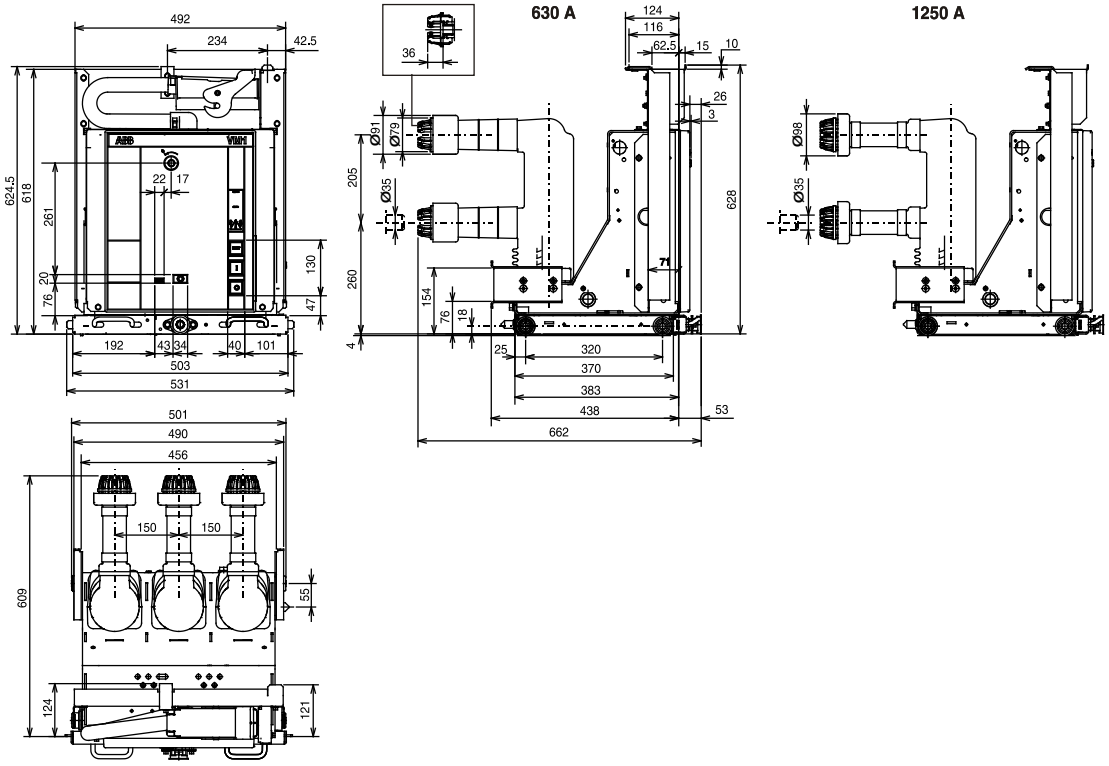
(*) Fixing interchangeable with the previous series (345 x 650).

9. Installation

Withdrawable circuit breakers for UniGear switchgear and PowerCube modules

VM1/P		
TN	1VCD00008 (E0148)	
Ur	12	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA

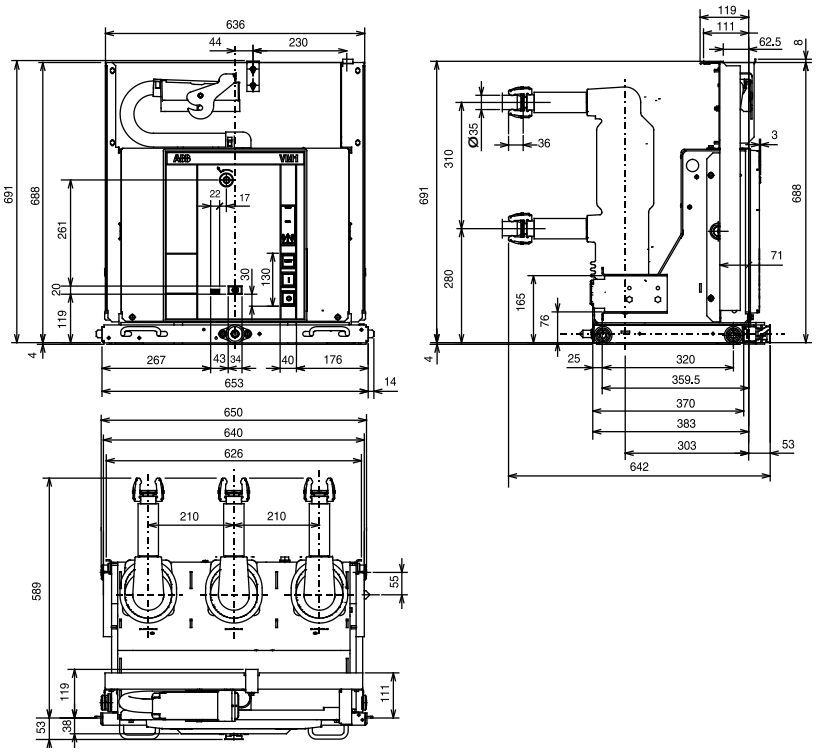
VM1/P		
TN	1VCD00008 (E0148)	
Ur	17.5	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA



Withdrawable circuit breakers for UniGear switchgear and PowerCube modules

VM1/W (1)		
TN	1VCD00074 (E0148)	
Ur	12	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA

VM1/W (1)		
TN	1VCD00074 (E0148)	
Ur	17.5	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA

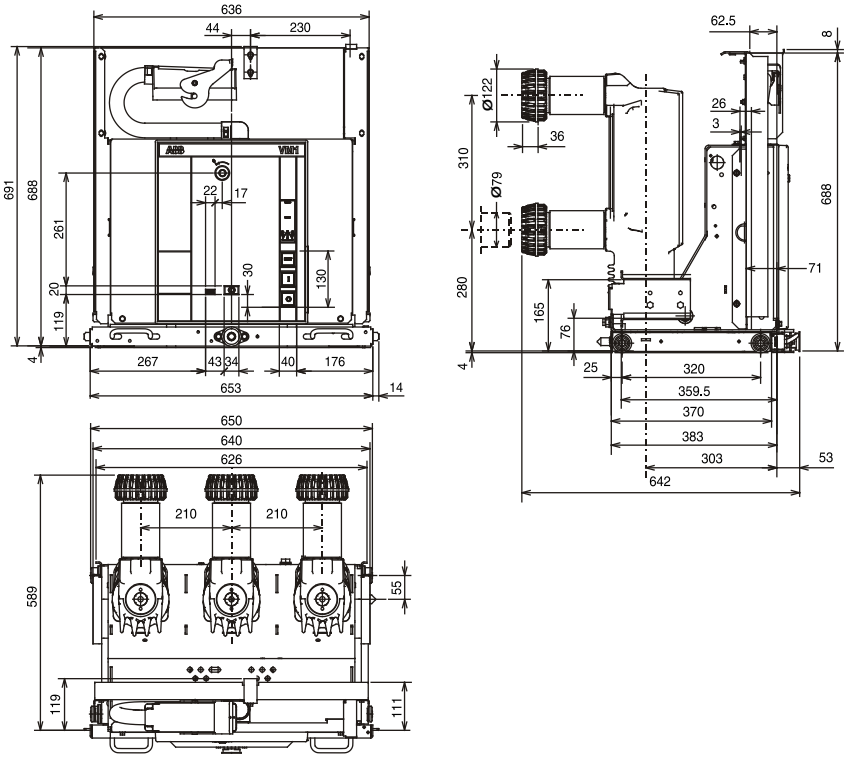


(*) Only for PB2 PowerCube.

Withdrawable circuit breakers for UniGear switchgear and PowerCube modules

VM1/P		
TN	1VCD00009 (E0148)	
Ur	12	kV
Ir	1600	A
	2000	A
Isc	20	kA
	25	kA
	31.5	kA

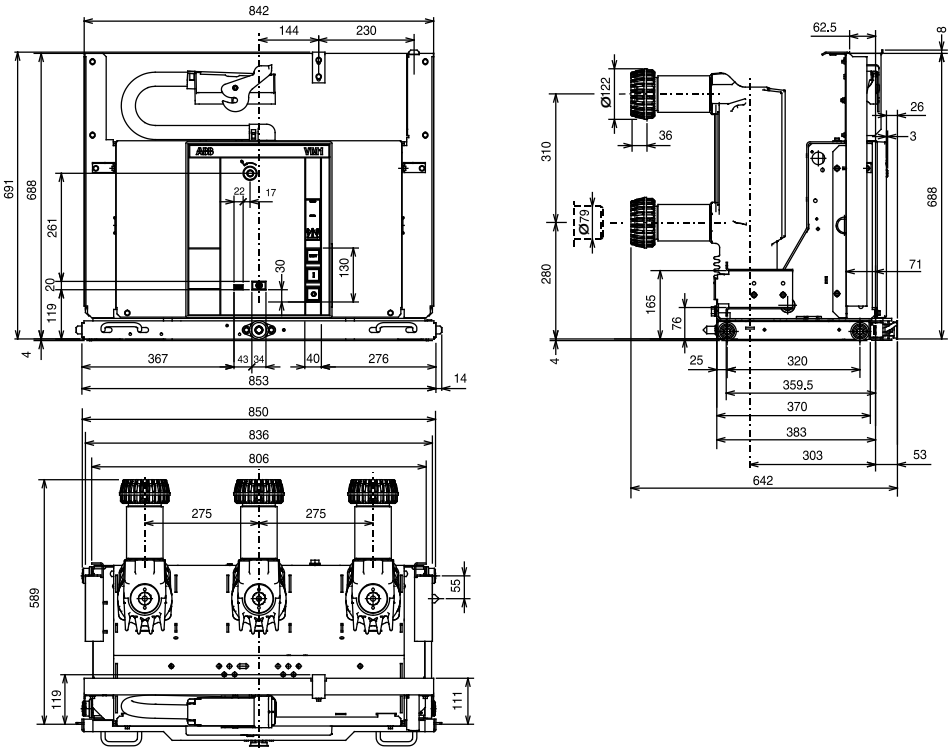
VM1/P		
TN	1VCD00009 (E0148)	
Ur	17.5	kV
Ir	1600	A
	2000	A
Isc	20	kA
	25	kA
	31.5	kA



Withdrawable circuit breakers for UniGear switchgear and PowerCube modules

VM1/P		
TN	1VCD00010 (E0148)	
Ur	12	kV
Ir	1600	A
	2000	A
Isc	16	kA
	20	
	25	kA
	31.5	kA

VM1/P		
TN	1VCD00010 (E0148)	
Ur	17.5	kV
Ir	1600	A
	2000	A
Isc	16	kA
	20	
	25	kA
	31.5	kA

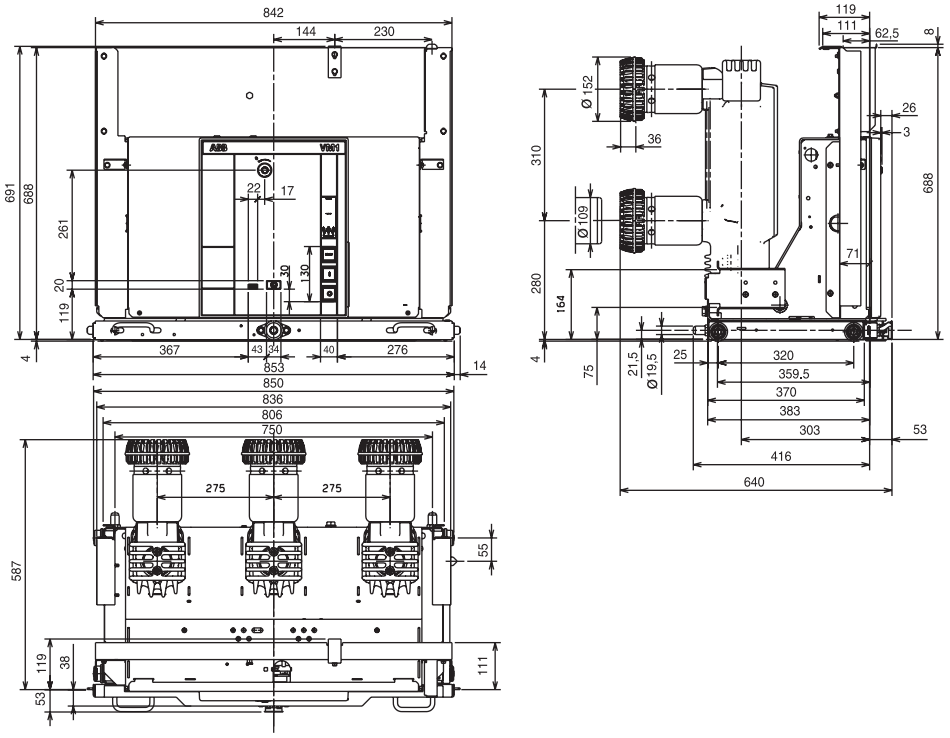


9. Installation

Withdrawable circuit breakers for UniGear switchgear and PowerCube modules

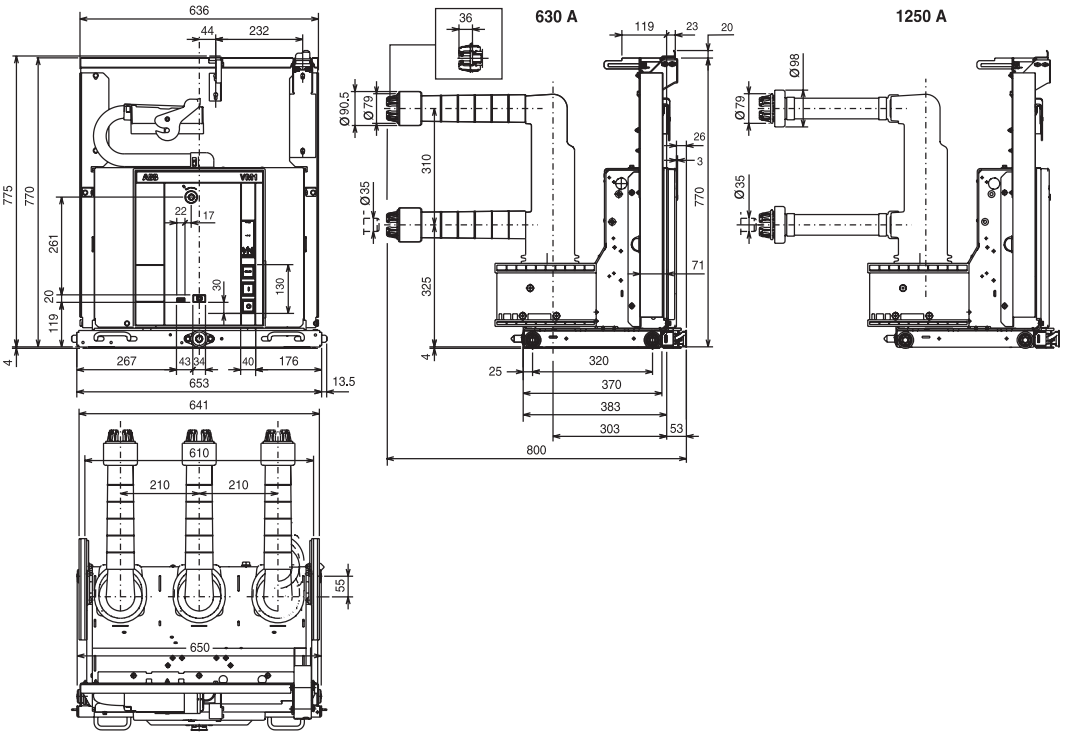
VM1/P		
TN	1VCD00011 (E0148)	
Ur	12	kV
Ir	2500	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA

VM1/P		
TN	1VCD00011 (E0148)	
Ur	17.5	kV
Ir	2000	A
Isc	16	kA
	20	kA
	25	kA
	31.5	kA



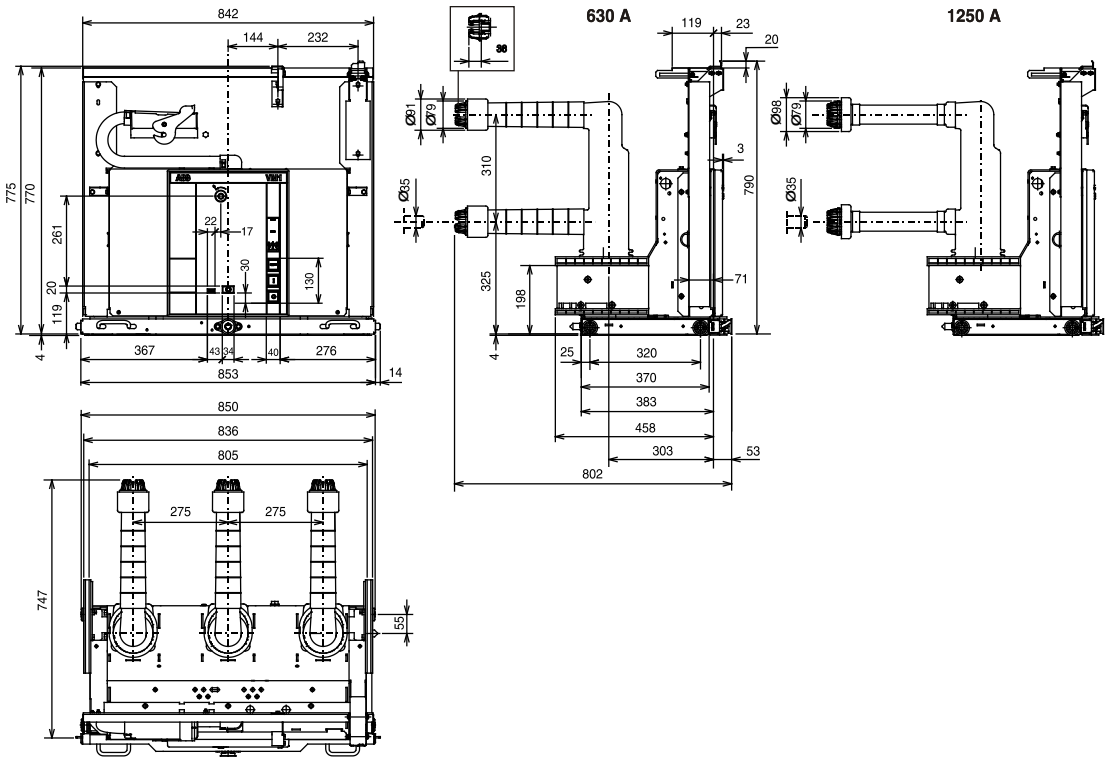
Withdrawable circuit breakers for UniGear switchgear and PowerCube modules

VM1/P		
TN	1VCD00012 (E0148)	
Ur	24	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA



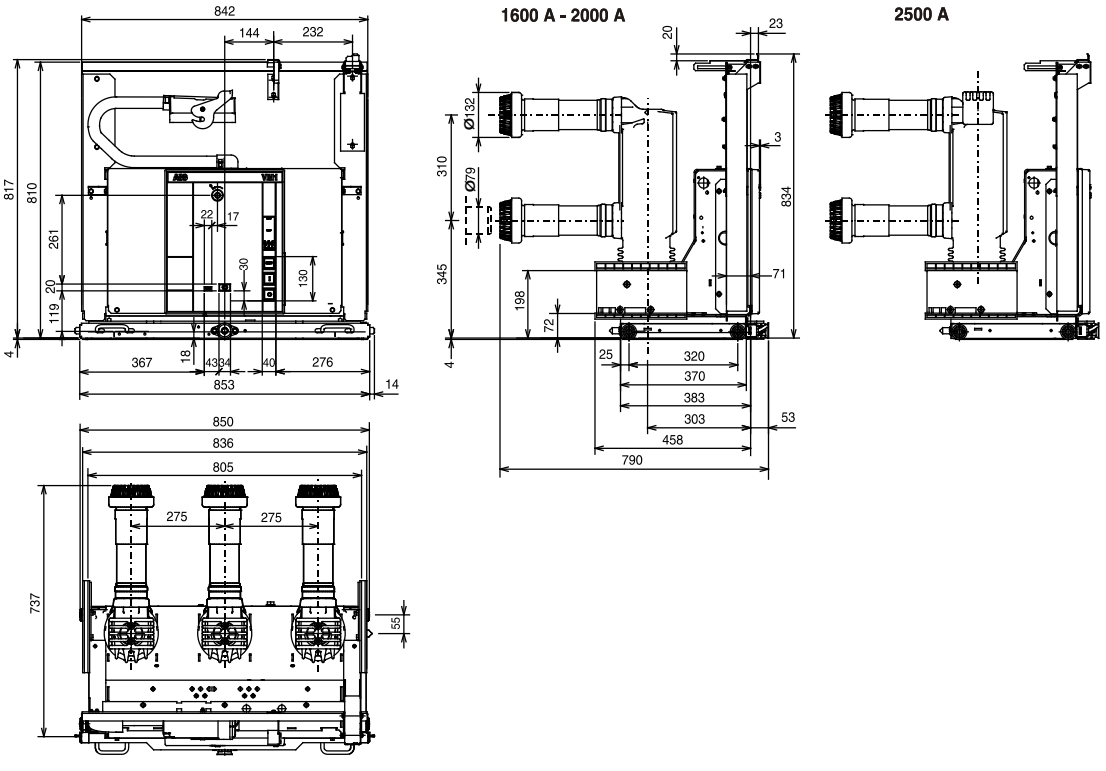
Withdrawable circuit breakers for UniGear switchgear and PowerCube modules

VM1/P		
TN	1VCD00013 (E0148)	
Ur	24	kV
Ir	630	A
	1250	A
Isc	16	kA
	20	kA
	25	kA



Withdrawable circuit breakers for UniGear switchgear and PowerCube modules

VM1/P		
TN	1VCD00014 (E0148)	
Ur	24	kV
Ir	1600	A
	2000	A
	1250	A (*)
Isc	16	kA
	20	kA
	25	kA



(*) For PowerCube module up to 2000 A with natural ventilation. For PowerCube module up to 2500 A with forced ventilation. For UniGear up to 2300 A with natural ventilation.For UniGear up to 2500 A with forced ventilation.

10. Putting into service

10.1. General procedures

All the operations regarding putting into service must be carried out by ABB personnel or by suitably qualified customer personnel with in-depth knowledge of the apparatus and of the installation. Should the operations be prevented, do not force the mechanical interlocks and check that the operating sequence is correct. The operating forces which can be applied for racking-in withdrawable circuit breakers are indicated in paragraph 9.5.

Closing in case of a power failure
Closing is not advisable and is not possible.

Manual emergency opening
Use the crank handle 1 (fig. 16) for manual emergency operation.
Proceed as follows:
- couple the crank handle (1) in the seat (2)
- turn the crank handle (1) counterclockwise as far as the end-of-run positionif the circuit breaker is in the racked-in position in the switchgear/ enclosure, it is now possible to take it to the isolated position.

10.2. Operation of the circuit breaker

Closing
This can be carried out remotely by applying voltage at the -SC2 input, or locally by pressing the “I” pushbutton on the front of the circuit breaker.

Opening
This can be carried out remotely by applying voltage at the -SO2 or -SO3 input, or locally by pressing the “O” pushbutton on the front of the circuit breaker.

Opening in case of a power failure
Opening can be carried out remotely by means of the control system, or locally by pressing the “O” pushbutton on the front of the circuit breaker within 60 s from the power failure.

Notes
- Manual emergency opening is possible even after the 60 s time limit.
- In the case of a power failure and after the 60 s time limit, the circuit breaker remains in its present position.
  If automatic opening is required after the 60 s time limit, Dip Switch “I 1004/1” must be enabled (see par. 7.1.7. Auto-shutdown function for low voltage of the capacitor/s).

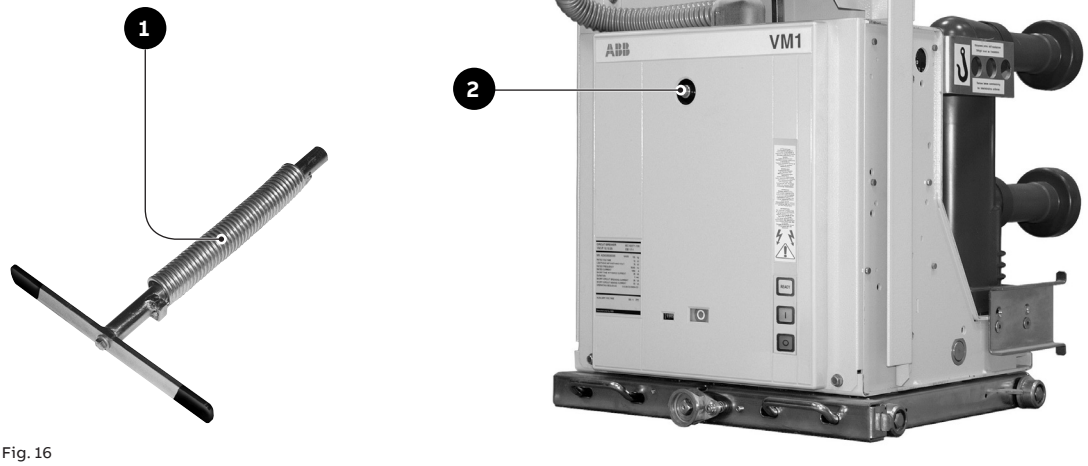


Fig. 16

10.3. Operations before putting into service

Before putting the circuit breaker into service, carry out the following operations:

- remove the lifting hooks;
- check tightness of the power connections at the circuit breaker terminals;
- establish the setting of the primary electronic overcurrent release (if provided);
- check that the value of the power supply voltage of the auxiliary circuits is between 85% and 110% of the rated voltage of the electrical accessories;
- remount any covers removed during the testing operations;
- check that no foreign bodies, such as bits of packing, have got into the moving parts;
- remount the covers which may have been removed during the testing operations;
- check that there is a sufficient exchange of air in the installation place to avoid overtemperatures;
- supply the auxiliary circuits with power;
- supply the -SO4 input (opening function for undervoltage) and the -SL1 input (lock on closing function) before carrying out the closing operation;
- check the functionality and efficiency of the mechanical and electrical locks;
- carry out a few circuit breaker opening and closing operations by means of the pushbuttons on the front of the circuit breaker;
- in the case of a circuit breaker with motorized isolation, check the direction of motor rotation and the direction of truck racking-in/racking-out;
- also carry out the checks indicated in table T3.

T3

Item inspected		Procedure	Positive check
1	Insulation resistance.	**Medium voltage circuit** With a 2500 V megger, measure the insulation resistance between the phases and the exposed conductive part of the circuit.	The insulation resistance should be at least 50 Mohm and in any case constant over time.
		Auxiliary circuits With a 500 V megger (if the apparatus installed allows this), measure the insulation resistance between the auxiliary circuits and the exposed conductive part. N.B. Before carrying out the test, disconnect the earthing of the electronic card from the circuit breaker frame and reconnect it after the test.	The insulation resistance should be a few Mohm and in any case constant over time.
2	Auxiliary circuits.	Check that the connections to the control circuit are correct: proceed with the relative power supply.	Operations and signals are normal.
3	Auxiliary contacts in the drive.	Insert the auxiliary contacts in suitable signalling circuits. Carry out a few closing and opening operations.	The signals take place normally.
4	Locking electromagnet on the circuit breaker truck (-RL2)	With the circuit breaker open, in the isolated for test position, and the locking electromagnet not supplied, attempt to rack in the circuit breaker.	Racking-in is not possible.
		Supply the locking electromagnet and carry out the racking-in operation.	Racking-in takes place correctly.
5	Auxiliary transmitted contacts signalling circuit breaker racked-in, isolated (UniGear switchgear or PowerCube modules).	Insert the auxiliary contacts in suitable signalling circuits. With the circuit breaker racked into the enclosure, carry out a few traversing operations from the isolated for test position to the racked-in position. Take the circuit breaker to the racked-out position.	The signals due to the relative operations take place regularly.

11. Maintenance

Maintenance operations are aimed at ensuring trouble-free operation of the apparatus for the longest possible time.
In accordance with what is specified in the IEC 61208 / DIN 31 051 Standards, the following operations must be carried out.

Inspection: Determination of the actual conditions

Servicing: Measures to be taken to maintain the specification conditions

Repairs: Measures to be taken to restore the specification conditions.

11.1. General

Vacuum circuit breakers are characterised by simple, sturdy construction and long life.
The drive is maintenance-free for its whole operating life and only requires functional inspections (see par. 11.3.2.).
The vacuum interrupters are maintenance-free for their whole operating life.
Vacuum interruption does not produce harmful effects even when there are frequent trips at the rated and short-circuit current.
The servicing interventions and their aim depend on the environmental conditions, on the sequence of operations and on the trips under short-circuit.

Note
For maintenance work, respect the following Standards:
- the relative specifications indicated in the "Standards and Specifications" chapter;
- regulations for safety in the workplace indicated in the "Putting into service and operations" chapter;
- regulations and specifications of the country where the apparatus is installed.

The maintenance operations can only be carried out by trained personnel who respect all the safety regulations. Furthermore, is recommended that ABB service personnel should be called in, at least to check the service performances, and for any repair work.

During maintenance work, turn the power supply off and put the apparatus under safe conditions.

Before carrying out any operations, always make sure that the circuit breaker is open, the capacitor discharged and that it is not supplied (medium voltage circuit and auxiliary circuits).

11.1.1. Operating life

All vacuum circuit breakers are characterised by simple, sturdy construction and long useful life.
Frequent operation of the service and short-circuit currents does not negatively affect the degree of vacuum of the interrupters.

Typical useful life expectancy of a VM1 vacuum circuit breaker is determined by the following factors:
- embedded vacuum interrupter, maintenance-free up to 30,000 mechanical operating cycles.
- drive with magnetic actuator, maintenance-free under normal service conditions
  - up to 100,000 operating cycles for all the circuit breakers with breaking capacity up to 25 kA and rated current up to 1250 A
  - up to 50,000 operating cycles for all the circuit breakers with rated current $\geq$ 1600 A and/or breaking capacity $\geq$ 31.5 kA
- control module and sensors, maintenance-free (excluding the auxiliary contacts)
- indication of ON/OFF position of the auxiliary contacts (optional) up to 30,000 operating cycles
- withdrawable truck: up to 1,000 handling operations can be carried out in the case of normal activation and with regular inspections.

Also see the IEC 62771.200 Standard.
The data on the useful life are in principle applied to all the components which are not directly affected by the operator.
The useful life of the manually activated components (movement of the withdrawable truck, etc.) can vary according to the type of handling.
The time intervals and amount of maintenance are determined by environmental agents, by the frequency of operation and by the number of trip operations under short-circuit.

11.1.2 Instructions for capacitor life

The following instructions shall be observed in order to guarantee the correct function of the capacitor/s over time:
- if the capacitor is kept on stock or warehouse for more than 2 years without power supply feeding, it is required to replace the capacitor.
- if the capacitor is kept on stock or warehouse for more than 1 year and less than 2 years in/out of temperature tolerance range (-25 °C to +55 °C), the reconditioning procedure of the capacitance by reforming must be executed.
- it is recommended to replace the capacitor every 10 years for both normal and stressed use (10000 operations) and for conditions of temperature within-25 °C to +55 °C.
- after 15 years the capacitor must be replaced.
- for applications in which the capacitors are installed in parallel (two, three or more), they should belong to the same production batch hence to have the same batch number YYWWXXXXX (QR-CODE).

11.1.3. Procedure for discharging the capacitor/s
Activate the circuit breaker.
Disconnect the power supply voltage.
Operate the circuit breaker by pressing the pushbuttons with the following cycle: O-C-O.
The luminous “Ready” signal turns off when the operation cycle has been completed, i.e. when the circuit breaker is no longer ready for operations.
After 8 minutes have passed, the capacitor voltage drops to a value of less than 15 V.
If required in specific cases, further information can be obtained from the technical documentation regarding the switching apparatus (e.g. any special service conditions agreed on), as well as from this instruction manual.

11.1.4. Drive with magnetic actuator
The drive with magnetic actuator is maintenance-free up to the number of operation cycles indicated in paragraph 11.1.1.

11.2. Inspections and functional tests

11.2.1. Interruption devices in general
- Carry out regular inspections to check that the interruption devices are in good condition.
- Inspection at fixed intervals can be waived when the apparatus is permanently monitored by qualified personnel.
- Above all, the checks must include a visual inspection to check for any contamination, traces of corrosion and electrical discharge phenomena.
- Carry out more frequent inspections when there are unusual operating conditions (including adverse climatic conditions) and in the case of environmental pollution (e.g. heavy contamination or an atmosphere with aggressive agents).
- Visual examination of the isolating contacts. Turning the system of contacts alternately is recommended, in order to keep the internal surface of the contact areas clean. The contact areas must be cleaned if there are signs of overheating (discoloured surface) (also see the paragraph on “Repairs”).
- If any anomalous conditions are found, appropriate servicing measures must be taken (see the paragraph on “Servicing).

11.2.2. Circuit breaker pole
No check is required apart from what has already been specified in par. 10.3.

11.3. Servicing

11.3.1. Interruption devices in general
If cleaning is found to be necessary during the inspections, as specified in par. 10.3., use the following procedure:
- insulate the working area and make it safe by following the safety regulations specified in the IEC/DIN VDE Standards.
- general cleaning of the surfaces:
  - dry and eliminate any light deposits of dirt using a soft dry cloth;
  - more resistant deposits of dirt can be removed using a slightly alkaline household cleanser or Rivolta BWR 210 type detergent.
- cleaning the insulating surfaces and conductive components:
  - light dirt: with Rivolta BWR 210 detergent;
  - resistant dirt: with cold 716 type detergent.

After cleaning, rinse thoroughly with clean water and dry carefully

Note
Only use halogen-free detergents and never trichloroethane, trichloroethylene or carbon tetrachloride!

11.3.2. Actuator and transmission system
A functional test of the drive must be carried out:
- when the number the number of operating cycles indicated has been exceeded, or
- during maintenance operations.

Before carrying out the functional test, open the circuit breaker and
- take it to the test position (withdrawable circuit breaker) or
- insulate the working area and make it safe in conformity with the safety rules and according to the regulations in force (fixed circuit breakers)
- follow the procedure for discharging the capacitor
- carry out a visual inspection of the state (removing the front panel), e.g. of:
  - lubrication of the ball bearings
  - the operation counter
  - assembly of the sensors
  - the position indicator.

Functional test:
- Connect the power supply voltage.
- Carry out several no-load operations. This test particularly applies to circuit breakers which are rarely activated under normal conditions.
  To check the capacitor, carry out a rapid O-C-O cycle of operations of the circuit breaker, by pressing the pushbuttons on the front of the circuit breaker in rapid succession.
- The LEDs on the inductive sensors are activated as soon as the circuit breaker has reached the closing and opening limit positions

Note
These operations can only be carried out by ABB personnel or suitably qualified and specially trained personnel.

11. Maintenance

11.3.3. Circuit breaker pole

The circuit breaker pole and relative vacuum interrupter are maintenance-free up to the maximum number of
electrical operations foreseen for the type of interrupter (see par. 9.2. Trip curves).
The operating life of the vacuum interrupter is defined by the sum of the ultimate currents corresponding to the specific type of interrupter in accordance with what is indicated in the graphs of par. 9.2. Trip curves: when the sum of the ultimate currents is reached, the complete pole must be replaced.

Note
Dismantling and replacement of the pole can only be carried out by ABB personnel or suitably qualified and specially trained personnel, especially for the necessary adjustments.

To carry out the interrupter test without dismantling the circuit breaker pole, use:
- the VIDAR vacuum tester, made by the company Programma Electric GmbH, Bad Homberg v.d.H.

To check vacuum tightness of the interrupter, the following test values must be set on the VIDAR tester:

Rated voltage of the circuit breaker	DC test voltage
12 kV	40 kV
17.5 kV	40 kV
24 kV	60 kV

The test must always be carried out with the circuit breaker open with the contacts at the nominal distance (12 to 24 kV).
Procedure for testing the degree of vacuum of the interrupter of the circuit breaker poles:
- turn the power supply off and make the working area safe by following the safety regulations specified in the IEC/DIN VDE Standards;
- open the circuit breaker;
- earth a terminal of each circuit breaker pole;
- connect the earthed terminal of the VIDAR tester to the circuit breaker structure;
- connect the high voltage terminal of the VIDAR tester to the terminal of the circuit breaker pole not connected to earth (L1 phase) and carry out the test. Repeat the test for phases L2 and L3.

Note
The tester connection cables can produce an indication due to the capacitive effect. In this case the cables must not be removed.

11.4. Repairs

Replacement of spare parts and accessories must only be carried out by ABB personnel or suitably qualified and specially trained personnel.
Always work with the circuit breaker open and locked so that it cannot be closed again, with the work area insulated and made safe.
The drive springs must be discharged.
All power supply sources must be disconnected and made safe against any reclosing during removal and installation work.

Should maintenance be carried out by the customer's personnel, responsibility for the interventions remains with the customer.
The replacement of parts not included in the "List of spare parts/accessories" (par. 13.1.) must only be carried out by ABB personnel. In particular:
- **complete pole with bushings/ connections**
- **actuator**
- **transmission system.**

12. Application of the X-ray emission Standards

One of the physical properties of vacuum insulation is the possibility of X-ray emission when the interrupter contacts are open.
The specific tests carried out at the PTB laboratories (Physikalisch-Technische Bundesanstalt, in Brunswick - Germany) show that local emission at a distance of 10 cm from the interrupter or pole surface, does not exceed 1 mSv/h.

It follows that:

- at the rated service voltage the use of vacuum interrupters is absolutely safe;
- application of the withstand voltage at power frequency, according to the IEC 62271-100 and VDE 0670 Standards, is safe;
- application of a voltage higher than the withstand voltage at power frequency or of a direct current test voltage, specified in the IEC and VDE Standards, cannot be used;
- limitation of the above-mentioned local phenomena, with interrupters with open contacts, depends on keeping the specific distance between the contacts.
  This condition is intrinsically guaranteed by correct operation of the drive and by adjustments of the transmission system.

13. Spare parts and accessories

All assembly operations of spare parts/ accessories must be carried out following the instructions enclosed with the spare parts, by ABB personnel or by suitably qualified customer personnel with in-depth knowledge of the apparatus (IEC 60694) and all the Standards aimed at carrying out these interventions in safe conditions. Should the maintenance be carried out by the customer's personnel, responsibility for the interventions remains with the customer.
Before carrying out any operation, always make sure that the circuit breaker is open, not supplied (medium voltage circuit and auxiliary circuits) and with the capacitors discharged.

To order circuit breaker spare parts/accessories, refer to the ordering sales codes indicated in the technical catalogue and always state the following:
- type of circuit breaker
- rated voltage of the circuit breaker
- rated normal current of the circuit breaker
- breaking capacity of the circuit breaker
- serial number of the circuit breaker
- rated voltage of any electrical spare parts.

For availability and to order spare parts, please contact our Service office.

13.1. List of spare parts

- Circuit breaker auxiliary contacts
- Position contact of the withdrawable truck
- Contacts signalling racked-in/isolated
- Isolation interlock with the door
- Locking electromagnet on the withdrawable truck
- Set of six tulip contacts.

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More product information:
abb.com/mediumvoltage
Your contact center:
abb.com/contactcenters
More service information:
abb.com/service

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