

VM1/A/P

Installation and service instructions

ANSI: ... 15 kV; ... 2000 A; ... 31.5 kA

For your safety!

	1
1. Foreword	2
2. Introduction and safe practices	4
3. Receiving, handling, and storage	6
4. Insertion and removal, putting into service	10
5. Installation	15
6. Description	19
7. Operation	29
8. Maintenance	35
9. Spare parts and accessories	41
10. Product quality and environmental protection	42
11. Overall dimensions	43
12. Electric circuit diagram	46



For your safety!	1	6.6. Types of withdrawable circuit-breakers available for PowerCube modules	24
1. Foreword	2	6.7. Mechanism and electrical operation	24
1.1. Introduction	2	6.8. Control scheme	25
1.2. Environmental protection programme	2	6.9. Standard fittings	26
1.3. Drawout	3	6.10. Optional accessories	27
1.4. Information on this booklet	3	7. Operation	29
1.5. Principle of extinction of the vacuum interrupter	3	7.1. Circuit-breaker function Magnetic actuator	29
1.6. Application of the X-ray emission Standards	3	7.2. Circuit-breaker control	29
2. Introduction and safe practices	4	7.3. Opening and closing procedure	30
2.1. Introduction	4	7.4. Autoreclosing sequence	30
2.2. Safe practices	4	7.5. Control module	30
2.3. Standard and regulations	5	7.6. Functions of the control module	30
2.4. Service conditions	5	7.7. "READY" signalling	31
3. Receiving, handling, and storage	6	7.8. Truck locking magnet (compulsory device)	31
3.1. Receiving and checking	6	7.9. Circuit-breaker control card	32
3.2. Handling	7	7.10. Characteristics of the control module contacts without potential	33
3.3. Storage	9	8. Maintenance	35
4. Insertion and removal, putting into service	10	8.1. General	35
4.1. Insertion and removal of withdrawable circuit-breaker	10	8.2. Maintenance on VM1/A/P circuit-breakers	35
4.2. Putting into service	11	8.3. Operating life	36
5. Installation	15	8.4. Procedure for discharging the capacitor/s	36
5.1. General	15	8.5. Mechanism and transmission system	36
5.2. Trip curves	15	8.6. Inspections and functional tests interruption device in general	37
5.3. Interlocks/protection against malfunction	16	8.7. Servicing	37
5.4. Racking	17	8.8. Circuit-breaker pole	38
5.5. Disconnect through connect	17	8.9. Repairs	38
5.6. Connect through disconnect	17	8.10. Control wiring	39
5.7. Connect through disconnect emergency rack out	18	8.11. Primary circuit assembly: (Pole)	39
5.8. Installation of withdrawable circuit-breakers	18	8.12. Vacuum interrupters	40
6. Description	19	9. Spare parts and accessories	41
6.1. Basic structure of the withdrawable circuit-breaker	19	9.1. List of spare parts	41
6.2. Circuit-breaker structure of the circuit-breaker	19	10. Product quality and environmental protection	42
6.3. Drive structure	21	11. Overall dimensions	43
6.4. Structure of the control module	22	12. Electric circuit diagram	46
6.5. General characteristics of withdrawable circuit-breakers for PowerCube modules	23		

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:



1. Foreword

1.1. Introduction

This publication contains the information needed to install medium voltage VM1/A/P and VM1/A/PW circuit-breaker and put them into service.

For correct use of the product, please read it carefully.

Like all the apparatus we manufacture, the VM1/A/P and VM1/A/PW 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.

For example, the racking and interlock sections do not apply to the fixed mount breaker styles. All information in this booklet was current at the time of printing. Unless otherwise noted, all references in this booklet are determined by viewing the circuit-breaker from the front.

Only use original spare parts for maintenance operations.

For further information, please also see the technical catalogue of the circuit-breaker.



CAUTION

ALL THE INSTALLATION, PUTTING INTO SERVICE, RUNNING AND MAINTENANCE OPERATIONS MUST BE CARRIED OUT BY SKILLED PERSONNEL WITH IN-DEPTH KNOWLEDGE OF THE APPARATUS.

1.2. 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.

Style	Frame width (inches)	Voltage rating	Continuous current rating	Interruption ratings (symmetrical RMS)	Configurations available
450mm Frames	450mm (17.7 inches)	5-15 kV	1200 A	to 31.5 kA	Drawout
570mm Frames	570mm (22.44 inches)	5-15 kV	1200 - 2000 A	to 31.5 kA	Drawout

1.3. Drawout

A Drawout circuit-breaker is a breaker that may be removed from a cell without unbolting connections or mounting supports. It is intended for use in ABB PowerCube modules. It contains primary and secondary disconnects and provides two operating positions: Disconnect and Connect.

1.4. Information on this booklet

This booklet provides information for the VM1/A/P circuit-breakers as described below. Not all sections of the bulletin apply to all types of VM1/A/P circuit-breakers. For example, the racking and interlock sections do not apply to the fixed mount breaker styles. All information in this booklet was current at the time of printing. Unless otherwise noted, all references in this booklet are determined by viewing the circuit-breaker from the front.

The purpose of this manual is to provide instructions for unpacking, storage, installation, operation, and maintenance for VM1/A/P vacuum circuit-breakers. This manual should be carefully read and used as a guide during installation, initial operation, and maintenance.

The specific ratings of each model circuit-breaker are listed on the individual nameplates. The VM1/A/P circuit-breakers are protective devices. As such, they are maximum rated devices. In no event should they be applied outside of their nameplate ratings.

1.5. 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.

1.6. 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 industrial frequency, according to the IEC 62271-100, VDE 0670 and IEEE C37.04 Standards, is safe;
- application of a voltage higher than the withstand voltage at industrial frequency or of a direct current test voltage in direct current, specified in the IEC, VDE and ANSI/IEEE Standards, cannot be used;
- limitation of the above-mentioned local phenomena, with interrupters with open contacts, depends on keeping the specified distance between the contacts.

This condition is intrinsically guaranteed by correct operation of the operating mechanism and by adjustments of the transmission system.

2. Introduction and safe practices

2.1. Introduction

The purpose of this manual is to provide instructions for unpacking, storage, installation, operation, and maintenance for VM1/A/P vacuum circuit-breaker. This manual should be carefully read and used as a guide during installation, initial operation, and maintenance.

The specific rating of each model circuit-breaker are listed on the individual nameplate. The VM1/A/P circuit-breaker are protective device. As such, they are maximum rated device. In no event should they be applied outside of their nameplate ratings.

The VM1/A/P type vacuum circuit-breakers are designed for indoor installation in air-insulated switchgear.

In respect of the technical characteristics, VM1/A/P 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/A/P 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/A/P type vacuum circuit-breakers are available in the withdrawable version. The basic structure is shown in the "Technical data" section.

2.2. Safe practices

VM1/A/P circuit-breakers are equipped with high energy / high speed mechanisms. The design includes several interlocks and safety features which help ensure safe and proper operating sequences. To ensure safety of personnel associated with installation, operation, and maintenance of these circuit-breakers, the following recommendations must be followed:

Only qualified persons, as defined in the National Electric Safety Code, who are familiar with the installation and maintenance of medium voltage circuits and equipment should be permitted to work on these circuit-breakers

Read these instructions carefully before attempting any installation, operation, or maintenance of these power circuit-breakers.

- **Do not work on an energized circuit-breaker.**
- **Do not work on a circuit-breaker unless all components are disconnected by means of a visible break and securely grounded.**
- **Do not work on a circuit-breaker with power supplied to the secondary control circuit.**
- **Do not defeat safety interlocks. This may result in bodily injury, death and/or equipment damage.**
- **Do not work on a closed circuit-breaker.**
- **Do not work on a circuit-breaker with charged energy capacitors.**
- **Do not use a circuit-breaker by itself as the sole means of isolating a high voltage circuit.**
- **Do not leave a circuit-breaker in an intermediate position in a cell. Always place the circuit-breaker in the disconnect, test or connect position.**



WARNING

THE CIRCUIT-BREAKERS DESCRIBED IN THIS BOOK ARE DESIGNED AND TESTED TO OPERATE WITHIN THEIR NAMEPLATE RATING. OPERATION OUTSIDE OF THESE RATINGS MAY CAUSE EQUIPMENT TO FAIL, RESULTING IN PROPERTY DAMAGE, BODILY INJURY AND/OR DEATH.

ALL SAFETY CODES, SAFETY STANDARDS AND/OR REGULATIONS AS THEY MAY BE APPLIED TO THIS TYPE OF EQUIPMENT MUST BE ADHERED TO STRICTLY.



NOTE

FAILURE TO OBSERVE THE REQUIREMENTS OF OSHA STANDARD 1910.269 CAN CAUSE DEATH OR SEVERE BURNS AND DISFIGUREMENT. THAT STANDARD SPECIFICALLY PROHIBITS THE WEARING OF POLYESTER, ACETATE, NYLON, OR RAYON CLOTHING BY EMPLOYEES WORKING WITH EXPOSURE TO ELECTRIC ARCS OR FLAMES.

2.3. Standards and regulations

2.3.1. Fabrication

The VM1/A/P circuit-breakers conform to the following Standards:

- DIN VDE 0670, part 104, and IEC 62271-100
- DIN VDE 0847, part 4, and IEC 61000-4
- IEEE C37.04

2.3.2. Installation and operation

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

- ANSI / NFPA70
- NEC

2.4. Service conditions

Normal service conditions

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

IEEE C37.09

IEEE C37.54

Ambient temperature

Maximum	+ 40 °C
Average maximum over 24 hours	+ 35 °C
Minimum (according to class – 5), apparatus for indoor installation	- 30 °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 (3300 ft.) m above sea level.
For application above 1000m (3300 ft.) C37.20.2 is applicable

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.

3. Receiving, handling, and storage

VM1/A/P circuit-breakers are subject to complete factory production tests and inspection prior to packaging and shipment. The shipping package is designed to provide reasonable protection during shipment and to provide convenient handling. Accessories such as opening handles and racking handles are shipped separately from the circuit-breaker. 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.

3.1. Receiving and checking



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.

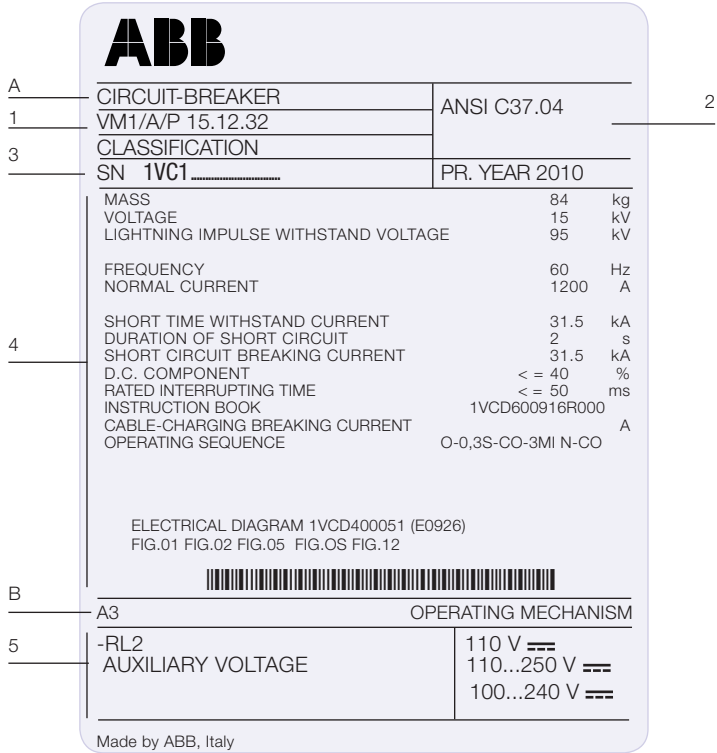
Should any damage or irregularity be noted in the supply on unpacking, notify ABB (directly or through the agent or supplier) as soon as possible and in any case within five days of receipt. The apparatus is only supplied with the accessories specified at the time of ordering and validated in the order 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 notes
- any drawings or documents referring to special configurations/conditions.



Caption

A Circuit-breaker rating plate.

B Drive ratingplate.

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

Immediately upon receipt of the circuit-breaker(s), examine the carton(s) to determine if any damage or loss was sustained during transit. If damage or indication of rough handling is evident, file a damage claim at once with the carrier and promptly notify the nearest district office. ABB is not responsible for damage to goods which occur after delivery. However, ABB will lend assistance if notified of claims. Use care in unpacking the circuit-breaker to avoid damaging any circuit-breaker parts.

Unpack circuit-breakers as soon as possible after receipt. If unpacking is delayed, difficulty may be experienced in making a claim for damages not evident upon receipt. Check the contents of each carton against the packing list before discarding any packing material. If any discrepancy is discovered, promptly notify the nearest district office. Information specifying the purchase order number, carton number, and part numbers of damaged or missing parts should accompany the claim.

3.2. Handling

VM1/A/P circuit-breaker shipping containers are designed to be handled by fork lift (not supplied). Once removed from the shipping container, the circuit-breaker wheels are designed to move the circuit-breaker across a smooth, paved surface. Care must be taken not to damage the secondary plug (item 1, Figure 2a) when transporting, rolling, or handling the VM1/A/P circuit-breakers.

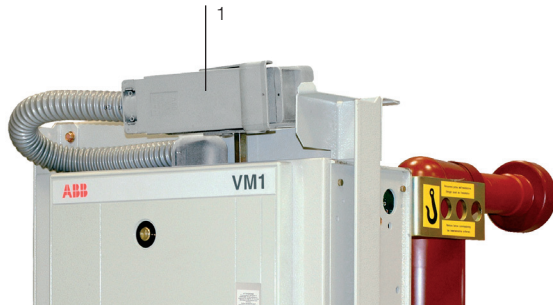


Fig. 2a

DO NOT pull the circuit-breaker by the front handles with the circuit-breaker in any position other than full Disconnect to avoid injuries at the hands.

DO NOT move the circuit-breaker by pushing on the embedded pole assemblies or primary leads of the embedded poles. Damage and misalignment of the pole assemblies will occur if force is applied to them.

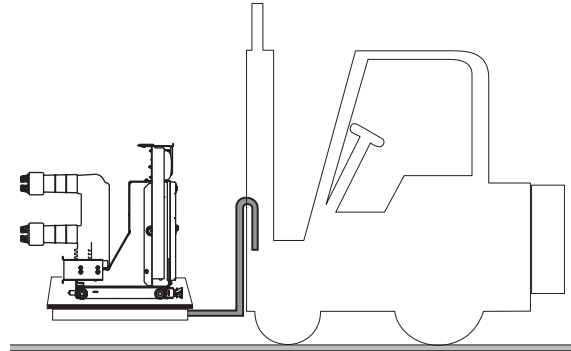


Fig. 2b

Lifting hook

The lifting hook is designed for general lifting and lowering of the device, such as for removal from shipping pallets or for lifting onto and off work tables. The lifting hook is not designed to be used for insertion or removal of the circuit-breaker from the switchgear compartment and therefore should never be used for any such purposes, instead, use the appropriate optional lift truck.



CAUTION



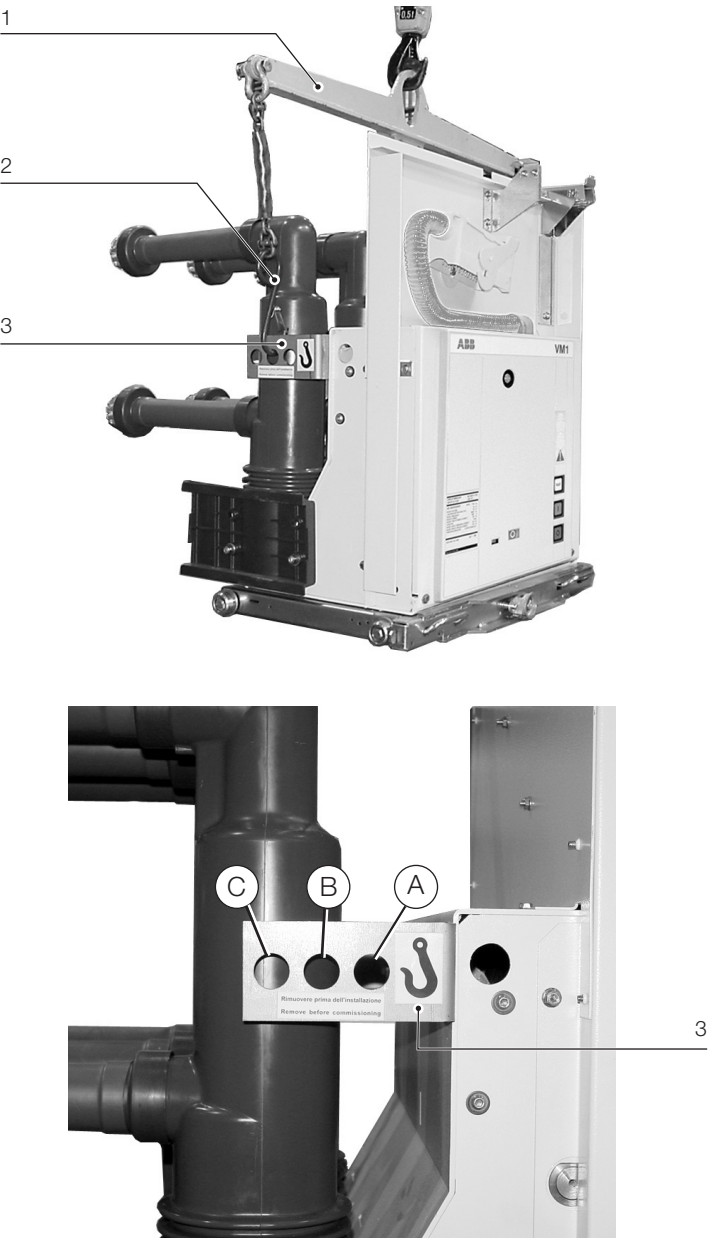
- ALWAYS FOLLOW SAFE WORK PRACTICES WHEN LIFTING CIRCUIT-BREAKER TO PROTECT THE SAFETY OF PERSONNEL AND EQUIPMENT.
- ALWAYS INSPECT LIFTING HOOK FOR SIGNS OF WEAR OR DAMAGE BEFORE USE.
- DO NOT USE A LIFTING HOOK THAT IS DAMAGED OR WORN.
- THE LIFTING DEVICE (I.E. HOIST, WENCH) SHOULD BE SUITABLY RATED FOR LIFTING THE CIRCUIT-BREAKER LOAD.
- ALWAYS REFER TO FIG.6 BELOW FOR THE PROPER INSTALLATION OF THE LIFTING HOOK.
- THE LIFTING HOOK IS NOT TO BE USED FOR INSERTION OF DRAWOUT CIRCUIT-BREAKERS INTO SWITCHGEAR COMPARTMENTS.
- THE LIFTING HOOK IS NOT TO BE USED AS THE SOLE MEANS OF SUPPORT WHEN SERVICING THE CIRCUIT-BREAKER.

Before carrying out any operations, always make sure that the capacitors are discharged.

To lift and handle the circuit-breaker, proceed as follows (Fig. 2c):

- 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.



Version	Pole centre distance	Rated current	Hole
Withdrawable	150 mm	up to 1250 A	A
Withdrawable	210 mm	up to 1250 A	C
Withdrawable	210 mm	up to 2000 A	B

Fig. 2c

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

Circuit-breakers should be installed in their permanent location as soon as possible. If the circuit-breakers are not placed in service for some time, it is advisable to provide adequate means of environmental protection. This may be done by keeping the circuit-breaker in its original shipping container and storing it in a warm, dry, and uncontaminated atmosphere. The circuit-breakers should be stored to minimize condensation. Moisture can cause deterioration of metal parts and high voltage insulation.

Prior to storage of the circuit-breaker, verification should be made that it is free from shipping damage and is in satisfactory operating condition.

3.3. Storage

When a period of storage is foreseen, our workshops can (on request) provide suitable packing for the specified storage conditions.

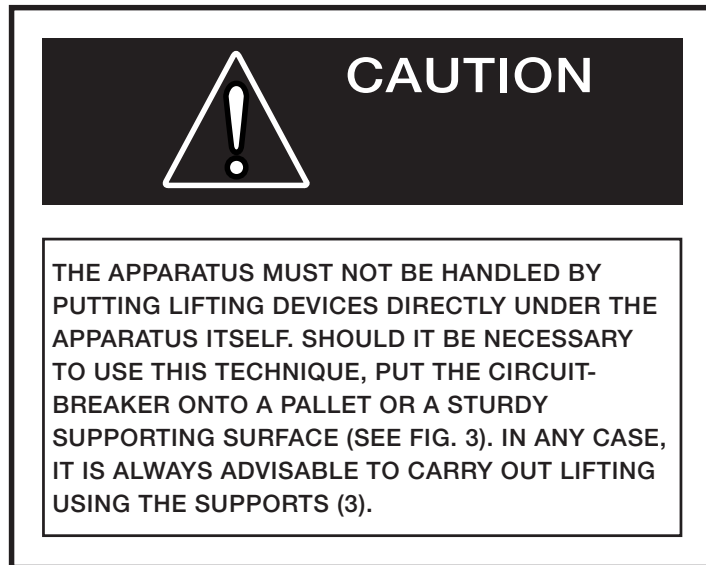
On receipt the apparatus must be carefully unpacked and checked as described in Checking on receipt.

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 $+45^{\circ}\text{C}$.

In any case avoid accidental impact or positions which stress the structure of the apparatus.



4. Insertion and removal, putting into service

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.

4.1. Insertion and removal of withdrawable circuit-breaker

This section describes the process for inserting the circuit-breaker into the Disconnect position of the switchgear and the removal of the circuit-breaker from the Disconnect position. Racking of the circuit-breaker to and from the Test Disconnect position is covered in the next section. The following rules must always be observed when inserting or removing the circuit-breaker device from the switchgear compartment.



DANGER



- DO NOT ATTEMPT TO REMOVE THE CIRCUIT-BREAKER FROM THE CIRCUIT- BREAKER COMPARTMENT WITHOUT THE REQUIRED RAMP, DOLLY OR LIFT TRUCK. REFER TO THE SPECIFIC SWITCHGEAR INSTALLATION AND MAINTENACE MANUAL FOR DETAILS.
- DO NOT ATTEMPT TO INSERT THE CIRCUIT-BREAKER INTO ANY COMPARTMENT PRIOR TO INSPECTION. COMPARE THE CIRCUIT-BREAKER NAME PLATE RATING WITH THE SWITCHGEAR RATING. VERIFY SECONDARY VOLTAGES ON THE CIRCUIT-BREAKER AND IN THE COMPARTMENT.
- DO NOT ATTEMPT TO INSERT A CLOSED CIRCUIT-BREAKER.
- ALWAYS INSPECT THE CIRCUIT-BREAKER COMPARTMENT TO INSURE THAT IT IS FREE OF OBSTRUCTIONS, TOOLS, OR OTHER EQUIPMENT.

Insertion: from Withdrawn position

1. Align the circuit-breaker and ramp, dolly or lift truck with the compartment (Fig. 4).
2. Pull the handles (1 - Fig. 5) to center (this withdraws Cell Interlock Tabs (3 - Fig. 5) allowing the circuit-breaker to be inserted).
3. Push the circuit-breaker into the compartment with the handles. Interlocks may restrict insertion. (Refer to Interlocks section)
4. Align the circuit-breaker interlock tabs (3 - Fig. 5) with the compartment slots (Fig. 4).
5. Push the handles out to fully engage the cell interlock tabs into the compartment slots.
6. Visually check that cell interlock tabs are engaged in the compartment slots (if cell interlock tabs are not fully extended, racking is prevented).
7. The circuit-breaker is now in the Disconnect position.

Removal: to Withdrawn Position

1. Visually verify that the truck (9 - Fig. 10a) is against the truck locator channel (8 - Fig. 5).
2. Pull the handles to the center (1 - Fig. 5).
3. Pull the circuit-breaker from the compartment with the handles onto the required transportation device.
4. The circuit-breaker is now in the withdrawn position.

4.1.1. 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 AWG16. Furthermore, they must be insulated for 3 kV test.

Please note that auxiliary circuits must be energized with 2 kV (maximum test voltage) as per standards indications.

The auxiliary circuits of withdrawable circuit-breakers are fully cabled in the factory as far as the connector.

For the external connections, refer to the electric wiring diagram of the switchgear.

Connect the plug (1 - Fig. 2a) with the secondary disconnectors (Fig. 6).

4.1.2. Capacitor discharge circuit

Procedure for discharging the capacitor/s

Remove the plug (1 - Fig. 2a).

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 10 minutes have passed, the capacitor voltage drops to a value of less than 15 V.

4.2. Putting into service

4.2.1. General procedures

**WARNING**

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 IS < 25 Nm.

4.2.2. 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 pag. 31 Fig.13. Auto-shutdown function for low voltage of the capacitor/s).

Closing in case of a power failure

Closing is not advisable and is not possible.

Manual emergency opening

Use the crank handle 1 (Fig. 3) 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 position
- if the circuit-breaker is in the racked-in position in the switchgear/enclosure, it is now possible to take it to the isolated position.

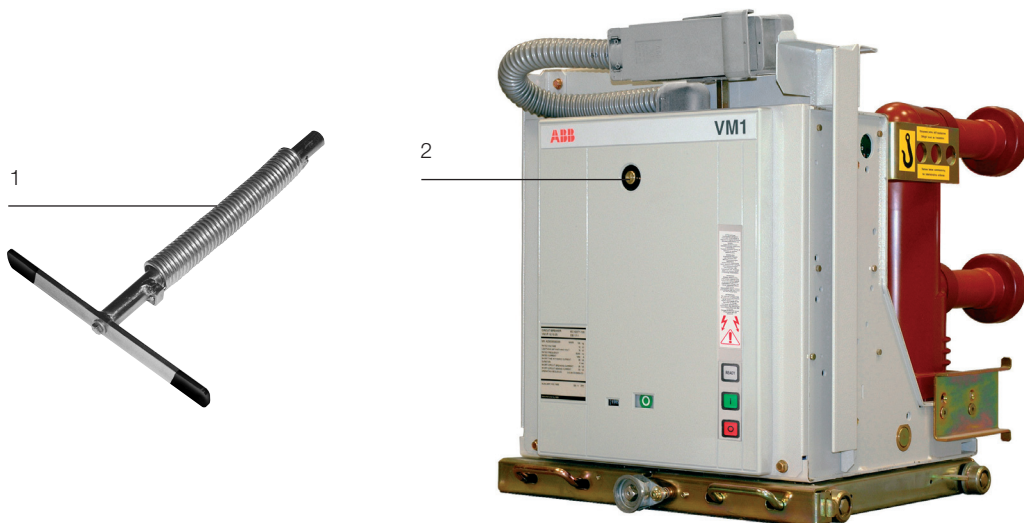


Fig. 3

4.2.3. 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.

4.2.4. Structure and function

Summary of racking data

Table 2. Summary Racking Data

	DISCONNECT	CONNECT
Distance from Disconnected	0 mm / 0 revolutions / 0 inches	200 mm / 20 revolutions / 7.89 inches
Manual opening	Yes	Not recommended unless necessary
Electrical Operation	Yes, while power cord is connect	Yes, while power cord is connect
Control Power Available	Yes, while power cord is connect	Yes
Shutter	CLOSED	OPEN
Primary Contacts Engaged	No	Yes
Requirements to rack breaker from position	Breaker Open / Power cord connect	Breaker Open / Power cord connect
Notes	A	A

Notes A: Closed door is mandatory between all positions

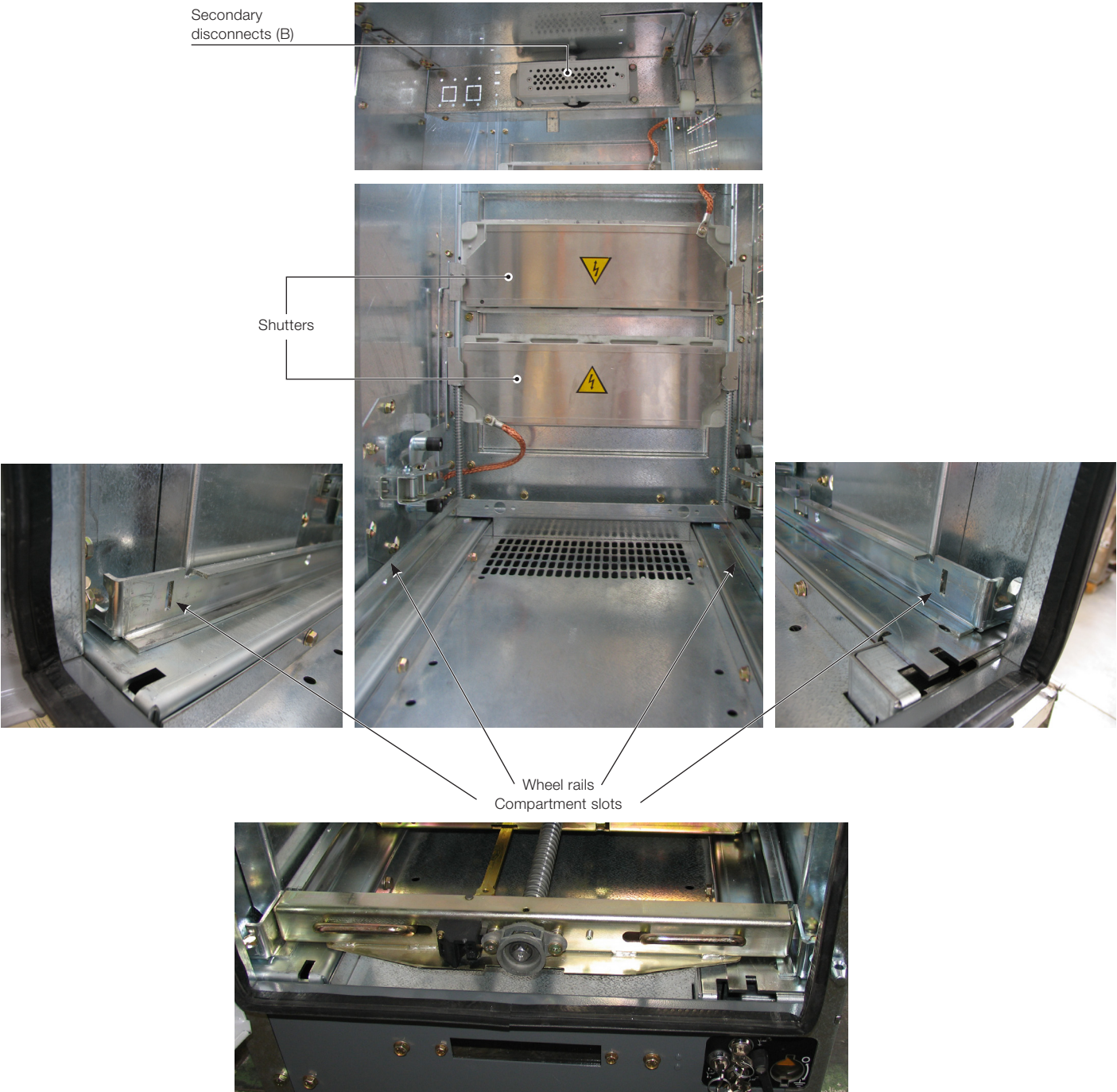


Fig. 4

Racking screw collar

Truck

The truck requires visual inspection of hardware, lubrication, and operation during routine maintenance. With the circuit-breaker outside the cell, verify all visible hardware tightness, including handles (1) and wheels (2). Wheels should rotate freely by hand movement. Replace or tighten any missing or loose hardware. With the circuit-breaker outside the cell, rotate the racking screw as though racking the circuit-breaker to the Connect position.

This process will expose surfaces inside the truck that need to be inspected and lubricated. Lubricate the exposed parts; specifically the entire Racking Screw (4). Inspect the circuit-breaker locking tabs (3) for any damage. Return truck to the Disconnect position. As a precaution, do not operate the circuit-breaker outside the cell unless the truck is in the full Disconnect position.

Truck
(shown with circuit-breaker removed)

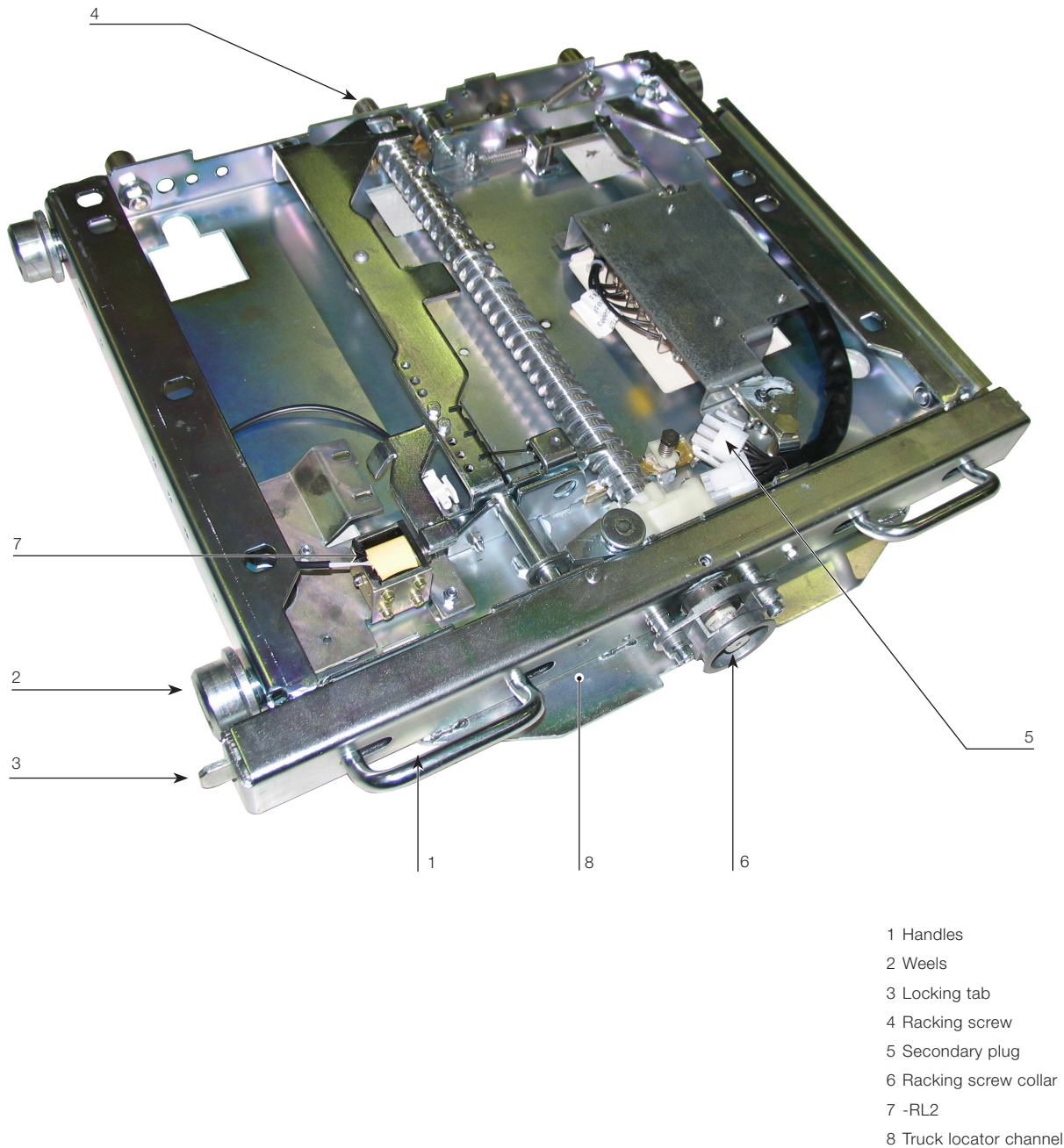


Fig. 5

5. Installation

5.1. General



WARNING

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.

5.2. Trip curves

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

Caption

Nr. Number of closing-opening cycles allowed for the vacuum interrupters.

I_a Breaking capacity of the vacuum interrupters.

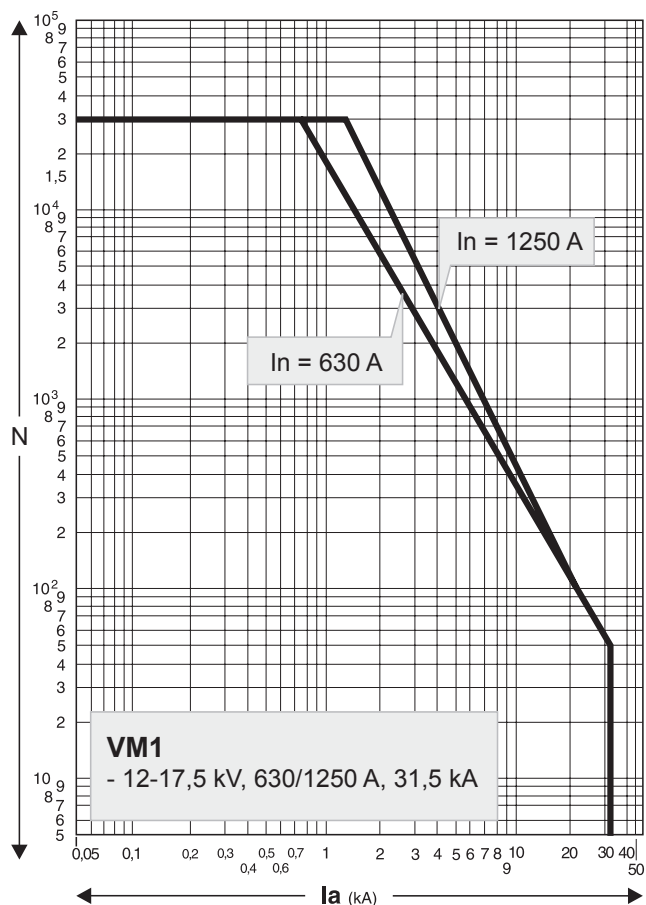


Fig. 6a

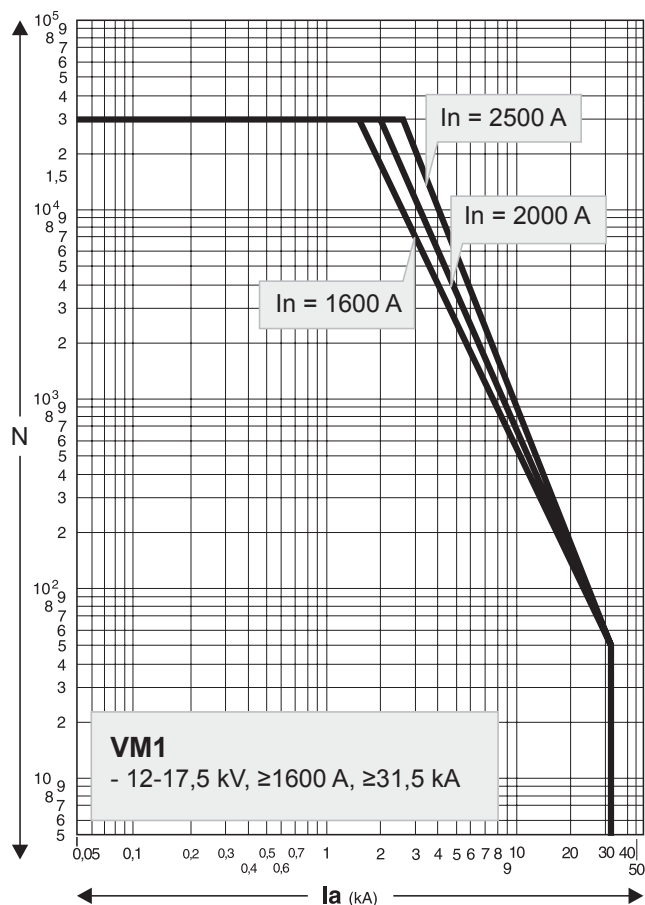


Fig. 6b

5.3. Interlocks/protection against malfunction

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 circuitbreaker 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 (Secondary disconnects Fig. 4) (Fig. 7) 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.



Fig. 7a

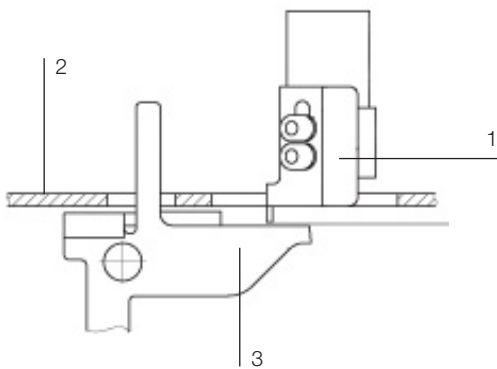


Fig. 7b

Interlocks

The VM1/A/P circuit-breaker contains a number of interlocks. A description of each interlock follows as encountered during racking of the circuit-breaker into the compartment.



Modification to interlocks may result in serious bodily injury or death.

Interference blocking: A mechanical plug interference blocking in the circuit-breaker compartment prevents under rated circuit-breakers from being inserted into higher rated compartments. The code plate rating includes continuous current, interrupting current, close and latch capability, and maximum voltage.

5.4. Racking

VM1/A/P circuit-breakers are designed with two positive racking positions: Disconnect, Connect. In the Disconnect position the shutters are closed. Electrical closing from the front panel is allowed for up to 60 seconds without control power (if the capacitors are fully charged) and manual opening is allowed. Electrical operation of the circuit-breaker is allowed with control power supplied through the secondary contacts with the shutters closed. As the circuit-breaker approaches the Connect position, an increase in racking force is required to lift the shutters and to engage the primary contacts. In the Connect position, the primary disconnects are fully engaged and the shutters are open. Electrical operation of the circuit-breaker through the secondary contacts remains enabled.

Close door racking is mandatory between all positions

1. Engage the racking handle (item 1 Figure 8) with the racking screw collar (item 2 Figure 8).

a. CLOCKWISE (cw) rotation inserts the circuit-breaker towards the primary contacts.

b. COUNTER-CLOCKWISE (ccw) rotation withdraws the circuit-breaker away from the primary contacts.

Circuit-breaker rack-ing-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 rack-ing-in and racking-out is <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.

5.5. Disconnect through connect

1. Perform a visual inspection of the circuit-breaker:
 - a. Verify Close/Open Indicator shows OPEN.
 - b. Verify "READY" indicator lamp turns on (may take approximately two minutes).
 2. Racking-in operation:
 - a. Verify switchgear door is CLOSED
 - b. Begin racking by rotating the racking handle to the CLOCKWISE direction.
 - c. Twenty (20) revolutions (200mm) will move the circuit-breaker between the Test and Connect positions.
- The Connect position is indicated by a positive lock, preventing further racking shaft rotation.
 - Closing of the circuit-breaker is prevented between Test and Connect positions.

5.6. Connect through disconnect

1. Perform a visual inspection of the circuit-breaker:
 - a. Verify Close/Open Indicator shows OPEN.
 - b. Verify switchgear door is CLOSED.
 2. Racking-out operations:
 - a. Begin racking by rotating the racking handle in the COUNTER-CLOCKWISE direction.
 - b. Twenty (20) revolutions (200mm) will move the circuit-breaker between the Connect and Disconnect positions.
- Closing of the circuit-breaker is prevented between Connect and Disconnect positions

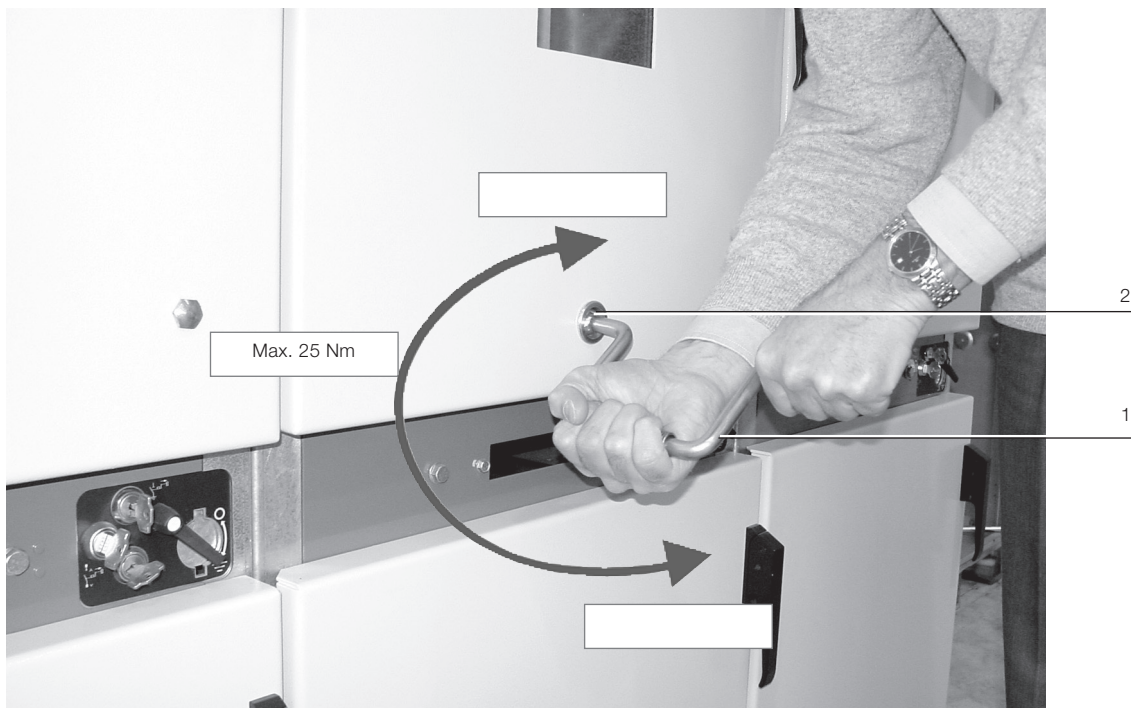


Fig. 8

5.7. Connect through disconnect emergency rack out (Fig. 9)

1. In the case of a locking magnet –RL2 fault, in an emergency the truck can be racked out manually following the instructions below:
 - a. Open the circuit-breaker
 - b. Verify Close/Open Indicator shows OPEN
 - c. cut off the power supply to the auxiliary circuit
 - d. verify “READY” indicator lamp turns off and wait 10 minutes.
 - e. open the enclosure door
 - f. remove the circuit-breaker front protection shield
 - g. 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. 9).



Fig. 9

5.8. Installation of withdrawable circuit-breakers

The withdrawable circuit-breakers are preset for use in Vesta 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. 8) in the appropriate seat (2) (Fig. 8) and work it clockwise for racking-in, and anti-clockwise for racking-out, until the end-of-run positions are reached (see par. 5.4. - 5.5- and 5.6.).

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 <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 .

WHEN THE CIRCUIT-BREAKER HAS REACHED THE CONNECT/ DISCONNECT 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.



CAUTION

THE RACKING-IN/OUT OPERATIONS MUST ALWAYS BE CARRIED OUT WITH THE CIRCUIT-BREAKER OPEN.

6. Description

6.1. Basic structure of the withdrawable circuit-breaker (Fig.10a)

The withdrawable truck (9), consists of a steel sheet structure with wheels (3), on which the circuit-breaker with the relative auxiliary components, the isolating contacts (10) for electrical connection with the switchgear and the multi-pole secondary 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.

6.2. Circuit-breaker structure of the circuit-breaker (Fig.10b)

The encapsulated poles are installed on the rear flat section of the circuit-breaker frame (1.1. Fig. 10a). The live parts of the circuit-breaker poles are enclosed in cast resin and protected from impacts and other external influences.

With the circuit-breaker closed the current path for each pole leads from the upper circuit-breaker terminal (1) to the fixed contact (2a) in the vacuum interrupter (2), then via the moving contact (2b) and the flexible connector (5) to the lower circuit-breaker terminal (4).

The change of contact state is delivered by means of the insulated link rod (7) with internal contact force springs (6).

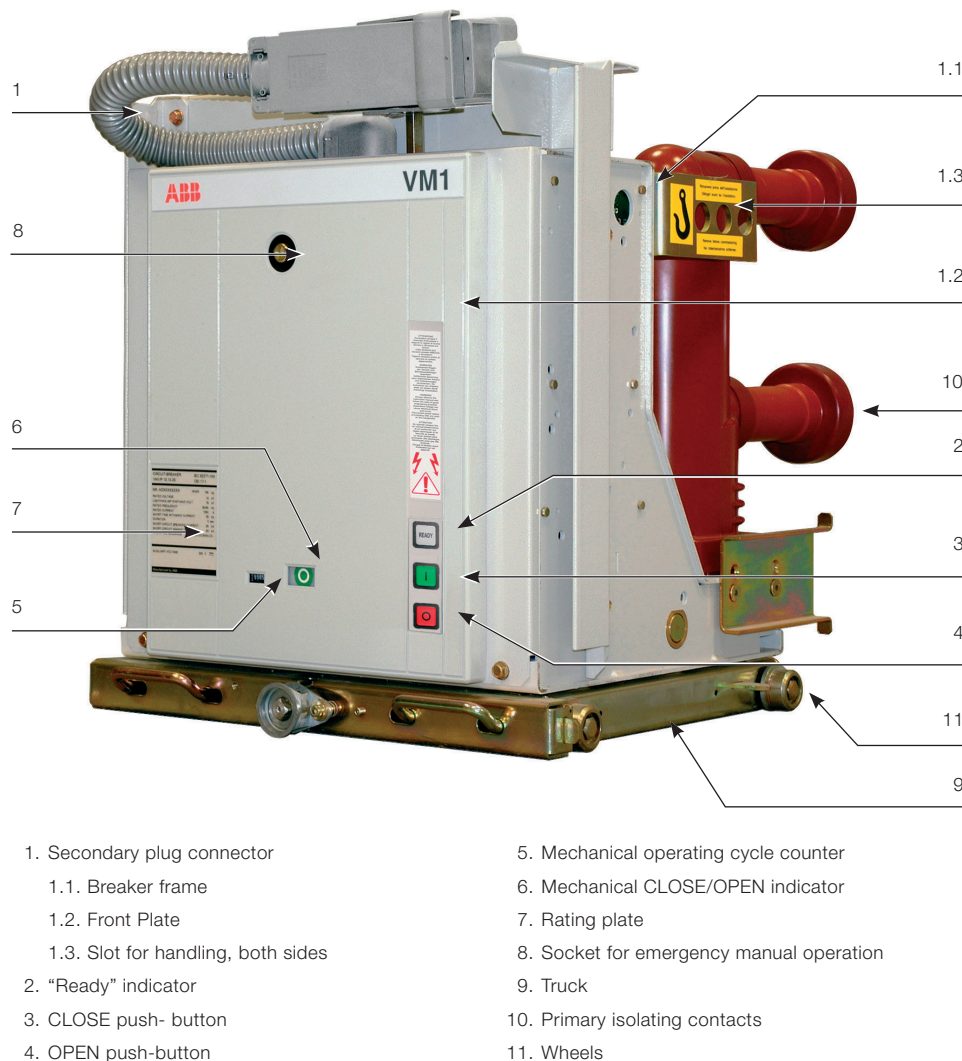
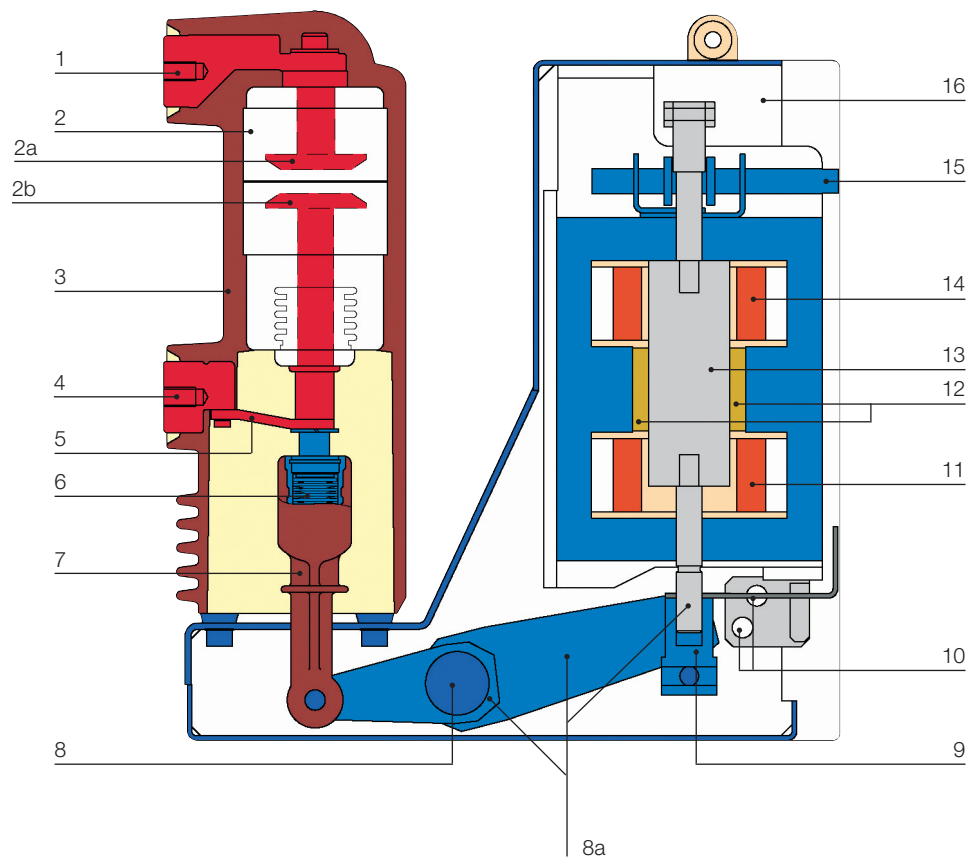


Fig. 10a



- | | |
|-------------------------|---|
| 1 Top terminal | 8a Kinematics for transmission of the drive movement to the circuit-breaker poles |
| 2 Vacuum interrupter | 9 Run regulator |
| 2a Fixed contact | 10 Position sensors |
| 2b Moving contact | 11 Closing coil |
| 3 Pole | 12 Permanent magnets |
| 4 Bottom terminal | 13 Moving armature |
| 5 Flexible connection | 14 Opening coil |
| 6 Shock absorber spring | 15 Device for manual emergency opening |
| 7 Insulating tie-rod | 16 Supporting structure |
| 8 Crank handle shaft | |

Fig. 10b

6.3. Drive structure

The drive is of the magnetic type and basically consists of the magnetic actuator (6) (Fig. 11), 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).

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.

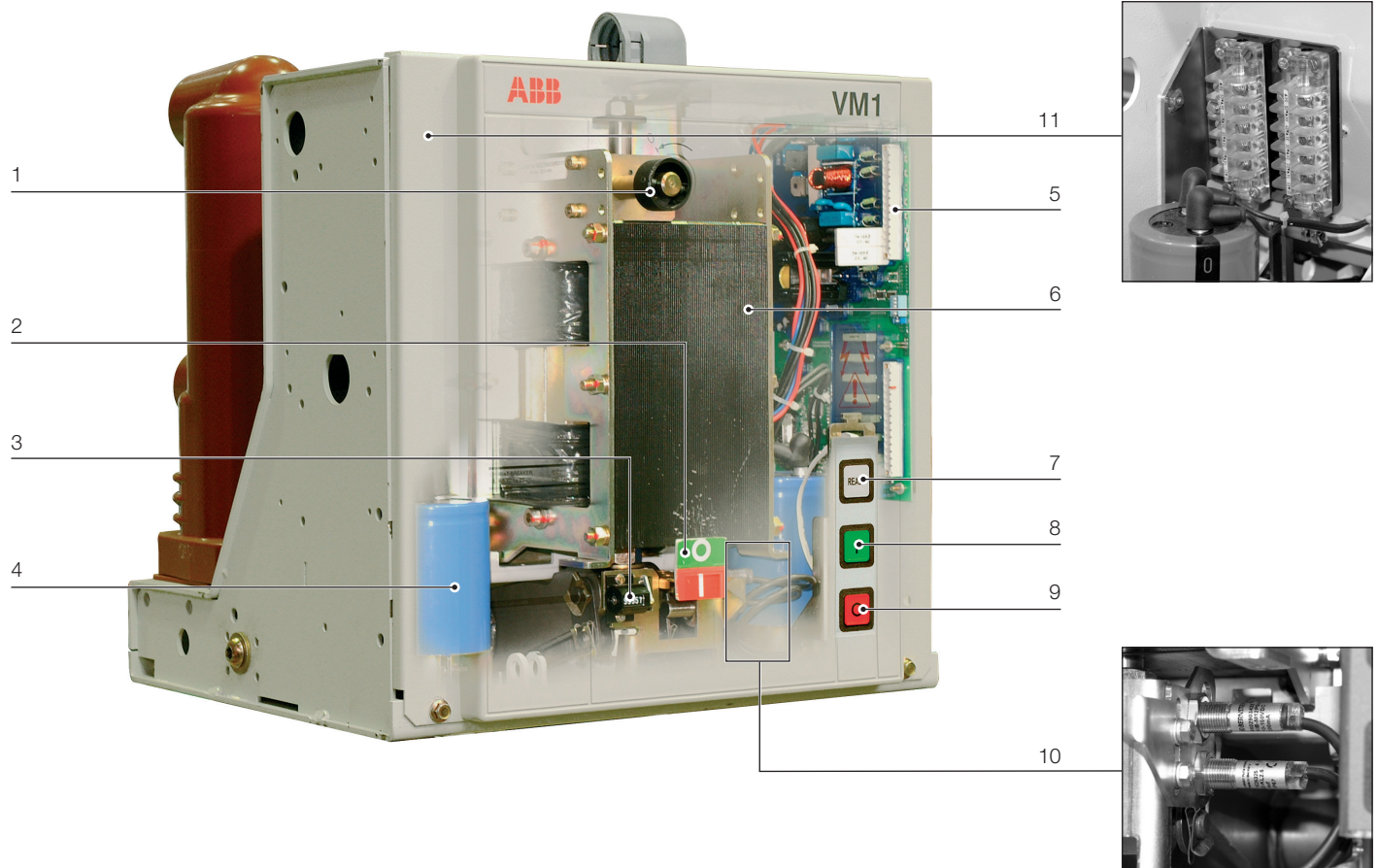


Fig. 11

6.4. Structure of the control module

The control module consists of a single circuit board. This board contains a series of components:

- AC/DC converter
- Logic circuit / Power Electronics
- Electric optocouplers for input
- Relays for output

The board is connected by a plug connector which ensures safe and trouble-free wiring. The boards and components are not user serviceable.

Storage capacitor

The energy for operation of the circuit-breaker is stored electrically in a capacitor. This capacitor is designed in such a way that when fully charged, the energy for an O-(0.3 sec.)-C-O* operating sequence is available without recharging. The energy stored by the capacitor is continuously monitored. This is achieved by measuring the capacitor voltage. The "READY" lamp indicates whether the circuit-breaker is functional or not, and indicates if the circuit-breaker is ready or not ready to operate.

The energy available in relation to the relevant switch position is the criteria which determines

- Case 1: Circuit-breaker in the OPEN position

The energy available is sufficient for an CLOSE and OPEN switching operation.

- Case 2: Circuit-breaker in the CLOSED position

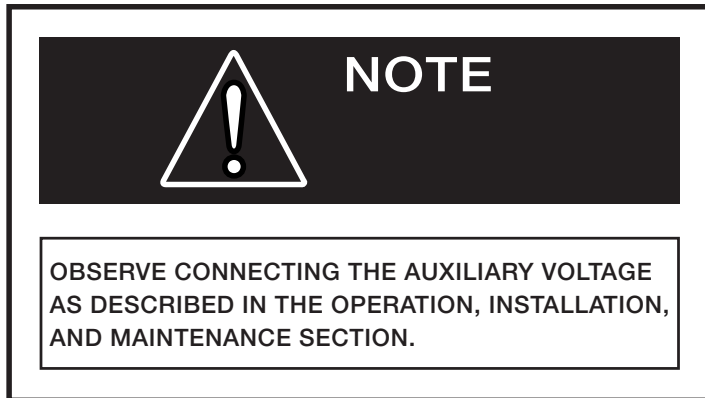
–The energy available is sufficient for a OPEN-CLOSE-OPEN switching sequence.

–The energy available is sufficient for an OPEN switching operation up to 200 seconds after failure of the auxiliary power supply.

* O-C-O is operation duty Open - Close - Open.

Position sensors

The use of two inductive proximity sensors (10 Fig. 11) 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.



6.5. General characteristics of withdrawable circuit-breakers for PowerCube modules (15 kV)



Circuit-breaker		VM1/A/P	VM1/A/PW	VM1/A/P
PowerCube modules		PB1	PB2	PB2
Standards	C37.04-C37.09.-C37.54-C37.55	•	•	•
Rated voltage	Ur [kV]	15	15	15
Rated insulation voltage	Us [kV]	15	15	15
Withstand voltage at 50 Hz	Ud (1 min) [kV]	36	36	36
Impulse withstand voltage	Up [kV]	95	95	95
Rated frequency	fr [Hz]	50-60	50-60	50-60
Rated normal current (40 °C)	(1) Ir [A]	1200	1200	2000
Rated breaking capacity (rated symmetrical short-circuit current - 5 cycles)	Isc [kA]	25 31,5	25 31,5	25 31,5
Rated-short time withstand current (3 s)	Ik [kA]	25 31,5 (2)	25 31,5 (2)	25 31,5 (2)
Making capacity	Ip [kA]	63 80	63 80	63 80
Operation sequence	[O-0.3s-CO-3min-CO]	•	•	•
Opening time	[ms]	40 ... 70	40 ... 70	40 ... 70
Arc duration	[ms]	8 ... 13	8 ... 13	8 ... 13
Total interruption time	[ms]	45 ... 60 < 83	45 ... 60 < 83	45 ... 60 < 83
Closing time	[ms]	45 ... 80	45 ... 80	45 ... 80
Mechanical operations (cycles)	Actuator [No] Interrupters [No]	... 100,000 ... 30,000	... 100,000 ... 30,000	... 100,000 ... 30,000
Electrical operations (cycles)	Rated current [No] Under short circuit [No]	... 30,000 ... 100	... 30,000 ... 100	... 30,000 ... 100
Maximum overall dimensions	H [mm/inch]	628/24.7	691/27.2	691/27.2
	W [mm/inch]	503/19.8	653/25.7	653/25.7
	D [mm/inch]	503/19.8	642/25.2	642/25.2
	Pole centre distance l [mm/inch]	150/5.9	210/8.26	210/8.26
Weight	< 25 KA [kg/lb]	137/302	141/310	192/423
	31.5 KA [kg/lb]	144/317.5	148/326	192/423
Standardized table of dimensions		1VCD03606	1VCD003658	1VCD003659
Operating temperature	[°C]	-30 ... + 40	-30 ... + 40	-30 ... + 40
Tropicalization	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) Only VM1/A/P 15.12.32 can leave (on request) UL type L liasted sticker.

6.6. Types of withdrawable circuit-breakers available for PowerCube modules

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

Withdrawable circuit-breaker - VM1/A/P-VM1/A/PW for PowerCube modules

Ur	Isc	Rated uninterrupted current (40°C) [A]			Type of circuit-breaker
kV	kA	W = 600	W = 750	W = 750	
		P = 150	P = 210	P = 210	
		u/l = 205	u/l = 310	u/l = 310	
		ø = 35	ø = 35	ø = 79	
PowerCube		PB1	PB2	PB2	
15	25	1250			VM1/P 12.12.25 p150
	31.5	1250			VM1/P 12.12.32 p150
	25		1250		VM1/W 12.12.25 p210
	31.5		1250		VM1/W 12.12.32 p210
	25			2000	VM1/P 12.20.25 p210
	31.5			2000	VM1/P 12.20.32 p210

W = Width of the switchgear.

P = Pole horizontal centre distance.

u/l = Distance between bottom and top terminal.

ø = Diameter of the isolating contact.

6.7. Mechanism and electrical operation

To operate the circuit-breaker electrically, control power must be available. The section entitled Racking describes the application of control power through the secondary disconnect when the circuit-breaker is in the Test and Connect positions.

- Inspect the initial state of the circuit-breaker to determine the operations available.
 - Close/Open Indicator.
 - Circuit-breaker position Test or Connect (or control power applied externally if withdrawn).
- Energize Control Power.
 - Wait until "READY" lamp is on; approximately two minute maximum depending on control voltage with 48 V DC taking the longest amount of time.
 - Circuit-breaker is ready to perform C-O operation.
- Close the circuit-breaker using the close push-button or by electrical signal to the magnetic actuator.
 - The magnetic armature moves down.
 - Close/Open indicator changes to Closed.
 - "READY" lamp illuminates again after about one second.
 - Circuit-breaker is ready to perform O-C-O operation.
- Open the circuit-breaker using the manual OPEN push-button or by electrical signal to the magnetic actuator.
 - The armature moves up.
 - Close/Open indicator changes to Open.
 - "READY" lamp will remain illuminated.
 - Circuit-breaker is ready to perform C-O operation.

6.8. Control scheme

VM1/A/P circuit-breakers are similar in switching control to standard spring stored energy mechanisms as indicated by the Sequence of Operation in Chart 1.

Notes for Chart 1: Once the capacitor(s) is(are) charged (<10amps), the control power will experience a constant drain of approximately 2mA in lieu of a typical motor circuit of a spring stored energy mechanism requiring impulse currents up to 20amps.

The capacitor voltage will vary 5 to 10Vdc during switching operations allowing for fast recharge and reclose schemes. The opening and closing coils are operated via the storage capacitor(s) and thus only require a minimal signal (24V min) to operate. The nominal circuit-breaker closing and opening times are typical at 55ms and 65ms respectively.

Note: Sample drawing for actual draft manual.

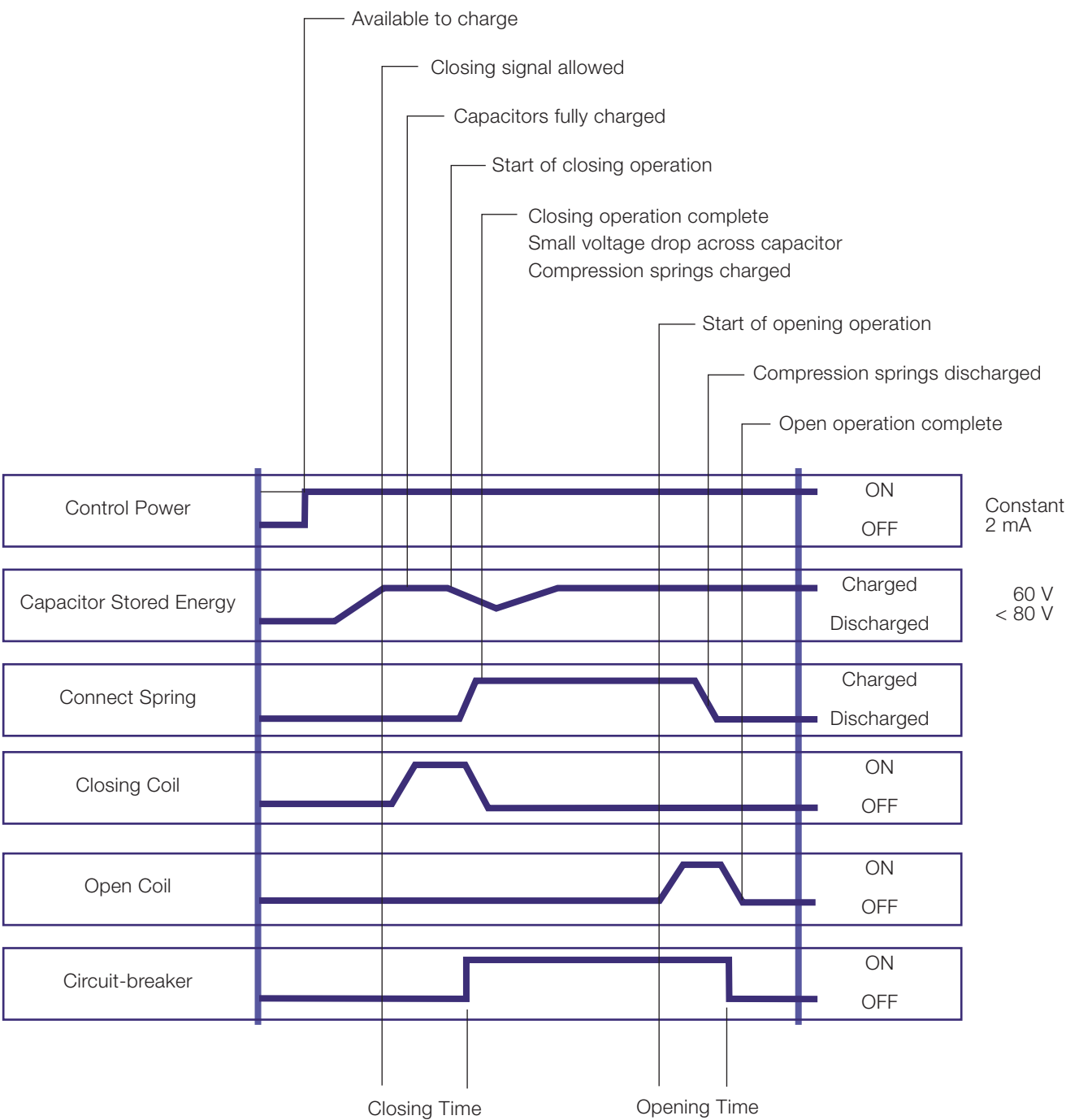


Chart 1: Sequence of operation (not to scale)

6.9. Standard fittings

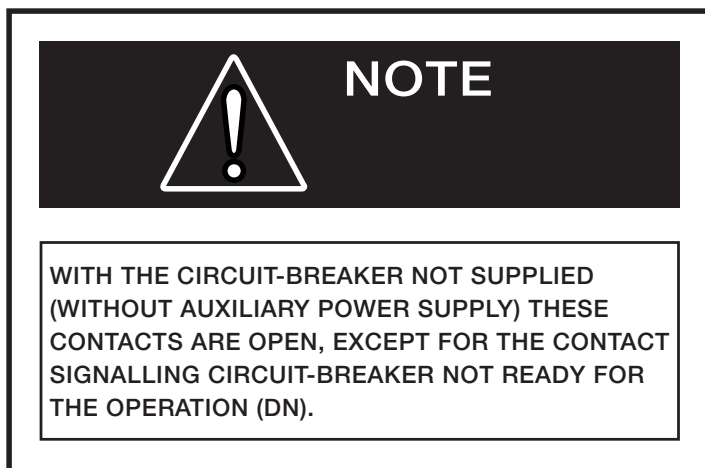
6.9.1. Standard fittings for circuit-breakers

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).



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).

Gli ingressi binari possono essere alimentati come segue:

- 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) isolating contacts
 - 9) 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).
 - 10) racking-in/out lever (the quantity must be defined according to the number of pieces of apparatus ordered)
 - 11) truck locking electromagnet (only only for ABB UniGear type switchgear).

6.10. Optional accessories

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

1 ED2.0 Control module

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 (-SO4):
The function can be excluded (bottom logical input activated).

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

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

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

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.

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:		$I_{th}^2 = 10\text{ A}$		
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

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).

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).

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

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 discharging device allows the waiting time to be reduced to one minute and guarantees safe access to the circuits which might be live.

7. Operation

7.1. Circuit-breaker function

Magnetic actuator (Refer to figure 10b)

The magnetic actuator used in the VM1/A/P circuit-breaker 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 the heart of the circuit-breaker operating mechanism. It combines the following integrated functions:

- Latching in the limit positions
- Release
- Switching

The actuator is a bistable permanent magnet system in which the armature (13) motion is affected by activating the close (11) and open (14) coil. In the limit positions the armature is held in place magnetically by the field of two permanent magnets (12). Changing of the switched position is performed by exciting one of the two coils until the latching force of the permanent magnets are exceeded.

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 (15).

7.2. Circuit-breaker control

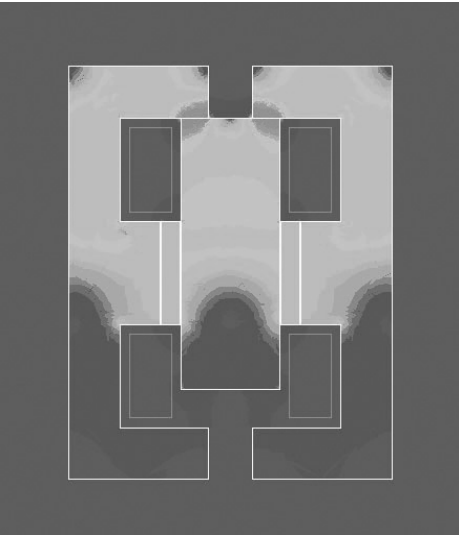
All the conditions for control of the magnetic actuator mechanism are defined in a permanently programmed logic module. These conditions are:

- Auxiliary voltage must be applied to the AC/DC converter.
- The storage capacitor must have sufficient charge for the next switching operation.
- The moving contacts in the circuit-breaker poles must be in a defined CLOSE or OPEN limit position.
- The closing coil can only be activated with the circuit-breaker in the OPEN position.

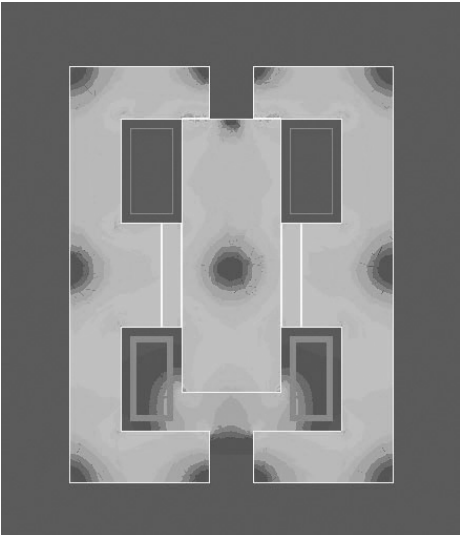
The opening coil can only be activated with the circuit-breaker in the CLOSE position.

- Closing is blocked when an opening command is simultaneously active.
- Activation of the closing coil can be disabled by an external blocking signal.
- The antipumping system ensures that, when a closing command is applied and followed by an opening command, only one CLOSE-OPEN switching operation is performed. For the next closing operation, the active closing command has to be cleared and must be issued again.
- Deactivation of the opening or closing coil takes place when the relevant limit position has been reached.

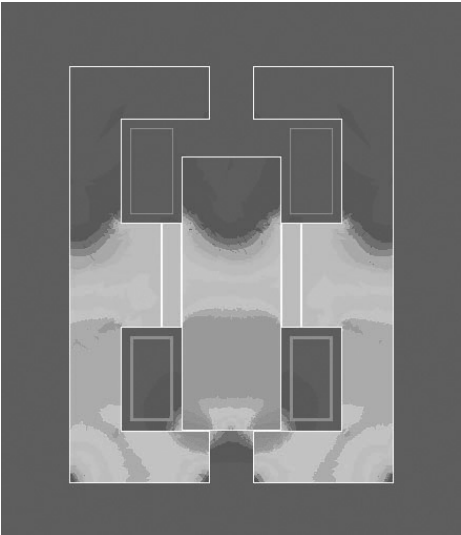
Switch position:	Storage capacitor energy for:
Open	Close and open
Close	Open



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. 12

7.3. Opening and closing procedure (Refer to figure 10)

The opening and closing processes are initiated either by remote control via closing contacts or locally by manual operation of push-buttons

In the closing process, the armature motion acts directly via the lever shaft (8) on the moving contact until the vacuum interrupter contacts meet.

In the full motion sequence, the spring arrangement (6) is tensioned to 100% and the necessary contact force thus applied. The available overtravel is greater than the maximum contact burn-off throughout the life of the vacuum interrupter.

7.4. Autoreclosing sequence

The operating mechanism is SUITABLE for autoreclosing, and with the short recharging time of the storage capacitor it is also suitable for multi-shot autoreclosing.

Thanks to the short duration of capacitor recharging, the drive is suitable for multiple reclosing operations with O-0.3s-CO-3min-CO cycle.

7.5. Control module

The control module is available in the full option version.

7.6. Functions of the control module

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	Close and open
Close	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).
- 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 Fig. 8).

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.

- 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.

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

7.8. 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.

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).

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

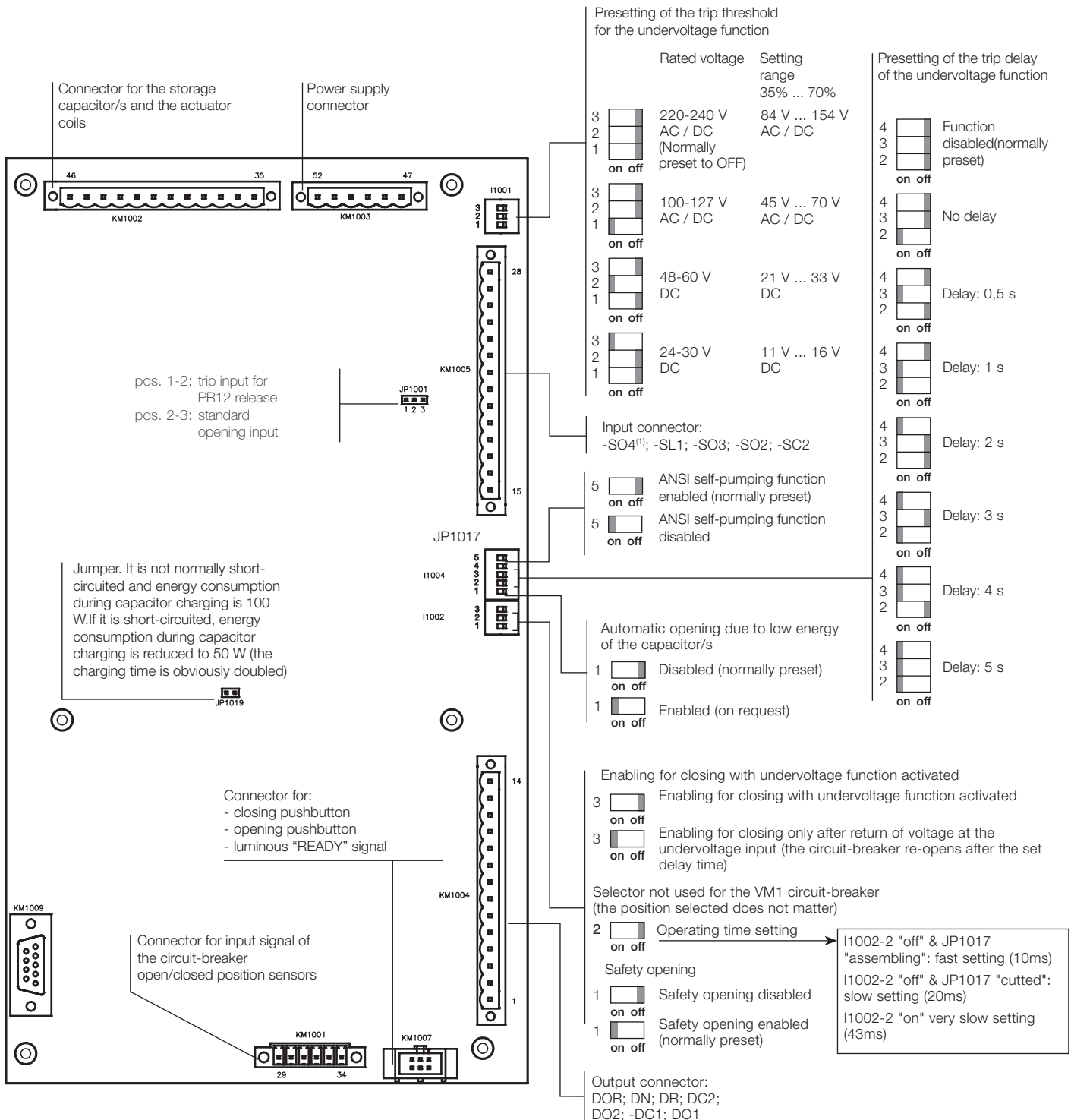
Circuit-breaker closed	Circuit-breaker open	Capacity of the capacitor/s
Ready signal: lit	Ready signal: lit	Sufficient energy for an O.C.O cycle
Ready contact: closed	Ready contact: closed	
Not Ready contact: open	Not Ready contact: open	
Ready signal: flashing	Ready signal: flashing	Sufficient energy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

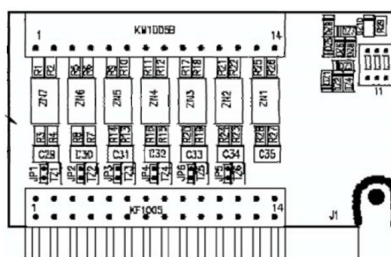
Circuit-breaker closed	Circuit-breaker open	State of the coils
Ready signal: flashing	Ready signal: off	No continuity in the closing coil
Ready contact: closed	Ready contact: open	
Not Ready contact: open	Not Ready contact: closed	
Ready signal: off	Ready signal: off	No continuity in the closing coil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

7.9. 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.



With ANSI version only the Dip-switch I1001 (call I1) for UV thresholds adjustment is mounted on a different board:



KM1005B is to be considered in place of KM1005.

Fig. 13

7.10.Characteristics of the control module contacts without potential

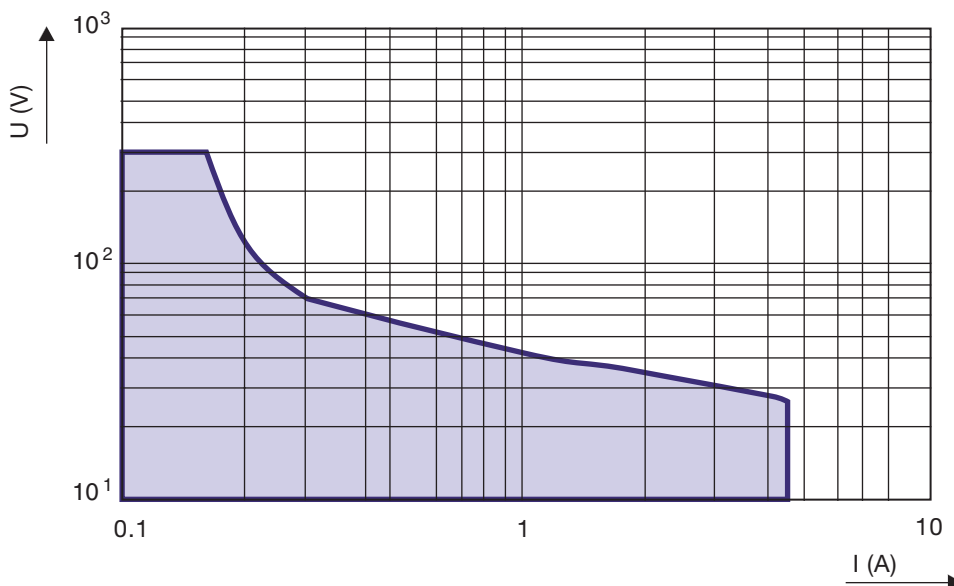
The contacts without potential are supplied with special relays.

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

Notes

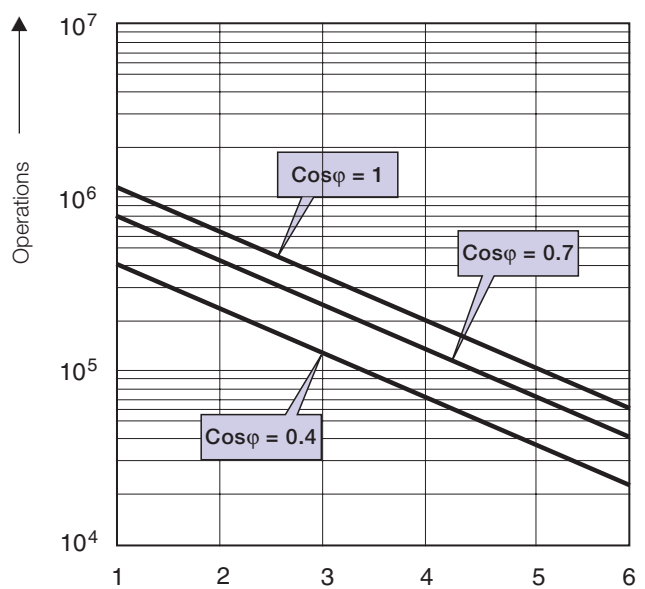
- In the case of inductive loads, the contacts must be protected against overvoltages by means of varistors.
- For the other characteristics, please refer to the IEC 60694.5.4.4.5.4 (Ed. 2.2), Class 3 Standards.

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)

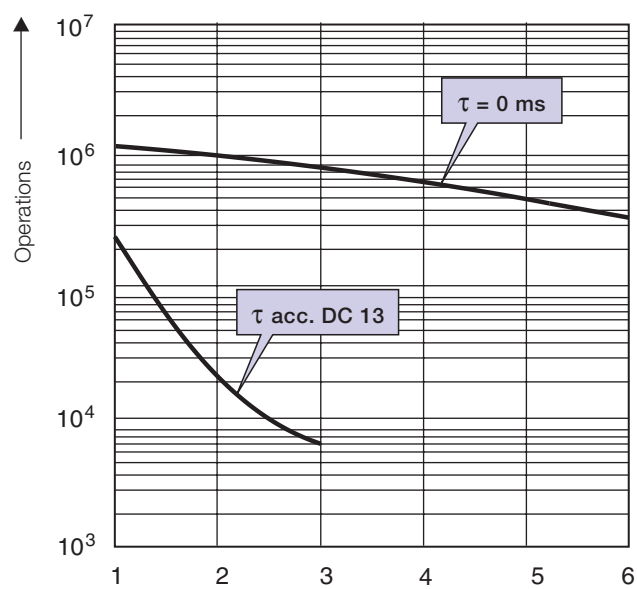


Curve A

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.

Fig. 14

8. Maintenance

8.1.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.

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.

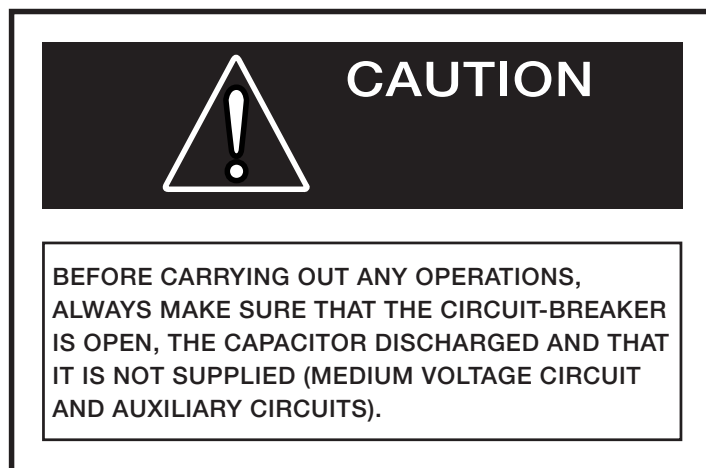
Note

For maintenance work, respect the following Standards:

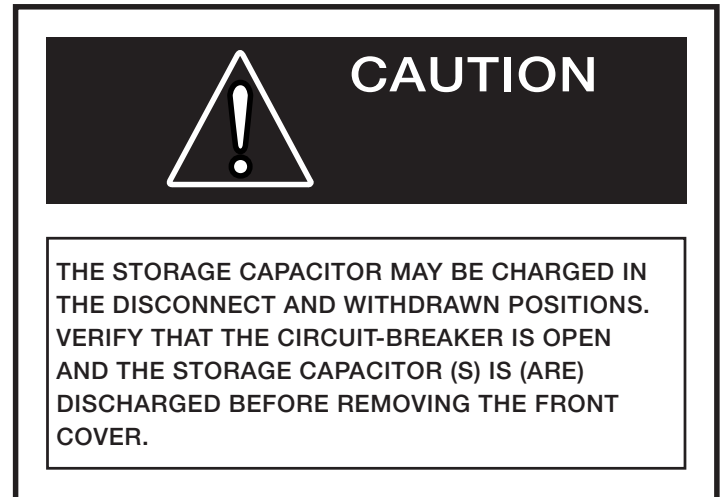
- the relative specifications indicated in the “Standards and Specifications” chapter;
- regulations for safety in the workplace indicated in the “Putting into service and operations” chapter;
- regulations and specifications of the country where the apparatus is installed.

The maintenance operations can only be carried out by trained personnel who respect all the safety regulations. Furthermore, it 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.



8.2. Maintenance on VM1/A/P circuit-breakers



VM1/A/P circuit-breakers are designed for a minimum amount of maintenance. Circuit-breakers in a clean, non-corrosive environment require only annual inspection. Dusty or corrosive environments require inspection more often at the discretion of the user. Following each interrupted fault inspection is required.

DO NOT work on an energized circuit-breaker.

DO NOT work on a circuit-breaker unless all of the components are disconnected by means of a visible break and securely grounded.

DO NOT work on a circuit-breaker with power supplied to the secondary control circuit.

DO NOT defeat safety interlocks. This may result in bodily injury, death and/or equipment damage.

DO NOT work on a closed circuit-breaker.

DO NOT work on a circuit-breaker with charged energy. capacitors.

DO NOT use a circuit-breaker by itself as the sole means of isolating a high voltage circuit.

DO NOT leave a circuit-breaker in an intermediate position in a cell. Always have the circuit-breaker in the Disconnect, Test, or Connect position.

8.3. Operating life

All vacuum circuit-breakers are characterised by simple, sturdy construction and long useful life. Frequent operation of the service and shortcircuit 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
 - up to 50,000 operating cycles for all the circuit-breakers with breaking capacity 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 1000 handling operations can be carried out in the case of normal activation and with regular inspections.

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.

8.4. Procedure for discharging the capacitor/s

Before accessing the circuits in the control box, it is compulsory to make sure that the capacitor is discharged. Even without auxiliary power supply, more than about ten minutes are needed to completely discharge 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 10 minutes have passed, the capacitor voltage drops to a value of less than 15 V.

It is available on request the Rapid Discharging Device that allows the waiting time to be reduced to just one minute and guarantees safe access to the circuits which might be live.

8.5. Mechanism and transmission system

The mechanism requires visual inspection of hardware, lubrication and operation during routine inspection.

Remove the front cover by unfastening its screws and correct any loose or missing hardware.

Always lubricate the working surface of the moving parts. Verify lubrication on the connections of the actuator and lever arm. Remove any grease on the circuit-breaker frame. Use only ISOFLEX TOPas NB52 (ABB GCE007249P0100/PL CRM). If the grease becomes caked and dirty, remove with a clean cloth and reapply lubrication.

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.

**DANGER**



**HIGH SPEED MECHANICAL PARTS.
SERIOUS INJURY MAY OCCUR.**
**KEEP HANDS AND TOOLS
CLEAR OF THE MECHANISM
DURING OPENING AND CLOSING
OPERATIONS AND ANYTIME
THE CAPACITORS OR OPENING
SPRINGS ARE CHARGED. BEFORE
MAINTENANCE VERIFY "READY"
LAMP IS OFF. OPENING SPRINGS
ARE ALWAYS CHARGED WHEN THE
CIRCUIT-BREAKER IS CLOSED.**

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
- isolate the working area and make it safe in conformity with the safety rules and according to the regulations in force (fixed circuitbreakers)
- 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-CO 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.

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.

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. "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.

8.6. Inspections and functional tests interruption device 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").

8.7.Servicing

Interruption device in general

If cleaning is found to be necessary during the inspections, as specified in par. "Operations before putting into service", 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!

8.8. 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.

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. "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 Homburg v.d.H.

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

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 Homburg 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
15 kV	36 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.

8.9. 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.



CAUTION

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" MUST ONLY BE CARRIED OUT BY ABB PERSONNEL. IN PARTICULAR:

- COMPLETE POLE WITH BUSHINGS/CONNECTIONS
- ACTUATOR
- TRANSMISSION SYSTEM.

8.10. Control wiring

During routine maintenance for control wiring, a visual inspection of the hardware should be performed and a low-frequency withstand voltage testing performed, and 2-5 manual operations should be conducted. Disconnect control power before verifying secondary hardware and before low-frequency withstand voltage testing.

Remove the front cover with a screwdriver. Correct any loose or missing mounting hardware. Verify the ground wire connection to the frame and all connectors' alignment and snugness on the electrical components. Visually inspect the secondary plug and correct any pins that may have become displaced.

To verify the integrity of the secondary insulation, perform the following low-frequency withstand voltage test:

1. Disconnect control power.
2. Connect all pins from the secondary to a test wire.
3. Connect test wire to the high potential lead of the test machine.
4. Ground the circuit-breaker frame.
5. Start machine with output potential at 0 (zero) VAC RMS.
6. Increase the potential to the required insulation test voltage (1125VAC RMS).
7. Hold for one minute.
8. Reduce potential to 0 (zero) VAC and turn off machine.

A successful withstand testing indicates satisfactory insulation strength of the secondary circuit. Failing insulation will not sustain the voltage across the secondary. Replace the circuit-breaker control wiring if the insulation fails during low-frequency withstand voltage testing.

Replace the front cover before operation. Verify the operation with 2-5 electrical operations in the Test position or with a remote power supply.

8.11. Primary circuit assembly: (Pole)

During routine maintenance for the primary circuit, a visual inspection of the hardware and a low-frequency withstand voltage testing, and lubrication of the primary contacts should occur as outlined hereinafter.

All insulation material should be clean and free of structural cracks. Inspect for structural cracks and replace damaged parts.

Dirt or dust may create a dielectric path to ground on the insulation. Remove dust and dirt with a clean, lint-free cloth. Apply distilled water to the cloth to remove any difficult dirt. DO NOT return the circuit-breaker into service until the insulation surfaces are completely dry.

Lubrication on the primary contacts should be inspected during routine maintenance. Use only grease ISOFLEX TOPAS NB52 (ABB GCE0007249P01001PLCRN).



CAUTION



APPLYING ABNORMALLY HIGH VOLTAGE ACROSS A PAIR OF OPEN CONTACTS IN A VACUUM MAY PRODUCE X-RADIATION.

THE RADIATION MAY INCREASE WITH THE INCREASE IN VOLTAGE AND/OR DECREASE IN CONTACT SPACING. IT IS RECOMMENDED THAT ALL OPERATING PERSONNEL STAND AT LEAST ONE METER AWAY AND IN FROM OF THE CIRCUIT-BREAKER DURING TESTING.

We should use stronger language than recommend ("Workers must stand back at least 1.5 meters")

To verify the integrity of the primary insulation, perform the following low-frequency withstand voltage test:

1. Close the circuit-breaker (no control power supplied)
 - Connect the high potential lead to one pole.
 - Ground the remaining poles and the circuit-breaker frame.
2. Start machine with output potential at 0 (zero) VAC.
3. Increase the potential to the required voltage (see Table 3; note that new condition test is a factory test only and is not valid for field condition tests.)
4. Hold for one minute.
5. Decrease potential to 0 (zero) VAC and turn off machine.
6. Repeat for the remaining poles.

A successful withstand indicates satisfactory insulation strength of the primary circuit.

Rated max voltage	Dielectric Test Value, 1 Minute Dry AC rms New condition reference c37.06	Dielectric Test Value, 1 Minute Dry AC rms Field condition reference c37.20.2
15 kV	36 kV	27 kV

Table 3: Primary low-frequency withstand test voltage

8.12. Vacuum interrupters

To verify the integrity of the vacuum interrupters perform the following low-frequency withstand voltage test:

1. Open the circuit-breaker (no control power supplied to the circuit-breaker).
 - a. Connect the high potential lead to one terminal.
 - b. Ground the remaining 5 terminals and circuit-breaker frame.
2. Start machine with output potential at 0 (zero) VAC.
3. Increase the potential to the required voltage (see Table 3).
4. Hold for one minute.
5. Decrease potential to 0 (zero) and turn off machine.
6. Repeat for the remaining 5 terminals.

A successful withstand indicates satisfactory vacuum integrity. Replace interrupters that fail to sustain the voltage across the open contacts. Testing **MUST** be done with an AC source only. DC testing is not considered a valid test for vacuum integrity. If DC is the only available option, the peak DC voltage should not exceed the corresponding AC RMS test voltage. Additionally, a failure during DC testing should only be considered preliminary. Additional AC testing should be completed before replacement of the pole is considered to be warranted. Testing with meggers or other similar devices is not considered valid under any circumstances.

**DANGER**



THE INTERNAL SHIELD OF A VACUUM INTERRUPTER CAN AN ELECTRIC CHARGE WHICH CAN BE RETAINED EVEN AFTER THE VOLTAGE IS REMOVED. DISCHARGE THE MID-BAND RING WITH A GROUNDING STICK BEFORE WORKING ON ANY PART OF THE CIRCUIT-BREAKER.

9. Spare parts and accessories

**WARNING**

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.

9.1. 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.

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.

10. Product quality and environmental protection

The apparatus are produced in compliance with the requirements of international standards for the quality management system and environmental management system. In these fields, the excellent level is proved by quality certificates according to ISO 9001 and by the EMS according to ISO 14 001.

End of life of product

The ABB company is committed to complying with the relevant legal and other requirements for environment protection according to the ISO 14 001 standard.

The duty of company is to facilitate subsequent recycling or disposal at the end of product life. During disposal of the product, it is always necessary to act in accordance with local legal requirements in force.

Methods of disposal

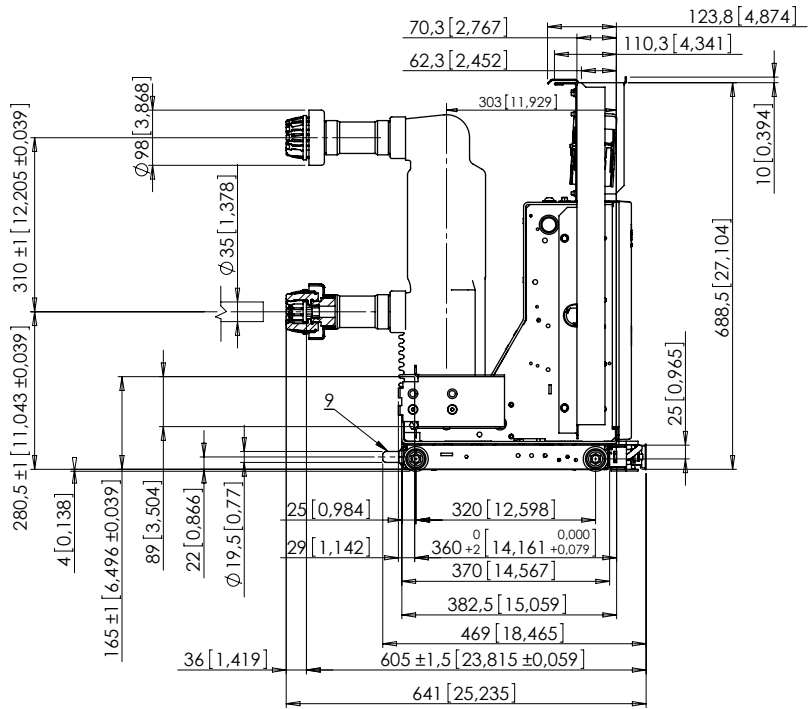
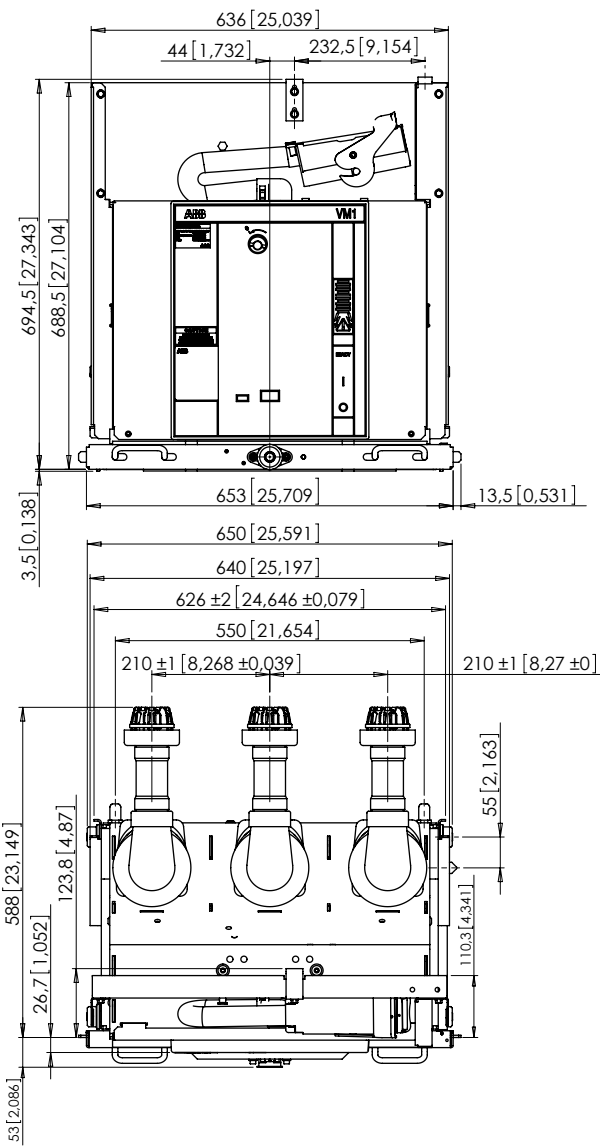
Disposal can either be carried out thermally in an incineration plant or by storing on a waste site.

RAW MATERIAL	RECOMMENDED METHOD OF DISPOSAL
Metal material (Fe, Cu, Al, Ag, Zn, W, others)	Separation and recycling
Thermoplasts	Recycling or disposal
Epoxy resin	Separation of metal material and the disposal of rest
Rubber	Disposal
Oil as dielectric (transformer oil)	Draining from equipment and further recycling or disposal
Packing material	Recycling or disposal
Packing material	Recycling or disposal

12 kV - 1200 A - 25-31.5 kA

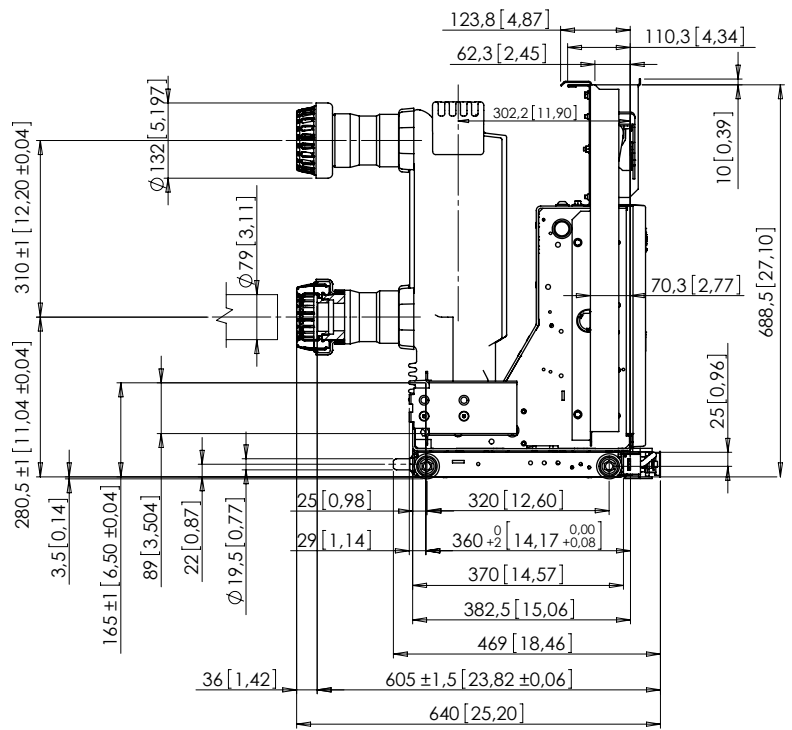
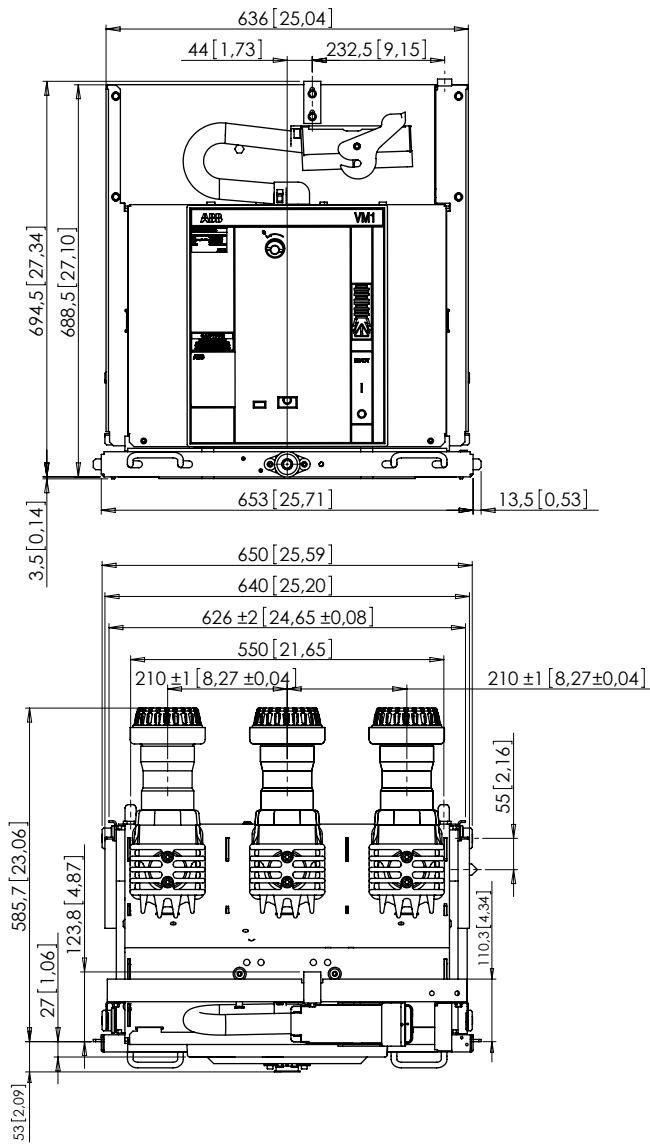


VM1/A/P - 1VDC003658
 15 kV - 1200 A - 25-31.5 kA



VM1/A/P - 1VDC003659

15 kV - 2000 A - 25-31.5 kA



12. Electric circuit diagram

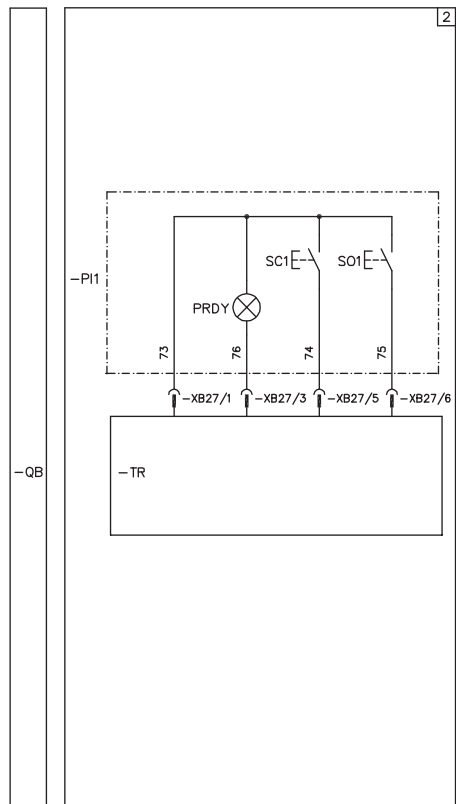
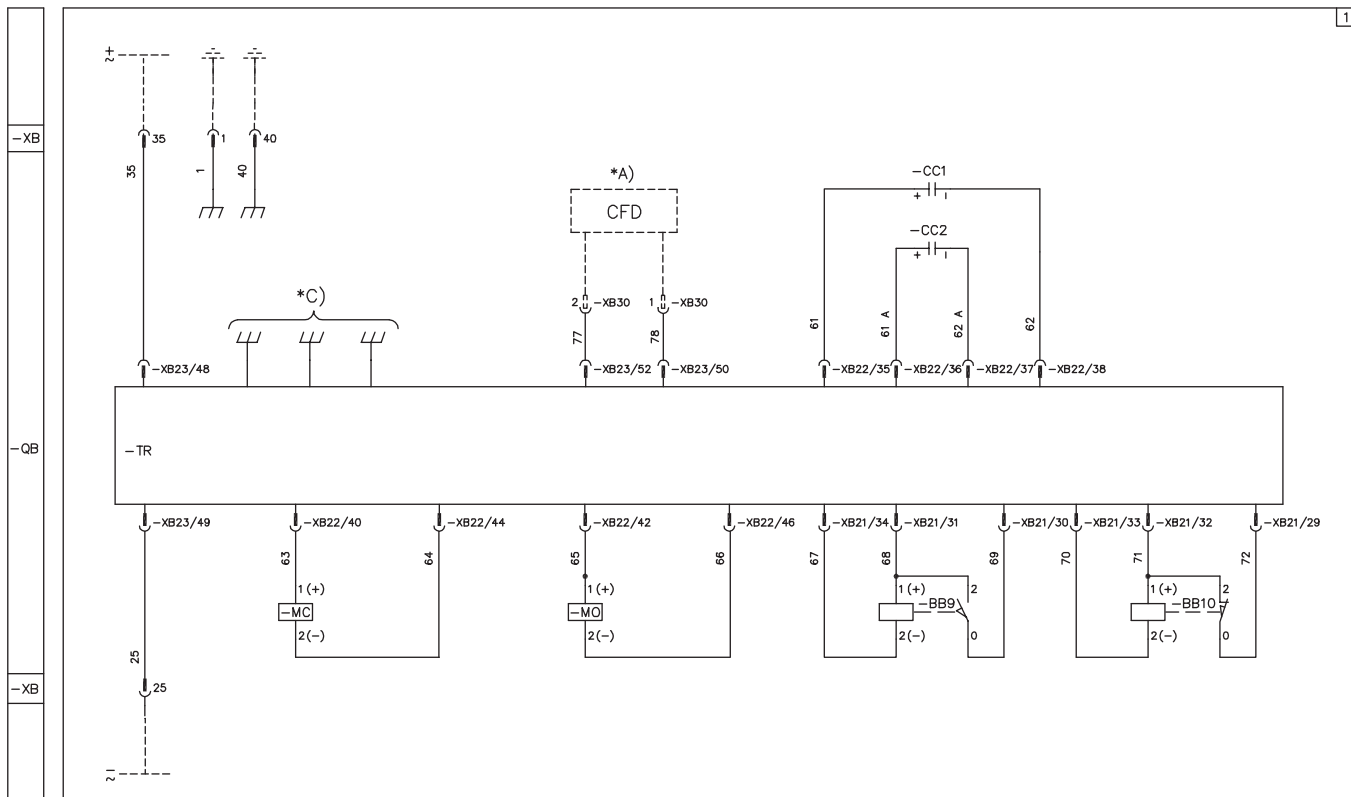
Circuit-diagram of VM1/P-W-Z-ZH circuit-breaker in withdrawable version with magnetic actuator.
For other circuit-breakers, please consult us.

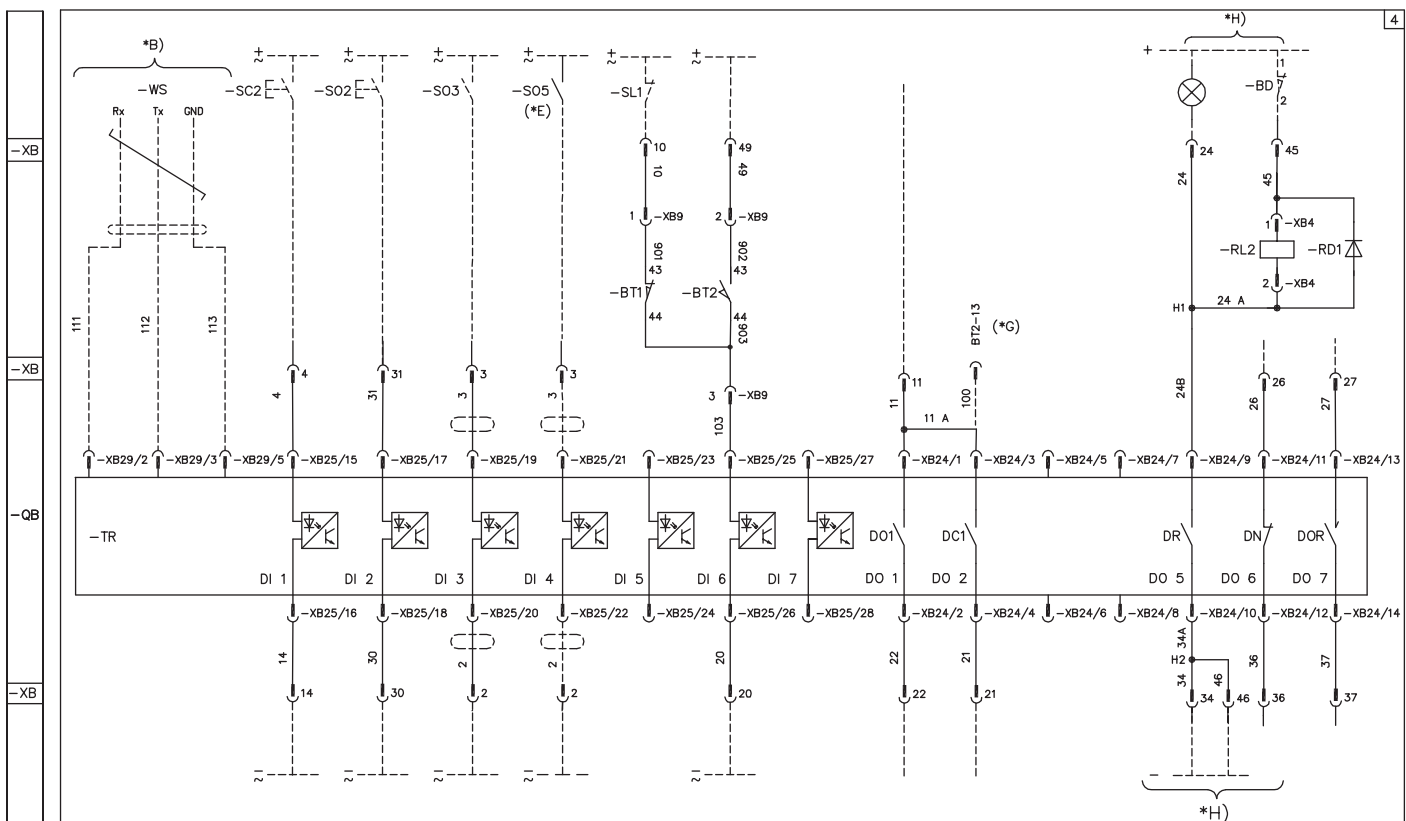
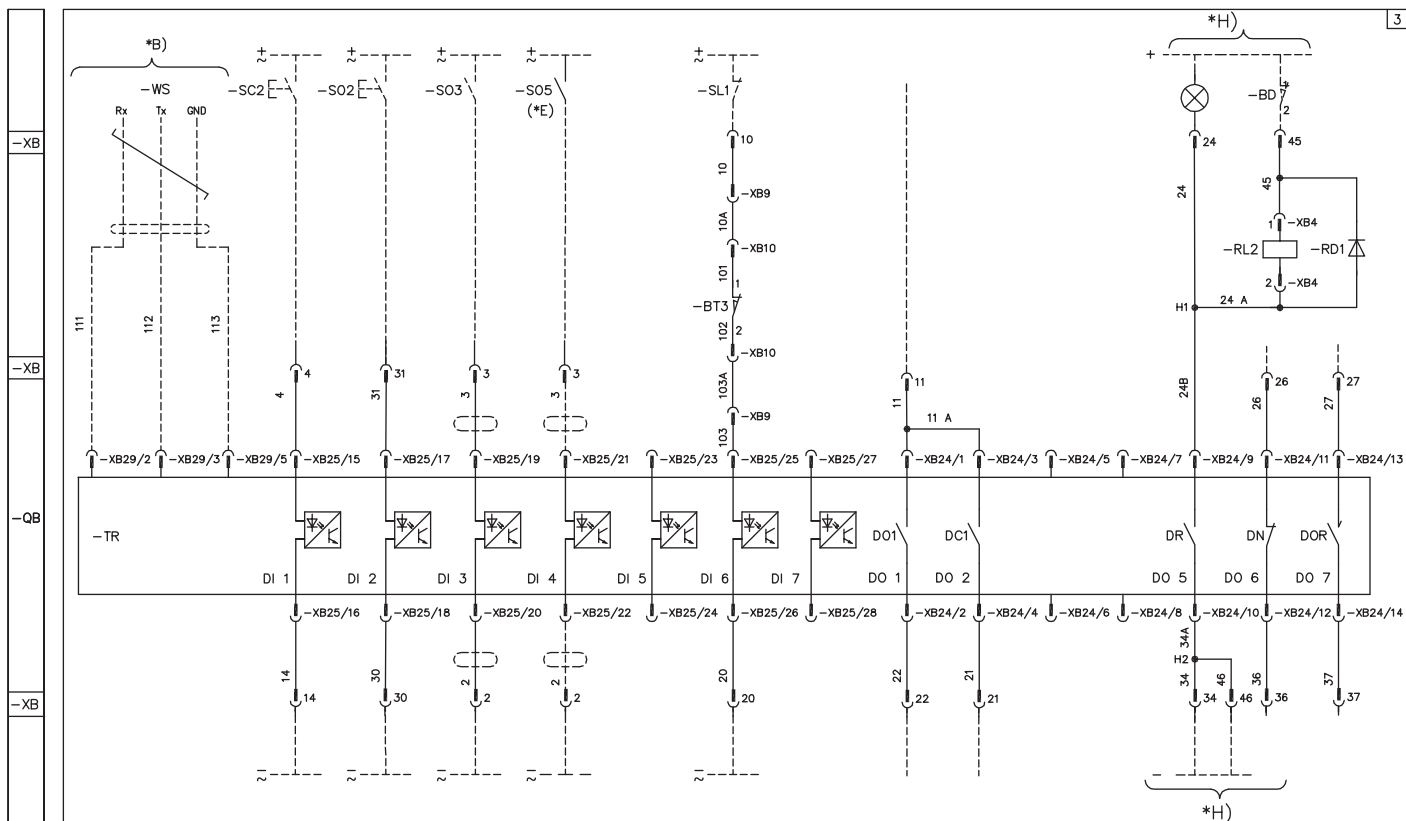
The diagram indicates the following conditions:

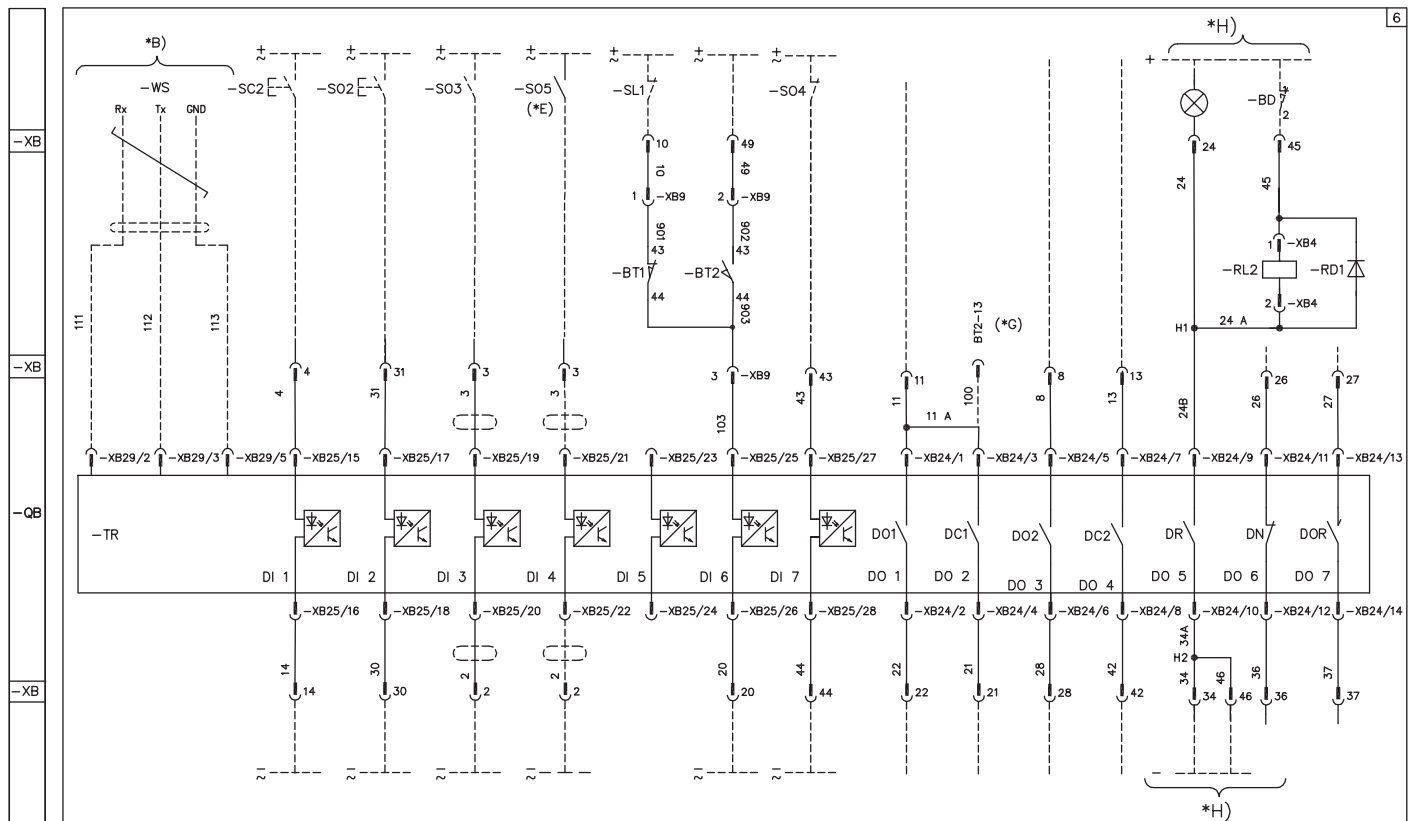
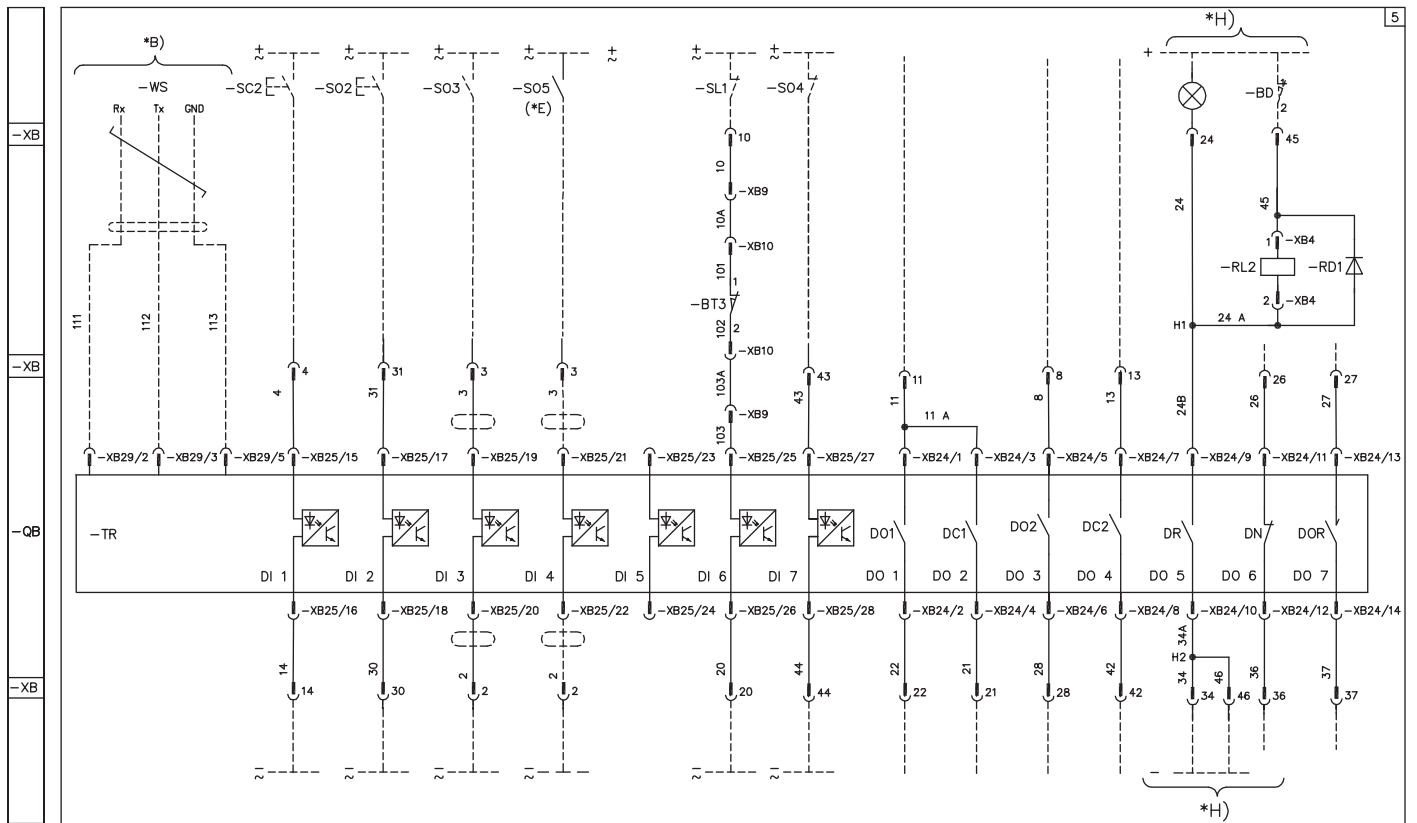
- circuit-breaker off and connected
- circuits de-energized

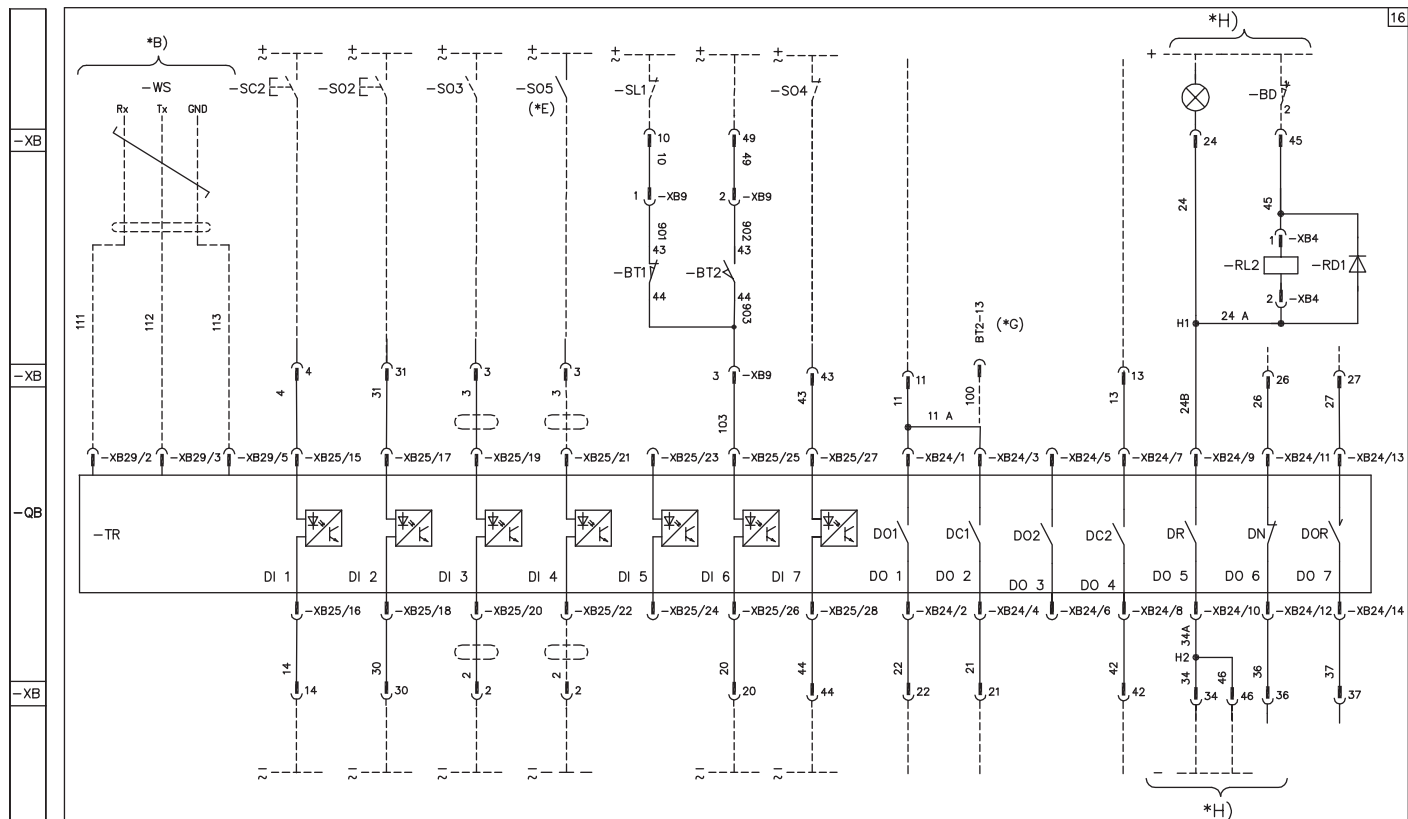
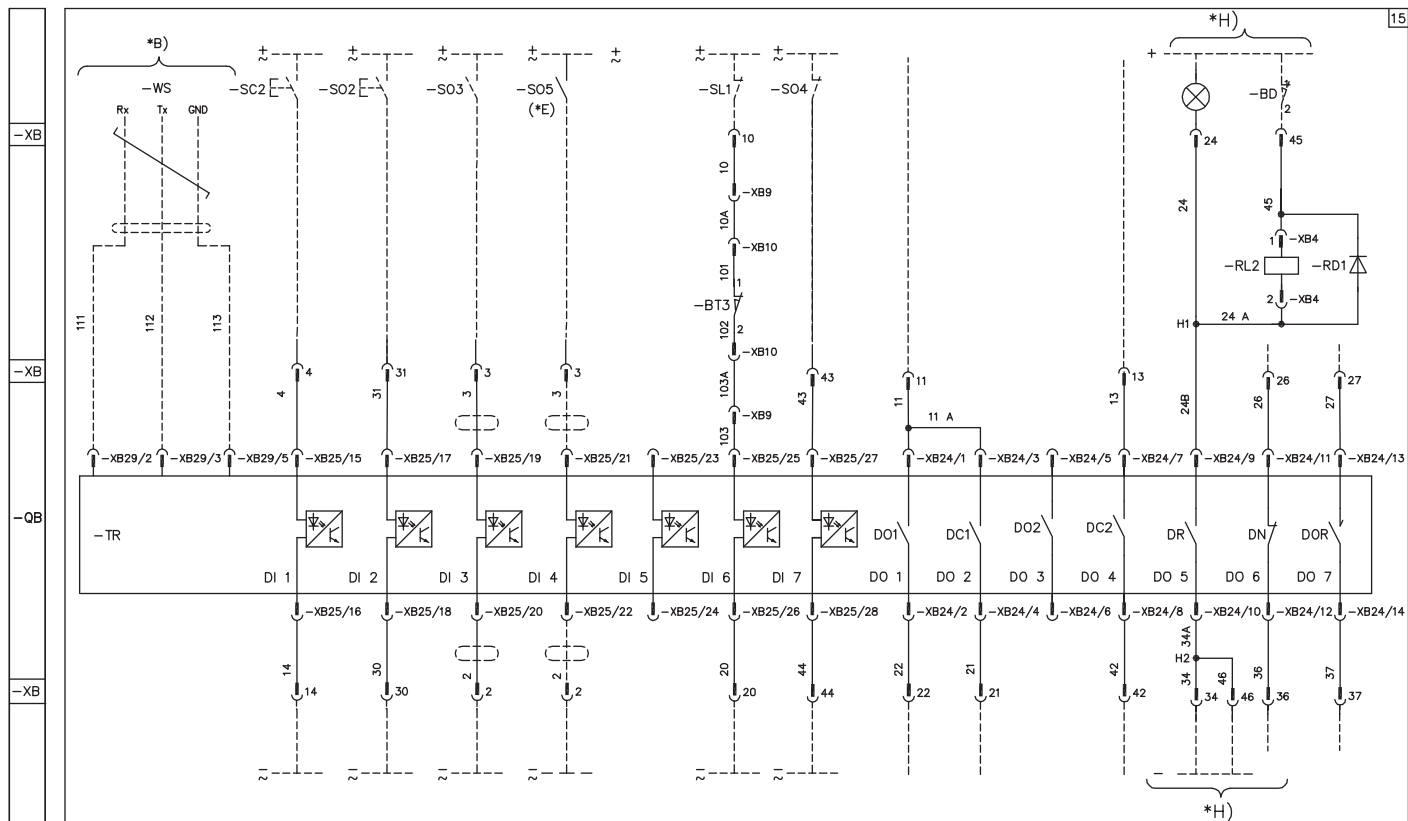
Graphical symbols for electrical diagrams (617 IEC Standards)

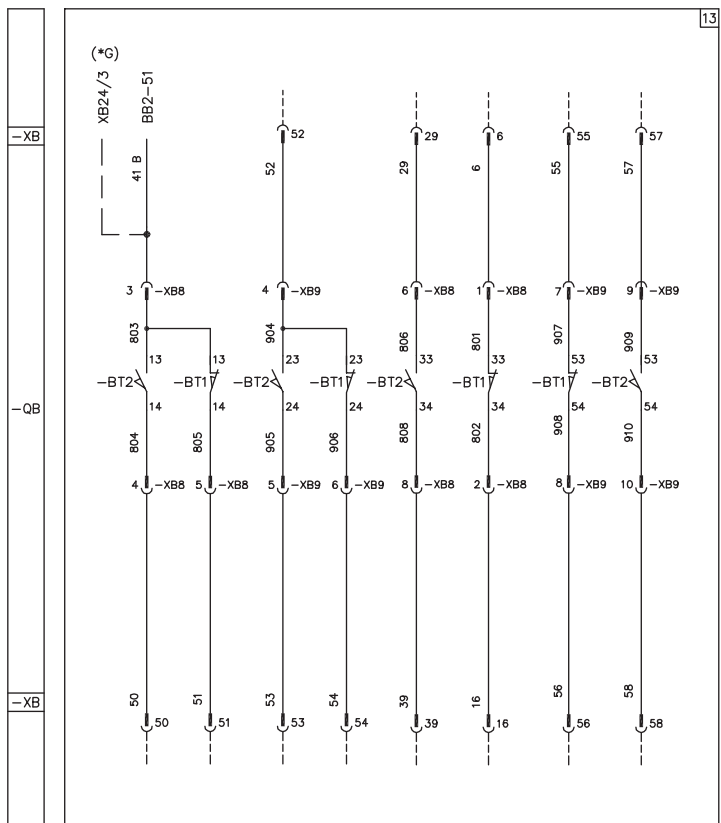
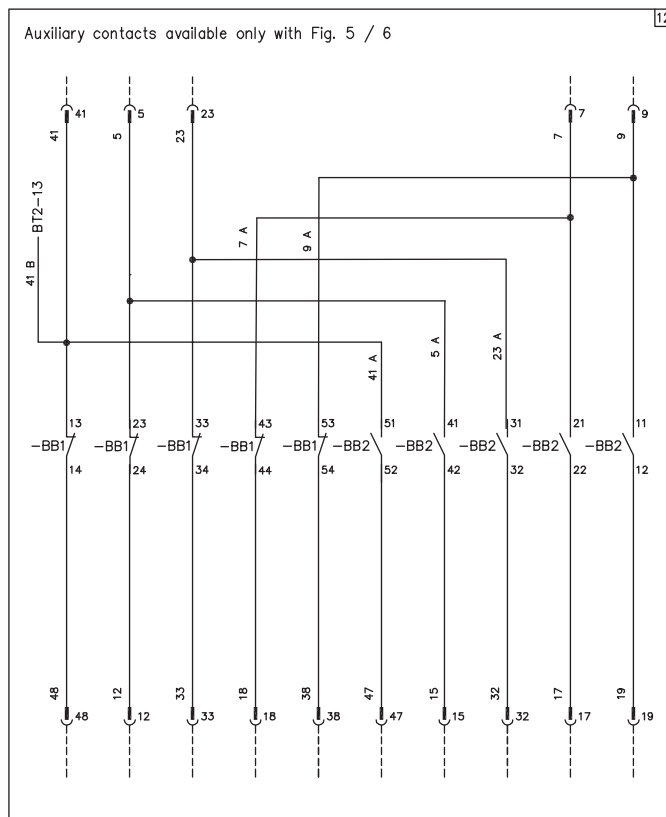
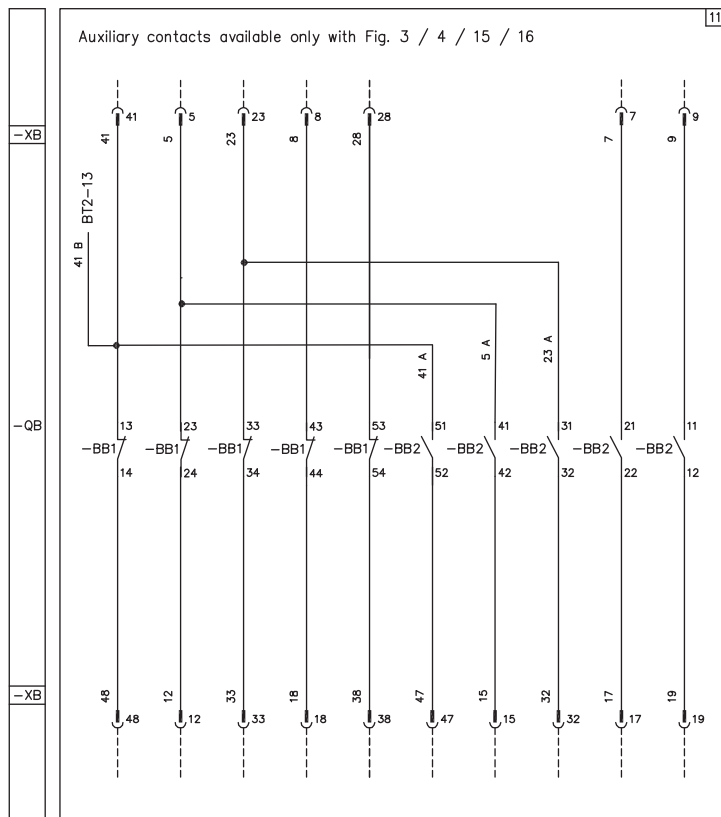
	Thermal effect		Conductors in screened cable (two conductors shown)		Rectifier in full wave connection (bridge)		Circuit-breaker with automatic release
	Electromagnetic effect		Connection of conductors		Make contact		Operating device (general symbol)
	Delay		Terminal or clamp		Break contact		Lamp (general symbol)
	Pushbutton control		Socket and plug (female and male)		Change-over break before make contact		Twisted conductors, two conductors shown
	Key control		Resistor (general symbol)		Passing make contact closing momentarily when its operating device is released		Delayed action (in the direction of movement from the arc towards its centre)
	Earth (general symbol)		Capacitor (general symbol)		Position switch (limit switch) make contact		Insulated binary digital input
	Frame		Motor (general symbol)		Position switch (limit switch) brake contact		Semiconductor diode (general symbol)

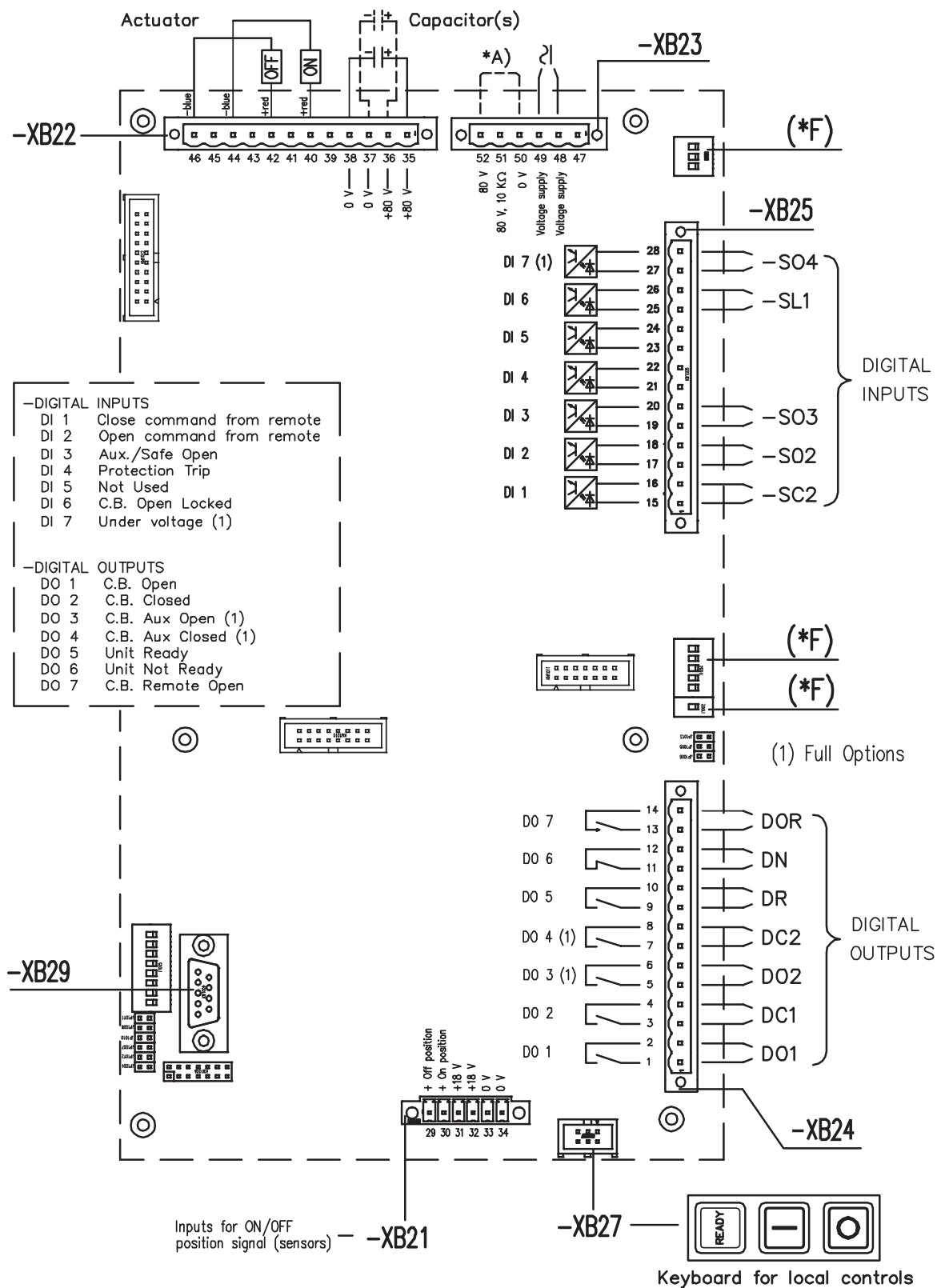












Caption

□	= Reference number of diagram figure	-SC 1	= Pushbutton for the circuit-breaker local closing
*	= See note indicated by the letter	-SO1	= Pushbutton for the circuit-breaker local opening
-QB	= Circuit breaker accessories	-RD1	= Diode
-TR	= Control and switching unit	-RL2	= Truck locking magnet
DR	= Signalling contact for unit ready (correct position and capacitor level)	-SC2	= Pushbutton or contact for the circuit-breaker remote closing
DN	= Signalling contact for unit not ready	-SL1	= Contact locking the circuit-breaker closing (closing command allowed with close contact)
DC1-2	= Signalling contact for circuit breaker closed	-SO2	= Pushbutton or contact for the circuit-breaker remote opening
DO1-2	= Signalling contact for circuit breaker open	-SO3	= Auxiliary and safety opening
DOR	= Signalling contact for remote opening command (100 ms close)	-SO4	= Pushbutton or contact for the circuit-breaker under voltage opening (contact closed when voltage is present)
-BB1-2	= Circuit breaker auxiliary contacts	-SO5	= Contact for the circuit-breaker opening by PR 512 only
-BB9	= Position contact for signalling circuit-breaker closed (limits switch with auxiliary supply)	-WS	= Serial bus interface for service operations only (RS2 32 interface)
-BB10	= Position contact signalling circuit-breaker open (limit switch with auxiliary supply)	-XB	= Plug connector for the circuit-breaker circuits
-BD	= Position contact of the enclosure door	-XB8	= Rack- in / Rack-out contacts connector
-BT1	= Contacts signalling circuit-breaker in the connected position	-XB9	= Rack- in / Rack-out contacts connector
-BT2	= Contacts signalling circuit-breaker in the removed position	-XB10	= Circuit-breaker position contact connector
-BT3	= Circuit-breaker position contact. It is open during the travel of the breaker.	-XB15	= Internal check connector
-CC1-CC2	= Capacitors	-XB21	= Connectors for position sensors – BS3 and –BS4
CFD	= Capacitor Fast Discharge (see note A)	-XB22	= Connectors for actuator and capacitor(s)
-MC	= Closing coil	-XB23	= Connectors for power supply
-MO	= Opening coil	-XB24	= Connectors for output contacts
-PI1	= Humane machine interface with open/close push buttons and ready signalling	-XB25	= Connectors for binary inputs
-PRDY	= Green led lamp for local indication of control and switching unit ready (correct position and capacitor level)	-XB27	= Connectors for local control panel
		-XB29	= Connector for serial bus interface
		-XB30	= Connector for CFD (Capacitor Fast Discharge)

Diagram figures description

- Fig. 1 = Basic circuits of circuit-breaker and magnetic actuator MABS
- Fig. 2 = Key board for local controls
- Fig. 3 = Inputs/Outputs for circuit-breaker with standard ED 2
- Fig. 4 = Inputs/Outputs for circuit-breaker with standard ED2 when truck auxiliary contacts are required
- Fig. 5 = Inputs/Outputs for circuit-breaker with full- options ED2 with or without auxiliary contacts (-BB1, -BB2)
- Fig. 6 = Inputs/Outputs for circuit-breaker with full- options ED2 with or without auxiliary contacts (-BB1, -BB2) when truck auxiliary contacts are required
- Fig. 11 = Circuit-breaker available auxiliary contacts with standard or full options ED2
- Fig. 12 = Circuit-breaker available auxiliary contacts with full-options ED2
- Fig. 13 = Circuit-breaker available auxiliary contacts on the truck
- Fig. 15 = Inputs/Outputs for circuit-breaker with full- options ED2 with auxiliary contacts (-BB1, -BB2) (CalorEmag type)
- Fig. 16 = Inputs/Outputs for circuit-breaker with full-options ED2 with auxiliary contacts (-BB1, -BB2) and truck auxiliary contacts (CalorEmag type)

Notes

- A) Connector for CFD (Capacitor Fast Discharge). WARNING: see instruction manual Short circuit XB23/50 with XB23/52 with a Resistor 10 Ohm /50 Watt in series to have a fast capacitors discharge
- B) Serial bus interface for service operations only (RS2 32 interface)
- C) Fix the ground copper strips under the relevants shock absorber on the unpainted zone.
- D) The circuit-breaker is delivered complete with the accessories listed in the ABB SACE PTMV order acknowledgement only. To draw up the order examine the apparatus catalogue.
- E) –SO5 contact for PR512 exclude –SO3 contact
- F) Setting DIP switches: see VM 1 Instruction manual
- G) Connect if BB1 and BB2 not installed
- H) Attention: wire taking into account supply voltage and Locking Magnet polarity

Incompatibility

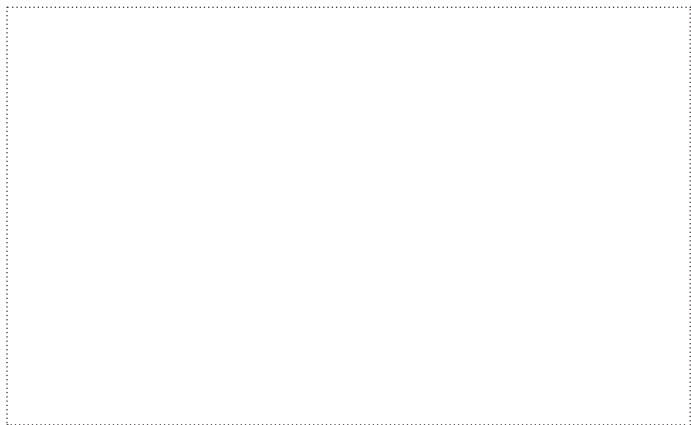
The combinations of circuits given in the figures below are not possible on the same circuit-breaker:

Fig. 3-4-5 -6-1 5-16

Handwriting practice lines consisting of 25 horizontal dotted lines.

Handwriting practice lines consisting of 20 horizontal dotted lines.

For more information please contact:



Your sales contact: www.abb.com/contacts

More product information: www.abb.com/productguide

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