VD4 Vacuum Circuit-breaker

With Embeded Poles

36...40.5 kV, 1250...2500A, 25...31.5kA

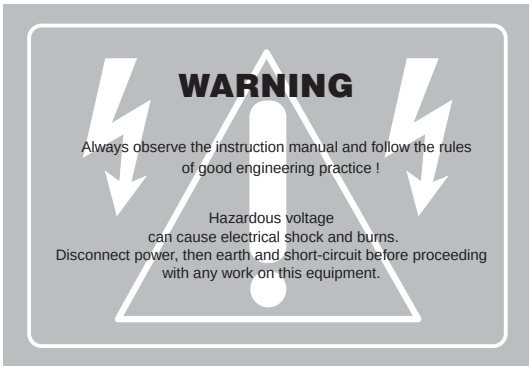
Instruction Manual

Your safety first — **always!**

That's why our instruction manual begins with these recommendations:

- Only install switchgear and/or switchboards in enclosed rooms suitable for electrical equipment.
- Ensure that installation, operation and maintenance are carried out by specialist electricians only.
- Comply in full with the legally recognized standards, the connection conditions of the local electrical utility and the applicable safety at work regulations.
- Observe the relevant information in the instruction manual for all actions involving switchgear and switchboards.
- ⚠ Danger!

  Pay special attention to the hazard notes in the instruction manual marked with this warning symbol.
- Make sure that under operation condition of the switchgear or switchboard the specified data are not exceeded.
- Keep the instruction manual accessible to all persons concerned with installation, operation and maintenance.
- The user's personnel are to act responsibly in all matters affecting safety at work and the correct handling of the switchgear.



If you have any further questions on this instruction manual, the members of our field organization will be pleased to provide the required information.

1 Summary

1.1 General

The vacuum circuit-breakers of type VD4 on withdrawable parts for 36 kV or 40.5 kV rated voltage are intended for indoor installation in air-insulated switchgear systems. Their switching capacity is sufficient to handle any conditions arising from switching of equipment and system components under normal operating and fault conditions, particularly short-circuits, within the parameters of their technical data.

Vacuum circuit-breakers have particular advantages for switching frequency in the working current range and/or where a certain number of short-circuit breaking operations are expected. Type VD4 vacuum circuit-breakers are suitable for auto-reclosing, and have exceptionally high operating reliability and long life.

The vacuum circuit-breakers designed in column form, are supplied as withdrawable modules. Their basic structure is shown in figures 3/1,3/2,3/7 and 3/8.

1.2 Standards and specifications

1.2.1 Switchgear manufacture

The switchgear complies with the following specifications in accordance with GB, IEC and the relevant DIN VDE publications respectively.

- GB/T 11022, IEC 60694 and DIN VDE 0670 part 100, "Common specifications for high-voltage switchgear and controlgear standards".
- GB 1984 and IEC 62271-100, "High-voltage alternating-current circuit-breakers".

1.2.2 Installation and operation

The relevant specifications are to be taken into account during installation and operation, particularly:

- IEC 61936, Electrical devices with rated voltage above AC 1 kV
- DIN VDE 0101, Power installations exceeding AC 1 kV
- DIN VDE 0105, operation of electrical installations
- DIN VDE 0141, earthing systems for special power installations with rated voltages over 1 kV
- Accident prevention regulations issued by the appropriate professional bodies or comparable organisations.

  In Germany, these comprise the following safety regulations:

  - Health and Safety at Work Standard VBG 1
  - Health and Safety at Work Standard VBG 4
- Safety guidelines for auxiliary and operating materials
- Order related details provided by ABB Xiamen Switchgear Co.,Ltd.

1.3 Operating conditions

1.3.1 Normal operating conditions

Design to GB/T 11022, "Common specification for high-voltage switchgear and controlgear standards", IEC publication 60694, VDE 0670 part 100, with the following limit values:

- Ambient temperature:
  - Maximum +40˚C
  - Highest mean value measured in 24 hours +35˚C
  - Minimum (according to "minus 5 indoor class") -15˚C
- Humidity
  - Highest mean value of relative humidity measured over 24 hours 95%
  - Highest mean value of vapour pressure measured over 24 hours 2.2kPa
  - Highest mean value of relative humidity measured over 1 month 90%
  - Highest mean value of vapour pressure measured over 1 month 1.8kPa
- Maximum site altitude:
  1000m above sea level

1.3.2 Special operating conditions

Special operating conditions are to be agreed on by the manufacturer and user. The manufacturer must be consulted in advance about each special operating condition:

- Site altitude over 1000 m:
  - Allow for the reduction in the dielectric strength of the air.
- Increased ambient temperature:
  - Current carrying capacity is reduced.
  - Provide additional ventilation for heat dissipation.
- Climate:
  - Avoid the risk of corrosion or other damage in areas:
    - with high humidity and/or
    - with major rapid temperature fluctuations.
  - Implement preventive measures (e.g. electric heaters) to preclude condensation phenomena.

2 Technical data

2.1 Technical data
circuit-breakers for fixed installation and on withdrawable part

Rated voltage	**kV**	**36**	**40.5**
Rated frequency	Hz	50/60	50/60
Rated lightning impulse withstand voltage	kV	170	185
Rated power frequency withstand voltage(1min)	kV	70	95
Rate of rise of transient recovery voltage	kV/μs	0.57	0.69
Peak of transient recovery voltage	kV	62	70
Rated operating sequence		O-3min-CO-3min-CO	
Rated operating sequence with autoreclosing		O-0.3s-CO-3min-CO	

Breaker-type	Rated voltage	Rated current	Rated short-circuit breaking current, symm.[1]	Rated short-circuit breaking current, asymmetr.[1]	Rated short-circuit mreaking current, (peak.)[1]	Rated short-circuit duration	Pole Centres Fixed	Pole Centres With-draw-able	Weight Fixed	Weight With-draw-able
VD4...	kV	A	kA	kA	kA	s	mm		approx. kg	
3612-25	36	1250	25	27.3	63	4	360	280	320	290
3616-25	36	1600							320	290
3620-25	36	2000							355	340
3625-25	36	2500							355	340
3612-31	36	1250	31.5	34.3	80	4	360	280	320	290
3616-31	36	1600							320	290
3620-31	36	2000							355	340
3625-31	36	2500							355	340
4012-25	40.5	1250	25	27.3	63	4	360	280	290	290
4016-25	40.5	1600							290	290
4020-25	40.5	2000							340	340
4025-25	40.5	2500							340	340
4012-31	40.5	1250	31.5	34.3	80	4	360	280	290	290
4016-31	40.5	1600							290	290
4020-31	40.5	2000							340	340
4025-31	40.5	2500							340	340

Guideline values for function times at the rated supply voltage:

Closing time	approx.	55~67 ms
Opening time	approx.	33~45 ms
Arcing time (at 50 Hz)	≤	15 ms
Total break time	≤	60 ms
Minimum command time on closing		20 ms (120 ms[2])
Minimum command time on opening		20 ms (80 ms[2])

[1] When the operating voltage is lower than the rated voltage, the same values apply as for rated voltage. Higher values on request.

[2] If the activating relay contact cannot itself interrupt the release coil current

2.2 Technical data
Releases and blocking magnet

Equipment		Power consumption[1] AC VA	DC W
Shunt release OFF	Y2[3], Y9[3]	250	250
	Y2[4], Y9[4]	310	310
Shunt release ON	Y3[3]	250	250
	Y3[4]	310	310
Blocking magnet	Y1[3] [4]	10	10
Undervoltage release	Y4		
undelayed		11	10
delayed		10	-
Indirect overcurrent release with intermediate current transformer	Y7		
two-phase		3.5[2] /15	-
three-phase		2.0[2] /15	-

[1] Approximate values
[2] With short-circuited intermediate current transformer
[3] Auxiliary voltages AC: 110 and 220 V, DC: 24, 48, 60, 110 and 220 V.
[4] Auxiliary voltage AC: 240 V, DC: 125 and 240 V.

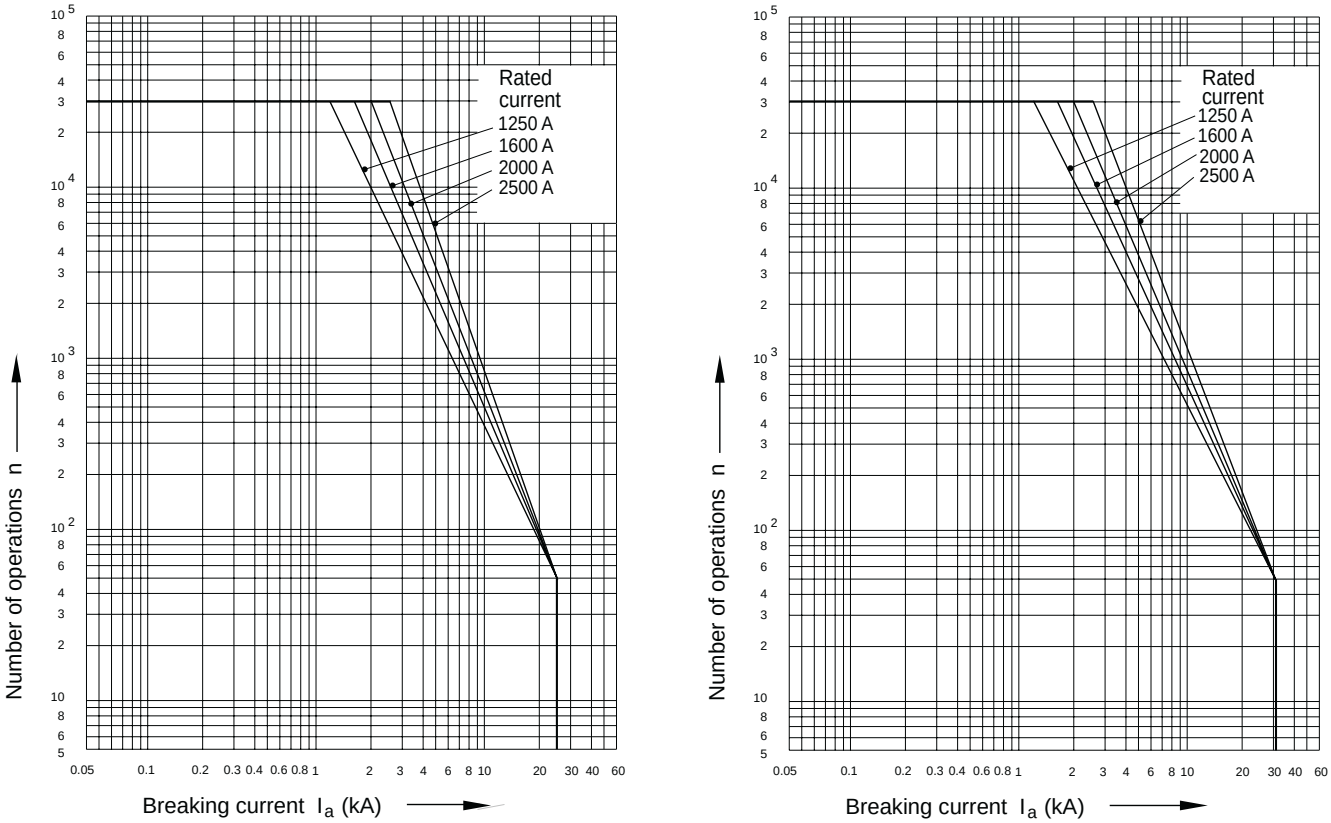
2.3 Technical data
Motor-operated mechanisms

Auxiliary voltage V	Power consumption [1] VA/W	Charging time (maximum)[2] s
AC		
110	150	15
220	150	15
240	170	15
DC		
24	130	15
30	130	15
48	130	15
60	130	15
110	140	15
125	160	15
220	140	15
240	150	15

[1] Approximate values
[2] At the rated auxiliary voltage

2.4 Permissible number of vacuum interrupter switching operations in relation to breaking current

See figure 2/1.



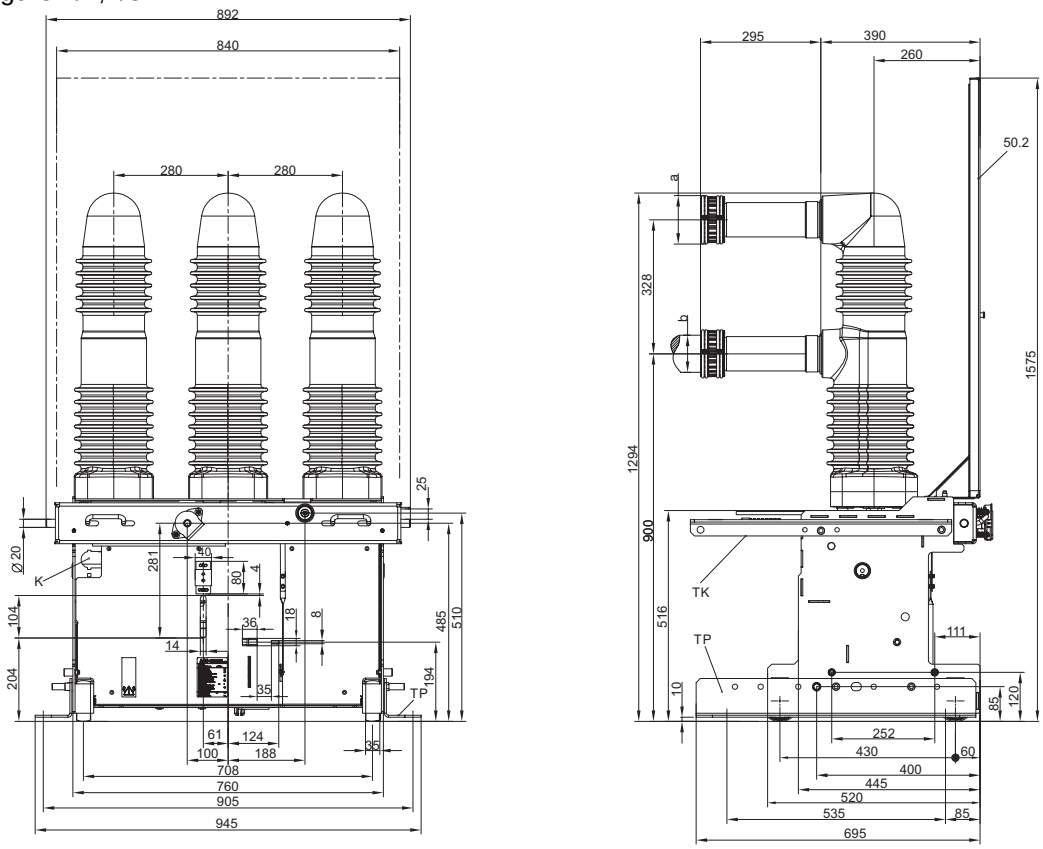
a) Circuit-breaker type VD4, 36 kV and 40.5 kV
Rated short-circuit breaking current 25 kA

b) Circuit-breaker type VD4, 36 kV and 40.5 kV
Rated short-circuit breaking current 31.5 kA

Figure 2/1: Permissible number of vacuum interrupter operating cycles n as a function of the breaking current I_a

2.5 Dimensions

See figure 2/2,2/3.



TK = Transport bracket 147

TP = Transport profile 148

K = Entrance for control cables

50.2 = Front partition plate

Note:

Transport bracket TK (147) and transport profile TP (148) only fitted for handling.

Remove and store prior to commissioning.

Rated current	a	b
1250/1600A	Ø74	Ø35
2000/2500A	Ø113	Ø79

Fig. 2/2 Dimension of withdrable VD4 40.5kV

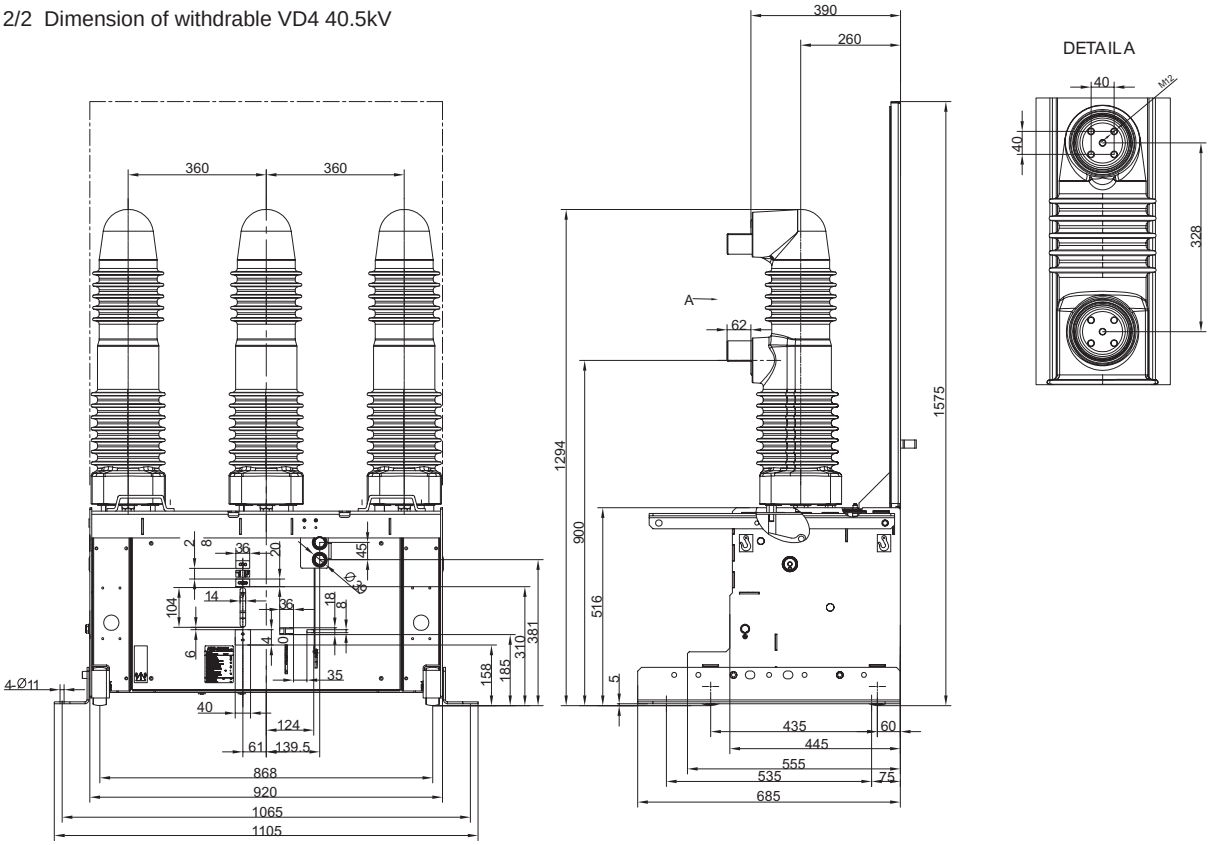
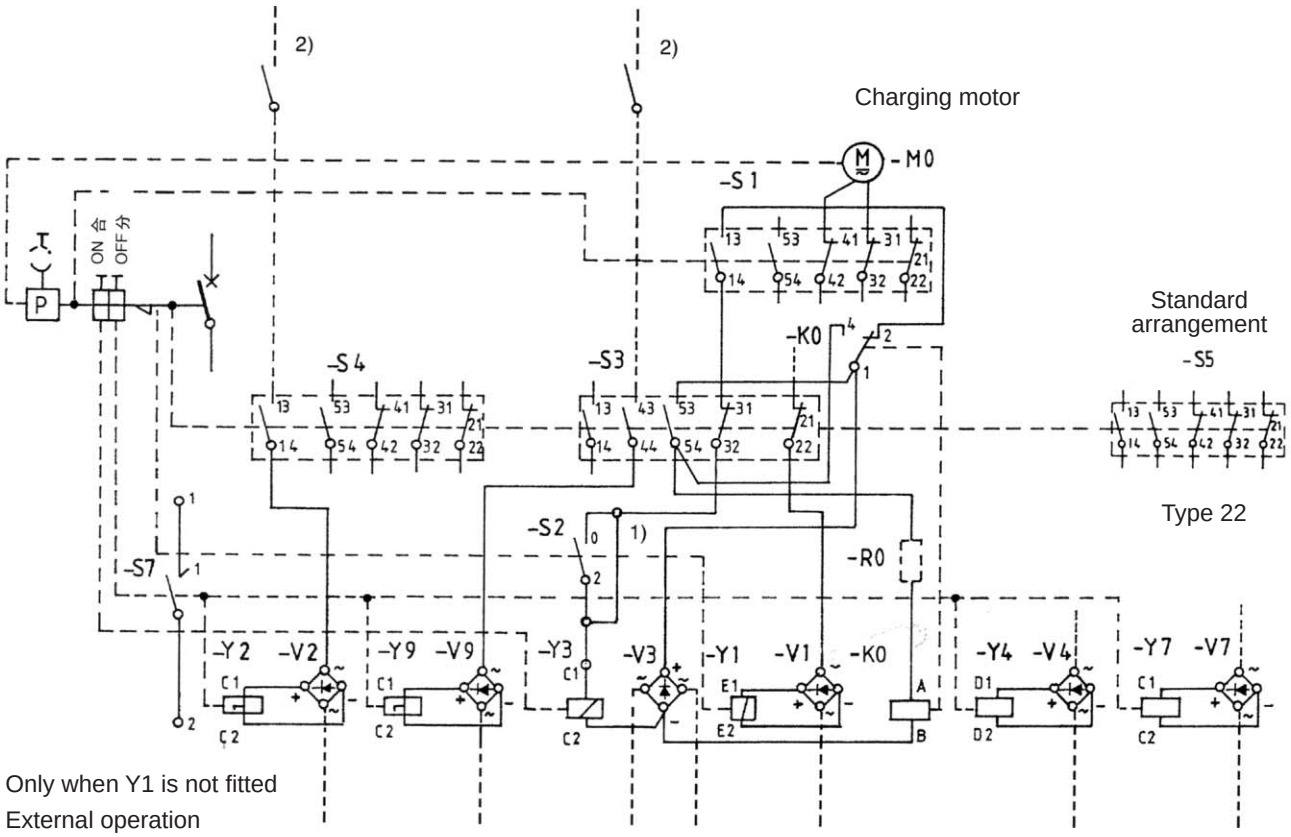
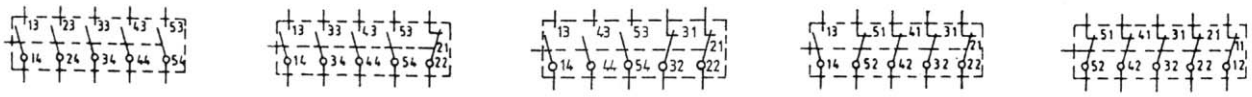


Fig. 2/3 Dimension of fixed VD4 40.5kV



1) Only when Y1 is not fitted
2) External operation

Special arrangement for -S5



Type 19 Type 20 Type 21 Type 23 Type 24

– S1 Auxiliary switch on operating mechanism
– S2 Auxiliary switch on blocking magnet
– S3 Auxiliary switch on the breaker shaft
– S4 Auxiliary switch on the breaker shaft
– S5 Auxiliary switch on the breaker shaft
– S7 Auxiliary switch for fault annunciation
(fleeting contact, time ⩾ 30 ms)

– Y1 Blocking magnet
– Y2 Shunt release OFF
– Y3 Shunt release ON
– Y4 Undervoltage release
– Y7 Indirect overcurrent release
– Y9 Second shunt release OFF
– V1 Series rectifier for –Y1
– V2 Series rectifier for –Y2

– V3 Series rectifier for –Y3 and –K0
– V4 Series rectifier for –Y4
– V7 Series rectifier for –Y7
– V9 Series rectifier for –Y9
– M0 Charging motor for stored-energy spring
– K0 Anti-pumping relay
– R0 Series resistor

Fig. 2/4 Circuit diagram for motor-charged operation mechanism

Note:

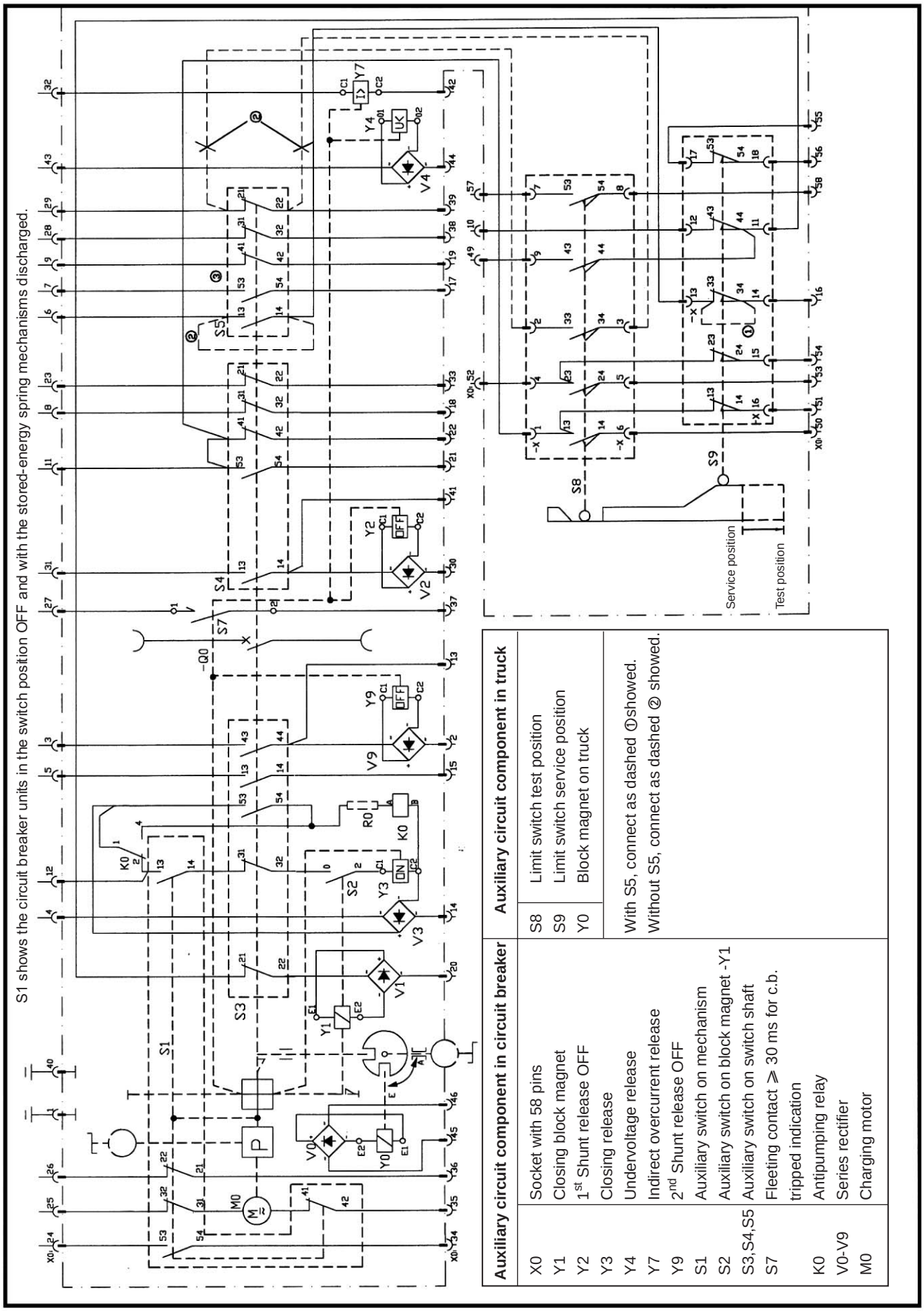
1) For DC 24V, 30V, 48V, 60V, 110V, 125V, 220V, 240V; AC 110V, 220V, 240V
2) Spring in the diagram is discharged. Standard configurations and options available for VD4 are contained in the diagram. Also see relative catalogues and order forms for all possible configuration.
3) Releases and blocking magnets are fundamentally wired with rectifiers (e.g. magnet holder 45 with integrated rectifiers V1, V2, V3 and V9). Rectifiers function as free-wheeling diodes with DC supply.

Tag. Available auxiliary circuit components

1) Motor charged, fixed version: Y2, Y3, K0, S1, S3, S4
2) Motor charged, withdrwable version: Y1, Y2, Y3, K0, S1, S2, S3, S4, S8, S9

Any requirement exceed mentioned above, should be declared in the contract.

Circuit diagram for withdrawable VD4

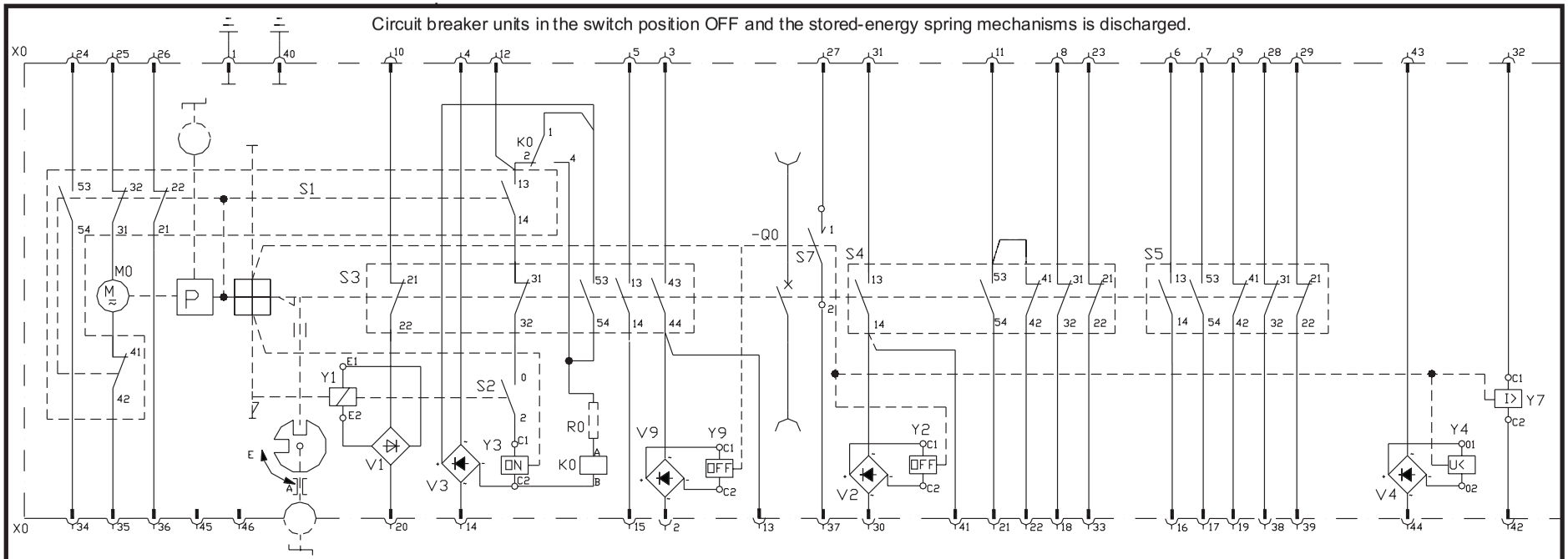


Auxiliary circuit component in circuit breaker		Auxiliary circuit component in truck	
X0	Socket with 58 pins	S8	Limit switch test position
Y1	Closing block magnet	S9	Limit switch service position
Y2	1st Shunt release OFF	Y0	Block magnet on truck
Y3	Closing release		
Y4	Undervoltage release	With S5, connect as dashed ①showed.	
Y7	Indirect overcurrent release	Without S5, connect as dashed ② showed.	
Y9	2nd Shunt release OFF		
S1	Auxiliary switch on mechanism		
S2	Auxiliary switch on block magnet -Y1		
S3,S4,S5	Auxiliary switch on switch shaft		
S7	Fleeting contact ⩾ 30 ms for c.b. tripped indication		
K0	Antipumping relay		
V0-V9	Series rectifier		
M0	Charging motor		

Fig. 2/5 Circuit diagram for withdrawable VD4

Circuit diagram for fixed VD4

Fig. 2/6 Circuit diagram for fixed VD4



Auxiliary circuit component in circuit breaker	
X0	Socket with 58 pins
Y1	Closing block magnet
Y2	1st Shunt release OFF
Y3	Closing release
Y4	Undervoltage release
Y7	Indirect overcurrent release
Y9	2nd Shunt release OFF
S1	Auxiliary switch on mechanism
S2	Auxiliary switch on block magnet -Y1
S3,S4,S5	Auxiliary switch on switch shaft
S7	Fleeting contact ⩾30 ms for c.b. tripped indication
K0	Antipumping relay
V0-V9	Series rectifier
M0	Charging motor

Note:

- S1 shows the stored-energy spring mechanisms discharged. Available auxiliary circuit
- components:
  Y2, Y3, K0, S1, S3, S4
  Any requirement exceed mentioned above, should be declared in the contract.

3 Structure and function

3.1 Structure of the breaker poles

(Figures 3/1, 3/2 , 3/6, 3/7 and 3/8)

The 36 kV and 40.5 kV circuit-breakers of type VD4 are designed as withdrawable units. The poles, which are constructed in column form, are mounted on a torsionally rigid enclosure sub-structure with rollers. The live parts of the breaker poles are located in the insulating material pole tubes and protected from impacts and other external influences.

With the breaker closed, the current path leads from the upper contact arm 57.1 and a chamber holder fixed in the pole tube to the fixed contact 58.2 in the vacuum interrupter 58, then via the moving contact 58.3 and roller contact to the lower contact arm 57.2. The switching motion is effected by means of the insulated coupling rod with internal contact force springs.

3.2 Structure of the breaker operating mechanism

(Figures 3/3, 3/4, 3/7, 6/1 to 6/5, 7/5 to 7/8)

The operating mechanism located in the housing substructure is of the stored-energy spring type and acts on the three breaker poles. The necessary operating energy is stored ready for activation by charging the spring energy storage mechanism.

The stored-energy spring mechanism essentially consists of drum 55.33 containing the spiral spring, the charging system, the latching and operating mechanism and the linkages which transmit the force to the breaker poles. In addition, there are supplementary components such as the charging motor, releases, auxiliary switches and the controls and instruments.

The operating mechanism is fundamentally suitable for autoreclosing and, due to the short charging times, also for multi-shot autoreclosing.

The operating mechanism is normally fitted with a charging motor. There is also a facility for charging the stored energy spring manually.

There is one rating plate 55.7 with the main data of the switch equipment on front cover plate left hand side 50.7, and another on breaker mechanism housing.

The basic version of the stored-energy spring mechnism is fitted with the following auxiliary equipment:

- Shunt release OFF Y2
- Shunt release ON Y3
- Blocking magnet Y1 with auxiliary switch S2
- Five-pole auxiliary switches S3 and S4
- ON-OFF operating shaft 54
- Mechanical switch position indicator 55.4
- Charging condition indicator 55.8 for the stored energy spring
- Mechanical operating cycle counter 55.5.
- Motor charging mechanism
- Five-pole auxiliary switch S1 to switch the charging motor
- Anti-pumping relay K0.

The following additional equipment can be installed:

- Blocking magnet Y0 on the withdrawable part
- Second shunt release OFF Y9
- Indirect overcurrent release Y7
- Auxiliary switch S7 for electrical opening signalling
- Undervoltage release Y4
- Five-pole auxiliary switch S5

3.2.1 Releases, blocking magnet and auxiliary switches

(Figures 2/4 to 2/6, 3/3, 6/2, 7/7 and 7/8)

The releases and the blocking magnet are mounted at the bottom of the stored-energy spring mechanism.

The allocation of the auxiliary switches can be seen in the wiring diagram of figure 2/4.

The five-pole auxiliary switch S1 is operated by the charging condition indicator 55.8. It controls the charging motor M1, serves as an electrical interlock for shunt release ON Y3 when the spring energy storage mechanism is not sufficiently charged, and also provides an electrical switching readiness signal.

Operation of the five-pole auxiliary switches S3, S4 and S5 is dependent on the switching position of the circuit-breaker.

Auxiliary switch S3 interrupts the circuit of the optional additional shunt release OFF Y9 with the circuit-breaker in the open position, and the circuits of shunt release ON Y3 and the optional blocking magnet Y1 with the circuit-breaker in the closed position. There is one further NOC for other purposes.

Auxiliary switch S4 interrupts the circuit of shunt release OFF Y2 with the circuit-breaker in the open position. One further NOC and three NCCs are available for annunciation, control and interlock purposes.

Auxiliary switch S5 can be optionally designed with any possible combination of contacts from five NOCs to five NCCs. Its contacts are available for any required control, annunciation or interlock functions. The auxiliary switch is normally configured as shown in figure 7/3.

The single pole auxiliary switch S7 (fleeting contact time 30 ms) serves to provide a fault signal ("breaker released"). With remote control, the auxiliary switch is necessarily operated via:

- Shunt release OFF Y2 or
- Shunt release OFF Y9 or
- Undervoltage release Y4 or
- Indirect overcurrent release Y7.

Note:

1. Shunt releases OFF (Y2) and ON (Y3) are exclusively provided for opening and closing in normal operation. For safety breaking operations, the second shunt release OFF (Y9) must be used, in most cases with a separate control voltage supply.

   These three releases are of the solenoid type and suitable for a large number of operating cycles.

2. The under voltage release (Y4) and/or indirect over current release (Y7) are pure safety and protection releases and must not be used for switching in normal operation.

3.3 Function

3.3.1 Charging of the spring energy store

(Figures 3/3, 3/10, 6/2, 6/6, 7/7 and 7/8)

To provide the necessary motive energy, the spring energy storage mechanism is charged via chain 55.34 fitted with ratchet wheel 55.35, either automatically by a charging motor or by hand in a vertical pumping action with charging lever 128. The current charging condition is shown at charging condition indicator 55.8

As a precondition for an autoreclosing sequence, the operating mechanism is either (re-)charged after a closing operation automatically by the charging motor, or it requires (re-)charging by hand if the operating mechanism is of the manual type.

3.3.2 Closing procedure

(Figures 3/4, 3/6, 6/1, 6/3 and 7/7)

The closing process is initiated manually by the double bit key 145 and the ON-OFF operating shaft 54, or electrically by activation of shunt release Y3. The release mechanism then permits drive shaft 55.30 to be rotated by the (previously) charged spiral spring. The moving contact 58.3 in vacuum interrupter 58 is moved until the contacts touch by cam disk and further kinematic links. In the further sequence of motion, spring arrangement is tensioned and the appropriate amount of contact force thus applied. The available overtravel is higher than the maximum value of contact erosion during lifetime of the interrupter. During the closing process, opening springs are simultaneously tensioned.

3.3.3 Opening procedure

(Figures 3/3, 3/6, 6/3 and 7/7)

The opening procedure is initiated manually by the double bit key 145 and the ON-OFF operating shaft 54, or electrically by activation of one of the releases Y2, Y4, Y7 or Y9. Release mechanism then permits drive shaft 55.30 to be turned further by the spring energy storage mechanism, which is still sufficiently charged. The opening spring, which is thus released, moves the contact 58.3 into the open position at a defined speed.

3.3.4 Autoreclosing sequence

An OFF-ON or OFF-ON-OFF autoreclosing sequence is activated and checked by the protection system. It is necessary for the spiral spring in the operating mechanism to be in the (re-)charged condition, with the circuit-breaker in the closed position. The (re-)charging process is carried out automatically after closing of the breaker on breakers with motor charging mechanisms, but must be carried out manually on breakers without charging motors (or when the charging motor has broken down). Opening of the breaker is also possible during the (re-)charging process, but sub-sequent closing of the breaker is however blocked until the charging process has been completed.

3.3.5 Quenching principle of the vacuum interrupter

Due to the extremely low static interrupter chamber pressure of 10^{-2} to 10^{-6} pa, only a relatively small contact gap is required to achieve a high dielectric strength. The arc is extinguished on one of the first natural current zeros.

Due to the small contact gap and the high conductivity of the metal vapour plasma, the arc drop voltage, and additionally, due to the short arcing time, the associated arc energy, are extremely low, which has advantageous effects on the life of the contacts and thus on that of the vacuum interrupters.

Figure 3/1: Withdrawable part with circuit-breaker, type VD4, operator's side

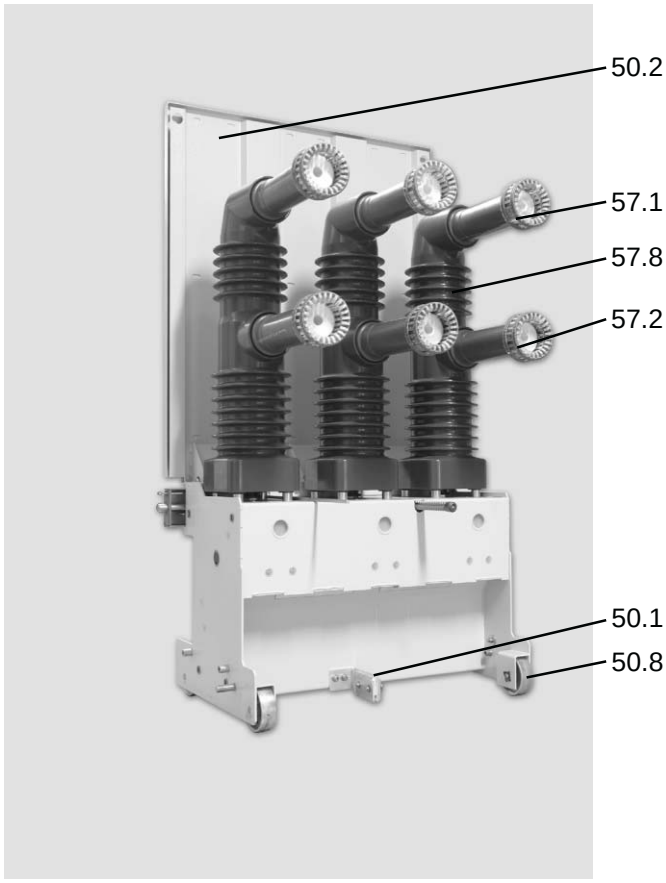


Figure 3/2: Withdrawable part with circuit-breaker, type VD4, pole side

50.1 Earthing contact
50.2 Front partition plate
50.8 Wheel
57.1 Upper contact arm
57.2 Lower contact arm
57.8 Insulating material pole tube

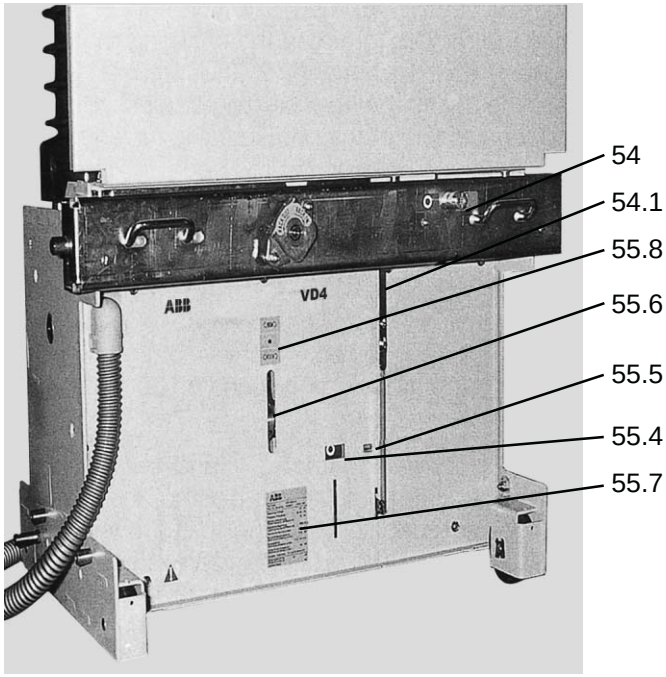


Figure 3/3: Withdrawable part with circuit-breaker, type VD4, controls for the circuit-breaker

54 ON-OFF operating shaft
54.1 Link rod
55.4 Switch position indicator
55.5 Operating cycle counter
55.6 Socket for charging lever
55.7 Rating plate
55.8 Charging condition indicator

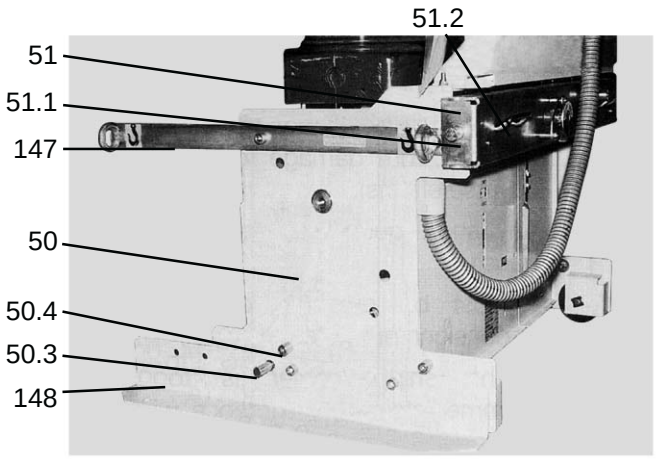


Figure 3/4: Withdrawable part with circuit-breaker, type VD4, left and operator's side view

50	Frame of the withdrawable part
50.3	Actuating pin
50.4	Guide cam
51	Interlock yoke
51.1	Catch pin
51.2	Sliding handle
147	Transport bracket
148	Transport profile

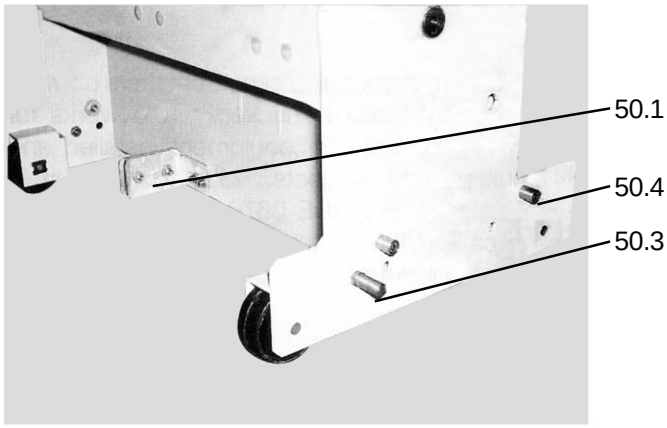


Figure 3/5: Withdrawable part with circuit-breaker, type VD4, (pole side, below)

50.1	Earthing contact
50.3	Actuating pin
50.4	Guide cam

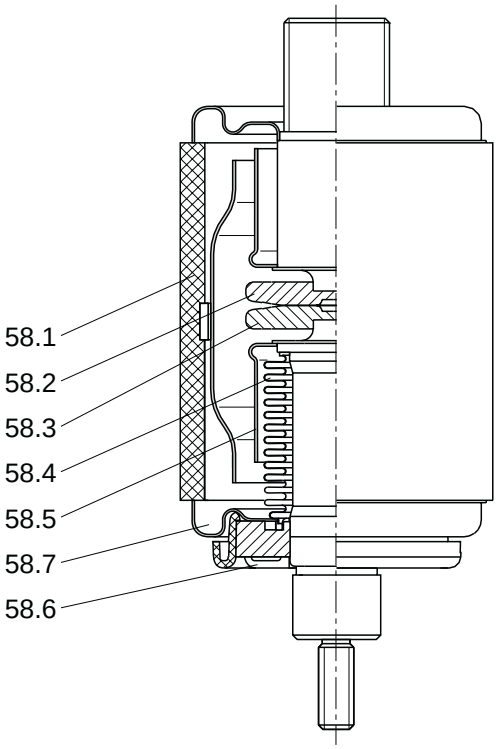


Figure 3/6: Partial section of a vacuum interrupter.

58.1	Insulator
58.2	Fixed contact
58.3	Moving contact
58.4	Metal bellows
58.5	Screen
58.6	Guide cylinder
58.7	Lid

Figure 3/7: Vacuum circuit-breaker, type VD4, for fixed installation, operating side.

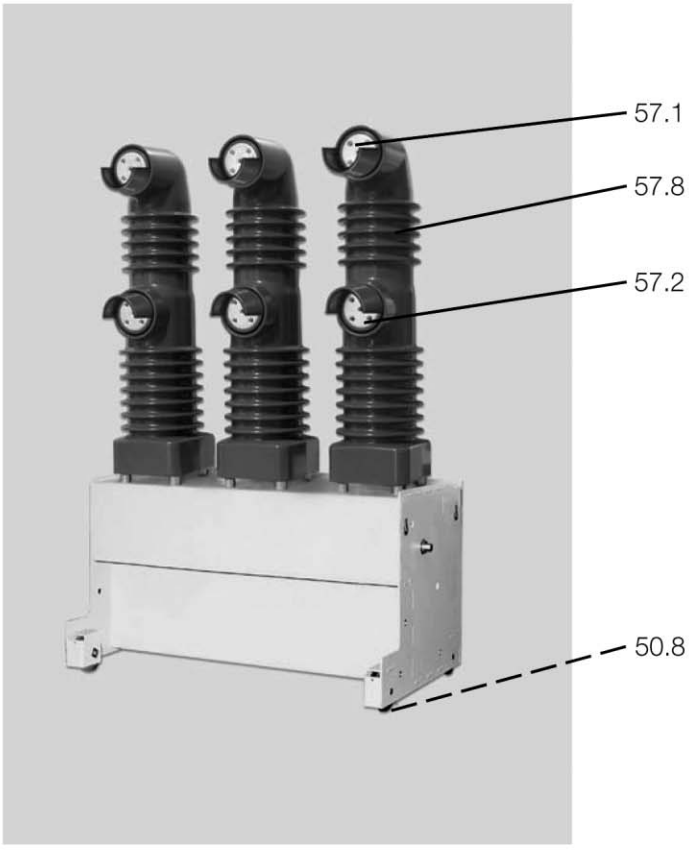


Figure 3/8: Vacuum circuit-breaker, type VD4, for fixed installation, terminal side.
50.8 Rollers
57.1 Upper breaker terminal
57.2 Lower breaker terminal
57.8 Embedded pole

Figure 3/9: Vacuum circuit-breaker, type VD4, for fixed installation, version with partition, terminal side.

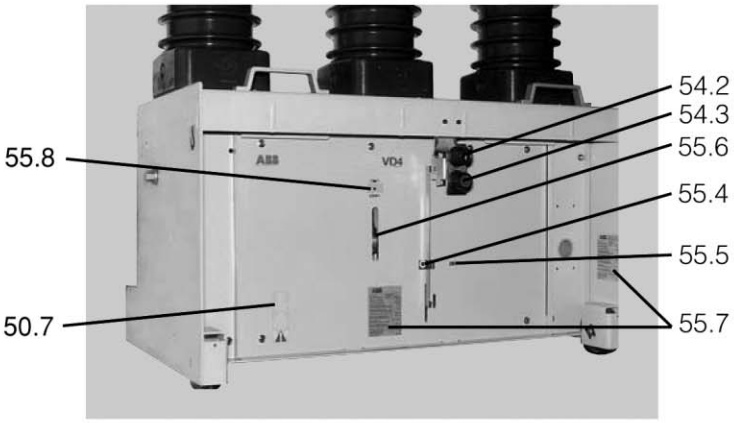


Figure 3/10: Indicators and controls on a circuit-breaker for fixed installation.
50.7 Front plate
54.2 Mechanical ON pushbutton
54.3 Mechanical OFF pushbutton
55.4 Mechanical switch position indicator
55.5 Mechanical operating cycle counter
55.6 Socket (for charging lever)
55.7 Rating plate
55.8 Charging condition indicator

4 Dispatch and storage

4.1 Condition on delivery

- The factory-assembled circuit-breakers on withdrawable parts are checked at the works for completeness of the equipment installed and simultaneously subjected to a routine test in accordance with GB/T 11022 GB 1984, IEC 60694,DIN VDE 0607 IEC publication 62271-100, thus verifying their correct structure and function.

4.2 Packaging

The circuit-breakers on withdrawable parts are mounted individually on wooden pallets and sealed in film and/or packed in cardboard for delivery.

Packaging for overseas shipment:

- Drying agent bags inserted in the film-sealed packaging.

4.3 Transport

Loading of the package units must only be carried out with a

- crane,
- fork-lift truck and/or
- trolley jack.

Notes:

- Avoid impact during handling.
- Do not subject to other damaging mechanical stresses.
- Lifting gear must not be attached to the breaker poles or parts of the operating mechanism.
- When moving the withdrawable part only use the sliding handles 51.2 (e.g. for racking in/out the circuit-breaker unit into/out of the switchgear panel or for the transport of the unit in the switchgear room). Do not bring any force on the front partition plate 50.2 of the withdrawable part.
- Only handle the modules by crane with bolted-on transport brackets 147, suitable lifting ropesand crane harness.
- Ensure that the circuit-breaker unit on the withdrawable part, with its relative high situated centre of gravity, cannot tip over when moving it by crane or fork-lift truck, or when handling it outside the switchgear room.

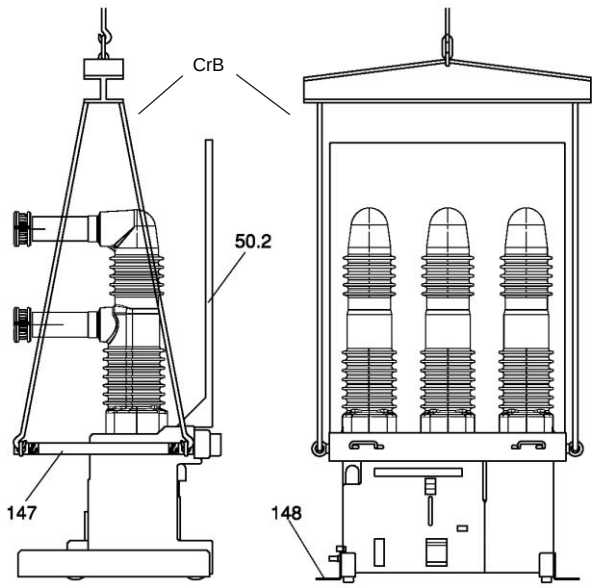


Figure 4/1: VD4 breaker on withdrawable part

Only handle by crane when the transport bracket 147 and crane harness are fitted.Always bear in mind that the high situated centre of gravity may induce the breaker to tip over!

50.2 Front partition plate (Do not stress this plate)
147 Transport bracket (TK)
148 Transport profile (TP)
CrB Crossbar

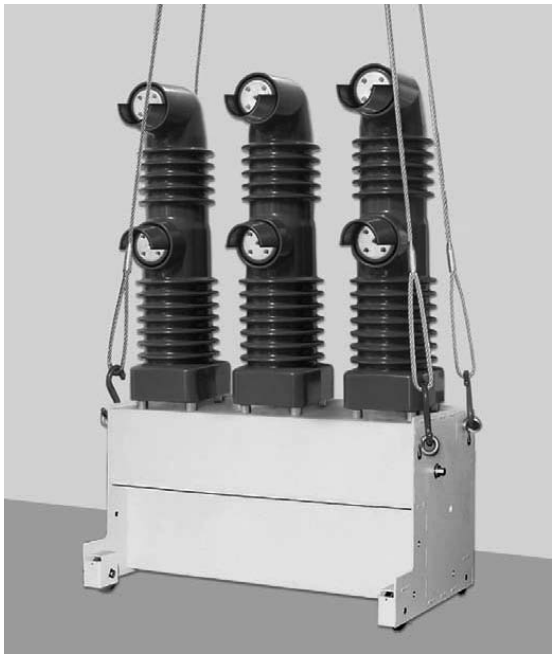


Figure 4/2: VD4 breaker for fixed installation

Only handle by crane when the lifting lugs are fitted. Always bear in mind that the high situated centre of gravity may induce the breaker to tip over!

4.4 Delivery

The duties of the consignee on receipt of the switching devices at site include the following:

- Checking the delivery for completeness and freedom from damage (e.g. moisture and itsadverse effects).
- Any short quantities, defects or damage intransit:
  - Must be precisely documented on the consignment note.
  - The shipper/carrier is to be notified immediately in accordance with the liability provisions.

Note:

Always take photographs to document any major damage.

4.5 Intermediate storage

Intermediate storage of the circuit-breaker unit in the switch position OFF and the stored-energy spring mechanisms discharged (Indicator DISCHARGED: ).

Conditions for optimum intermediate storage:

1. Devices with basic packaging or unpacked:
   - A dry and well ventilated storeroom with climate in accordance with GB/T 11022, IEC 60694, DIN VDE 0670.
   - Room temperature which does not fall below -15˚C.
   - Do not remove or damage the packaging.
   - Unpackaged devices:
     - Are to be loosely covered with protective sheeting.
     - Sufficient air circulation must be maintained.
   - Check regularly for any condensation.
2. Devices with seaworthy or similar packaging with internal protective sheeting:
   - Store the transport units:
     - protected from the weather,
     - dry,
     - safe from damage.
   - Check the packaging for damage.
   - Check the drying agent
     - on arrival of the consignment,
     - subsequently at appropriate intervals.

5 Installation

(Figures 3/4, 4/1 and 4/2)

Perfect operation of the circuit-breaker depends on careful and professional handling of the withdrawable part.

- Allocate each unit to the appropriate switchgear panel in accordance with the switchgear plan and the rated electrical data.
- Remove the transport profile 148 and transport brackets 147.
- Insert the withdrawable part in the switchgear panel checking for unimpeded motion and function sequences, including the closing of primary contacts when the service position is reached.
- Remove any dirt.

When the switchgears are operated in areas with high humidity and/or major rapid temperature fluctuations, there is a risk of dew deposits which must remain an exception in normal operating conditions Provisions should be taken according to section 1.3.2 (special operating conditions).

6 Commissioning/Operation

(Figures: 3/2, 3/3, 3/10, 6/1 to 6/7)

6.1 Note on safety at work

- The switchgear may only be operated by specially trained personnel who are familiar with the characteristics of the particular device.
- Operating circuit breaker in normal condition in accordance with relevant regulations in GB/T 11022, IEC 60694,is a pre-condition of fault-free operation.

6.2 Preparatory activities

(Prior to application of primary voltage)

- Check the circuit-breaker for damage and restore to the proper conditions where necessary.
- Remove any contamination (particularly on the insulating materials) which has occurred during transit, storage or installation.
- Check the primary connections and the earthing contact 50.1.
- Check the charging motor on circuit-breakers with motor-operated mechanisms by applying auxiliary voltage.
- On breakers with manual charging mechanisms, charge the stored energy spring by hand (see Section 6.3.1).
- Perform a trial opening or closing operation of the circuit-breaker using the double bit key 145 at the ON-OFF operating shaft 54 (taking into account any required auxiliary voltage and any relevant interlocks). Observe switch position indicator 55.4 and charging condition indicator 55.8.
- The further procedure results from the interaction of the truck with the switchgear cubicle.
  See the Operation Manual for the switchgearts.
- Ensure that the Instruction Manual is available to the operators at all times.

6.3 Operation of the circuit-breaker

(Figures 6/1 to 6/3 and 6/6, 6/7)

6.3.1 Charging the spring energy storage mechanism

Circuit-breakers with charging motors:

- Charging takes place automatically.
- If the charging motor breaks down, the charging process can be carried out or completed manually.

Circuit-breakers with manual charging mechanisms:

- Insert charging lever 128 into the socket 55.6 and pump up and down for approx. 25 strokes until the charged condition is displayed.
- When the charged condition is reached, the charging mechanism automatically disengages, and further strokes of the charging lever have no effect.

Note:

Charging of the spring energy storage mechanism by hand should only take place when the truck is in the test/disconnected or removed position.

Key to the charging condition indications:

Discharged

Charged

As a precondition for an autoreclosing sequence, the operating mechanism is either (re-)charged after a closing operation automatically by the charging motor, or it requires (re-)charging by hand if the operating mechanism is of the manual type.

6.3.2 Closing and opening

- Operate the local or remote electrical control unit.
- Observe switch position indicator 55.4.

The mechanical control system facilitates manual operation of the circuit-breaker in the switchgear cubicle even with the door closed:

- Fit double bit key 145 on ON-OFF operating shaft 54.
- Turn the double bit key approx. 15 clockwiese until the stop is reached to close the circuit-breaker, or anti-clockwise to open it.

The operating cycle counter 55.5 is automatically incremented by one complete figure with each switching cycle. On completion of a switching operation the switch position indicator 55.4 in the window of front cover plate 50.7. shows the appropriate position of the circuit-breaker.

The anti-pumping relay K0 (wiring diagram in firgure 2/3) prevents repeated ON-OFF switching operations if, for example, the breaker is tripped by a protection relay in response to a primary side fault while a permanent electrical closing command is simultaneously applied. The circuit-breaker can then only be closed after the closing command has been interrupted.

6.3.3 Operating sequence

Circuit-breaker with motorized charging of the stored-energy spring mechanism

Operating sequence	Result of operation Breaker Position Charging Condition	Possible subsequent switching operation
Switch on charging motor	O 	-
Automatic charging	O 	On-Off
Close breaker... and	I 	Off
automatically (re-)charge	I 	Off-On-Off or auto-reclosing sequence
Open breaker	O 	On-Off
Close breaker... and	I 	Off
automatically (re-)charge	I 	Off-On-Off or auto-reclosing sequence
Autoreclosing Off sequence	O 	
(Activation via On protection system	I 	(automatic charging starts)
Off	O 	
Automatic charging completed	O 	On-Off
Close breaker... and	I 	Off
automatically (re-)charge	I 	Off-On-Off or auto-reclosing sequence

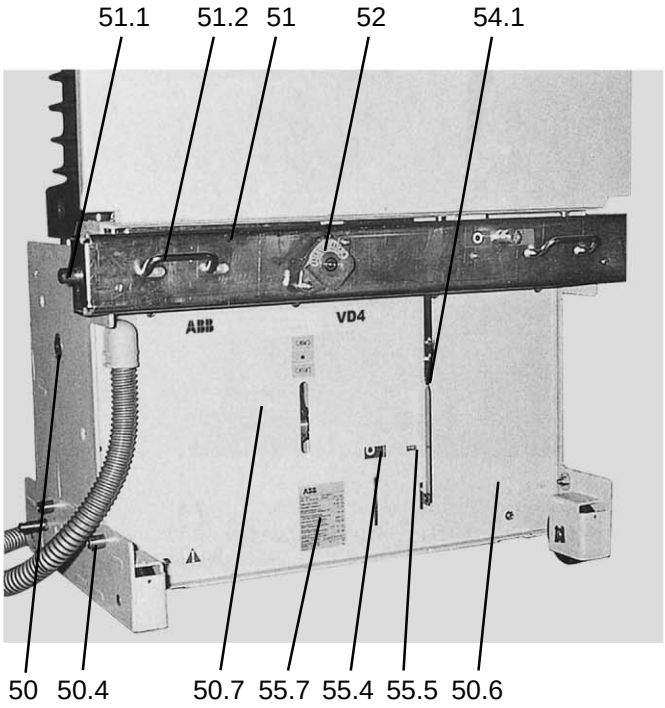


Figure 6/1: Withdrawable part with circuit-breaker, type VD4, control area

50 Frame of the withdrawable part
50.4 Guide cam
50.6 Cover plate, right hand side
50.7 Cover plate, left hand side
51 Interlock yoke
51.1 Catch pin, (spring loaded)
51.2 Sliding handle
52 Spindle
54.1 Link rod
55.4 Switch position indicator
55.5 Operating cycle counter
55.7 Rating plate

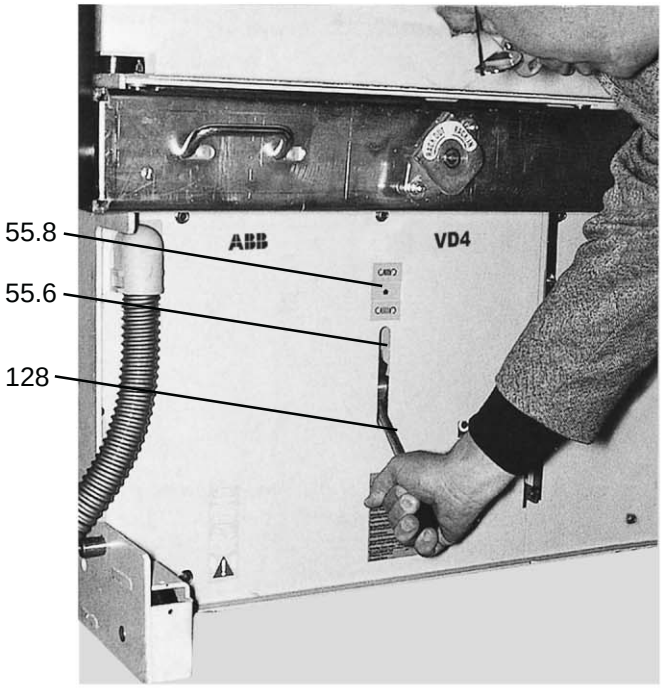


Figure 6/2: Changing the store-energy spring mechanism manually by moving the inserted charging lever up and down

55.6 Socket for charging lever
55.8 Charging condition indicator
128 Charging lever

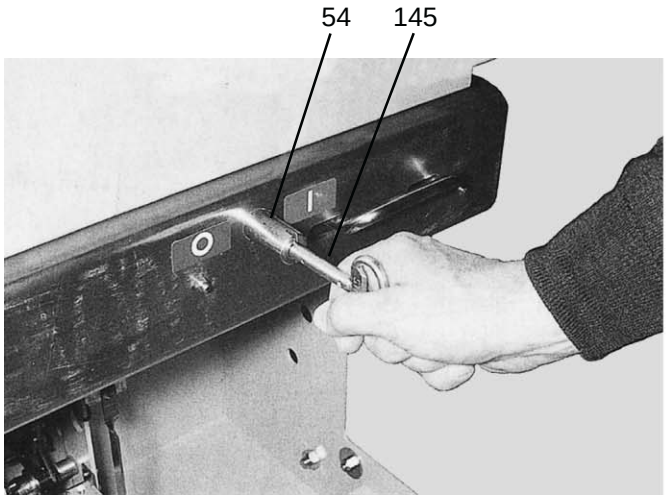


Figure 6/3: Manual operation of the circuit-breaker, by turning the double bit key approx. 15 clockwise (ON), or approx. 15 anti-clockwise (OFF)

54 ON-OFF operating shaft
145 Triple bit key (ON-OFF operation)

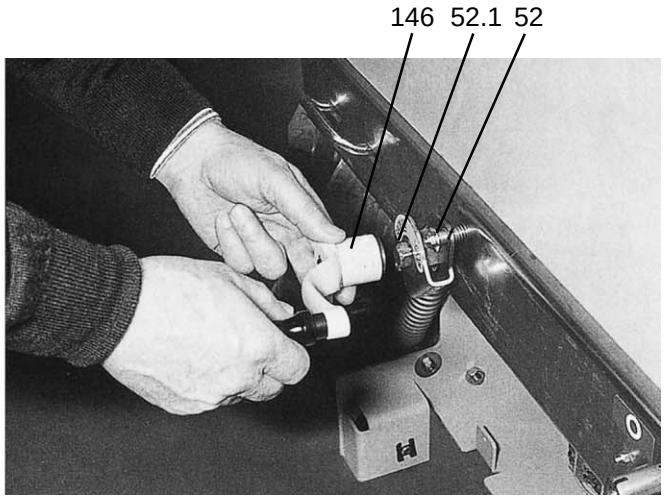


Figure 6/4: Fitting the hand crank (against spring-loaded intermediate plate) to move the withdrawable part inside the panel clockwise towards the service position, and anti-clockwise from the service position towards the test/ disconnected position

52 Spindle
52.1 Square spigot
146 Hand crank

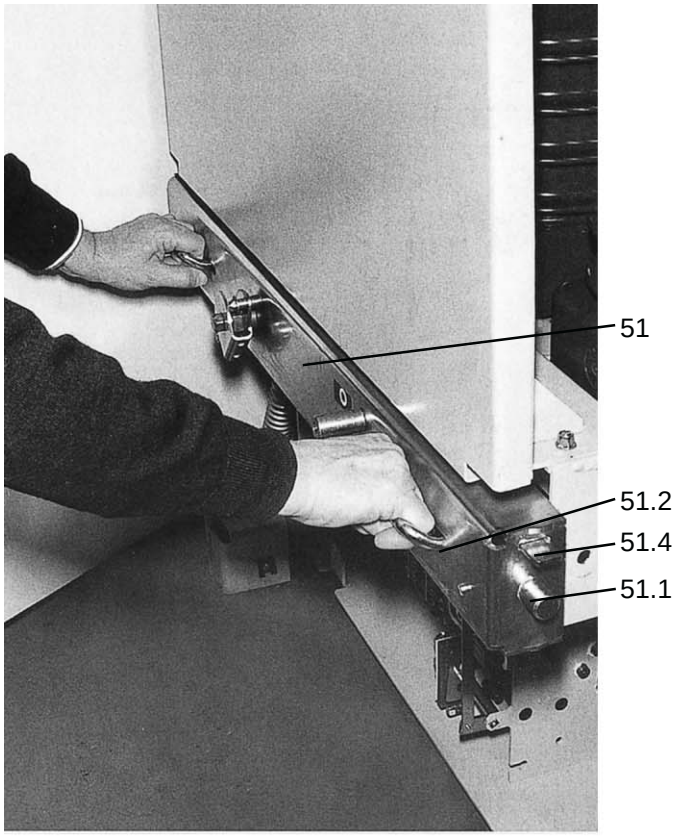


Figure 6/5: Interlock yoke with sliding handles which will be moved inwards to release the withdrawable part for withdrawing from the panel.

- 51 Interlock yoke
- 51.1 Catch pin, spring loaded
- 51.2 Sliding handle
- 51.4 Blocking shaft (interlocking circuit-breaker and withdrawable part)

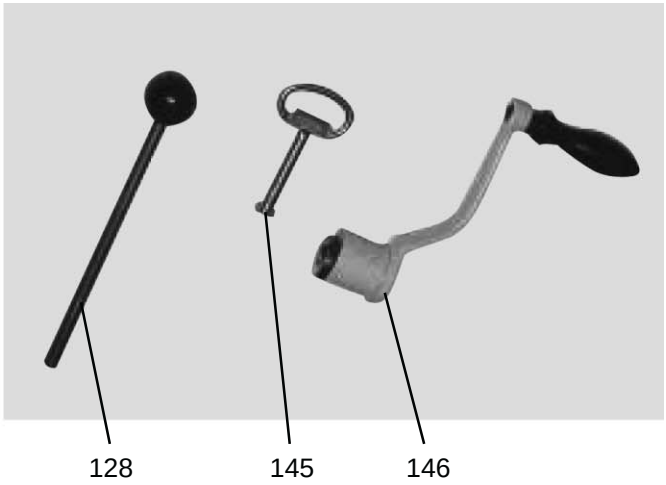


Figure 6/6: Operating accessories

- 128 Charging lever
- 145 Triple bit key (ON-OFF operation)
- 146 Hand crank (for moving of the truck)

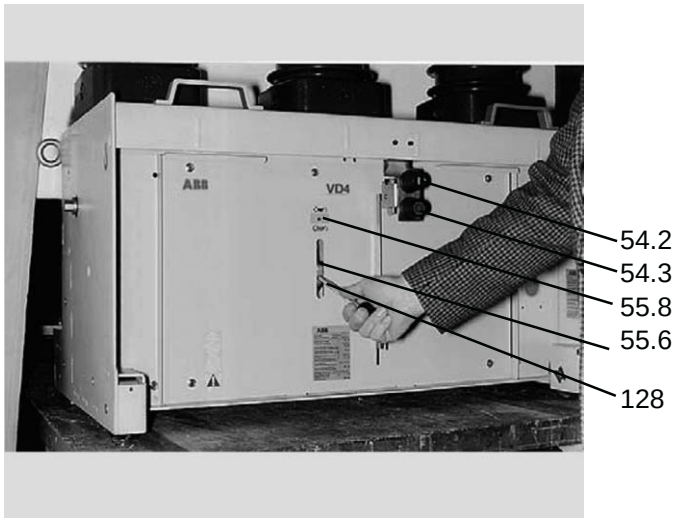


Figure 6/7: Vacuum circuit-breaker, type VD4, for fixed installation.
Manual charging of the stored-energy spring.

- 54.2 Mechanical ON push-button
- 54.3 Mechanical OFF push-button
- 55.6 Socket
- 55.8 Charging condition indicator
- 128 Charging lever

7 Maintenance

Maintenance serves to ensure trouble-free operation and achive the longest possible working life of the switchgear. It comprises the following closely related activities:

Inspection: Determination of the actual condition

Servicing: Measures to maintain the specified condition

Repair: Measures to restore the specified condition.

7.1 General

(Figure 7/1)

Vacuum circuit-breakers are characterized by their simple and robust construction. They have a long life expectancy. Their operating mechanisms have a low maintenance requirement, and the interrupters are maintenance-free during their working life. There is no adverse effect on the vacuum, even from frequent switching of operating and short-circuit currents.

The servicing intervals and scope are determined by environmental influences, the switching sequences and number of short-circuit breaking operations.

With carefully performed inspections and servicing work, and under normal operating conditions, the circuit-breakers, depending on the type, have a service life of up to 30,000 operating cycles and more.

Note:

The following must be observed for all maintenance work:

- The relevant specifications in section 1.2.2
- Notes on safety at work in section 6.1
- Standards and specifications in the country of installation.

Maintenance work may only be performed by fully trained personnel, observing all the relevant safety regulations. It is recommended that ABB Xiamen Switchgear Limited Co. after-sales service personnel should be called in, at least during the performance of servicing and repair work.

While the work is in progress, all auxiliary voltage sources must also be disconnected and secured to prevent reconnection.

Note:

⚠ In order to prevent accidents (particularly injury to hands!) extreme care should be taken during all repair work on the operating mechanism, especially with front cover plates 50.6 and 50.7 removed.

The spiral spring in the spring energy strage mechanism, for instance, retains a basic tension which is independent of the charging and discharging processes during switching, so as to ensure correct function. This spring energy can be inadvertently released if work is performed incorrectly on the spring mechanism!

7.2 Inspection and functional testing

7.2.1 Switching devices in general

The proper condition of the switching device is to be verified by regular inspection.

Under normal operating conditions, testing by a qualified personnel is to be performed at least every 4 years.

In unusual operating conditions (including adverse climatic conditions) and/or special environmental pollutions (e.g. heavy contamination and aggressive atmosphere), inspection may also be necessary at shorter intervals.

Inspection at fixed intervals may be waived if the switchgear is permanently monitored by a qualified personnel.

The checks first and foremost comprise visual examination for contamination, corrosion, moisture and discharge phenomena.

If an incorrect condition is found, appropriate servicing measures are to initiated.

7.2.2 Stored-energy spring mechanism

(Figures 7/2 to 7/5)

Functional testing of the operating mechanism is to be performed:

- after 5000 operating cycles or during servicing work as set out in 7.2.1.
- Prior to functional testing, switch the breaker off and isolate the outgoing feeder.

Scope of functional testing:

- Perform several switching operations under no load, above all with circuit-breakers seldom operated in normal service.
- Switch off the charging motor (if fitted) and discharge the spring mechanism by ON/OFF switching operations.
- Examine visual the condition of the lubrication on rotary bearings, sliding surfaces, etc.
- Check the proper mechanical/electrical sequence of the individual functions.
- Check circuit breaker's appearance.

7.2.3 Checking auxiliary switch settings on withdrawable part

(Figures 6/4, 6/6, 2/5 and 7/2)

Compliance with the interlock conditions in the areas of the test/disconnected position and the service position is ensured by auxiliary switches S8 and S9, located in the breaker housing.

In test operations, the withdrawable part must be moved by hand with the crank 146 fitted.

1. Settings in the area of the test/disconnected position

   - Move the withdrawable part out of the test/disconnected position towards the service position with a few turns of the crank 146.
   - Slowly move the withdrawable part back to the stop.
   - Auxiliary switch S8 must then operate when the hand crank has a remaining angle of + 60 of turn to reach the stop.
   - Slowly insert the withdrawable part from the test/disconnected position towards the service position until auxiliary switch S8 just operates.

     In this position, it must still just be possible to move closing push rod 55.2. For this test, the function of the blocking magnet Y0 (if fitted) must be deactivated manually.

     This condition ensures that the electrical interlock takes effect before the mechanical interlock in the motion sequence involved.

2. Settings in the area of the service position

   - Move the withdrawable part out of the limit position towards the test/disconnected position with a few turns of the crank 146.
   - Slowly move the withdrawable part forwards again to the stop:
   - Auxiliary switch S9 must then operate when the hand crank has a remaining angle of + 60 of turn to reach the stop.

7.2.4 Testing of interlock conditions

(Figures 6/4, 6/6, 2/4, 2/5 and 7/2)

The testing procedures for the withdrawable part.

1. The withdrawable part must only be movable from the test/disconnected position into the service position when the circuit-breaker is open.

   Check the following conditions individually:

   - With the circuit-breaker closed, insertion of the withdrawable part towards the service position must be blocked after only half a turn of the crank in the clockwise direction.
   - With the earthing switch closed, insertion of the withdrawable part towards the service position must be blocked after only two clockwise turns of the crank.

   Do not use force !

2. The withdrawable part must only be movable from the service position into the test/ disconnected position with the circuit-breaker open.

   Check this condition as follows:

   - With the circuit-breaker closed, withdrawal movement of the withdrawable part must be blocked after only half a turn of the crank in anti-clockwise direction.

3. Closing of the circuit-breaker must only be possible when the withdrawable part is in the defined test/disconnected position or service position.

   The control wiring plug 10.2 must previously have been inserted.

   Check this condition as follows:

   - It must not be possible to close the circuit breaker with the withdrawable part in any position between the test/disconnected position and the service position.
   - Enabling of switching when the withdrawable part moves into the service position is effected electrically by operation of auxiliary switch S9 in the breaker housing.
   - For motion into the test/disconnected position, the same enabling conditions apply analogously, in this case by means of auxiliary switch S8 in the breaker housing.

4. It must only be possible to open the circuit-breaker (manually) when the withdrawable part is in the service position or test / disconnected position and the control voltage has failed.

7.2.5 Breaker pole

No inspection of the breaker pole above and

beyond the stipulations of section 7.2.1 is necessary.

7.3 Servicing

7.3.1 Switching devices in general

If cleaning is found to be necessary during inspections as set out in 7.2.1, the following procedure is to be adopted:

- Prior to cleaning, the working area is to be isolated and secured against reclosing where necessary in accordance with the safety regulations.
- Cleaning of surfaces in general:
  - Dry, lightly adhering dust deposits with a soft, dry cloth.
  - More strongly adhering contamination with slightly alkaline household cleanser or Rivolta BWR 210.
- Cleaning of the insulating material surfaces and conductive components:
  - Light contamination: with Rivolta BWR 210.
  - Strongly adhering contamination: with cold cleanser 716.

Wipe down after cleaning, using clean water, and dry properly.

- Observe the manufacturer's instructions and the special ABB instruction manuals Ba 1002/E or BA 1006/E on safety at work.

Note:

Use only halogen free cleansers, and in no case 1.1.1-trichlorethane, trichlorethylene or carbon tetrachloride!

7.3.2 Stored-energy spring mechanism

Servicing for 10 years or the spring mechanism is to be performed after 10,000 operating cycles.

Prior to servicing, switch the breaker off, and isolate the outgoing feeder.

Observe the safety regulations!

Details of the servicing:

- Swich off the charging motor (if fitted), and discharge the spring energy storage mechanism by closing and opening the breaker once.
- Replace parts subject to high climatic and mechanical stresses after 10,000 operating cycles as a precaution (for details see ABB Xiamen Switchgear Limited Co. after-sales service).
- For replacing highly stressed parts neutralize basic tension of the spiral spring, state the rate. Be careful when carrying out!

- Relubricate pawls, support shafts, sliding and rotating bearing surfaces. Lubricant: Isoflex Topas NB 52.(Code GCE 0007249P0100)
- Check the fit of fasteners (e.g. locking pins) in cranks, pins, bolts etc. Check the tightness of fastening bolts.
- Always replace any spring lock washers, split pins and other fasteners removed during the work with new parts when reassembling the equipment.
- Perform comprehensive mechanical and electrical functional tests.

Note:

This work may only be performed by the after-sales service personnel of ABB Xiamen Switchgear Limited Co. or adequately qualified personnel.

7.3.3 Breaker pole

The breaker pole with the vacuum interrupter is maintenance-free up to reaching the permissible number of vacuum interrupter operating cycles in accordance with section 2.4.

Checking of the vacuum is only necessary when there is good cause to suspect that force applied externally to a pole tube has caused damage to the vacuum interrupter inside.

If the pole tube is damaged or destroyed, it may be necessary to replace the complete breaker pole.

The working life of the vacuum interrupter is defined by the sum current limit corresponding to the equipment data in individual cases in accordance with section 2.4:

- When the sum current limit is reached, the complete breaker poles are to be replaced.
- When the permissible number of mechanical operating cycles (i.e. the number corresponding to $I_a = 0$ on the characteristic curve) of the vacuum interrupters has been reached, the breaker poles must be replaced. However, it should be investigated before hand as to whether the installation of a new breaker would be more advantageous.

Note:

Dismantling and Replacement of the complete breaker poles should only be carried out by ABB Xiame Switchgear Limited Co. after-sales service personnel or by specially trained personnel, particularly as proper adjustment is necessary.

7.4 Repair

Replacement of circuit-breaker parts and accessories

Only remove and reassemble circuit-breaker parts and accessories when the breaker has been switched off and the working area is to be isolated and secured against reclosing. The spring energy storage mechanism must be discharged.

All auxiliary voltage sources must be disconnected and secured against reclosing during the removal and installation work.

7.5 Spare parts and auxiliary materials

Designation	Item no.	Rated voltage
Auxiliary switch	S1	
(with clamp-type terminal)	S3	
	S4	DC 24V
	S5	DC 48V
Auxiliary switch on blocking magnet	S2	DC 60V
Auxiliary switch for fault annunciation	S7	DC/AC 110V
1st shunt release OFF	Y2	DC 125V
2nd shunt release OFF	Y9	DC/AC 220/240V
Shunt release ON	Y3	
Blocking magnet	Y1	
Undervoltage release with spring mechanism	Y4	
Delayed undervoltage release with spring mechanism	Y4	
Indirect overcurrent release with intermediate current transformer and spring mechanism	Y7	
Intermediate current transformer for indirect overcurrent release Magnet holder, complete (with integrated rectifiers V1, V2, V3, V9) Series rectifier	V4/V7	
Charging motor (with gearing)	M0	

Auxiliary materials	Ident no. (order code)
Lubricant:	
Isoflex Topas NB 52	GCE0007249P0100

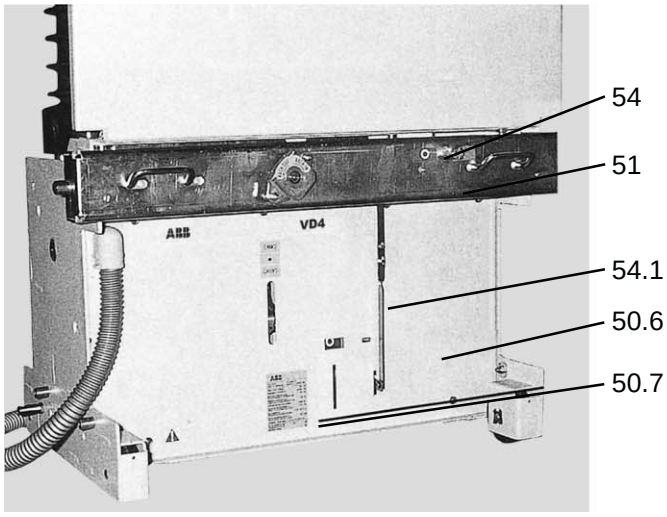


Figure 7/1: Before moving the front plate, first disconnect the link rod 54.1 at the lower point and swing it to one side. Turn the hand crank anti-clockwise first to move the interlock yoke 51 an appropriate distance away.

50.6	Cover plate, right hand side
50.7	Cover plate, left hand side
51	Interlock yoke
54	ON-OFF operating shaft
54.1	Link rod

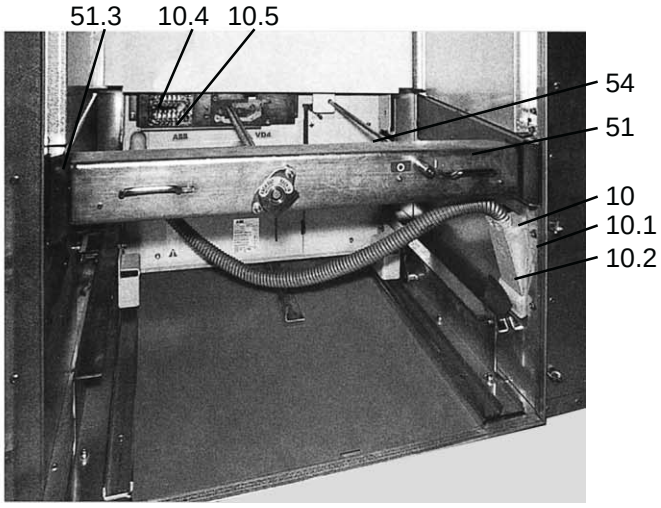


Figure 7/2 Auxiliary switches for interlocking withdrawable part and switchgear panel (withdrawable part in service position)

10	Control wiring plug connector, closed
10.1	Control wiring socket
10.2	Control wiring plug
10.4	S8, limit switch for test position indicator
10.5	S9, limit switch for service position indicator
51	Interlock yoke
51.3	Guiding rail (panel)
54	ON-OFF operating shaft

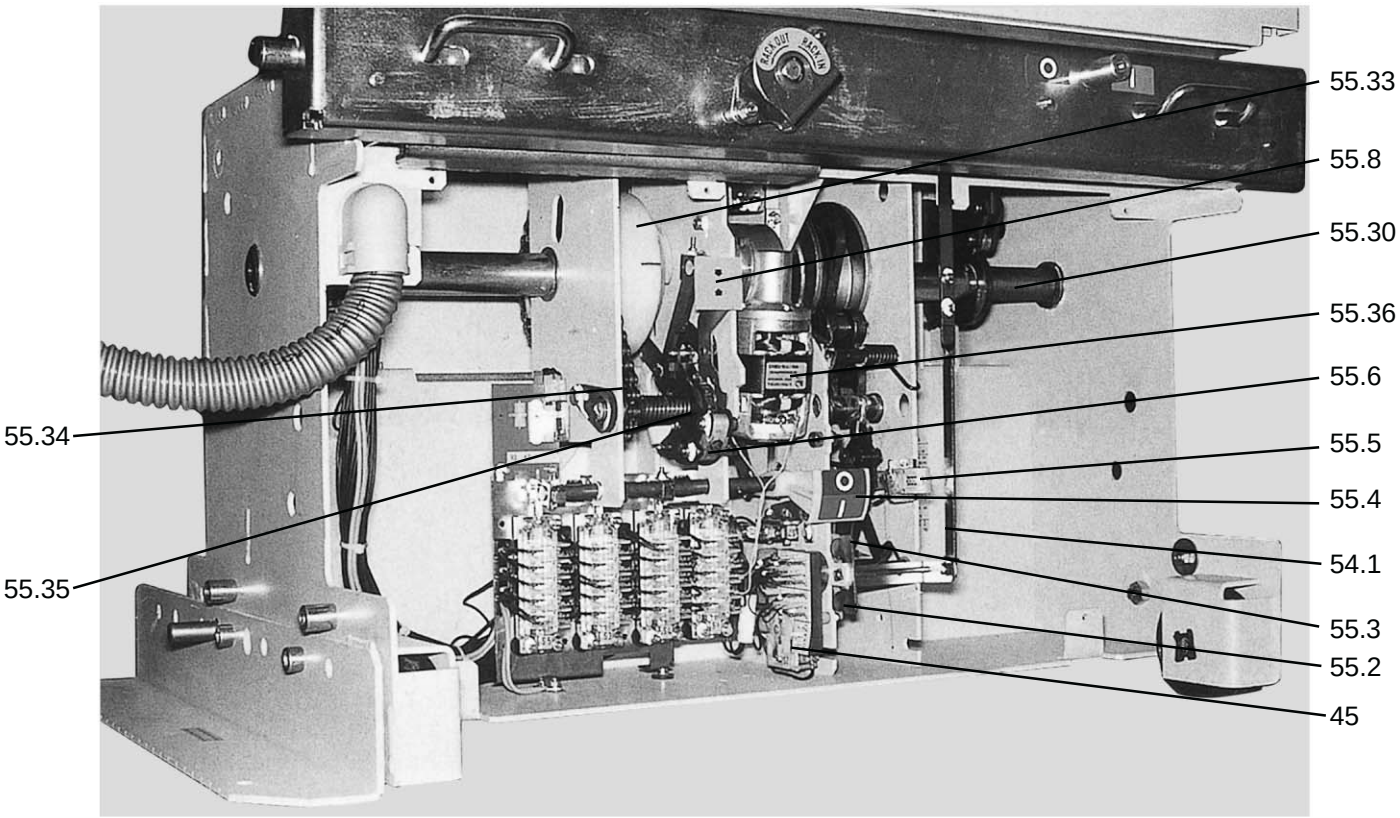


Figure 7/3: The spring-loaded operating mechanism in the frame of the withdrawable part, front cover plates removed

45	Magnet holder, complete
54.1	Link rod
55.2	ON push rod
55.3	OFF push rod
55.4	Switch position indicator
55.5	Operating cycle counter
55.6	Socket for charging lever
55.8	Charging condition indicator
55.30	Drive shaft
55.33	Drum with spiral spring
55.34	Chain
55.35	Ratchet wheel
55.36	Charging motor

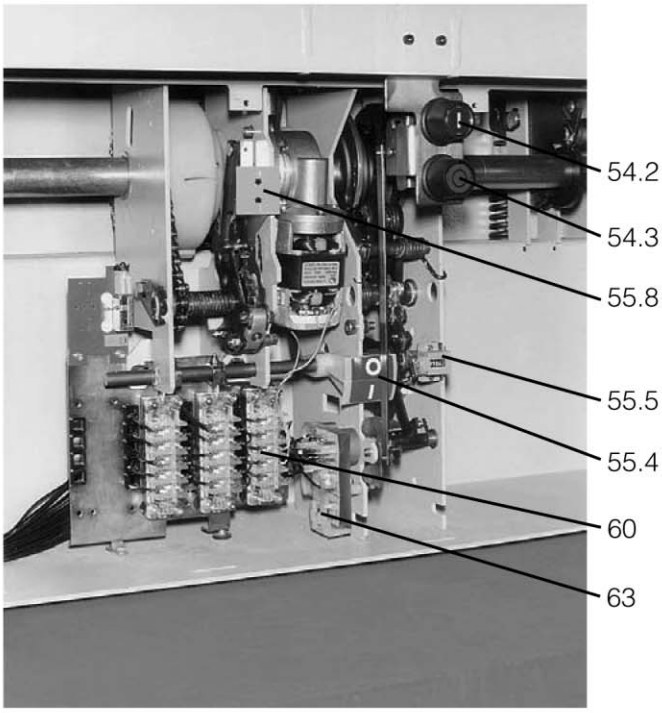


Figure 7/4 Vacuum circuit-breaker, type VD4, for fixed installation, stored-energy spring mechanism, front panel removed.

54.2 Mechanical ON push-button
54.3 Mechanical OFF push-button
55.4 Mechanical switch position indicator
55.5 Mechanical operating cycle counter
55.8 Charging condition indicator
60 Auxiliary switch block
63 Magnet holder, complete

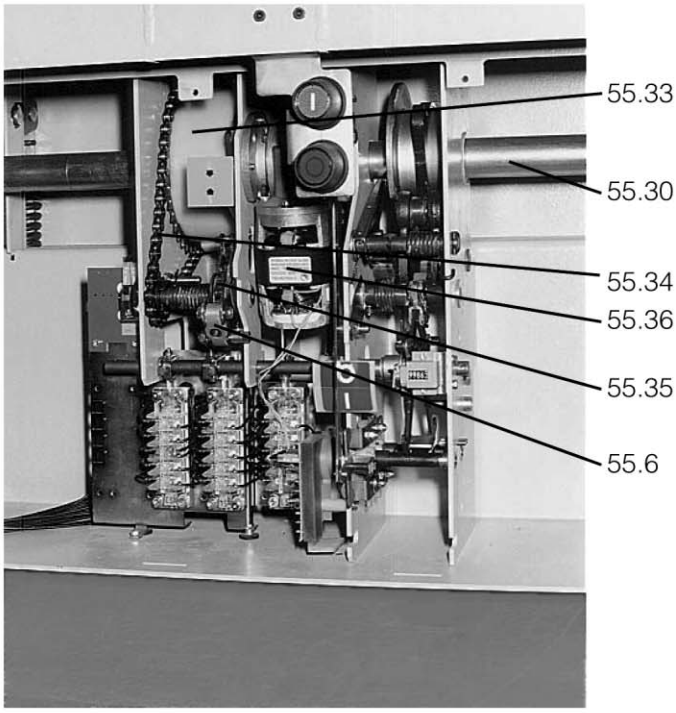


Figure 7/5 Vacuum circuit-breaker, type VD4, for fixed installation, stored-energy spring mechanism, front panel removed.

55.6 Socket (for charging lever)
55.30 Drive Shaft
55.33 Drum with spiral spring
55.34 Chain
55.35 Ratchet wheel
55.36 Charging motor

8 Application of the X-ray regulations

One of the physical properties of vacuum insulations is the possibility of X-ray emissions when the contact gap is open. The specified type test performed by the Physikalisch-Technische Bundesanstalt (PTB) in Brunswick demonstrates that the local dosage output of 1Sv/h at a distance of 10 cm from the touchable surface is not exceeded.

The results are as follows:

- The use of the vacuum interrupters at rated voltage is completely safe.
- The application of the rated power frequency withstand voltage specified for the switching devices by VDE 0670 and IEC 62271-100: 2001 is also safe.
- Higher voltages than the rated power frequency withstand voltage or DC test voltage specified in DIN VDE or IEC standards must not be applied!
- Fulfilment of the above requirement with the vacuum interrupter in the open position is dependent on maintenance of the specified distance between the contacts (which is automatically ensured with correct mechanism function and force transmission).

Comparison of designations to VDE-DIN 40719 Part 2 and IEC 61346-1/IEC 61346-2

VDE **DIN 40719 Part 2**	**Description**	**IEC** **61346-1/61346-2**
-Y0	Block magnet on truck	-RL2
-Y1	Closing block magnet	-RL1
-Y2	1. Shunt release OFF	-MO1
-Y3	Closing release	-MC
-Y4	Undervoltage release	-MU
-Y7	Indirect overcurrent release	-MO3
-Y9	2. Shunt release OFF	-MO2
-M0	Charging motor	-MS
-K0	Antipumping relay	-KN
-S1	Auxiliary switch on mechanism	-BS1
-S2	Auxiliary switch on block magnet -Y1	-BL1
-S3	Auxiliary switch on switch shaft	-BB1
-S4	Auxiliary switch on switch shaft	-BB2
-S5	Auxiliary switch on switch shaft	-BB3
-S7	Fleeting contact ≥ 30 ms for c.b. tripped indication	-BB4
-S8	Limit switch test position	-BT2
-S9	Limit switch service position	-BT1
-R0	Series resistor	-RR
-V0	Series rectifier for -Y0	-TR5
-V1	Series rectifier for -Y1	-TR4
-V2	Series rectifier for -Y2	-TR1
-V3	Series rectifier for -Y3	-TR3
-V4	Series rectifier for -Y4	-TR6
-V9	Series rectifier for -Y9	-TR2

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