

SIEMENS



Instruction manual

Type 3AH35-MA vacuum circuit breaker
magnetic-actuator operator module

Installation operation maintenance E50001-F710-K378-V6-4A00

	! DANGER
	<p>Hazardous voltages and stored energy.</p> <p>Will cause death, serious injury or property damage.</p> <p>Even if the circuit breaker and control circuits have been de-energized for a long time, the power supply capacitors will maintain significant stored energy. Always discharge the capacitors before maintenance. Always de-energize and ground the equipment before maintenance.</p> <p>Read and understand this instruction manual before using equipment. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause death, severe injury or equipment damage. Follow all safety instructions contained herein.</p>

	! DANGER
	<p>Stored energy and high speed moving parts.</p> <p>Will result in serious injury. Fingers can be crushed by the magnetic actuator.</p> <p>Do not remove guard panel. Do not operate circuit breaker if guard panel removed.</p>

Important

The information contained herein is general in nature and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation and maintenance of the equipment purchased. Siemens reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligation. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence.

Qualified person

For the purpose of this instruction manual a **qualified person** is one who has demonstrated skills and knowledge related to the installation, construction and operation of the equipment and the hazards involved. In addition, this person has the following qualifications:

- **Is trained and authorized to** de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
- **Is trained** in the proper care and use of protective equipment, such as: rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
- **Is trained** in rendering first aid.

Further, a qualified person shall also be familiar with the proper use of special precautionary techniques, personal protective equipment, insulation and shielding materials, and insulated tools and test equipment. Such persons are permitted to work within limited approach of exposed live parts operative at 50 volts or more, and shall, at a minimum, be additionally trained in all of the following:

- The skills and techniques necessary to distinguish exposed energized parts from other parts of electric equipment
- The skills and techniques necessary to determine the nominal voltage of exposed live parts
- The approach distances specified in NFPA 70E® and the corresponding voltages to which the qualified person will be exposed
- The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.

Note:

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise that are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local sales office.

The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens Industry, Inc. The warranty contained in the contract between the parties is the sole warranty of Siemens Industry, Inc. Any statements contained herein do not create new warranties or modify the existing warranty.

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Introduction

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	<p>Stored energy and high speed moving parts.</p> <p>Will result in serious injury. Fingers can be crushed by the magnetic actuator.</p> <p>Do not remove guard panel. Do not operate circuit breaker if guard panel removed.</p>

Introduction

The type 3AH35-MA vacuum circuit breaker magnetic-actuator module is designed to meet all applicable ANSI, NEMA and IEEE standards. Successful application and operation of this equipment depends as much upon proper installation and maintenance by the user as it does upon the proper design and fabrication by Siemens.

The purpose of this instruction manual is to assist the user in developing safe and efficient procedures for the installation, maintenance and use of the equipment.

Contact the nearest Siemens representative if any additional information is desired.

Signal words

The signal words "danger," "warning" and "caution" used in this manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

Danger - Indicates an imminently hazardous situation that, if not avoided, **will** result in death or serious injury.

Warning - Indicates a potentially hazardous situation that, if not avoided, **could** result in death or serious injury.

Caution - Indicates a potentially hazardous situation that, if not avoided, **may** result in minor or moderate injury.

Notice - Indicates a potentially hazardous situation that, if not avoided, **may** result in property damage.

Hazardous procedures

In addition to other procedures described in this instruction manual as dangerous, user personnel must adhere to the following:

1. Always work only on a de-energized circuit breaker. The circuit breaker should be isolated, grounded and have all control power removed before performing any tests, maintenance or repair.

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).

2. Before working on the circuit breaker make sure the capacitors (106.2) are fully discharged (refer to Figure 2: Operator controls and discharging capacitors on page 7). Verify that the CLOSE/OPEN indicator (58.0) is in the OPEN position. Discharge the capacitors (106.2) by unplugging the connector (105.2) on the controller board (105.0). The red LED (106.4) on each of the capacitor boards (106.1) indicate the state of the charge on the capacitors (106.2). When the capacitors (106.2) are in fast-discharge mode (by unplugging connector (105.2)), the LEDs are flashing. This indicates hazardous voltage. When the LEDs stop flashing, the capacitors are discharged to a low voltage.
3. Always let an interlock device or safety mechanism perform its function without forcing or defeating the device.

Field service operation and warranty issues

Siemens can provide competent, well-trained field service representatives to provide technical guidance and advisory assistance for the installation, overhaul, repair and maintenance of Siemens equipment, processes and systems. Contact regional service centers, sales offices or the factory for details, or telephone Siemens field service at +1 (800) 347-6659 or +1 (919) 365-2200 outside the U.S.

For medium voltage customer service issues, contact Siemens at +1 (800) 347-6659 or +1 (919) 365-2200 outside the U.S.

Installation checks and functional tests



Figure 1: Type 3AH35-MA 27.6 kV 25 kA vacuum circuit breaker magnetic-actuator operator module

Introduction

This section provides a description of the inspections, checks and tests to be performed on the circuit breaker magnetic-actuator module only.

The inspections and checks in this section are to be performed with the circuit breaker disconnected and isolated from primary (high-voltage) power sources.

Inspections, checks and tests without control power

De-energizing control power

To de-energize control power in the outdoor circuit breaker, open the control power disconnect device in the relay and control compartment.

The control power disconnect device is normally a fused knife switch. Opening the knife switch de-energizes control power to the circuit breaker operating mechanism. In some outdoor circuit breakers, a molded-case circuit breaker or pullout-type fuse holder may be used in lieu of the fused knife switch. Opening the fused knife switch, or molded-case circuit breaker, or removing the pullout-type fuse holder accomplishes the desired result: control power is disconnected.

If any maintenance is to be performed, discharge the capacitors.

Fast discharge of capacitors

After control power has been removed, discharge stored energy from the capacitors (refer to Figure 2: Operator controls and discharging capacitors on page 7).

1. Press red Open pushbutton (54.0).
2. Remove the mechanism housing cover sheet (60.1).
3. The green LED on the power supply (104.0 in Figure 2: Operator controls and discharging capacitors on page 7) should not be illuminated. If the green LED is on, open the control power disconnect device in the relay and control compartment.

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).

4. Discharge the capacitors (106.2) by unplugging the connector (105.2) from the controller board (105.0). Do not unplug connector (106.3) from the capacitor boards, or damage to the capacitor board or the controller board may occur. The red LED (106.4) on each of the capacitor boards (106.1) indicates the state of charge of the capacitors (106.2). When the capacitors (106.2) are in fast-discharge mode (by unplugging connector (105.2)), the red LEDs are flashing. This indicates a hazardous voltage. When the LEDs stop flashing, the capacitors (106.2) are discharged to a low voltage.



Item	Description
53.0	Close pushbutton (black)
54.0	Open pushbutton (red)
58.0	CLOSED/OPEN indicator
59.0	Operations counter
60.0	Mechanism housing
60.1	Mechanism housing cover
104.0	Power supply (green LED shown circled)
105.0	Controller board
105.1	Light-emitting diodes (LEDs) (red, yellow, green)
105.2	Connector for capacitors
105.5	Power supply connector
106.1	Capacitor board (two or three depending upon rating)
106.2	Capacitor
106.3	Connector (for each capacitor board)
106.4	Red LED capacitor discharge state



Figure 2: Operator controls and discharging capacitors

As-found and vacuum-integrity check tests

Perform and record the results of both the as-found insulation test and the vacuum-integrity check (dielectric) test. Procedures for these tests are described in the Maintenance section of this instruction manual beginning on page 26.

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	⚠ DANGER
	<p>Stored energy and high speed moving parts.</p> <p>Will result in serious injury. Fingers can be crushed by the magnetic actuator.</p> <p>Do not remove guard panel. Do not operate circuit breaker if guard panel removed.</p>

Automatic capacitor charging

When control power is energized, the controller board (105.0) executes a self-test of the capacitors (106.2) and checks the status of the capacitors (106.2). This self-test runs automatically and regularly. The result of the self-test is stored in the memory of the controller board (105.0).

Capacitor charging check

The capacitor charging system of the circuit breaker must be checked. Control power is required for capacitor charging.

Note: A temporary source of control power and test leads may be required if the control power source has not been connected to the circuit breaker. Refer to the specific wiring information and rating label for your circuit breaker to determine the voltage required and the terminal points where the control voltage signal should be applied. When control power is connected to the circuit breaker, the capacitors should automatically charge.

1. Close the control power disconnect device in the relay and control compartment to energize the circuit breaker control circuit. If not previously charged, the capacitors should charge automatically.

When the capacitors are fully discharged and control power then is applied, the red LED lights, and green LED lights after approximately 30-35 seconds. The red LED is off when the green LED lights.

If the capacitors have been fully discharged for a very long time, charging time may be significantly longer than indicated. If capacitor charging time is much longer than expected on initial energization, refer to "Capacitor charging after very long de-energization" on page 40 of the "Maintenance" section of this instruction manual.

2. Use the Close and Open pushbuttons on the circuit breaker operating mechanism (refer to Figure 3: Operator panel controls on page 10) to first close, and then open the circuit breaker contacts. Verify contact positions visually by observing the OPEN/CLOSED indicator on the circuit breaker.
3. In step 2, when the Close pushbutton was pressed, the circuit breaker should have closed, and the capacitors should have recharged automatically. Upon closing, the yellow LED should be on, followed by the green LED when full capacitor charge has been obtained. The yellow LED is off when the green LED lights. The meaning of the LEDs (105.1) on the controller board:
 - a) Green LED indicates ready (energy sufficient for OPEN-CLOSE-OPEN cycle).
 - b) Yellow LED indicates open possible (energy sufficient for OPEN operation).
 - c) Red LED indicates error (energy not sufficient for operation).
4. Perform the magnetic-actuator discharge check.
 - a) Initial status: circuit breaker open.
 - b) Press red Open pushbutton (54.0).
 - c) Press black Close pushbutton (53.0).
 - d) Verify main contact status indicator shows CLOSED.
 - e) Press red Open pushbutton (54.0) again.
 - f) Verify main contact status indicator shows OPEN.
5. De-energize the control power by opening the control power disconnect device in the relay and control compartment. Remove the mechanism housing cover sheet (60.1). Do not unplug connector (106.3) from the capacitor boards, or damage to the capacitor board or the controller board may occur. Fast discharge the capacitors (106.2) by unplugging the connector (105.2) on the capacitor controller board (105.0). During fast discharge of the capacitors, a red LED on each capacitor board will flash, indicating that discharge is in process. The process is complete when the red LED stops blinking.

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).

6. After the fast-discharge process is complete, plug in the connector (105.2) to the controller board (105.0).

Final mechanical inspections without control power

1. Make a final mechanical inspection of the circuit breaker. Verify the contacts are in the OPEN position.
2. Check visually that the connectors (106.3) for each capacitor board are firmly connected. Do not disconnect these connections.
3. Reinstall the mechanism housing cover sheet (60.1).
4. Check for loose hardware.

Vacuum interrupter/ operator

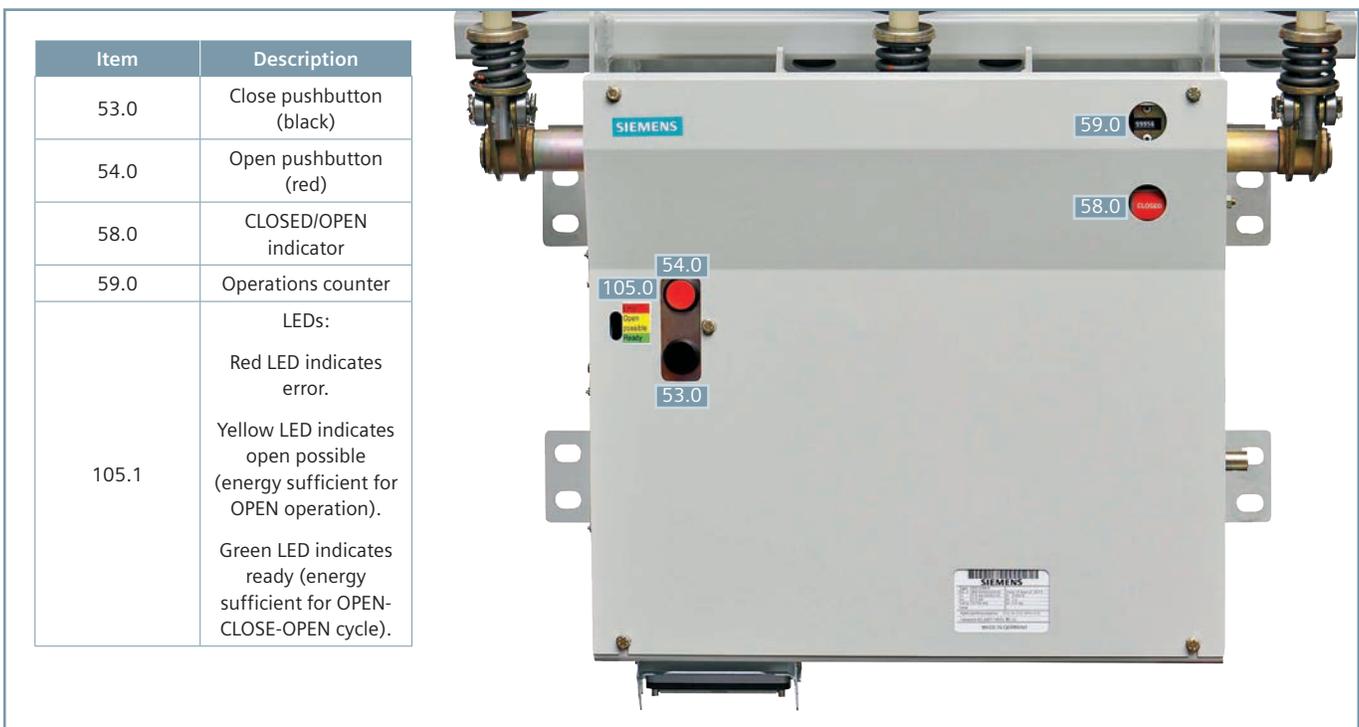


Figure 3: Operator panel controls

Item	Description
16.0	Pole support channels
16.1	Post insulator
20.0	Fixed-end pole head
27.0	Fixed-end connection pad
28.0	Strut
29.0	Moving-end connection pad
30.0	Vacuum interrupter
40.0	Moving-end pole head
48.0	Insulating coupler
49.0	Contact pressure spring
60.0	Mechanism housing

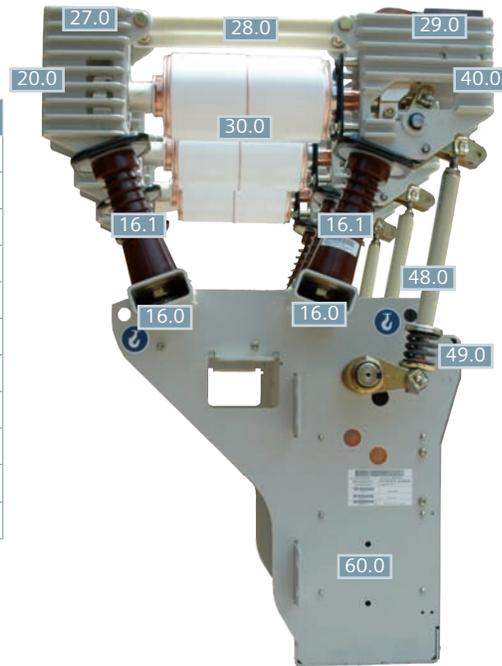


Figure 4: Vacuum circuit breaker magnetic-actuator operator module

Introduction

The type 3AH35-MA vacuum circuit breaker magnetic-actuator operator is intended for stationary applications, such as the type SDV7-MA outdoor distribution circuit breaker. The type 3AH35-MA circuit breaker magnetic actuator conforms to the requirements of ANSI/IEEE standards, including C37.04, C37.06, C37.09 and C37.010.

The circuit breaker includes three vacuum interrupters, a magnetic-actuator operating mechanism, necessary electrical controls and an operator housing. In a typical installation, insulating barriers may be located between the vacuum interrupters.

This section describes the operation of each major subassembly as an aid in the operation, maintenance and repair of the circuit breaker.

Vacuum interrupters

The operating principle of the vacuum interrupter is simple. Figure 5: Vacuum interrupter cutaway view is a section view of a typical vacuum interrupter. The entire assembly is sealed after a vacuum is established. The vacuum interrupter stationary contact is connected to the fixed-end pole head (20.0) of the circuit breaker.

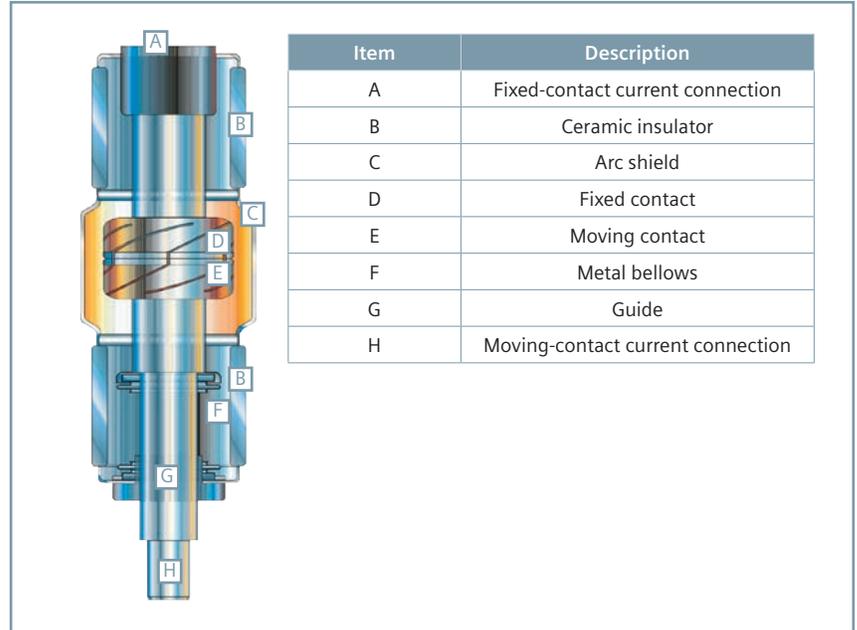


Figure 5: Vacuum interrupter cutaway view



Figure 6: Vacuum circuit breaker magnetic-actuator operator module

The vacuum interrupter movable contact is connected to the flexible shunt (29.1) associated with the other pole head and to the driving mechanism of the circuit breaker. The metal bellows provide a secure seal around the movable contact, preventing loss of vacuum while permitting motion of the movable contact along the axis of the vacuum interrupter.

When the two contacts separate, an arc is initiated that continues conduction up to the following current zero. At current zero, the arc extinguishes and any conductive metal vapor that has been created by and supported the arc condenses on the contacts and on the surrounding arc shield. Contact materials and configuration are optimized to achieve arc motion and to minimize switching disturbances.

Primary connections

Figure 4: Vacuum circuit breaker magnetic-actuator operator module on page 11 illustrates the pad provision to accept the primary connections.

Each circuit breaker has three connection pads at the fixed end of the vacuum interrupter, and three connection pads on the flexible connectors that are associated with the movable contact of the vacuum interrupter. Interconnecting bus in the circuit breaker enclosure connects these connection pads to the roof bushing terminals. Bolting hardware is M12 x 1.75 grade 8. Torque M12 bolts to 52 ft-lb (70 Nm).

Phase barriers (if applicable)

For certain ratings, insulating barriers are attached to the circuit breaker and provide suitable electrical insulation between the vacuum interrupter and primary conductors and the enclosure.

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).

Magnetic-actuator operating mechanism

The energy needed for closing and tripping is stored in two or three capacitor boards (106.1) (depending on circuit breaker rating) charged to approximately 160 V. The self-discharging function is activated by removing the connector (105.2) of the controller board (105.0). Do not unplug connector (106.3) from the capacitor boards, or damage to the capacitor board or the controller board may occur. The capacitors are charged automatically when control power is applied. From fully discharged condition, the capacitors are fully charged in approximately 30-35 seconds.

If the capacitors have been fully discharged for a very long time, charging time may be significantly longer than indicated. If capacitor charging time is much longer than expected on initial energization, refer to "Capacitor charging after very long de-energization" on page 40 of the "Maintenance" section of this instruction manual.

The capacitor charge is monitored constantly by the controller board (105.0). If the control power source fails, the capacitors can initiate one open operation initiated by the operator-mounted pushbutton (54.0). This last operation must be initiated within 300 s after loss of control power supply.

Within 300 s after loss of operator control power, the circuit breaker can perform one open operation initiated by a remote command if the remote command is from a wet (powered) contact.

The green LED, when illuminated indicates that energy is sufficient for an OPEN-CLOSE-OPEN operation.

Vacuum interrupter/operator module

The vacuum interrupter/operator module consists of the three poles, each with its vacuum interrupter and primary insulators, mounted above the common magnetic-actuator operating mechanism housing (60.0). This module is shown in Figure 6: Vacuum circuit breaker magnetic-actuator operator module on page 12.

Construction

Each of the circuit breaker poles is fixed to the pole support channel (16.0) by two cast-resin insulators. The insulators also connect to the fixed- and moving-end pole heads (20.0 and 40.0) that in turn support the ends of the vacuum interrupter. The pole supports are aluminum castings or sheet steel (for 15.5 kV and 27.6 kV up to 25 kA). Refer to Figure 3: Operator panel controls on page 10 and Figure 4: Vacuum circuit breaker magnetic-actuator operator module on page 11, Figure 7: Pole assembly on page 14 and Figure 8: Magnetic-actuator operating mechanism on page 15.

The magnetic-actuator mechanism and all the control and actuating devices are installed in the operator housing.

The CLOSE-OPEN indicator, Open pushbutton, Close pushbutton, the LEDs on the controller board and the operation counter are located on the front of the mechanism housing.

The control connector for the control and signalling cables is a multi-contact plug. The mating control plug wiring connects to the terminal blocks in the relay and control compartment.

Circuit breaker pole (refer to Figure 7: Pole assembly on page 14)

The vacuum interrupter is bolted to the fixed-end pole head (20.0), which is rigidly connected to the pole support channel (16.0) by the post insulator (16.1). The moving contact end of the vacuum interrupter is stabilized against lateral forces by a centering ring (28.1) on the moving-end pole head (40.0). The external forces due to switching operations and the contact pressure are absorbed by the struts (28.0).

Current-path assembly (refer to Figure 7: Pole assembly on page 14)

The current-path assembly consists of the fixed-end pole head (20.0), the stationary contact and the moving contact, plus a flexible shunt (29.1) between the moving contact terminal clamp (29.2) and the moving-end connection pad (29.0).

Vacuum interrupter (refer to Figure 7: Pole assembly on page 14)

The moving-contact motion is aligned and stabilized by a guide bushing. The metal bellows follows the travel of the contact and seals the vacuum interrupter against the surrounding atmosphere.

Switching operation

The sequence of actions involved in various switching operations are described in this section. Refer to Figure 7: Pole assembly on page 14 and Figure 8: Magnetic-actuator operating mechanism on page 15.

When a closing command is initiated, the capacitors (106.2) power the magnetic actuator (101.0). This process is monitored by the controller board (105.0). The electrical current in the coil (101.3) generates a magnetic field. An attractive force causes the anchor (101.4) moving upwards.

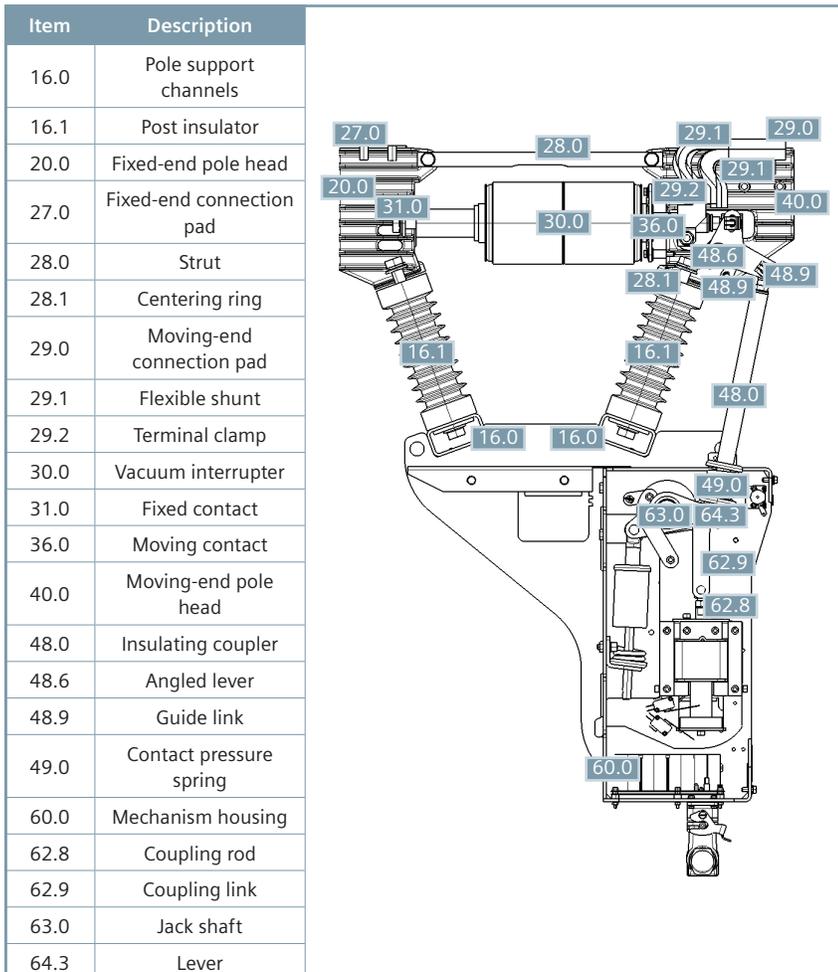
The coupling rod (62.8) moves upwards by compressing the opening springs (64.0) by means of the jack shaft (63.0). The contact pressure springs (49.0) are compressed and the insulating couplers (48.0) are moved upwards. Through the angled levers (48.6) the contacts in the vacuum interrupter (30.0) are closed.

The forces that occur when the action of the insulating coupler (48.0) is converted into the action of the moving contact along the axis of the vacuum interrupter are absorbed by the guide link (48.9) that pivots on the moving-end pole head and the eye bolt.

In the closed state, the necessary contact pressure is maintained by the contact pressure springs (49.0) and the atmospheric pressure. The magnetic actuator maintains a stable closed position without supplemental energy input. The contact pressure spring automatically compensates for arc erosion, which is very small.

When a opening command is initiated, the capacitors (106.2) power the magnetic-actuator coil (101.3) with a reverse current. This opposes the attractive force between the magnetic actuator (101.0) and the permanent magnet. Due to the energy stored in the contact pressure springs (49.0) and the opening spring (64.0), the magnetic-actuator's anchor (101.4) is pushed downwards. This opening process is supported by the opening spring (64.0). In the OPEN position the opening spring assures that the ambient pressure does not close the contacts in the vacuum interrupters (30.0).

Figure 7: Pole assembly



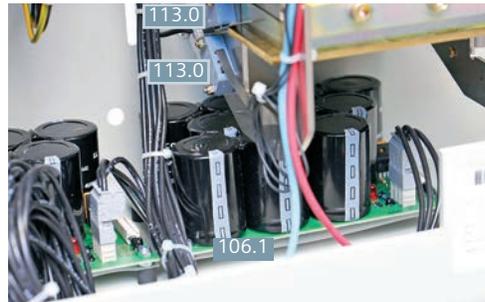
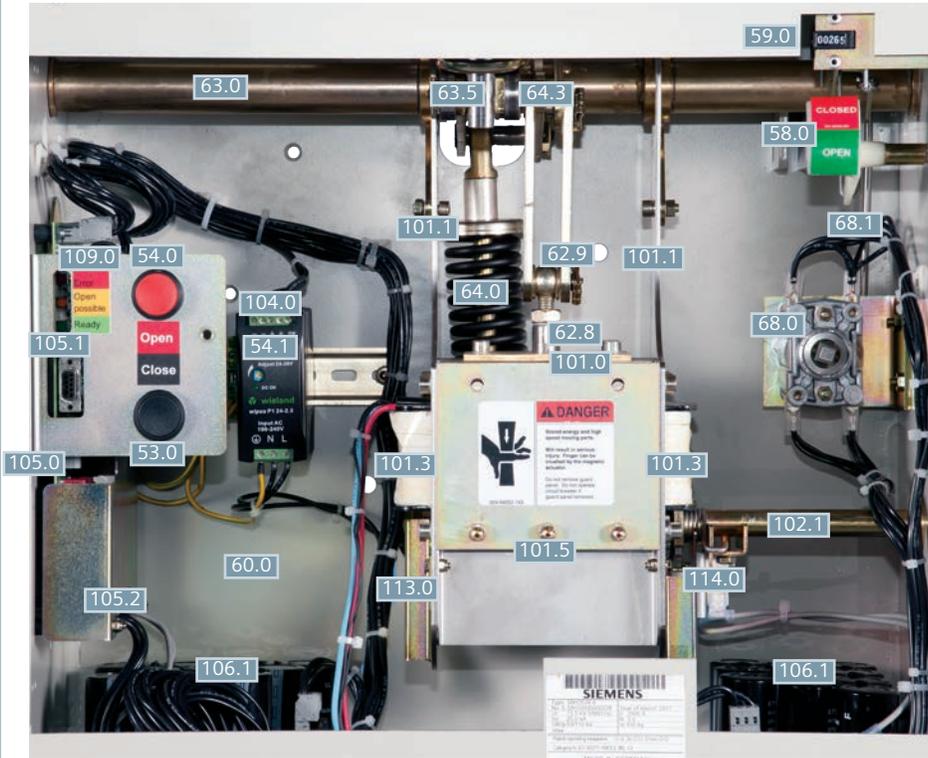
Operating mechanism

The operating mechanism is comprised of the mechanical and electrical components required to:

1. Charge the capacitors for providing sufficient electrical energy to move the magnetic actuator and close or open the circuit breaker.
2. Mechanisms to release closing and opening actions.
3. Means of transmitting force and motion to each of the three vacuum interrupters.
4. Operate all these functions automatically through the capacitors (106.2), the controller board (105.0), auxiliary switch 3SV9 (68.0), the lock out switch (114.0) and the opening spring (64.0).
5. Provide indication of the circuit breaker status (OPEN/CLOSED), indicate capacitor energy status (green LED indicates ready, yellow LED indicates OPEN operation is possible and red LED indicates error) and number of operations.

Figure 8: Magnetic-actuator operating mechanism

Circuit breaker shown in OPEN position.



Item	Description
53.0	Close pushbutton (black)
54.0	Open pushbutton (red)
58.0	CLOSED/OPEN indicator
59.0	Operations counter
60.0	Operator mechanism housing
62.8	Coupling rod
62.9	Coupling link
63.0	Jack shaft
63.5	Lever phase B
64.0	Opening spring
64.3	Lever
68.0	Auxiliary switch
68.1	Auxiliary switch drive linkage
101.0	Magnetic actuator
101.1	Side plate
101.3	Coil of magnetic actuator
101.5	Safety guard
102.1	Manual opening shaft
104.0	Power supply for controller board
105.0	Controller board
105.1	LEDs: Red LED indicates error (energy not sufficient for operation). Yellow LED indicates open possible (energy sufficient for OPEN position). Green LED indicates ready (energy sufficient for OPEN-CLOSE-OPEN cycle).
105.2	Connector (disconnect to discharge capacitors)
105.5	Power supply connector
106.1	Capacitor board
106.3	Connector for each capacitor board
106.4	Red LED - capacitor discharge state
109.0	Control panel
113.0	Position switches
114.0	Lockout switch

Construction

The essential parts of the operating mechanism are shown in Figure 8: Magnetic-actuator operating mechanism on page 15.

The essential parts of the magnetic actuator (101.0) are the side plates, cover plate, permanent magnets, coupling rod, coil, armature parts and bearing plate for armature.

The magnetic actuator (101.0) is connected by the side plates with the mechanism housing (60.0). Also, the magnetic actuator (101.0) secures to the jack shaft (63.0). The magnetic actuator (101.0) requires no maintenance.

If the circuit breaker is stored for a long time without control power, the capacitors will fully discharge. Charge the capacitors at least every two years for a minimum of three hours.

If the capacitors have been fully discharged for a very long time, charging time may be significantly longer than indicated. If capacitor charging time is much longer than expected on initial energization, refer to "Capacitor charging after very long de-energization" on page 40 of the "Maintenance" section of this instruction manual.

Apply control power to the power terminals as shown on the drawings specific to the order on which the circuit breaker was supplied. Refer to the example of circuit diagram shown in Figure 14 on page 24.

Mode of operation

The capacitors have been charged, the mechanism is ready for an operation at any time. This is indicated by the green LED (105.1) on the front panel. If the control voltage fails, the stored energy is sufficient for one open operation initiated by the operator-mounted Open pushbutton (54.0) within five minutes. Within five minutes after loss of operator control power, the circuit breaker can perform one open operation initiated by a remote command if the remote command is from a wet (powered) contact.

Closing

There are two different closing operations possible:

- Remote (electrical)
- Local (electrical) (by pressing the pushbuttons).

When a close command is initiated, the capacitors supply current to the actuator coil, creating an electromagnetic field. This field adds to the magnetic field of the permanent magnets. As a result, the coupling rod (62.8) moves upward. In turn, this transfers force to the jack shaft (63.0) by means of the coupling link (62.9), closing the circuit breaker. Simultaneously, the opening spring (64.0) is compressed.

Trip-free function

For the type SDV7-MA outdoor distribution circuit breaker, the trip-free function is embedded in the controller electronics.

Opening

When an opening command has been given, a reverse current is supplied to the magnetic-actuator coil (101.3). This cancels the attractive force between the magnetic actuator armature and the permanent magnet. Due to the stored energy of the contact pressure spring (49.0), the magnetic-actuator's armature is pushed downwards. This opening process is supported by the opening spring (64.0). In the OPEN position, the opening spring assures that the ambient atmospheric pressure does not close the contacts in the vacuum interrupters (30.0).

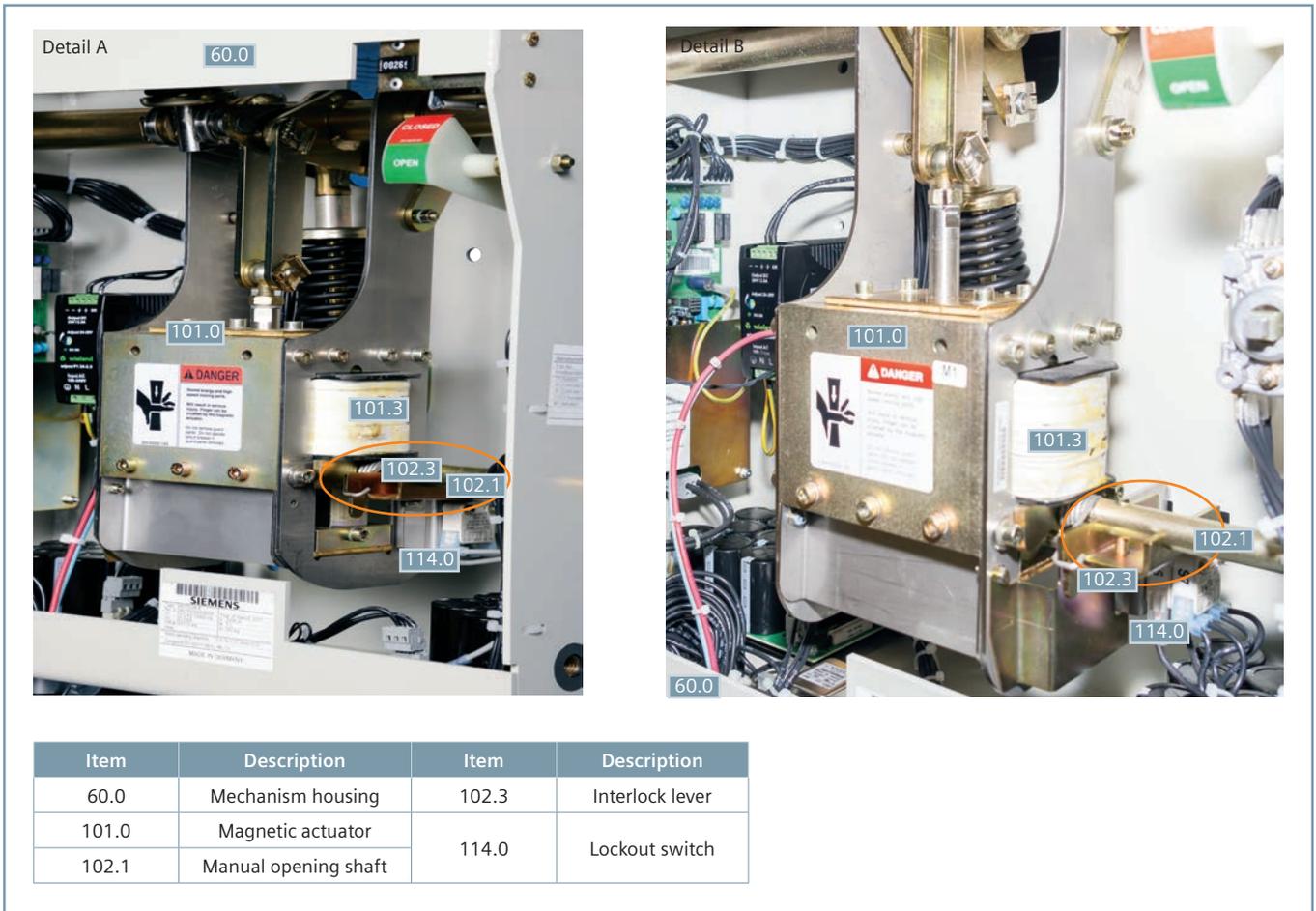


Figure 9: Manual opening mechanism components

Manual opening

The manual opening lever can be used to open the circuit breaker manually, and can also be used to block the circuit breaker in the OPEN position. The manual opening lever is located to the right side of the operator, on the exterior of the type SDV7-MA circuit breaker enclosure.

Figure 9 shows the mechanism internal components that are part of the manual opening system. In detail A, the interlock lever (102.3) is shown in the normal position. The shaft (102.1) of the manual opening lever is connected by a spring to the interlock lever (102.3). When the manual opening lever is rotated a few degrees, electrical opening is disabled by position switch S6 (114.0). On further shaft rotation, the circuit breaker opens.

If the shaft is returned to the normal position, electrical closing and opening operations can be performed. If instead, the manual opening shaft is rotated 90°, the interlock lever (102.3) prevents closing by mechanically blocking movement of the magnetic actuator. In this position, position switch S6 (114.0) continues to disable electrical operation.

When maintenance is to be performed, operation of the circuit breaker can be prevented by installing a padlock on the external manual opening lever. Refer to Figure 10: Use of manual opening lever.



Figure 10: Use of manual opening lever

Figure 11: Operating mechanism section diagram

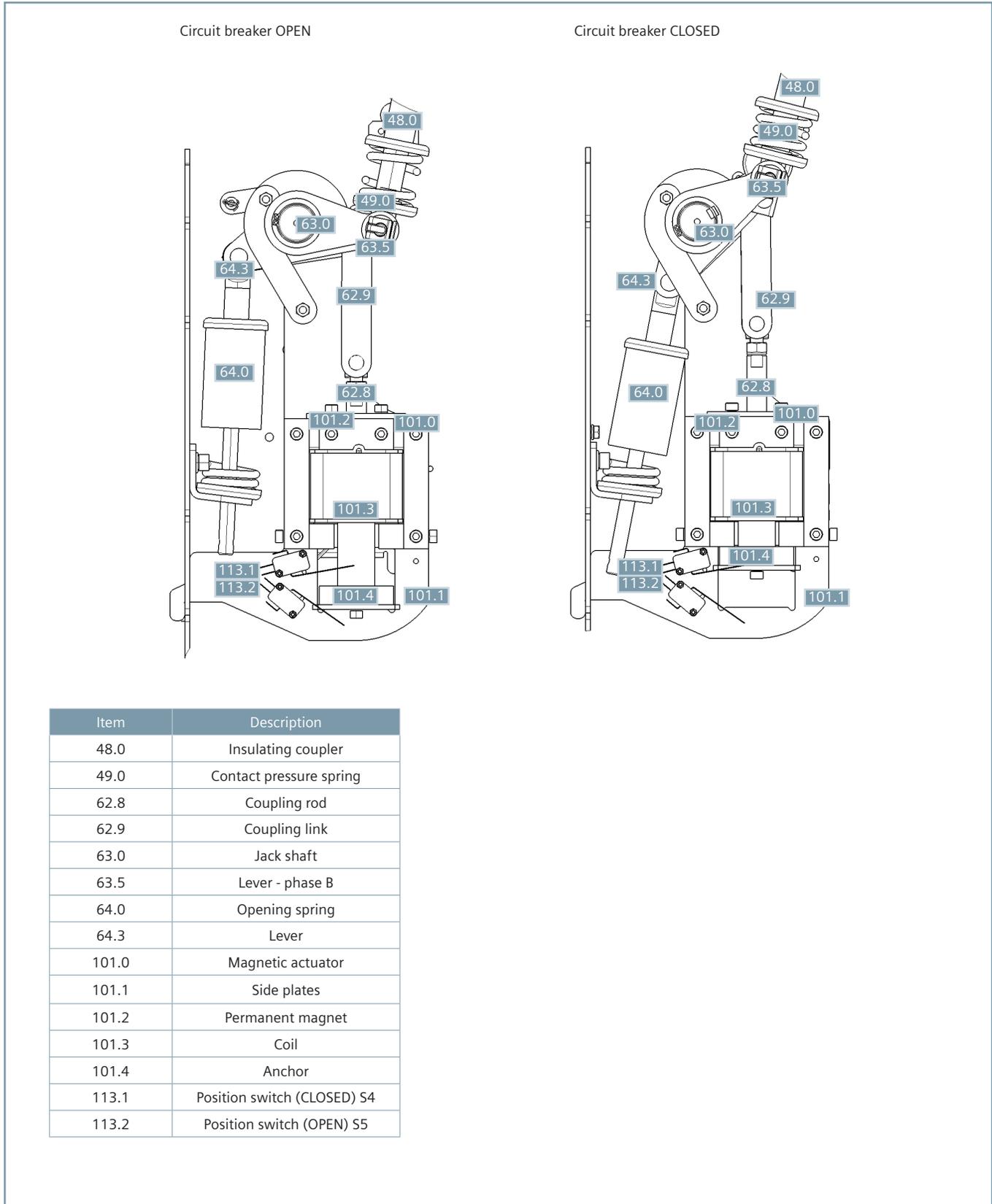
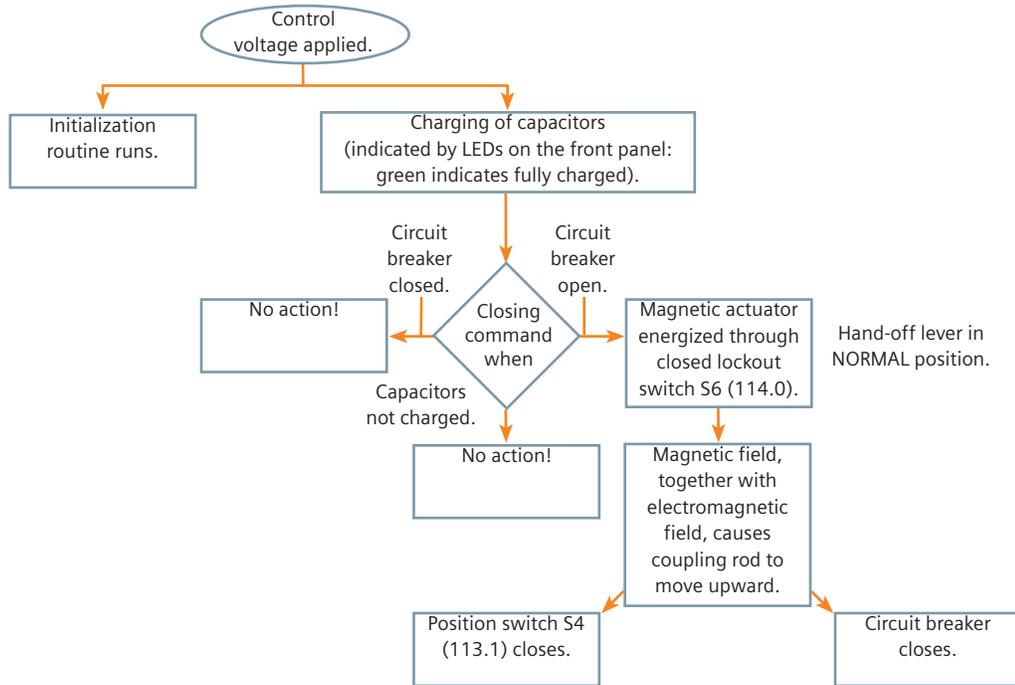
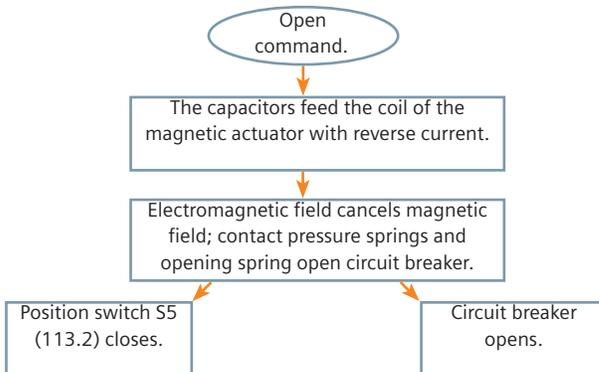


Figure 12: Operator sequential flow diagram

Closing (electrical) using pushbutton or external command



Opening (electrical) using pushbutton or external command



Opening using manual opening lever

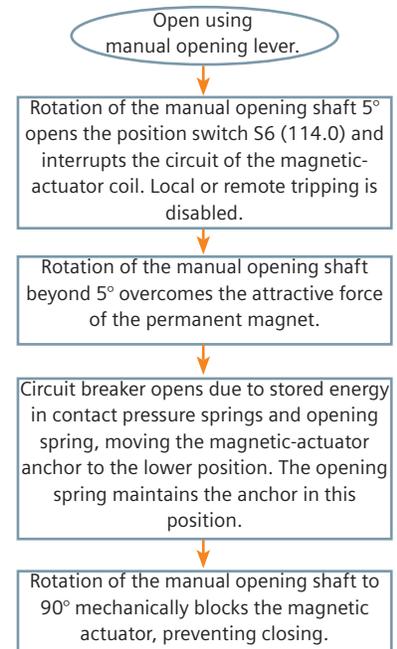


Figure 13: Magnetic-actuator controller flow diagram

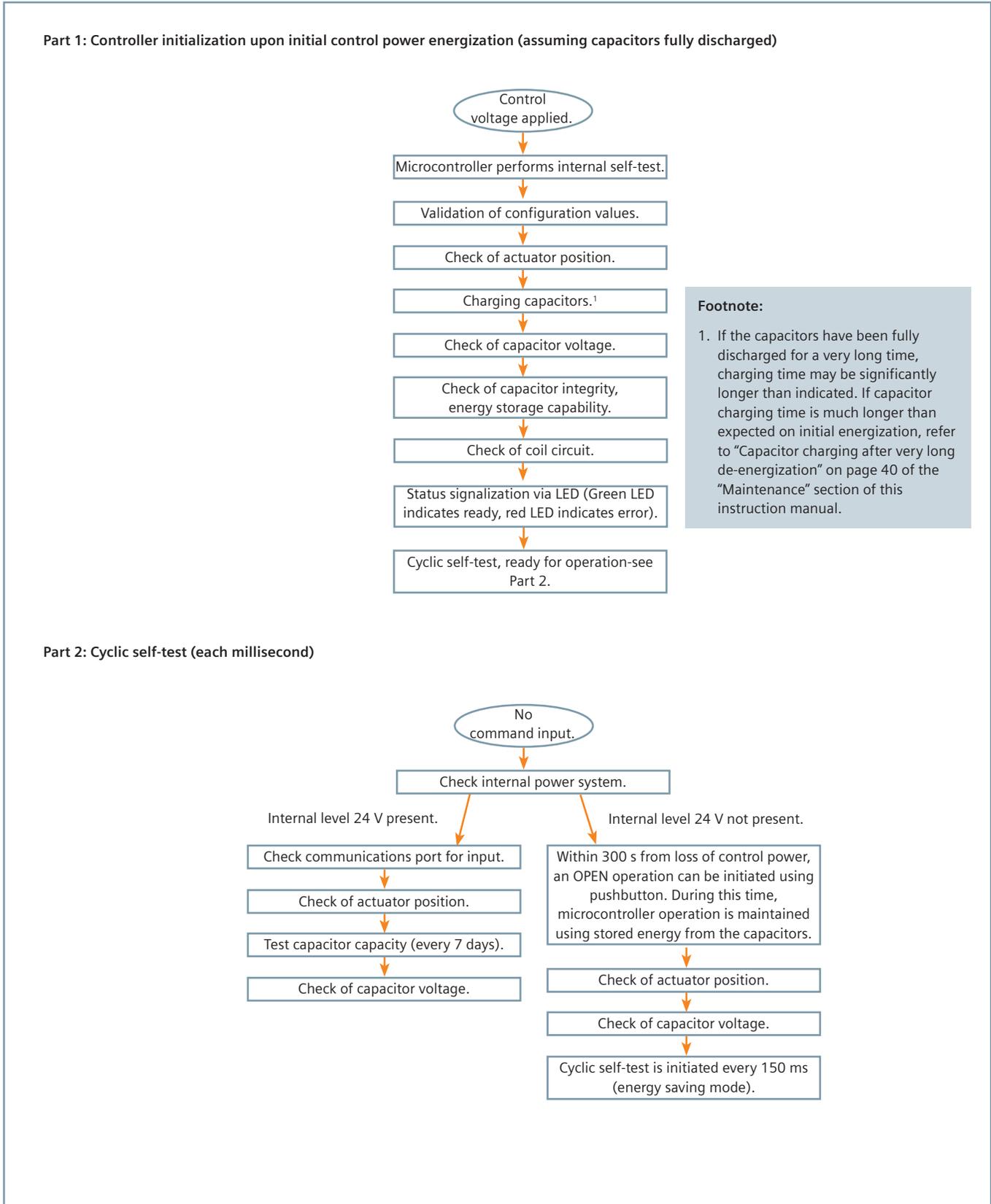
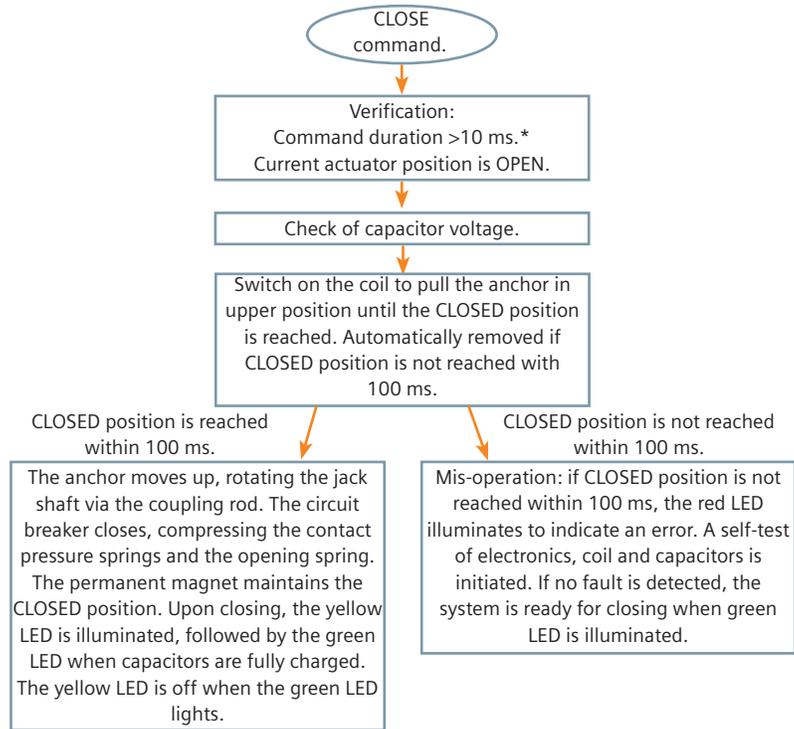


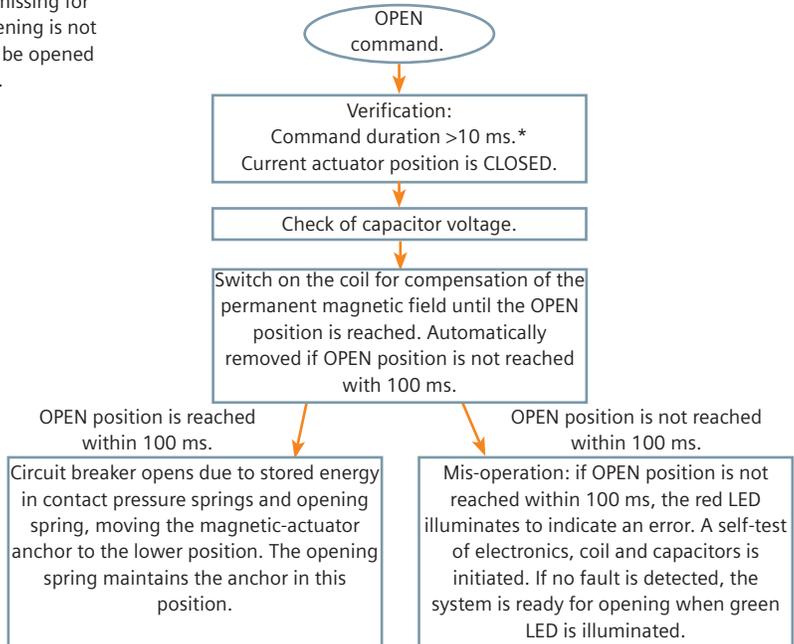
Figure 13: Magnetic-actuator controller flow diagram (continued)

Part 3: CLOSE command using local pushbutton or external command



Part 4: OPEN command using local pushbutton or external command

If control voltage has been missing for 300 s or more, electrical opening is not possible; circuit breaker can be opened using manual opening lever.



* 10 ms for dc power (20 ms for ac power) to close and trip command terminals.

Table 1: Controller capacitor monitoring - LED status

Energy	Circuit breaker position		Alarm status	
Circuit capacitor condition	CLOSED local monitoring LED status Remote output relay (NO contact)		OPEN local monitoring LED status	
Energy sufficient for OPEN-CLOSE-OPEN operation	Green LED ON	OPEN-CLOSE-OPEN operation possible	Error: Local red LED alarm	
	Yellow LED OFF		Red LED OFF	
	"Ready" status contact (ST2-1) CLOSED		Alarm status contact (ST2-3) OPEN (Red LED OFF)	
	"Open possible" status contact (ST2-2) OPEN			
Energy sufficient for CLOSE-OPEN operation			Green LED ON	
			Yellow LED OFF	
			"Ready" status contact (ST2-1) CLOSED	CLOSE-OPEN operation possible
			"Open possible" status contact (ST2-2) OPEN	
Energy sufficient for OPEN operation	Green LED OFF	OPEN operation possible	Green LED OFF	
	Yellow LED ON		Yellow LED ON	
	"Ready" status contact (ST2-1) OPEN		"Ready" status contact (ST2-1) OPEN	Blocked OPEN position, no CLOSE permitted because energy not sufficient for CLOSE-OPEN
	"Open possible" status contact (ST2-2) CLOSED		"Open possible" status contact (ST2-2) CLOSED	
Energy not sufficient for any operation	Green LED OFF	No operation possible	Green LED OFF	
	Yellow LED OFF		Yellow LED OFF	
	"Ready" status contact (ST2-1) OPEN		"Ready" status contact (ST2-1) OPEN	No operation possible
	"Open possible" status contact (ST2-2) OPEN		"Open possible" status contact (ST2-2) OPEN	

The schematic shown in Figure 14: Typical circuit breaker schematic on page 24 is intended to aid in understanding the mechanism operation discussed in this instruction manual. Refer to the schematic diagram furnished with your circuit breaker for specific information.

Also, refer to Figure 12: Operator sequential flow diagram on page 19 and Figure 13: Magnetic-actuator controller flow diagram on pages 20-21.

Electrical operations are performed through the magnetic-actuator controller using the stored energy in the capacitor boards.

Local electrical operation is initiated using the black Close (53.0) or Open (54.0) pushbuttons (refer to Figure 3: Operator panel controls on page 10), designated as S2 and S3 in Figure 14: Typical circuit breaker schematic on page 24. External commands (for example, from protective relays or remote circuits) for closing or opening can be connected through terminals A2/C3 and A4/D3 as shown.

Electronic controller binary inputs/ outputs

The status output contacts (for controller energy status and circuit breaker position) available from the electronic controller are shown on the schematic diagrams (Figures 14 on page 24 and 15 on page 25). These status output contacts have ratings as follows:

N.O. contacts (terminals 1-6, 2-6, 4-6 and 5-6 on -ST2):

- Switching capability: 375 VA ac/ 90 W dc (resistive)
- Current rating: 3 A
- Voltage rating: up to 240 Vac or 250 Vdc.

N.C. contacts (terminals 3-6 on -ST2):

- Switching capability: 5 A@24 Vdc; 0.4 A@48 Vdc; 0.2 A@125 Vdc; 0.15 A@250 Vdc (all resistive)
- Current rating: 3 A
- Voltage rating up to 240 Vac or 250 Vdc.

The alarm contact (ST2-3/ST2-6 in Figure 15: Controller schematic on page 25) opens when an alarm condition begins.

Approximately five seconds after all error conditions cease, the red LED is turned off and the alarm contact opens. If the control voltage fails or is removed, the alarm contact closes and remains closed until control power is restored.

The binary inputs (for electrical closing or opening commands from pushbuttons, protective relays, etc.) have a threshold of response as follows:

- For high-range model, input voltage to the binary inputs must be at least 53 Vac or 69 Vdc for operation
- For low-range model, input voltage must be at least 17 Vac or 17 Vdc for operation.

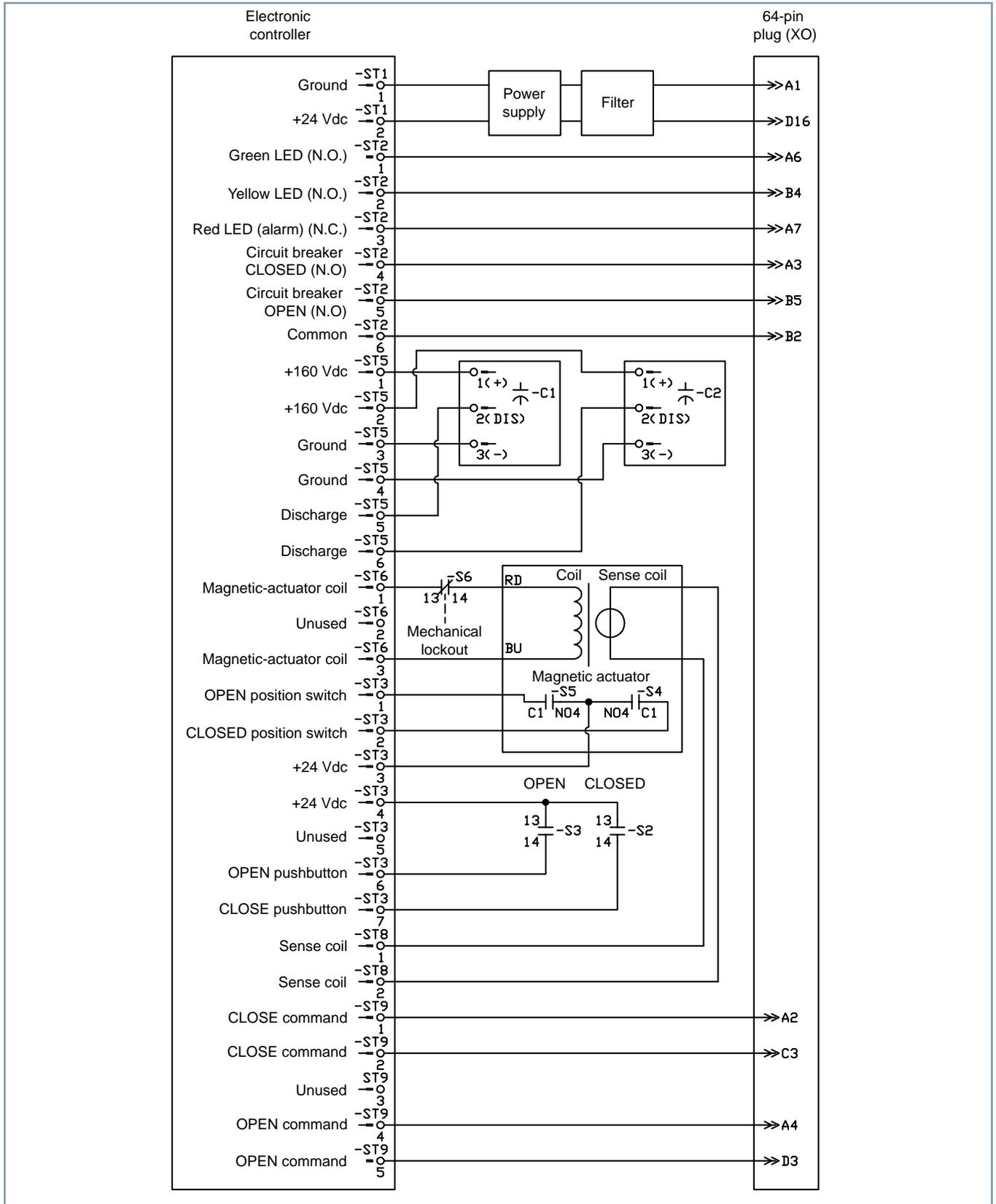
For increased security of close and open operations, the control signal to initiate a close or open action must exceed the threshold response voltage above for at least 10 ms (for dc power) or 20 ms (for ac power) to be considered a valid command. Commands which do not persist for at least 10 ms (for dc power) or 20 ms (for ac power) are ignored by the microprocessor. To allow for microprocessor processes and circuit breaker function, a minimum signal duration of 100 ms is recommended.

If controller power fails, capacitors retain sufficient charge to open the circuit breaker within 300 seconds, with minimum command duration of 100 ms (mandatory).

Auxiliary switch (52a/b)

Figure 8: Magnetic-actuator operating mechanism on page 15 shows the circuit breaker mounted auxiliary switch (68.0). This switch provides auxiliary contacts for use in control and protection circuits. Contacts are available for use in relaying and external logic circuits. This switch is driven by linkage (68.1) connected to the jack shaft (63.0). The auxiliary switch contains both "b" (normally closed) and "a" (normally open) contacts. When the circuit breaker is open, the "b" contacts are closed and the "a" contacts are open.

Figure 15: Controller schematic



Maintenance

WARNING

Failure to maintain the equipment can result in death, serious injury, property damage or product failure, and can prevent successful functioning of connected apparatus.

The instructions contained herein should be carefully reviewed, understood and followed.

The maintenance tasks in Table 2 must be performed regularly.

Introduction and maintenance intervals

Periodic inspections and maintenance are essential to safe and reliable operation of the circuit breaker.

When circuit breakers are operated under “usual service conditions,” maintenance and lubrication are recommended at five-year intervals for the type SDV7-MA outdoor distribution circuit breaker, or at the number of operations indicated in Table 23: Maintenance and lubrication schedule on page 29. “Usual” and “unusual” service conditions for outdoor medium-voltage circuit breakers are defined in ANSI/IEEE C37.04, section 4 and ANSI/IEEE C37.010, section 4. Generally, “usual service conditions” are defined as an environment where the equipment is not exposed to excessive dust, acid fumes, damaging chemicals, salt air, rapid or frequent changes in temperature, vibration, high humidity and extreme temperatures.

The definition of “usual service conditions” is subject to a variety of interpretations. Because of this, you are best served by adjusting maintenance and lubrication intervals based on your experience with the equipment in the actual service environment.

Regardless of the length of the maintenance and lubrication interval, Siemens recommends that circuit breakers should be inspected and exercised annually.

For the safety of maintenance personnel as well as others who might be exposed to hazards associated with maintenance activities, the safety related work practices of NFPA 70E® (especially chapters 1 and 2) should always be followed when working on electrical equipment.

Maintenance personnel should be trained in the safety practices, procedures and requirements that pertain to their respective job assignments.

This instruction manual should be reviewed and retained in a location readily accessible for reference during maintenance of this equipment.

The user must establish a periodic maintenance program to ensure trouble-free and safe operation. The frequency of inspection, periodic cleaning and a preventive maintenance schedule will depend upon the operation conditions. NFPA publication 70B, “Electrical equipment maintenance” may be used as a guide to establish such a program.

Note: A preventive maintenance program is not intended to cover reconditioning or major repair, but should be designed to reveal, if possible, the need for such actions in time to prevent malfunctions during operation.

	<h2 style="margin: 0;">⚠ DANGER</h2>
	<p>Hazardous voltages and stored energy.</p> <p>Will cause death, serious injury or property damage.</p> <p>Even if the circuit breaker and control circuits have been de-energized for a long time, the power supply capacitors will maintain significant stored energy. Always discharge the capacitors before maintenance. Always de-energize and ground the equipment before maintenance.</p> <p>Read and understand this instruction manual before using equipment. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause death, severe injury or equipment damage. Follow all safety instructions contained herein.</p>

	<h2 style="margin: 0;">⚠ DANGER</h2>
	<p>Stored energy and high speed moving parts.</p> <p>Will result in serious injury. Fingers can be crushed by the magnetic actuator.</p> <p>Do not remove guard panel. Do not operate circuit breaker if guard panel removed.</p>

	<h2 style="margin: 0;">NOTICE</h2>
	<p>Electrostatic discharge hazard.</p> <p>May result in damage to printed circuit boards.</p> <p>To prevent damage to printed circuit boards, discharge any static electrical charges on hands or tools by touching grounded surfaces of the enclosure before touching capacitors (106.2), capacitor board (106.1) or controller board (105.0) and before disconnecting any connector plugs.</p>

Recommended hand tools

Metric hardware is used on these circuit breakers.

The following list of hand tools describes those normally used in disassembly and re-assembly procedures:

- Open-end wrenches: 3, 5.5, 7, 8, 10, 13, 17, 19 and 24 mm
- Sockets: 7, 8, 10, 13 and 17 mm
- Socket: 36 mm (used for replacing post insulators (16.1))
- Deep sockets: 19 and 24 mm
- Hex keys: 5, 6, 8 and 10 mm
- Torque wrench: 0-150 Nm (0-100 ft-lbs)
- Screwdrivers: 0.032 x 1/4 in wide and 0.055 x 7/16 in wide
- Pliers
- Light hammer
- Mechanic's mirror
- Flashlight
- Drift pins: 1/8, 3/16 and 1/4 in
- Retaining ring plier (external type, tip diameter 0.038 in).

Recommended maintenance and lubrication

Periodic maintenance and lubrication should include all the tasks shown in Table 2. Recommended procedures for each of the listed tasks are provided in this section of the instruction manual.

The list of tasks in Table 2: Maintenance tasks does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the equipment. Particular applications may require further procedures. Should further information be desired or should particular problems arise that are not covered sufficiently for the user's purposes, the matter should be referred to the local Siemens sales office.

Inspection items and tests
Primary-power path checks
■ Cleanliness check
■ Inspection of flexible connectors
Magnetic-actuator operator-mechanism checks
■ Maintenance and lubrication
■ Fastener check
■ Capacitor charging check
■ Contact-erosion check
Electrical-control checks
■ Wiring and terminals checks
■ Capacitor charging check
■ Electrical close and trip check
Vacuum-integrity check
High-potential test
Insulation test
Contact-resistance test
Inspection and cleaning of circuit breaker insulation
Functional tests

Table 2: Maintenance tasks

Checks of the primary power path

The primary power path consists of the three vacuum interrupters, the three fixed-end and three moving-end connections to the enclosure bus system. These components are checked for cleanliness and condition. The vacuum interrupters are also checked for vacuum integrity.

The contact erosion check is performed with the contacts in the vacuum interrupter (30.0) in the CLOSED position.

The vacuum-integrity check is usually performed in conjunction with the high-potential tests.

⚠ WARNING

The use of unauthorized parts in the repair of the equipment, or tampering by unqualified personnel can result in hazardous conditions, that can result in death, serious injury or property damage.

Follow all safety instructions contained herein.

Circuit breaker type	Number of years/closing operations (whichever comes first)
SDV7-MA	5 years/ 10,000 operations

Table 3: Maintenance and lubrication schedule

Cleanliness check

Figure 4: Vacuum circuit breaker magnetic-actuator operator module on page 11 is a side view of the circuit breaker with the insulating barriers removed (if furnished) to show the vacuum interrupters, and the fixed-end and moving-end connection pads (29.0).

All of these components must be clean and free of dirt or any foreign objects. Use a dry lint-free cloth. For stubborn dirt, use a clean cloth dipped in isopropyl alcohol (except for the vacuum interrupters). For stubborn dirt on a vacuum interrupter use a cloth and warm water and a small amount of mild liquid-household detergent as a cleaning agent. Dry thoroughly using a dry lint-free cloth.

Inspection of flexible connectors

Inspect the flexible connectors that connect the movable contacts of the vacuum interrupters to the moving-end connection pad (29.0) for tightness and absence of mechanical damage, burning or pitting.

Checks of the magnetic-actuator operator mechanism

The magnetic-actuator operator checks are divided into mechanical and electrical checks for simplicity and better organization. This first series of checks determine if the basic mechanism is clean, lubricated and operates smoothly. The contact-erosion check of the vacuum interrupter is also performed during these tasks.

Maintenance and lubrication

Table 3 gives the recommended maintenance intervals for circuit breakers. These intervals assume that the circuit breaker is operated under “usual service conditions” as discussed in ANSI/IEEE C37.04, section 4 and elaborated in ANSI/IEEE C37.010, section 4 for outdoor distribution circuit breakers. The maintenance and lubrication interval is the lesser of the number of closing operations or the time interval since last maintenance.

The magnetic-actuator operator mechanism is shown in Figure 16: Magnetic-actuator operating mechanism lubrication on page 31, with the front cover (60.1) removed to show construction details. Both the magnetic actuator and the opening spring (64.0) are shown. The movable end of the opening spring (64.0) is connected to a lever (63.5) on the jack shaft (63.0). Clean the entire linkage assembly and opening spring (64.0) with a dry, lint-free cloth.

Check all components for evidence of excessive wear. Place special attention to the insulating couplers (48.0) and linkages.

Lubricate all non-electrical moving or sliding surfaces with a light coat of synthetic grease or oil. Lubricants composed of ester oils and lithium thickeners will be generally compatible.

For all lubrication (except electrical moving or sliding surfaces), use one of the following:

- Klüber Isoflex Topas L32 (part 3AX11333H)
- Klüber Isoflex Topas L32N (spray) (part 15-172-879-201).

Source:

- Klüber Isoflex Topas L32 or L32N: Klüber Lubrication North America L.P. www.klueber.com.

Fastener check

Inspect all fasteners for tightness. Both locknuts and retaining rings are used. Replace any fasteners that appear to have been frequently removed and replaced.

Capacitor charging check and contact-erosion checks

Perform the capacitor charging check contained in the section describing the installation check and initial functional tests (refer to pages 6-9). The key steps of this procedure are repeated here:

Note: A temporary source of control power and test leads may be required if the control power source has not been connected to the circuit breaker. Refer to the specific wiring information and rating label for your circuit breaker to determine the voltage required and where the control voltage signal should be applied. When control power is connected to the circuit breaker, the capacitors should automatically charge.

1. Close the control power disconnect device to energize the circuit breaker control circuit. If not previously charged, the capacitors should charge automatically.
2. Use the Close and Open pushbuttons on the circuit breaker operating mechanism (refer to Figure 3: Operator panel controls on page 10) to first close, and then open the circuit breaker contacts. Verify contact positions visually by observing the OPEN/CLOSED indicator on the circuit breaker. When the capacitors are fully discharged and control power is first applied, the red LED lights while the capacitors are charging, followed by the green LED lights when energy storage is sufficient for circuit breaker operation. The red LED is off when the green LED lights.

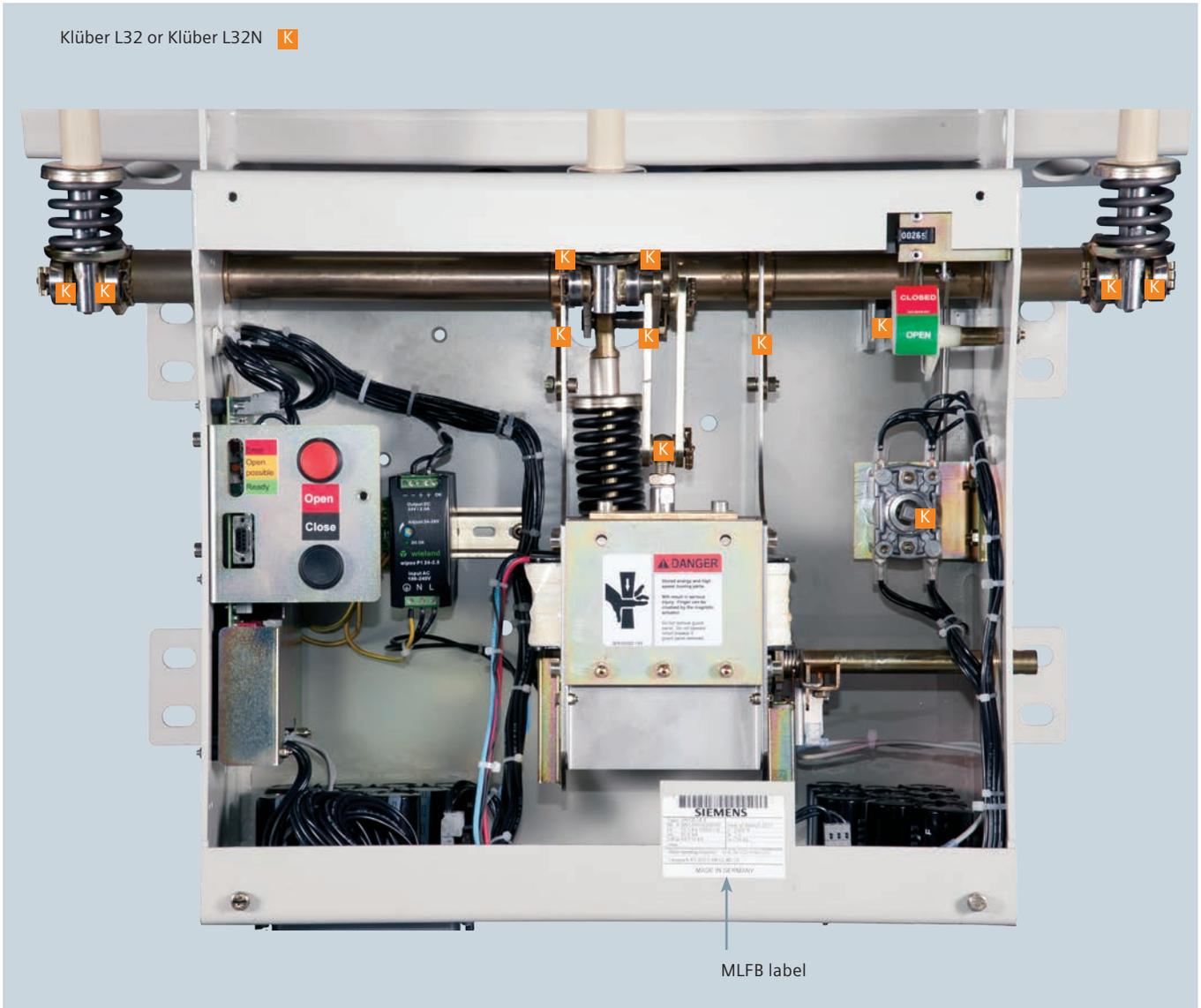
If the LEDs do not conform to this sequence, check further as follows:

If the capacitors have been fully discharged for a very long time, charging time may be significantly longer than indicated. If capacitor charging time is much longer than expected on initial energization, refer to "Capacitor charging after very long de-energization" on page 40 of the "Maintenance" section of this instruction manual.

- a) Power supply (T1) secondary output should be 23-25 Vdc (ST1-1 to ST1-2), and the green LED on the power supply (104.0 in Figure 2: Operator controls and discharging capacitors on page 7) should be on. If the voltage is incorrect or the green LED is not on, check the leads to the power supply.
 - b) If power supply output voltage is correct, check wires between connectors 105.2 and 106.3 and the LED panel (105.1).
 - c) If wires are undamaged, replace the controller board (105.0) and all capacitor boards (106.1) (two or three depending on rating).
3. In step 2, when the Close pushbutton was pressed, the circuit breaker should have closed, and the capacitors should have recharged automatically. The meaning of the LEDs (105.1) on the controller board:
 - a) Green LED indicates ready (energy sufficient for OPEN-CLOSE-OPEN cycle).
 - b) Yellow LED indicates open possible (energy sufficient for OPEN operation). The yellow LED is illuminated while capacitors are charging.
 - c) Red LED indicates error.
 4. Perform the magnetic-actuator discharge check.
 - a) Initial status: circuit breaker open.
 - b) Press red Open pushbutton (54.0).
 - c) Press black Close pushbutton (53.0).
 - d) Verify main contact status indicator shows CLOSED.
 - e) Press red Open pushbutton (54.0) again.

Figure 16: Magnetic-actuator operator mechanism lubrication

Klüber L32 or Klüber L32N 



- f) Verify main contact status indicator shows OPEN.
5. Refer to notice on page 27 to prevent damage due to electrostatic discharge. De-energize the control power by opening the control power disconnect device in the relay and control compartment. Fast discharge the capacitors (106.2) by unplugging the connector (105.2) on the capacitor controller board (105.0). Do not unplug connector (106.3) from the capacitor boards, or damage to the capacitor board or the controller board may occur.
6. After the fast-discharge process, plug in the connector (105.2) on the controller board (105.0).
When the capacitors are charged, press the Close pushbutton (53.0). The CLOSE/OPEN indicator (58.0) must indicate the CLOSED position.

	⚠ DANGER
	<p>Hazardous voltages and stored energy.</p> <p>Will cause death, serious injury or property damage.</p> <p>Even if the circuit breaker and control circuits have been de-energized for a long time, the power supply capacitors will maintain significant stored energy. Always discharge the capacitors before maintenance. Always de-energize and ground the equipment before maintenance.</p> <p>Read and understand this instruction manual before using equipment. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause death, severe injury or equipment damage. Follow all safety instructions contained herein.</p>

	⚠ DANGER
	<p>Stored energy and high speed moving parts.</p> <p>Will result in serious injury. Fingers can be crushed by the magnetic actuator.</p> <p>Do not remove guard panel. Do not operate circuit breaker if guard panel removed.</p>

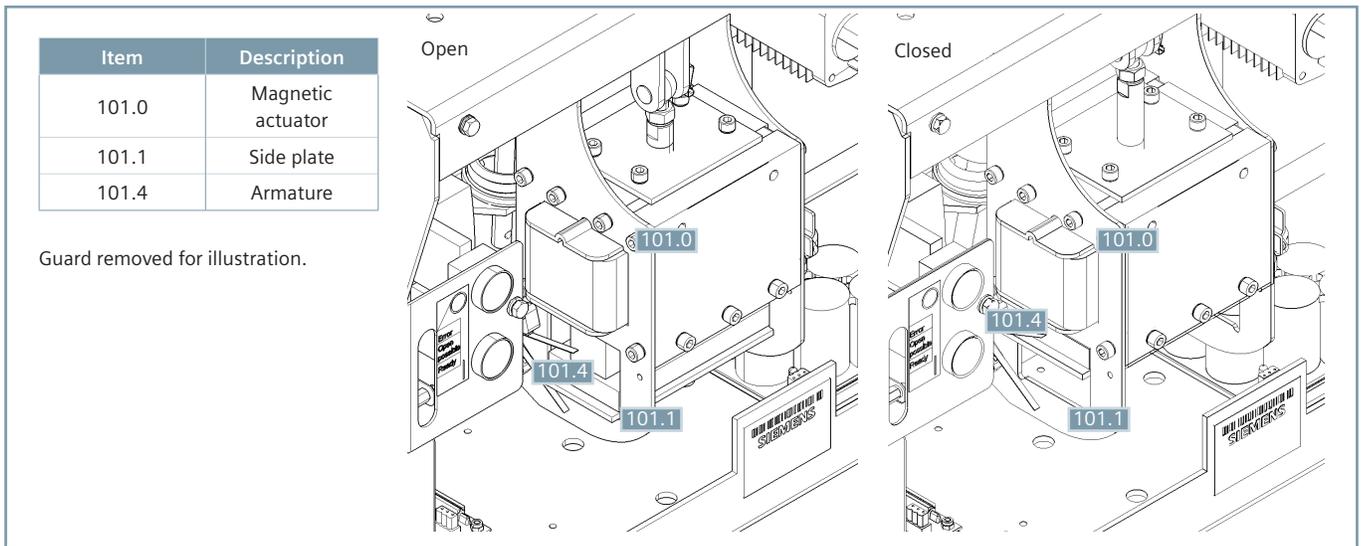


Figure 17: Visual position check of the magnetic actuator in OPEN/CLOSED position

Visual position check of the magnetic actuator

In the OPEN position of the circuit breaker, the armature (101.4) is in the lower position.

Verify visually that the air gap between bottom edge of the armature (101.4) and the lower edge of the opening in the side plate (101.1) is even along the edge.

In the CLOSED position of the circuit breaker, armature (101.4) is in the upper position. Check that the armature is in a secure end (upper) position at the upper edge of the opening in the side plate (101.1).

1. Perform the contact-erosion check. Contact erosion occurs when high fault currents are interrupted. Determination of acceptable contact condition is checked by the visibility of the white contact-erosion mark shown in Figure 18: Contact-erosion check mark dot circled in orange (shown with circuit breaker CLOSED). The white contact-erosion mark is located on the movable stem of the vacuum interrupter, near the plastic guide bushing. The contact-erosion check procedure is:
 - a) Be sure the circuit breaker primary contacts are closed.
 - b) Observe the white contact-erosion mark.

Refer to Figure 18: Contact-erosion check mark dot circled in orange (shown with circuit breaker CLOSED). When any part of the white contact-erosion mark is visible, contact wear is within acceptable limits. A mechanic's mirror is a convenient means for viewing the contact-erosion mark on each vacuum interrupter.

2. Press the Open pushbutton (54.0) after completing the contact-erosion check. Visually verify that the circuit breaker contacts are open.

Electrical control checks

The electrical controls of the circuit breaker should be checked during inspections to verify absence of any mechanical damage, and proper operation of the magnetic actuator and associated closing and opening operations.

Unless otherwise noted, all of these tests are performed without any control power applied to the circuit breaker.

Check of the wiring and terminals

1. Physically check all of the circuit breaker wiring for evidence of abrasion, cuts, burning or mechanical damage.
2. Check all terminals to be certain they are solidly attached to their respective device.

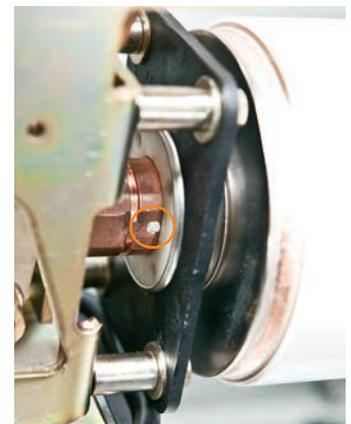


Figure 18: Contact-erosion check mark dot circled in orange (shown with circuit breaker CLOSED)

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).



⚠ DANGER

Hazardous voltage and high-speed moving parts.

Will cause death, serious injury and property damage.

Do not bypass interlocks or otherwise make interlocks inoperative. Interlocks must be in operation at all times.

Read instruction manuals, observe safety instructions and use qualified personnel.

Capacitor charging check

Before conducting the capacitor charging check, discharge the capacitors first (refer to Fast discharge of capacitors (page 6) and automatic capacitor charging (page 9)). Then plug the connector (105.2) to the controller board (105.0), and switch on the control power disconnect device in the relay and control compartment. Observe the LEDs (105.1) at the front panel (109.0).

Primary tasks of this check are:

1. De-energize the control power source.
2. Unplug connector (105.2) to fast-discharge the capacitors.
3. After fast discharge is complete, plug in connector (105.2).
4. Energize the control power source. The capacitors should charge automatically.

When the capacitors are fully discharged and control power is then applied, the red LED lights, and the green LED lights after approximately 30-35 seconds. The red LED is off when the green LED lights.

If the capacitors have been fully discharged for a very long time, charging time may be significantly longer than indicated. If capacitor charging time is much longer than expected on initial energization, refer to "Capacitor charging after very long de-energization" on page 40 of the "Maintenance" section of this instruction manual.

Electrical close and trip check (control power required)

A check of the circuit breaker control circuits should be performed. This check is made with the control circuit of the circuit breaker energized.

1. Once the capacitors are charged (106.2), operate the circuit breaker electrical close command (via Close pushbutton). Verify by both the sound of the circuit breaker closing and by the main contact status indicator that the circuit breaker contacts are closed.
2. As soon as the circuit breaker has closed, the capacitors (106.2) will recharge automatically. This charging process is indicated by the LEDs (105.1) on the front panel. The capacitors retain sufficient charge for an opening operation while recharging is occurring.
3. After a satisfactory close operation is verified, operate the circuit breaker electrical open (or trip) command (via Open pushbutton, control switch or equivalent means). Verify by both the sound of the circuit breaker opening and by the main contact status indicator that the circuit breaker contacts are open.
4. After a satisfactory open operation is verified and the green LED lights, apply an electrical close signal and maintain the close signal. The circuit breaker should close, the capacitors (106.2) should recharge and the circuit breaker should not attempt to close again. The circuit breaker should not close again until the first close signal is removed and a second close signal is applied.

Table 4: Typical vacuum interrupter contact expected life

Rated maximum voltage kV	Interrupting class kA	Rated short-circuit current	Vacuum interrupter type	Graph	Right hand limit of curve (refer to Figure 19) ¹
15.5	20	20	VS-25008	A	20
15.5	25	25	VS-25008	A	25
15.5	31.5	31.5	VS-15052	B	31.5
15.5	40	40	VS-15052	B	40
27.6	20	20	VS-25008	A	20
27.6	25	25	VS-25008	A	25
38.0	20	20	VS-30030	C	20
38.0	25	25	VS-30030	C	25
38.0	31.5	31.5	VS-30041	C	31.5
38.0	40	40	VS-30041	C	40

Footnote:

¹ Rated short-circuit current. Refer to Table 10: Technical ratings on page 50.

Completion of these checks demonstrates satisfactory operation of auxiliary switches (68.0), the capacitor boards (106.1), the magnetic actuator (101.0), the opening spring (64.0) and the anti-pump function.

Vacuum interrupters

The expected life of vacuum interrupters is a function of the number of interruptions and magnitude of current interrupted (refer to Table 4: Typical vacuum interrupter contact expected life and Figure 19: Typical vacuum interrupter contact life curves on page 36).

The vacuum interrupters must be replaced before the number of mechanical operations (listed in Table 3: Maintenance and lubrication schedule on page 29) are reached, or when the contacts have been eroded beyond allowed limits. Vacuum interrupter replacement procedures are detailed in the following maintenance instructions.

The vacuum interrupter contact life curves (refer to Figure 19: Typical vacuum interrupter contact life curves on page 36) are offered as a guide to expected life.

Vacuum-integrity check (using mechanical test)

Before putting the circuit breaker into service, or if a vacuum interrupter is suspected of leaking as a result of mechanical damage, check the vacuum integrity either mechanically as described in this section, or alternatively, electrically using a high-potential test set as described in the next section.

Open and isolate the circuit breaker and detach the insulating coupler (48.0) from lever (48.6).

The atmospheric pressure will force the moving contact of a hermetically sealed vacuum interrupter into the closed position, causing lever (48.6) to move into the position shown in Figure 20: Manual check of vacuum integrity on page 38).

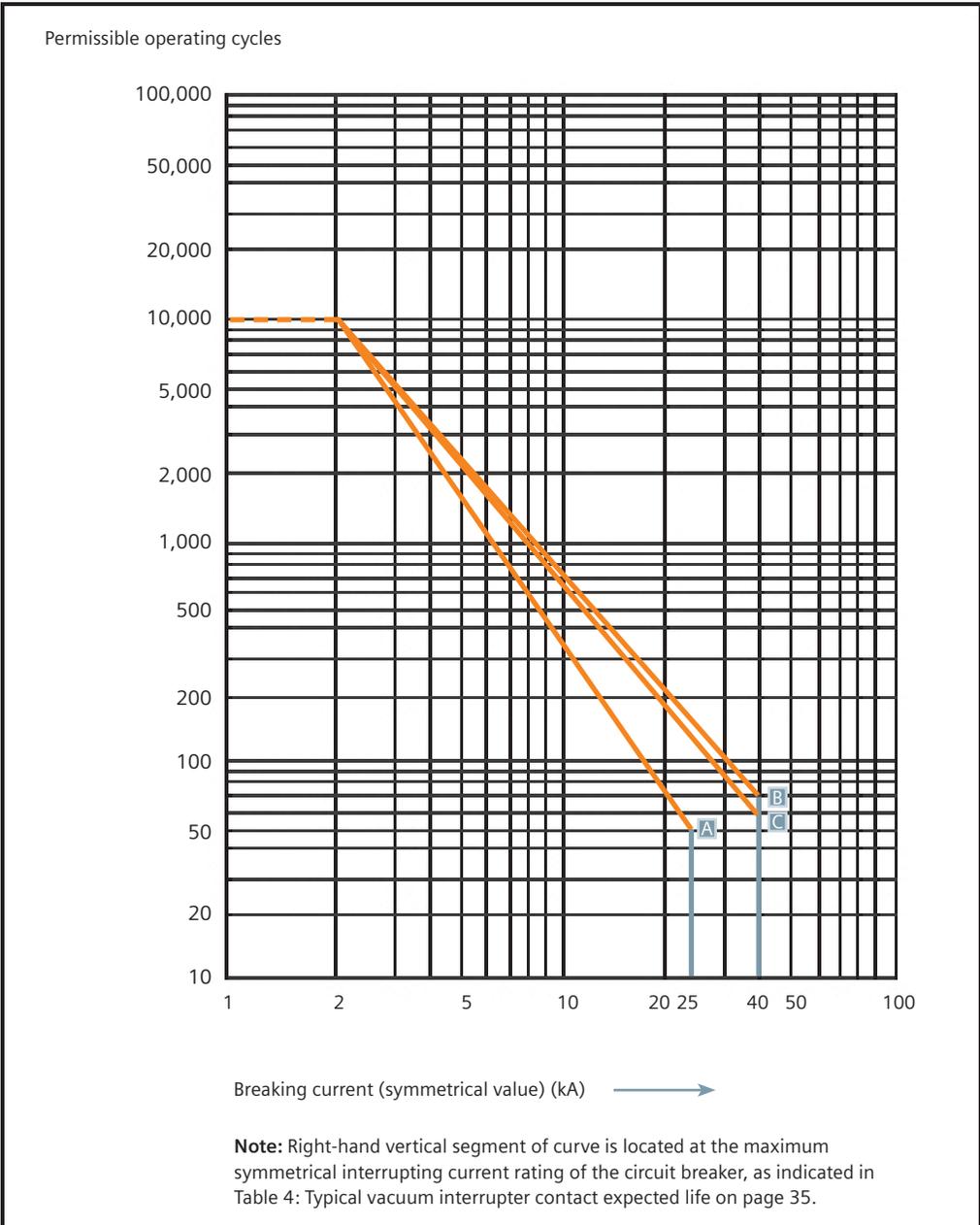
A vacuum interrupter may be assumed to be intact if it shows the following characteristics:

1. An appreciable closing force has to be overcome when lever (48.6) is moved to the OPEN position by hand;
2. When the lever is released, it must automatically return to the CLOSED position with an audible sound as the contacts touch.

After checking the vacuum, reconnect the lever (48.6) to the insulating coupler (48.0).

Figure 19: Typical vacuum interrupter contact life curves

Load graph "A" vacuum interrupter type VS-25008
 Load graph "B" vacuum interrupter type VS-15052
 Load graph "C" vacuum interrupter types VS-30030 and VS-30041



	 <b style="font-size: 1.2em; margin-left: 10px;">DANGER
	<p>High-potential tests employ hazardous voltages.</p> <p>Will cause death and serious injury.</p> <p>Follow safe procedures, exclude unnecessary personnel and use safety barriers. Keep away from the circuit breaker during application of test voltages.</p>

	 <b style="font-size: 1.2em; margin-left: 10px;">WARNING
	<p>Vacuum interrupters may emit X-ray radiation.</p> <p>Can result in serious injury.</p> <p>Keep personnel more than six feet away from a circuit breaker under test.</p>

High-potential tests

The next series of tests (vacuum-integrity test and insulation tests) involve use of high-voltage test equipment. The circuit breaker under test should be inside a suitable test barrier equipped with warning lights.

Vacuum-integrity check (using dielectric test)

A high-potential test is used to verify the vacuum integrity of the circuit breaker. The test is conducted on the circuit breaker with its primary contacts in the open position.

Vacuum integrity test procedure

1. Observe safety precautions listed in the danger and warning advisories. Construct the proper barrier and warning light system.
2. Ground the frame of the circuit breaker, and ground each pole not under test.
3. Apply test voltage (refer to Table 5: High-potential test voltages on page 38) across each pole for one minute (circuit breaker open).
4. If the pole sustains the test voltage for that period, its vacuum integrity has been verified.

Note: Do not use dc high-potential testers incorporating half-wave rectification. These devices produce high-peak voltages.

High-peak voltages will produce X-ray radiation. DC testers producing excessive peak voltages also show erroneous readings of leakage current when testing vacuum circuit breakers.

Note: This test includes not only the vacuum interrupter, but also the other insulation components in parallel with the vacuum interrupter. These include the post insulators (16.1) and the insulating coupler, as well as the insulating (tension) struts (28.0) between the upper and lower vacuum interrupter supports. If these insulation components are contaminated or defective, the test voltage will not be sustained. If so, clean replace the affected components, and retest.



Item	Description
48.0	Insulating coupler (shown disconnected on right pole for checking vacuum integrity)
48.6	Lever

Figure 20: Manual check of vacuum integrity

Equipment maximum voltage rating kV	Equipment rated power-frequency withstand kV (rms)	Maximum ac rms test voltage kV	Maximum dc test voltage kV
15.5	50	38	53
27.6	60	45	64
38	80	60	85

Table 5: High-potential test voltages

High-potential test voltages

The voltages for high-potential tests are shown in Table 5.

As-found insulation and contact resistance tests

As-found tests verify the integrity of the circuit breaker insulation system. Megger* or insulation-resistance tests and contact-resistance tests conducted on equipment prior to installation provide a basis of future comparison to detect changes in the protection afforded by the insulation system, and in the integrity of the current carrying path. A permanent record of periodic as-found tests enables the maintenance organization to determine when corrective actions are required by watching for significant deterioration in insulation resistance, or increases in contact resistance.

* Megger is a registered trademark of Megger Group, Ltd.

Insulation and contact-resistance test equipment

In addition to the high-potential test equipment capable of test voltages as listed in Table 5, the following equipment is also required:

- AC high-potential tester with test voltage of 1,500 volts, 60 Hz
- Test equipment for contact-resistance tests.

Insulation and contact-resistance test procedure

1. Observe safety precaution listed in the danger and warning advisories for the vacuum integrity check tests (refer to pages 37).
2. Ground the frame of the circuit breaker. Apply control power for electrical charging of capacitors (106.2). Close the circuit breaker.
3. Apply the proper ac or dc high-potential test voltage (refer to Table 5: High-potential test voltages on page 38) between a primary conductor of the pole and ground for one minute.

4. If no disruptive discharge occurs, the insulation system is satisfactory.
5. Open the circuit breaker using the red pushbutton.
6. After test, ground both ends and the middle of each vacuum interrupter to dissipate any static charge.

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).

7. Unplug the connector (105.2) to the controller board (105.0).
8. Disconnect secondary circuits for the operating mechanism by disconnecting the multiple pin-plug at the lower left corner of the operator, and connect all pins on the operator side with a shorting wire. Connect the shorting wire to the high-potential lead of the high-voltage tester, and ground the circuit breaker housing. Starting with zero voltage, gradually increase the test voltage to 1,500 volts rms, 60 Hz. Maintain test voltage for one minute.

9. If no disruptive discharge occurs, the secondary control insulation level is satisfactory.
10. Disconnect the shorting wire, reattach the multiple pin-plug and reattach the plug (105.2) to the controller board (105.0). Switch on the control power disconnect device in the relay and control compartment.

11. Close the circuit breaker using the black pushbutton.
12. Open the circuit breaker using the red pushbutton.
13. Switch off the control power disconnect device in the relay and control compartment, unplug the connector (105.2) from the controller board.
14. Perform contact-resistance tests of the primary contacts. The resistance should be determined between the fixed-end connection pad and the moving-end connection pad (refer to Figure 7: Pole assembly on page 14). Contact resistance should not exceed the values listed in Table 6: Maximum contact resistance.

Inspection and cleaning of circuit breaker insulation

Rotate the manual opening lever 90° to the OFF position. This prevents the circuit breaker from closing. Lock the manual opening lever with a padlock.

1. Open the upper doors of the type SDV7-MA circuit breaker.
2. Remove any phase barriers if furnished (applicable for certain types only).
3. Clean barriers and post insulators (16.1) using clean cloth dipped in isopropyl alcohol.
4. Reinstall all barriers. Check all visible fasteners again for condition and tightness.

Note: Do not use any cleaning compounds containing chlorinated hydrocarbons, such as: trichlorethylene, perchlorethylene or carbon tetrachloride.

These compounds will damage the phenylene ether copolymer material used in the barriers and other insulation on the circuit breaker.

Current rating A	Contact resistance Micro-Ohms
1,200	35
2,000	30
2,500	30
3,000	30

Table 6: Maximum contact resistance

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).

Functional tests

Refer to the installation checklist in the installation checks and initial functional tests section of this instruction manual (refer to pages 6-9).

1. Discharge the capacitors (106.2).
 - a) Remove the mechanism housing cover (60.1) from the mechanism housing (60.0).
 - b) Refer to notice on page 27 to prevent damage due to electrostatic discharge. Switch off the control power disconnect device in the relay and control compartment.
 - c) Fast discharge the capacitors (106.2) by unplugging the connector (105.2) from the controller board (105.0). Do not unplug connector (106.3) from the capacitor boards, or damage to the capacitor board or the controller board may occur.

The red LED on each of the capacitor boards (106.1) indicates the discharge state of the capacitors (106.2). When the capacitors are discharging, the red LEDs are flashing. When the red LEDs stop flashing, the capacitors (106.2) are discharged.

If the capacitors have been fully discharged for a very long time, charging time may be significantly longer than indicated. If capacitor charging time is much longer than expected on initial energization, refer to "Capacitor charging after very long de-energization" on page 40 of the "Maintenance" section of this instruction manual.

2. Charge the capacitors.
 - a) Plug the connector (105.2) to the controller board (105.0).
 - b) Switch on the control power disconnect device in the relay and control compartment. The system runs its initialization routine.
 - c) When the capacitors are fully discharged and control power is first applied, the red LED will be illuminated, followed by the green LED after approximately 30-35 seconds. The red LED is off when the green LED lights.

Verify that the discharging/charging procedures have been completed successfully.

3. Perform at least three OPEN-CLOSE procedures.
 - a) Press the Open pushbutton (54.0). Verify that the circuit breaker contacts open by inspecting the indicator (58.0).
 - b) Press the Close pushbutton (53.0). Verify that the circuit breaker contacts close by inspecting the indicator (58.0).

If the circuit breaker will not be returned to service, open the control power disconnects for the circuit breaker. Using the manual opening lever, rotate the interlock lever from the NORMAL position 90° to prevent closing of the circuit breaker (refer to Figure 9: Manual opening mechanism components on page 17). Use a padlock to lock the circuit breaker in the OPEN position. Reinstall the operator mechanism housing cover (60.1).

Charging capacitors after lengthy de-energized state

The capacitors used in the capacitor boards (item 106.1 in Figure 8: Magnetic-actuator operating mechanism on page 15) are of the electrolytic type. If an electrolytic capacitor has not been energized for a very long time, a significantly longer charging time may be required when first energized.

If during charging, the red LED does not change status within three minutes, disconnect control power and wait for ten minutes (or alternatively, disconnect the plug (item 105.2 in Figure 8: Magnetic-actuator operating mechanism on page 15), and wait for the red LED (item 106.4 in Figure 2: Operator controls and discharging capacitors on page 7) to stop blinking. After ten minutes (or after the capacitors are discharged and the red LED has stopped blinking), energize the control circuit again. The LEDs on the front panel (item 105.1 in Figure 2: Operator controls and discharging capacitors on page 7) should now indicate charging system function normally.

These steps should not be necessary if the control circuit has been energized recently, as the oxide layer of the positive plates of the capacitor should be in normal condition.

Overhaul

Introduction

The following procedures along with Table 9: Troubleshooting on page 49, provide maintenance personnel with a guide to identifying and correcting possible malfunctions of the circuit breaker.

Circuit breaker overhaul

Table 7 gives the recommended overhaul schedule for the type 3AH35-MA operating mechanisms. These intervals assume that the circuit breaker is operated under “usual service conditions” as discussed in ANSI/IEEE C37.04 section 4 and elaborated in C37.010 section 4. If the circuit breaker is operated frequently, the overhaul interval in Table 7 may coincide with the maintenance interval in Table 3: Maintenance and lubrication schedule on page 29.

Circuit breaker type	Closing operations
SDV7-MA outdoor distribution circuit breaker	10,000

Table 7: Overhaul schedule

Replacement at overhaul

The following components are replaced during an overhaul of the circuit breaker, when required:

- Vacuum interrupters as determined by vacuum integrity test, contact erosion or according to overhaul schedule (refer to Table 7)
- Controller board
- Capacitor boards
- Power supply.

When these parts are changed, locking devices must also be removed and replaced. These include lock washers, retaining rings, retaining clips, spring pins, cotter pins, etc.

1. Replace vacuum interrupter; instructions follow.
2. Lubricate operating mechanism according to maintenance and lubrication information (refer to pages 29-31).
3. When work is finished, operate circuit breaker and close and open several times, and check that all screw connections are tight. Refer to “Installation checks and functional tests” on pages 6-9.

When it necessary to replace electronic components (for example, the controller board (105.0) in Figure 21: Controller board replacement or a capacitor board (107.1) in Figure 22: Capacitor board replacement on page 43), it is necessary to provide the circuit breaker serial number (as for any parts needed), and in addition, the MLFB number of the magnetic actuator. The MLFB number is located on a label in front of and below the magnetic actuator, as shown in Figure 16: Magnetic-actuator operator mechanism lubrication on page 31.

Controller board replacement

When replacing controller board, use appropriate procedures to avoid electrostatic discharges, which could damage the new controller board.

A replacement controller board is supplied with replacement washers and nylon insert locknuts. Tools required for replacement of the controller board are a 7 mm wrench and a 5 mm hex key.

1. Remove the front cover of the operator housing.

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).

2. Unplug the connector (105.2) from the bottom of the controller board and wait for the red LED on each capacitor board to stop blinking. This indicates discharge of the capacitors to a low voltage. Do not unplug connector (106.3) from the capacitor boards, or damage to the capacitor board or the controller board may occur.
3. Remove the cables from the pushbuttons (53.0, 54.0) on the panel (109.0). This might be easier to perform after the panel is loose as in step 5.
4. Remove the screws (109.1) and retaining elements from the panel (109.0).
5. Remove the panel (109.0).
6. Unplug the connector (105.5) from the bottom of the controller board (105.0) and the several connectors at the top of the controller board (105.0).
7. Disconnect the ground wire (105.4).
8. Remove the mounting nuts and washers (105.3) from the side of the mechanism housing (60.0).
9. Remove the controller board (105.0).
10. Install the replacement controller board (105.0) and tighten the mounting nuts and washers (105.3).
11. Connect the ground wire (105.4).
12. Plug in the connectors (105.2, 105.5 and the several connectors at the top of the controller board).
13. Fasten the panel (109.0) with the screws (109.1).
14. Reconnect the cables to the pushbuttons (53.0, 54.0).

When work is finished, operate circuit breaker and close and open several times, and check that all screw connections are tight. Refer to "Installation checks and functional tests" on pages 6-9.

Capacitor board replacement

1. Remove the front cover of the operator housing.
2. Use appropriate procedures to prevent electrostatic discharges.
3. Unplug the connector (105.2) from the bottom of the controller board and wait for the red LED on each capacitor board to stop blinking. This indicates discharge of the capacitors to a low voltage. Do not unplug connector (106.3) from the capacitor boards, or damage to the capacitor board or the controller board may occur.
4. Unplug the connector (106.3) from the capacitor board (106.1).
5. Remove the mounting screws (106.5) from the underside of the mechanism housing (60.0).
6. Remove the capacitor board (106.1).
7. Install the replacement capacitor board (106.1), fasten the mounting screws (106.5) and plug in the connector (106.3) to the board.

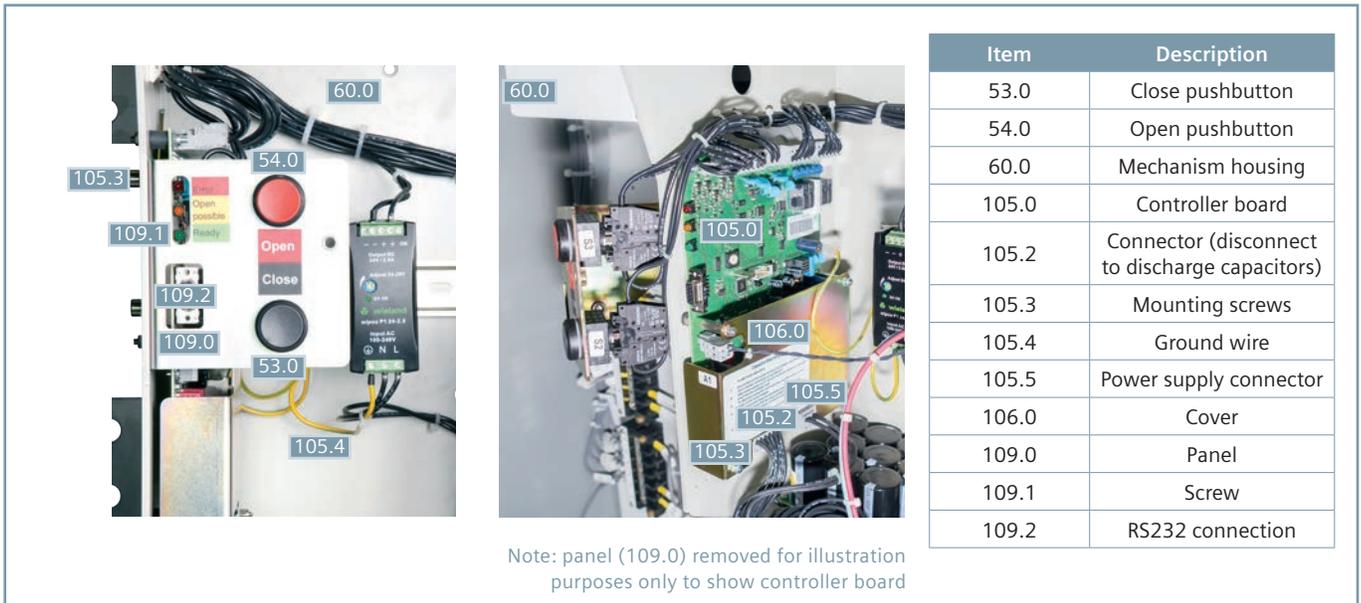


Figure 21: Controller board replacement



Figure 22: Capacitor board replacement

When work is finished, operate circuit breaker and close and open several times, and check that all screw connections are tight. Refer to "Installation checks and functional tests" on pages 6-9.

If the capacitors have been fully discharged for a very long time, charging time may be significantly longer than indicated. If capacitor charging time is much longer than expected on initial energization, refer to "Capacitor charging after very long de-energization" on page 40 of the "Maintenance" section of this instruction manual.



Item	Description
104.0	Power supply

Figure 23: Power supply replacement

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).

Power supply replacement

The electronic controller power supply is suitable for input voltages for the high range of 95-250 Vdc or 85-265 Vac, and for the low range 28-56 Vdc.

1. Remove the front cover of the operator housing.
2. Use appropriate procedures to prevent electrostatic discharges.
3. Unplug the connector (105.2) from the bottom of the controller board and wait for the red LED on each capacitor board to stop blinking. This indicates discharge of the capacitors to a low voltage. Do not unplug connector (106.3) from the capacitor board, or damage to the capacitor board or the controller board may occur.
4. Mark the wires so that they can be reinstalled to the correct terminals.
5. Remove the wires from the power supply.
6. Disconnect the power supply from the DIN-rail by pushing down on the latch on the rear top surface of the power supply.
7. Install the replacement power supply by snapping it onto the DIN-rail.
8. Reinstall the wires to the power supply.

When work is finished, operate circuit breaker and close and open several times, and check that all screw connections are tight. Refer to "Installation checks and functional tests" on pages 6-9.

Replacement of vacuum interrupters

Replacement vacuum interrupters are furnished as a complete assembly. They have been completely tested and dielectrically and mechanically conditioned.

It is recommended that one vacuum interrupter be removed and replaced completely rather than removing two or more vacuum interrupters at a time.

The following procedure in check list format describes the procedure for removing and replacing a vacuum interrupter. Components may be identified by reference to Figure 24: Vacuum interrupter replacement illustration on page 46 and Figure 25: Illustration showing required technique for fastening terminal-clamp hardware on page 47.

Instructions herein apply for replacement of all vacuum interrupters except vacuum interrupters on 3,000 A circuit breakers having the flexible connector (refer to 29.1 in Figure 24: Vacuum interrupter replacement illustration on page 46) electron-beam welded to the moving terminal (refer to 36.1 in Figure 24: Vacuum interrupter replacement illustration on page 46) of the vacuum interrupter. These interrupters must be replaced by factory-trained personnel. Contact Siemens medium-voltage customer service at +1 (800) 347-6659 or +1 (919) 365-2200 outside the U.S.

1. Removing the vacuum interrupter

Note: Special care needs to be exercised in removal or installation of hardware around the movable contact end of the vacuum interrupter.

The movable contact uses a metal bellows to maintain the vacuum seal while still permitting motion of the contact along the axis of a vacuum interrupter. The bellows is rugged and reliable, and is designed to withstand years of axial movement. However, care should be exercised to avoid subjecting the bellows to excessive torque during removal and replacement. Twisting the bellows through careless bolt removal or tightening may damage the vacuum interrupter, resulting in loss of vacuum integrity.

- 1.1 Before starting work, the circuit breaker should be isolated from all primary and control power sources. Make sure that the capacitors are discharged by unplugging connector 105.2 from the controller board. Discharge any static charge by grounding both ends and the middle of each vacuum interrupter. Carefully remove phase barriers (if present).
- 1.2 Loosen the lateral bolt(s) on terminal clamp (29.2). Employ the illustrated procedure to loosen clamp hardware (refer to Figure 25: Illustration showing required technique for fastening terminal-clamp hardware on page 47).
- 1.3 Withdraw pin (48.5) from insulating coupler (48.0) and levers (48.6).
- 1.4 Remove coupling pin from the eye bolt (36.3).

- 1.5 Free struts (28.0) from the pole head (20.0). Loosen the strut hardware on the moving-end pole head (40.0) and swing the struts (28.0) away from the vacuum interrupter.
- 1.6 Loosen screws fastening the centering ring (28.1).
- 1.7 Remove bolt (31.2), lock washer and large washer at the stationary contact end of the vacuum interrupter (18 mm or 24 mm socket with extension).
- 1.8 Using a 24 mm socket with an extension, loosen and remove hex-cap screw fastening the fixed-end pole head (20.0) to the post insulator (16.1). Completely remove the fixed-end pole head (20.0) and set aside.
- 1.9 Grasp the vacuum interrupter (30.0) and withdraw horizontally. Assistance may be required to work the terminal clamp off the movable stem of the vacuum interrupter.
- 2.5 Attach struts (28.0) to the fixed-end pole head (20.0), replace hardware (M10), but do not tighten at this time.
- 2.6 Couple levers (48.6) and drive link (48.9) to the eye bolt (36.3), using the pin supplied. Apply retaining clips. Appropriate pin is modestly chamfered, not to be confused with pin for the insulating coupler.
- 2.7 Align fixed-end pole head (20.0) correctly and tighten bolt fastening it to the post insulator (16.1). Torque M16 bolt to 130 Nm (96 ft-lb). Fasten securely all bolts associated with struts (28.0).
- 2.8 Tighten vacuum interrupter fastening bolt (31.2) on the fixed-end pole head (20.0) holding the vacuum interrupter firmly by its fixed-end insulator and operate levers (48.6), by hand, to see whether the movable contact moves freely. If any binding or lack of freedom is noted, loosen bolt (31.2) and adjust the vacuum interrupter in the fixed-end pole head (20.0) by turning and moving it slightly. Torque M12 bolt to 60 Nm (44 ft-lb) and M16 bolt to 130 Nm (96 ft-lb).

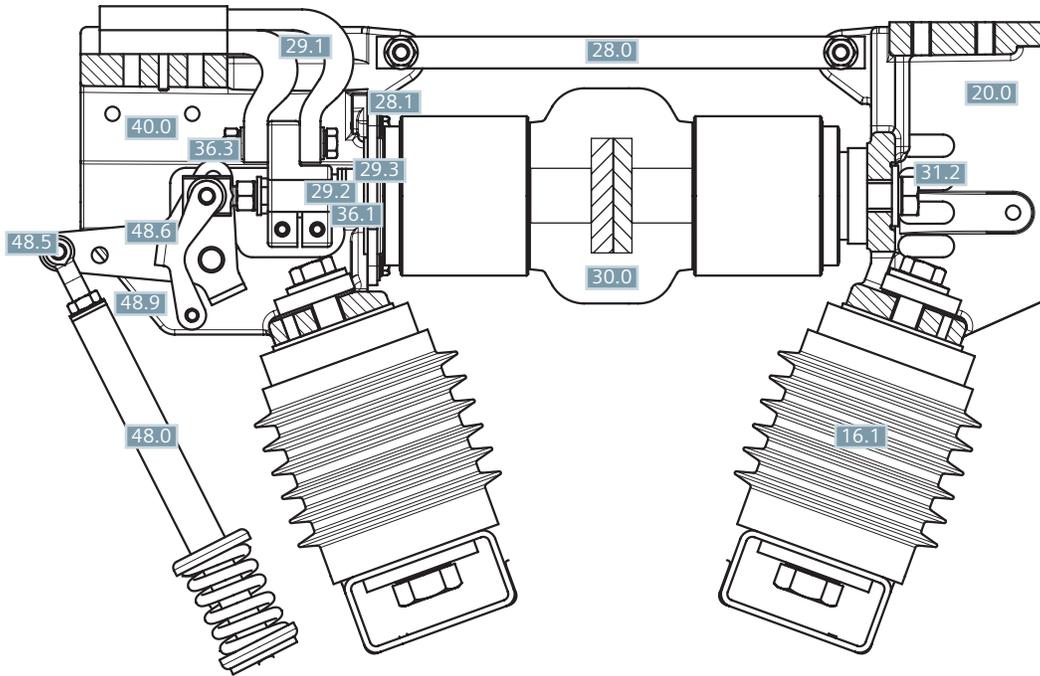
Note: DO NOT USE UNDUE FORCE OR TWISTING MOTION. If the terminal clamp (29.2) cannot be easily removed, STOP!, check to be certain hardware is loose, and that the terminal clamp (29.2) is not binding.

2. Installing a vacuum interrupter

Note: Replacement vacuum interrupter (30.0) will be received from the factory with an eye bolt (36.3) in place, adjusted and torqued to specific requirements. DO NOT ALTER THE ADAPTER (EYE-BOLT) SETTING.

- 2.1 Inspect all silver-plated connection surfaces for cleanliness. Clean only with a cloth and solvent. Do not abrade, as this will damage the silver plating.
- 2.2 Insert vacuum interrupter (30.0) into the moving-end pole head (40.0). Slip terminal clamp (29.2) into position on the movable stem.
- 2.3 Fasten the fixed-end pole head (20.0) to the post insulator (16.1) "finger tight" using hex-head bolt, lock washer and flat washer.
- 2.4 Align vacuum interrupter and fasten "finger tight" to the fixed-end pole head (20.0) using heavy flat washer, lock washer and bolt (31.2).
- 2.9 The centering ring (28.1) has been loose and "floating" during installation of the vacuum interrupter. Check that the movable contact is free to move axially without binding, and then tighten the hardware which secures the centering ring (28.1). Recheck that the movable contact is free to move axially without binding.
- 2.10 Move the terminal clamp (29.2) against the step or the spacer (if applicable) of the moving contact (36.1) of the vacuum interrupter (30.0) so that the recess of the movable contact faces the connecting surface of the flexible connector (29.1). Employ technique illustrated to fasten terminal clamp (refer to Figure 25: Illustration showing required technique for fastening terminal-clamp hardware on page 47). Note opposing wrenches. Tighten the bolt(s) of the terminal clamp to a torque of 40 Nm (30 ft-lb), taking care to see that the terminal of the vacuum interrupter is not subjected to excessive bending movement.

Figure 24: Vacuum interrupter replacement illustration



Item	Description
16.1	Post insulator
20.0	Fixed-end pole head
28.0	Strut
28.1	Centering ring
29.1	Flexible connector
29.2	Terminal clamp
29.3	Spacer (or shoulder)
30.0	Vacuum interrupter
31.2	Fixed-end terminal bolt
36.1	Moving terminal
36.3	Eye bolt (or adapter)
40.0	Moving-end pole head
48.0	Insulating coupler
48.5	Pin
48.6	Angled lever
48.9	Guide link

Note: Excessive bending movement exerted while fastening the terminal clamp will damage the vacuum interrupter.

2.11 Attach insulating coupler (48.0) and lever (48.6) together, using pin (48.5). Apply retaining clips. Correct pin has ends that have been generously chamfered.

NOTICE

Capacitor discharge plug (105.2)

Disconnect control power prior to removing or replacing the capacitor discharge plug. Refer to Figure 2 on page 7.

To discharge capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect device (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- After control power is off, disconnect the capacitor discharge plug (105.2) from the controller board (105.0) to discharge capacitors.

To reconnect capacitors:

- Disconnect control power to the circuit breaker by opening the disconnect (device 08 in the typical schematic in Figure 14 on page 24) located in the control compartment.
- Insert the capacitor discharge plug (105.2) (with six pins) into the left-hand receptacle on the controller board (105.0). Ensure that the plug is properly seated and the plug position is level with the power supply connection plug (105.5) that is located to the right of the capacitor discharge plug.
- After the capacitor discharge plug is firmly seated, reconnect control power to the circuit breaker (device 08 in the typical schematic in Figure 14 on page 24).

2.12 Open and close circuit breaker several times and then check to see that all bolted joints and devices are tight. Plug in the connector (105.2) to the controller board and close the control power disconnect device in the relay and control compartment.

3. Checking the contact stroke

3.1 Open the circuit breaker. Open the control power disconnect device in the relay and control compartment and unplug the connector (105.2) from the controller board.

3.2 Free insulating coupler (48.0) by removing pin (48.5). The vacuum interrupter contacts must now close automatically as a consequence of atmospheric pressure.

3.3 Observe the terminal clamp (29.2) through the openings on each side of the moving-end pole head (40.0). Using vernier calipers, measure the

distance from the bottom surface of the terminal clamp to the bottom edge of the cutout opening. Measure carefully and record your result.

3.4 Connect the insulating coupler (48.0) using pin (48.5) and the retaining clips provided.

3.5 Repeat the measurement described in step 3.3 again with care to maximize accuracy. Record your result.

3.6 Determine difference between the measurements made under steps 3.3 and 3.5. Your results should be per Table 8: Vacuum interrupter stroke on page 48.

3.7 If you fail to achieve the listed results, carefully repeat the entire procedure making certain of your measurements.

3.8 To adjust the stroke, loosen eye bolt locking nut on insulating coupler (48.0), and retain position of the eye. Make adjustments in one-half turn increments. After adjustment is completed, tighten eye bolt locking nut to 26-34 ft-lb. (35-45 Nm).

4. After eye bolt is tightened to proper torque, repeat all measurement procedures, making certain they are in agreement with values indicated in step 3.6.

5. Complete all other maintenance procedures. Completely reassembled circuit breaker should pass the high-potential test before it is ready for service.

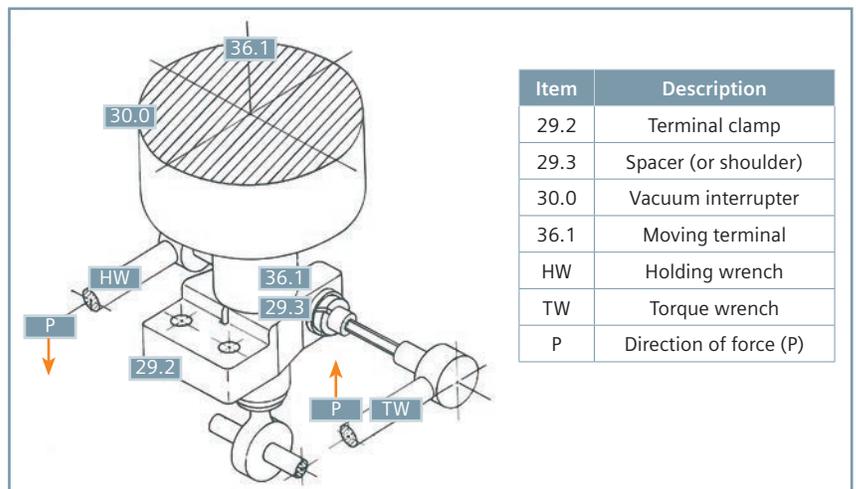


Figure 25: Illustration showing required technique for fastening terminal-clamp hardware

Technical data and troubleshooting

Table 8: Vacuum interrupter stroke

Rated maximum voltage	Interrupting class	Rated short-circuit current	Vacuum interrupter	Continuous current	Stroke ²
kV	kA	kA	Type	A	mm
15.5	20	20 kA@15.5 kV	VS-25008	1,200, 2,000	13-15
15.5	25	25 kA@15.5 kV	VS-25008	1,200, 2,000	13-15
15.5	31.5	31.5 kA@15.5 kV	VS-15052	1,200, 2,000, 3,000	7-9
15.5	40	40 kA@15.5 kV	VS-15052	1,200, 2,000, 3,000	7-9
27.6	20	20 kA@27.6 kV	VS-25008	1,200, 2,000	13-15
27.6	25	25 kA@27.6 kV	VS-25008	1,200, 2,000	13-15
38.0	20	20 kA@38.0 kV	VS-30030	1,200, 2,000, 2,500	18-22
38.0	25	25 kA@38.0 kV	VS-30030	1,200, 2,000, 2,500	18-22
38.0	31.5	31.5 kA@38.0 kV	VS-30041	1,200, 2,000, 2,500	18-22
38.0	40	40 kA@38.0 kV	VS-30041	1,200, 2,000, 2,500	18-22

Footnotes:

1. The vacuum interrupter type designation is labeled on the vacuum interrupter. If the vacuum interrupter installed does not match that indicated in this table, contact the nearest Siemens representative.
2. If you need assistance achieving the indicated stroke setting, contact the nearest Siemens representative.

Table 9: Troubleshooting

Problem	Symptoms	Possible causes and remedies
Circuit breaker fails to close.	No sound of circuit breaker closing. CLOSE/OPEN indicator (58.0) in OPEN position.	<ol style="list-style-type: none"> 1. Manual opening lever is in the lockout position (114.0). S6 is open. 2. Control voltage is absent. Check the: <ul style="list-style-type: none"> ■ Control power disconnect device in the relay and control compartment ■ Supply of control power - check incoming control voltage ■ Controller board ■ LEDs (105.1) should show green. Pay attention to damage to wiring, terminals and connectors. 3. Internal position switch OPEN (113.2 S5) is not in OPEN position. 4. Capacitors are not charged sufficiently. Check the: <ul style="list-style-type: none"> ■ Connector (105.2) from capacitors to controller board (105.0) correctly and firmly connected ■ Connector on the capacitor board for tight seat ■ Capacitor board. Pay attention to damage to wires and signs of capacitor damage. 5. Check the linkage assembly including the opening spring. 6. Interruption of the circuit of magnetic-actuator's coil (101.0). 7. If the red LED is illuminated, check these possible causes: <ul style="list-style-type: none"> ■ Actuator position inconsistent, S4 or S5 malfunction or connections to controller board incorrect ■ Lockout switch S6 activated or not connected correctly ■ Coil circuit connections damaged or incorrect ■ Capacitor board(s) damaged, or connections incorrect. 8. If the yellow LED is illuminated (temporarily), additional time is necessary for capacitors to reach sufficient charge. 9. If the yellow LED is illuminated (continuously), the capacitor board(s) is damaged or not connected properly. 10. If no LEDs are illuminated, refer to item 7. 11. If the green LED is illuminated, the controller self-test process was successful. Refer to item 5.
Circuit breaker fails to trip.	No sound of circuit breaker closing. CLOSE/OPEN indicator (58.0) in CLOSED position.	<ol style="list-style-type: none"> 1. Control voltage is absent. Check the: <ul style="list-style-type: none"> ■ Control power disconnect device in the relay and control compartment ■ Supply of control power - check incoming control voltage ■ Controller board ■ LEDs (105.1) should show green. Pay attention to damage to wiring, terminals and connectors. 2. Internal position switch CLOSED (113.1, S4) is not in CLOSED position. 3. Capacitors are not charged sufficiently. Check the: <ul style="list-style-type: none"> ■ Connector (105.2) from capacitors to controller board (105.0) correctly and firmly connected ■ Connector on the capacitor board for tight seat ■ Capacitor board. Pay attention to damage to wiring and signs of capacitor damage. 4. Check the linkage assembly including the opening spring. 5. Interruption of the circuit of magnetic-actuator's coil (101.0).

Table 10: Technical ratings

Circuit breaker type SDV7-MA	Rated maximum voltage	Rated withstand voltages		Rated short-circuit and short-time current	Rated interrupting time	Rated continuous current	Rated transient recovery voltage ¹		Rated permissible tripping delay time Y	Rated closing and latching current
		Lightning impulse (BIL)	Power frequency				u _c TRV peak value	t ₃ time to voltage u _c		
	kV, rms	kV ²	kV	kA, rms	ms/cycles	A, rms	kV	µs	sec	kA, peak
15.5-20	15.5	110/142	50	20	50/3	1,200, 2,000	29.2	32	2	52
15.5-25	15.5	110/142	50	25	50/3	1,200, 2,000	29.2	32	2	65
15.5-31.5	15.5	110/142	50	31.5	50/3	1,200, 2,000, 3,000	29.2	32	2	82
15.5-40	15.5	110/142	50	40	50/3	1,200, 2,000, 3,000	29.2	32	2	104
27.6-20	27.6	150/194	60	20	50/3	1,200, 2,000	52.1	45	2	52
27.6-25	27.6	150/194	60	25	50/3	1,200, 2,000	52.1	45	2	65
38.0-20	38.0	200/258	80	20	50/3	1,200, 2,000, 2,500	71.7	59	2	52
38.0-25	38.0	200/258	80	25	50/3	1,200, 2,000, 2,500	71.7	59	2	65
38.0-31.5	38.0	200/258	80	31.5	50/3	1,200, 2,000, 2,500	71.7	59	2	82
38.0-40	38.0	200/258	80	40	50/3	1,200, 2,000, 2,500	71.7	59	2	104

Footnotes:

- ¹ TRV values are in accord with IEEE C37.06-2009. TRV peak value u_c is roughly equal to historic E₂ value in ANSI C37.06-2000. Value t₃, time to voltage u_c, is approximately 1/1.138 times the T₂ value in ANSI C37.06-2000.
- ² First value is full-wave impulse withstand circuit breaker open or closed. Second value is chopped-wave impulse withstand, applicable only with circuit breaker closed.

Table 11: Control data

Electronic controller power supply	Input voltage range	Input power ⁴	Controller output		Capacitor voltage ^{2,3}
			Close	Open	
	28-56 Vdc	80 W ⁴	40-55 A	10-15 A	160 Vdc
	95-250 Vdc/ 100-254 Vac	60 W/60 VA ⁴	40-55 A	10-15 A	160 Vdc
Binary inputs (close and open commands)	Low range model		≥ 17 Vdc or 17 Vac		Recommended duration ≥ 100 ms
	High range model		≥ 69 Vdc or 53 Vac		Recommended duration ≥ 100 ms

Footnotes:

- ¹ If controller power fails, capacitors retain sufficient charge to open circuit breaker within 300 seconds, with minimum open command duration 100 ms.
- ² Capacitors discharge to 10 V or less within five minutes after disconnecting plug 105.2.
- ³ Capacitor charging time approximately 30-35 seconds from complete discharge, approximately 12 seconds after OPEN-CLOSE-OPEN sequence.
- ⁴ On initial energization, power demand is approximately 100 W, declining to approximately 20 W when capacitors are fully charged. When the circuit breaker operates (open or close), power demand again increases to approximately 100 W, declining to approximately 20 W when capacitors are fully charged.

Table 12: Interrupting capacity auxiliary switch contacts

Type auxiliary switch	Continuous current A	Control circuit voltage				
		120 Vac	240 Vac	48 Vdc	125 Vdc	250 Vdc
Circuit breaker auxiliary switch	10	Non-inductive circuit interrupting capacity in A				
		10	5	10	9.6	4.8
		Inductive circuit interrupting capacity in A				
		6	3	10	6	3

Table 13: Technical ratings

Item	Unit	15.5 kV	27.6 kV	38.0 kV
Lightning impulse withstand voltage				
■ Full wave 1.2/50 μ s	kV	110	150	200
■ Chopped wave 2 μ s ¹		142	194	258
■ Chopped wave 3 μ s		----	----	----
Power-frequency withstand voltage	kV	50	60	80
Rated short-circuit current	kA	20/25/31.5/40	20/25	20/25/31.5/40
%dc component	%	48	48	48
Rated (making) closing and latching current	kA	52/65/82/104	52/65	52/65/82/104
Rated duty cycle				
■ Reclosing duty	----	O-0.3 s-CO-3 min.-CO CO-15 s-CO	O-0.3 s-CO-3 min.-CO CO-15 s-CO	O-0.3 s-CO-3 min.-CO CO-15 s-CO
■ Non-reclosing duty				
Minimum reclosing time ²	s	0.3	0.3	0.3
Rated power frequency	Hz	60	60	60
Capacitance switching				
■ Overhead line	A	100	100	100
■ Isolated bank		400	400	250
■ Back-to-back		400	400	250
Operating temperature range				
■ Standard	°C	-30 to +40	-30 to +40	-30 to +40
■ Special		-40 to +40 ³	-40 to +40 ³	-40 to +40 ³
Operating mechanism	----	Magnetic actuator	Magnetic actuator	Magnetic actuator
Closing time ⁴	ms	≤55	≤55	≤55
Opening time ⁴	ms	≤33	≤33	≤33
Emergency manual trip (externally operable)	----	Standard	Standard	Standard
Auxiliary voltages				
■ Close, trip and protection	----	Refer to Table 11 120/240	Refer to Table 11 120/240	Refer to Table 11 120/240
■ Space heaters, auxiliaries				
Interrupting medium	----	Vacuum	Vacuum	Vacuum
Breaks per pole	----	1	1	1
Contact gap (stroke)				
1,200 A	mm	20/25	31.5/40	
2,000 A		13-15	7-9	13-15
3,000 A		13-15	7-9	13-15
		----	7-9	----
Radio influence voltage (RIV) 1,000 kHz	μ V	≤500	≤650	≤650
Seismic withstand (optional) (ANSI/IEEE 693-2005 high-response spectrum)	g	0.5	0.5	0.5

Footnotes:

- ¹ Circuit breaker is in closed position.
- ² User must supply external time delay (typically using setting in reclosing relay) to assure the minimum reclose time interval of 0.3 s in accordance with ANSI/IEEE C37.06.
- ³ Consult factory for -50 °C.
- ⁴ Add 10 ms if command power is ac.

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

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