Installation and service
instructions

Installation, service and
maintenance instructions
for low voltage air circuit-breakers

1SDH000635R0002   L3447-PRELIMINARY

Emax DC

ABB

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Model	L3447			Apparatus	**Emax DC**	Scale	
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1. Description

1.1 General characteristics

The SACE Emax DC series of circuit-breakers consists of a steel sheet structure which houses the operating mechanism, the poles and the auxiliary parts.
Each pole is insulated from the others and contains the circuit-breaking parts, the shunt and the override protection.
The fixed version circuit-breaker has its own terminals for connection to the power circuit; in the withdrawable version the circuit-breaker comprises the moving part of the apparatus, which is completed with a fixed part fitted with terminals for connecting to the power circuit of the installation. The moving part and fixed part are coupled by means of special clamps installed in the fixed part.

1.2 External front view of the circuit-breaker
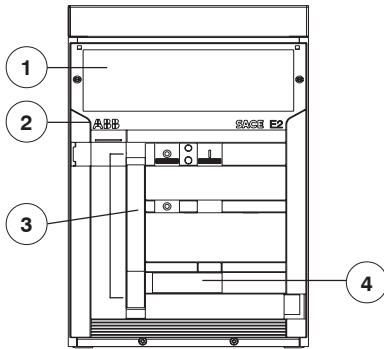
Fixed circuit-breaker

Fig. 1

1 PR122/DC or PR123/DC electronic microprocessor-based release
2 Trade mark
3 Operating and control parts of the operating mechanism and release tripped signals
4 Rating plate

1.3.1 Three-pole circuit-breaker rating plate

Fig. 2a

1.3.2 Four-pole circuit-breaker rating plate

Fig. 2b

1.4 Moving part construction characteristics

Selective circuit-breaker

Fig. 3
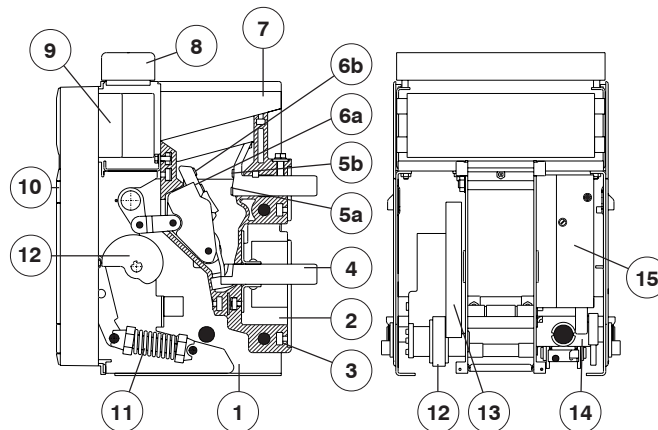
1 Supporting structure made of steel sheet
2 Current sensor for protection release
3 Terminal supporting insulating box
4 Horizontal rear terminals
5a Main fixed contact plates
5b Fixed arcing contact plates
6a Main moving contact plates
6b Moving arcing contact plates
7 Arcing chamber
8 Terminal box for the fixed version-Sliding contacts for the withdrawable version
9 Protection release
10 Circuit-breaker closing and opening mechanism
11 Closing springs
12 Spring loading geared motor (on request)
13 Lever for manually loading the closing springs
14 Racking-out device (only for withdrawable circuit-breakers)
15 Service releases (shunt closing release, shunt opening release, undervoltage release) (on request)

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1.5 Fixed part construction characteristics

Fig. 4

1 Steel sheet supporting structure
2 Earthing contacts (a: for all versions; b: for E4, E6)
3 Safety shutters (IP20 degree of protection)
4 Insulating terminal support base
5 Terminals
6 Contacts for signalling connected/test isolated/disconnected (on request)
7 Sliding contacts
8 Padlock for safety shutters (on request))
9 Anti-racking-in lock for circuit-breakers of different size
10 Fixing holes (qty 4 for E2, E3, 6 for E4, E6)

2. Checking on receipt

Examine the state of the material received and its consistency with the content of the order. Should any damage or errors be found on unpacking, which must be carried out carefully, make the relative notification within and not over 5 days from the receipt of the material. The notification must indicate the number of the shipping note.

3. Storage, lifting and weights

The circuit-breaker, protected by an external wooden crate, is fixed by means of screws to the transport pallet or to the bottom of the packing case. If the circuit-breaker has to remain in the warehouse even for a short time before being put into service, after checking it on receipt, it must be put back in its container and covered with a waterproof sheet.

Caution
− Use a dry, dust-free room free of aggressive chemical agents as a storage room
− Position the circuit-breaker and any fixed part on a horizontal surface, not in direct contact with the floor, but on a suitable support surface (Fig. 5)
− The maximum number of stackable circuit-breakers is indicated in figure 6
− Keep the circuit-breaker in the open position and with the closing springs unloaded to avoid unnecessary stresses and the risk of accidents to the personnel.
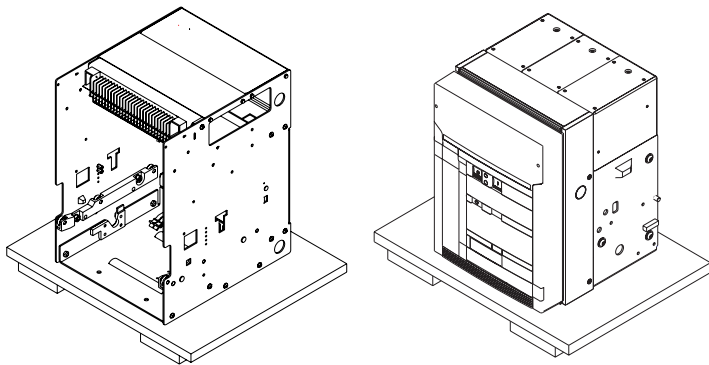
Fig. 5
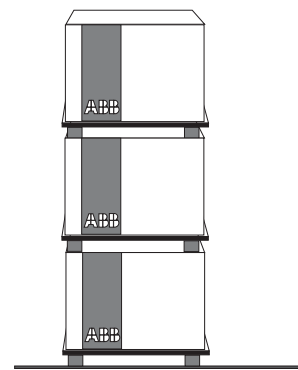
Fig. 6

With regard to lifting, follow the instructions: the circuit-breakers must be placed on a sturdy supporting surface and lifted, preferably, by means of a special fork-lift truck. However, the use of ropes is allowed. In this case, the lifting ropes must be hooked up as shown in the figures (the lifting plates are always supplied with the circuit-breaker).
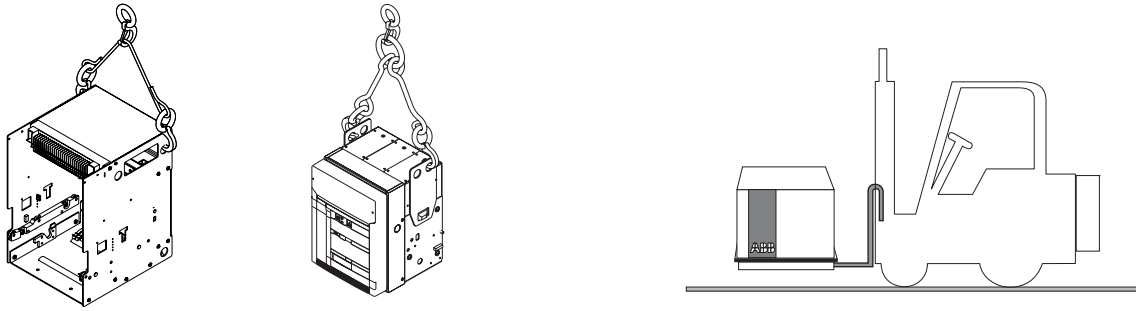
Fig. 7

Table of the circuit-breaker weights (Kg.)

Selective circuit-breaker	Fixed version		Withdrawable version	
	3 poles	4 poles	3 poles	4 poles
E2	50	61	78	93
E3	66	80	104	125
E4	97	120	147	170
E6	140	165	210	250

4. Installation

4.1 Installation room

Install the circuit-breaker in a dry, dust-free, non-corrosive room, and in such a way that it is not subject to shocks or vibrations. Where this is not possible, install it inside a switchboard with a suitable degree of protection.
For the preparation of the installation room, please refer to the "Overall dimensions" paragraph, which gives information on the following points:
− minimum installation volumes of the circuit-breakers and derived versions
− distances to be respected for circuit-breakers in compartments
− overall dimensions of the circuit-breakers
− fixing drillings
− compartment door drillings.
The installation, commissioning and any ordinary and extraordinary maintenance have to be done by skilled personnel, with a detailed knowledge of the apparatus.

4.2 Installation of the fixed circuit-breaker

Fix the circuit-breaker to a horizontal surface using the screws (M10 x 12 min.).
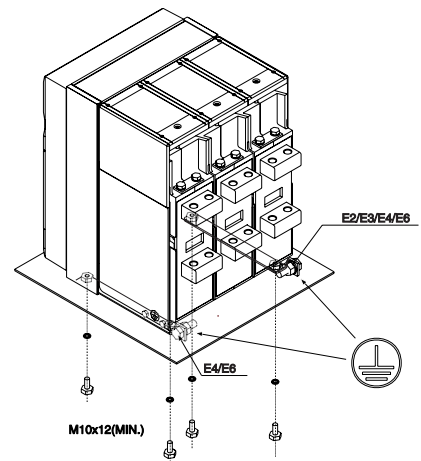
Fig. 8

4.3 Installation of the fixed part of the withdrawable circuit-breaker

4.3.1 Preparation of the fixed part

Assembly of the anti-racking-in lock

Before installing the fixed part, it is necessary to check the presence of the anti-racking-in lock for circuit-breakers with different electrical characteristics from those of the fixed part. If the anti-racking-in lock has been supplied separately, proceed to assemble it as follows:
− On the self-adhesive plate (4), find the assembly position of the stop bolts in relation to the circuit-breaker which has to be housed in the fixed part.
− Insert the hexagonal-head screws (1) in the holes found in the previous item as shown in the figure.
− Fix the screws with the washers (2) and the hexagonal stops (3).
Make sure that the anti-racking-in lock corresponding to the one installed on the fixed part is present on the circuit-breaker (moving part).
− Anti-racking-in plate on the moving part (5).

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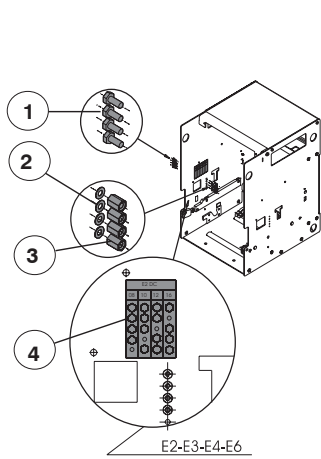
Fig. 9
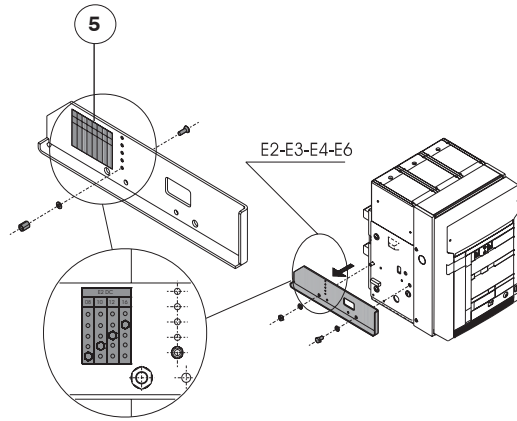
Fig. 10

4.3.2 Installation of the fixed part (Fig. 12)

Attach the fixed part by means of the screws (1), washers (2) and nuts (3) (M8 x 16), supplied by ABB SACE. if other screws are used, make sure that the head of the screws does not extend more than 5.5 mm from the base of the fixed part.

4.3.3 Installation of the fixed part on board a ship (Fig. 11)

Regarding the fixing points of the SACE Emax withdrawable version air circuit-breakers, for applications on board a ship, additional fixing on the sides of the fixed part itself is recommended (the M12 screws and the spacers are not provided in the supply).

E2 - E3

E4 - E6
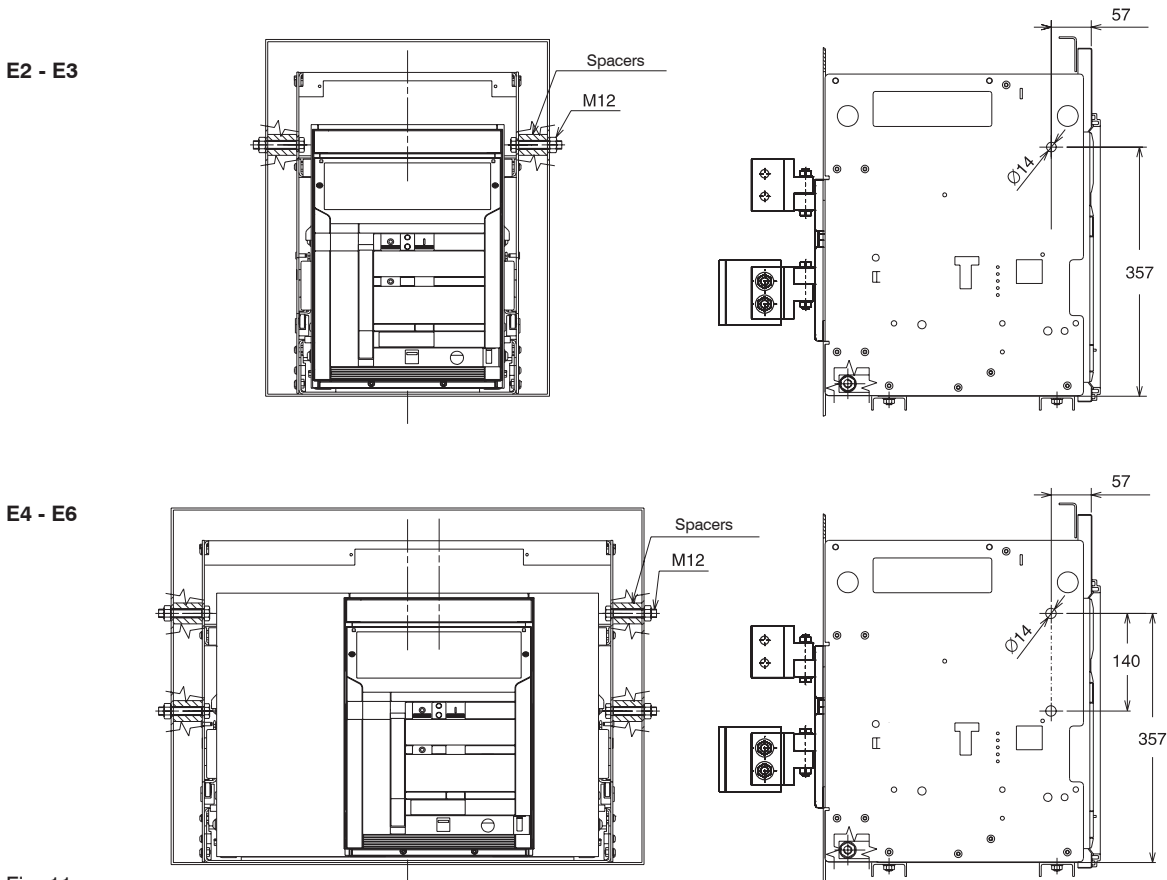
Fig. 11

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4.4   Installation of the flange on the compartment door (Fig. 13)

– Make the compartment door drillings specified in the "Overall dimensions" paragraph.
- Attach the flange (1) on the front of the compartment door, fixing it from the inside by means of the self-tapping screws (2).

E2/E3/E4/E6
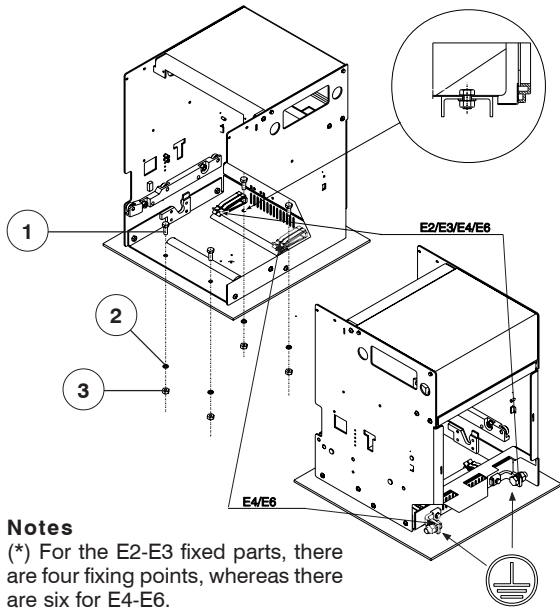
E4/E6

Notes
(*) For the E2-E3 fixed parts, there
are four fixing points, whereas there
are six for E4-E6.

Fig. 12
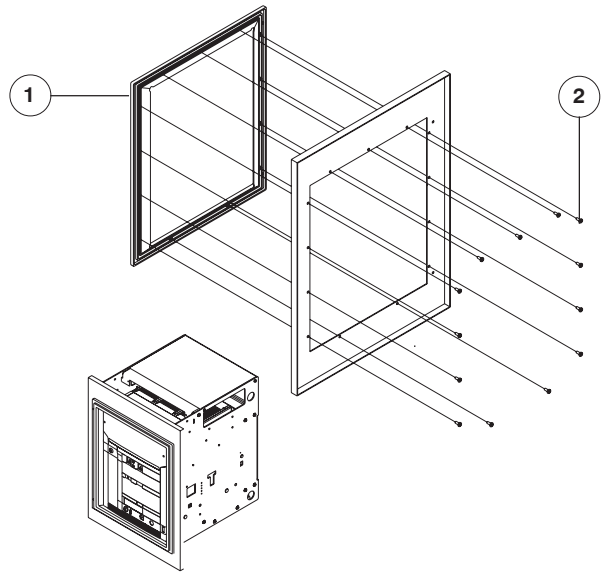
Fig. 13

5.   Electrical connections

5.1   Connections to the power circuit

Fixed circuit-breaker

VR
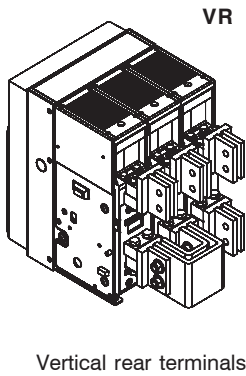
Vertical rear terminals

Fig. 14

Fixed part for withdrawable circuit-breaker

VR
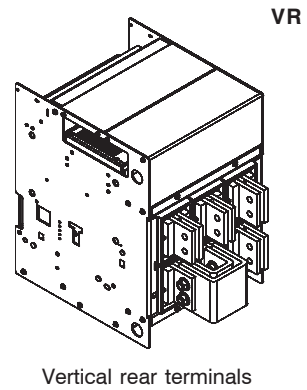
Vertical rear terminals

Fig. 15

Note
The drawings are provided to show the type of terminal in graphic form. The exact shape of the terminals is given in the "Overall dimensions" chapter.

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5.1.1 Examples of positioning the connection busbars according to the terminals

The connection busbars enable the connection between the terminals of the circuit-breakers and the busbars of the switchgear. Their sizing must be carefully studied by the switchgear designer. Some examples of possible constructions are given in this paragraph. The various types of terminals are of constant dimensions for each size of circuit-breaker: it is normally advisable to exploit the whole contact surface of the terminal, so the width of the connection busbars should be the same as that of the terminal. In some cases, reductions in the width of the connection in relation to that of the terminal are allowable as shown in the following examples.

Circuit-breaker	Iu [A]	Vertical terminals		Busbar cross-section [mm²]	
		Continuous current-carrying capacity [A]			
		45°C	55°C		
E2B 800	800	800	800	1x(60x10)	
E2B 1000	1000	1000	1000	1x(80x10)	
E2B 1250	1250	1250	1250	1x(80x10)	
E2B/N 1600	1600	1600	1600	2x(60x10)	
E3N 800	800	800	800	1x(60x10)	
E3N 1000	1000	1000	1000	1x(80x10)	
E3N 1250	1250	1250	1250	1x(80x10)	
E3N/H 1600	1600	1600	1600	2x(60x10)	
E3N/H 2000	2000	2000	2000	3x(60x10)	
E3N/H 2500	2500	2500	2500	2x(100x10)	
E4S 1600	1600	1600	1600	2x(60x10)	
E4S 2000	2000	2000	2000	3x(60x10)	
E4S 2500	2500	2500	2500	3x(60x10)	
E4S/H 3200	3200	3200	3200	3x(100x10)	
E6H 3200	3200	3200	3200	3x(100x10)	
E6H 4000	4000	4000	4000	4x(100x10)	
E6H 5000	5000	5000	4600	6x(100x10)	

Fig. 16

Positioning the first anchoring baffle of the busbars according to the short-circuit current

Anchoring to the switchgear

P	E2	E3-E4-E6
VERTICAL	250	150
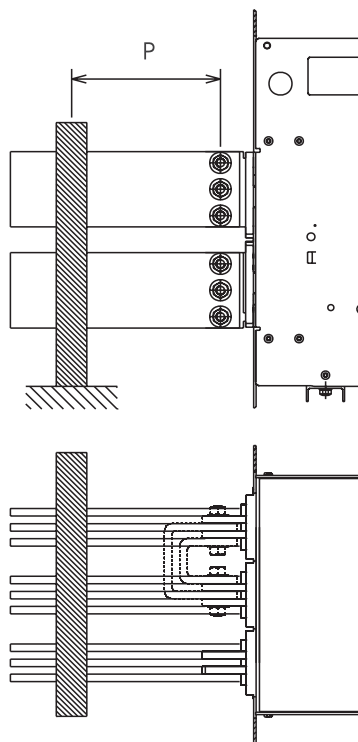
Fig. 17

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5.1.2 Assembly procedure for the connection busbars

Check the state of the contact surfaces of the connections very carefully: they must be very clean with no burrs, dents or traces of rust which must be eliminated using a fine file or an emery cloth to prevent localized increases in temperature. On completion of the operation, remove all traces of grease or dust with a cloth soaked in a suitable solvent. When copper connections are used, it is advisable to tin-plate the contact surfaces. When aluminium connections are used, it is advisable to apply a thin layer of Vaseline over the contact surfaces.
The connections must not exert any strain on the terminals in any direction.
Always insert a large-diameter flat washer and a spring washer between them (to spread the tightening pressure over a greater area).
Make the contact between connection and terminal and tighten the fixing screws completely.
Always use two wrenches (so as not to strain the insulating parts excessively), applying the tightening torque indicated in Fig. 18. Check tightness after 24 hours.

M12 high strength screws
Tightening torque of the main terminals: 70 Nm

E2-E4
F-W

	No. of screws for terminal
E2	2
E4	4

E3-E6
F-W

	No. of screws for terminal
E3	3
E6	6
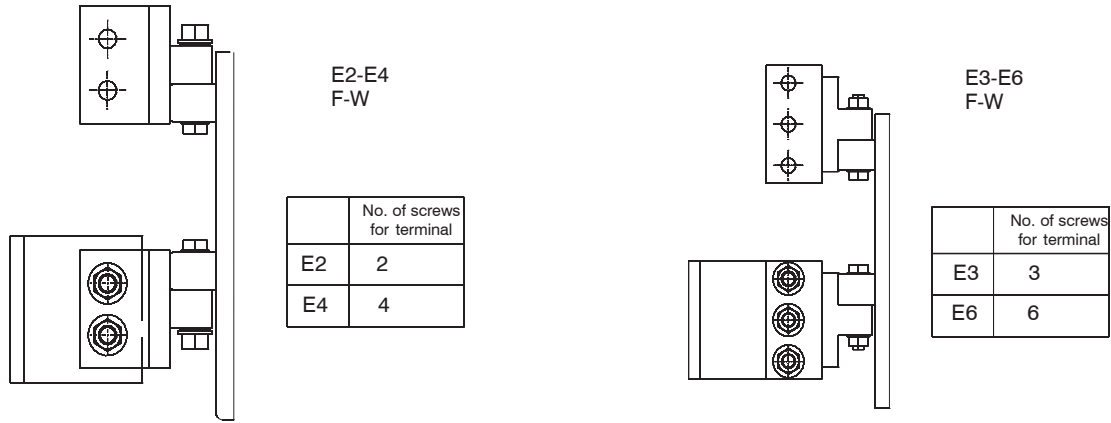
Fig. 18

5.2 Earthing

The fixed circuit-breaker and the fixed part of the withdrawable circuit-breaker have one or two terminals on the rear, marked with the special symbol, for connection to earth (Fig. 9 and Fig. 12).
Each terminal is complete with a bolt for fixing the connection. A conductor with a cross-section conforming to current standards must be used for the connection.
Before assembling the connection, clean and degrease the area around the screw.
After the assembly, tighten the bolt with a torque of 70 Nm.

5.3 Wiring the circuit-breaker auxiliary circuits

5.3.1 Interfacing elements for fixed circuit-breakers

A special terminal box is provided, fitted with screw terminals for connecting the auxiliary circuits.
The terminals are marked with alphanumerical identification codes as for the electrical circuit diagram.
The terminal box is identified by code XV on the electrical circuit diagram.
The terminal box is immediately accessible when the compartment door is open.

XV
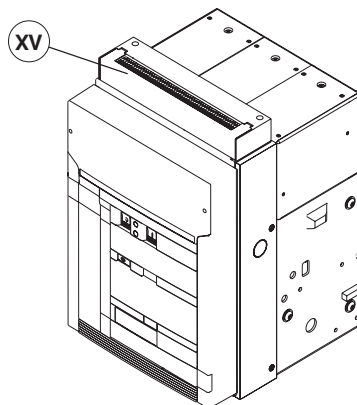
Fig. 19

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5.3.2 Withdrawable circuit-breaker

For connection of the moving part to the auxiliary circuits, a connection with sliding contacts is available on the fixed part (see figure), identified by code X on the electrical circuit diagram.

The terminals of the fixed connector are immediately accessible when the compartment door is open.

Furthermore a terminal box identified by code XF is available for connecting the position contacts of the moving part in relation to the fixed part. The connector and terminal box have screw terminals.
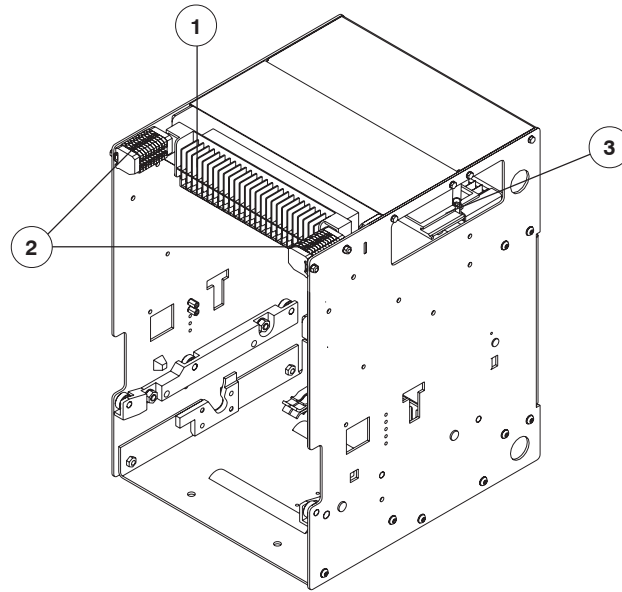
E2 - E3
10 contacts in position
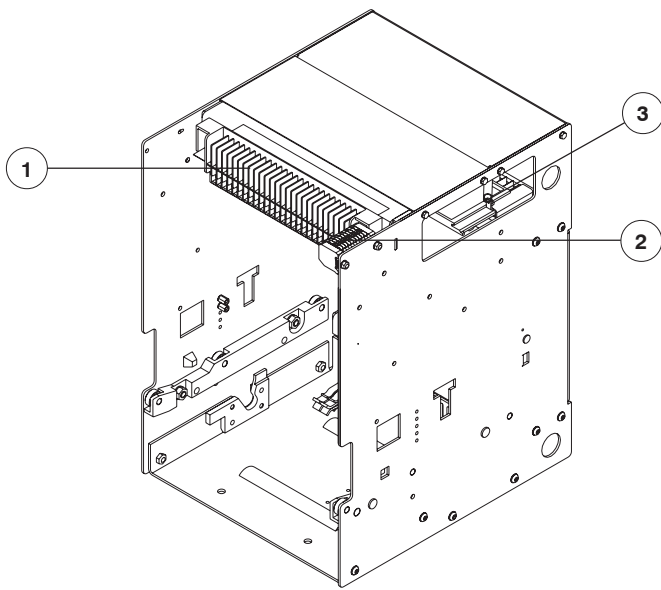
E2 - E3 - E4 - E6
5 contacts in position
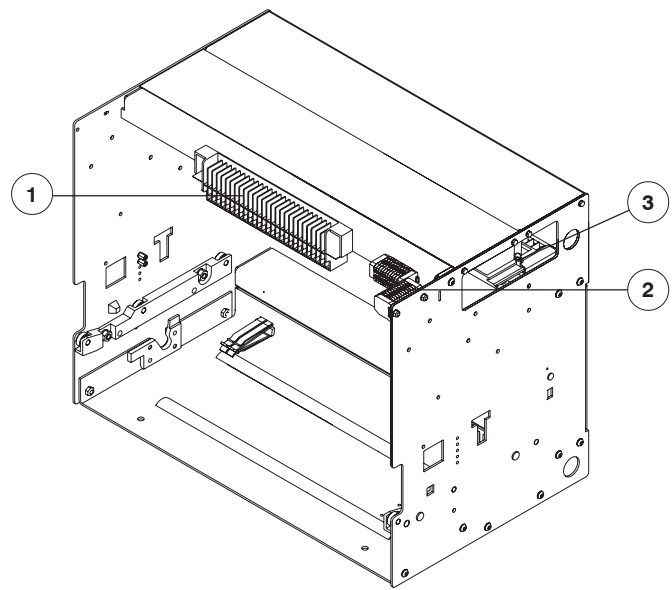
E4 - E6
10 contacts in position

Caption
① Sliding contacts (X)
② Terminal box for position contacts (XF)
③ Position contacts

Fig. 20

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5.4 Conversion of the auxiliary contacts or of the signalling contacts (disconnected - test isolated - connected), from normally closed (opening) to normally open (closing) or vice versa

The contacts are wired at the factory as shown on the electrical circuit diagram. If it is necessary to change their state for installation requirements, proceed as follows.

a) Auxiliary contacts

To access the auxiliary contacts, carry out the following operations:

− remove the front protection (3) of the release by taking action on the blocks (1) as shown in the figure
− remove the protection release (4) removing the side nuts (2) and then sliding the release out from the front of the circuit-breaker.
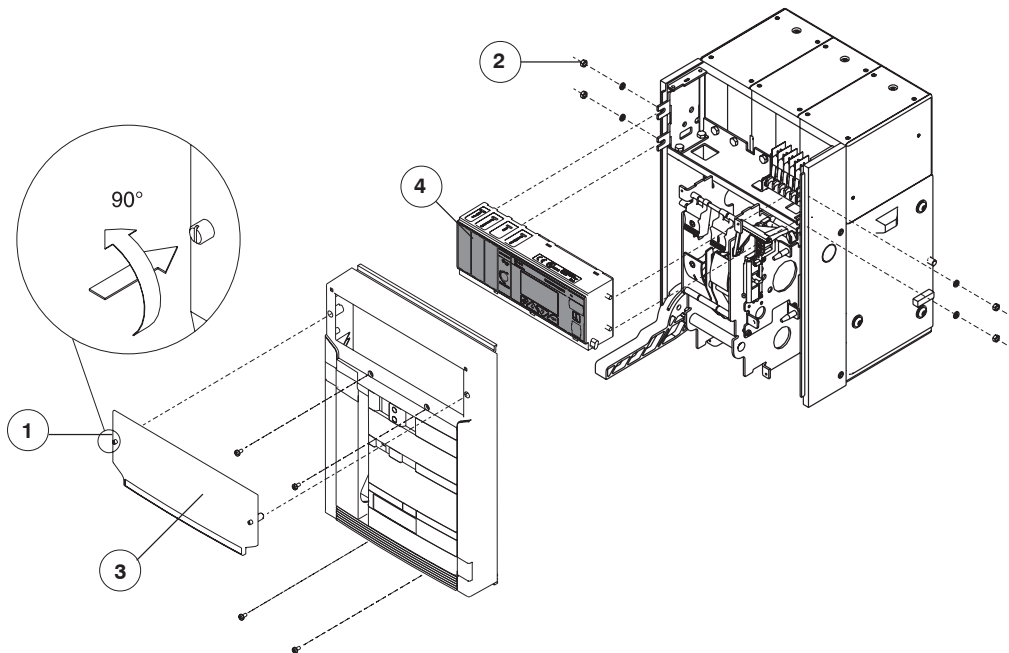
Fig. 21

Being of the two-way type (changeover contacts), the auxiliary contacts can be modified from break contacts to make contacts and vice versa simply by moving the output conductor from one position to the other, as shown in the figure.
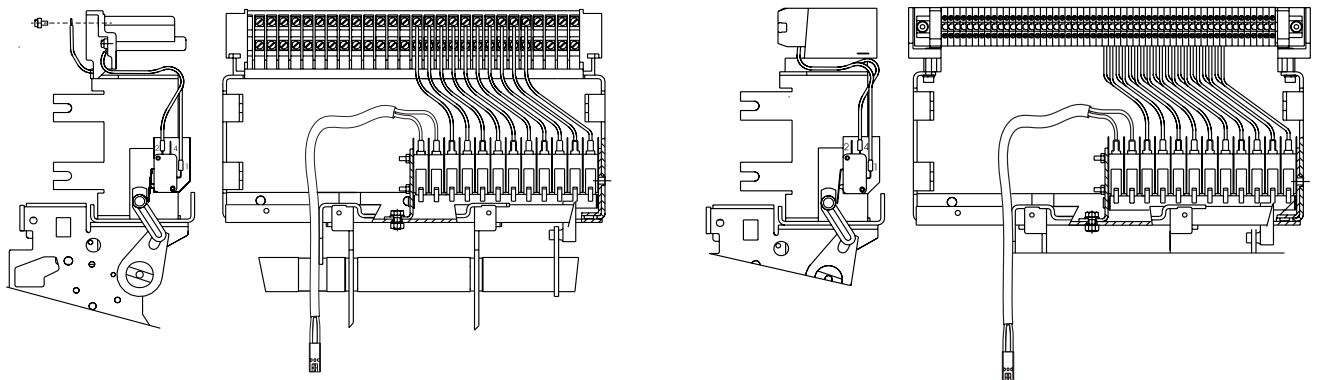
| N.C. contact | Sliding contacts | | N.O. contact | Terminal box |

Fig. 22

b) Signalling contacts disconnected - test isolated - connected

To change the state of the position contact, proceed in the same way as explained for the auxiliary contacts.
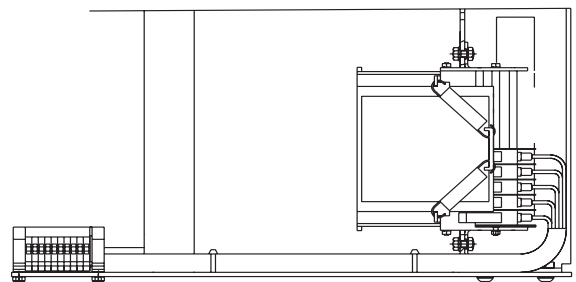
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6. Putting into service

6.1 General procedures

– Check tightness of the power connections at the circuit-breaker terminals
– Carry out all the preparatory operations on the release
– Make sure that the value of the auxiliary circuit power supply voltage is between 85 and 110% of the rated voltage of the electrical applications
– Make sure that there is an adequate air circulation in the place of installation to avoid overheating
– Also carry out the checks specified in the following table.

Item inspected	Procedure	Positive check
1 Manual operating mechanism	Carry out some opening and closing operations (see the chapter 7.2). CAUTION When there is an undervoltage release, the circuit-breaker can only be closed after the release has been electrically energized.	The spring loading lever moves correctly.
2 Geared motor (if any)	Supply the spring loading geared motor at the corresponding rated voltage. Carry out some closing and opening operations. Note. Supply the undervoltage release at the corresponding rated voltage (if any).	The springs are loaded correctly. The signals are correct. The geared motor stops with the springs loaded. The geared motor reloads the springs after each closing operation.
3 Undervoltage release (if any)	Supply the undervoltage release at the corresponding rated voltage and carry out the circuit-breaker closing operation. Disconnect voltage to the release. Supply the undervoltage release at the corresponding rated voltage and carry out the circuit-breaker closing operation.	The circuit-breaker closes correctly. The signals are correct. The circuit-breaker opens. The signal changes over.
4 Shunt opening release (if any)	Close the circuit-breaker. Supply the shunt opening release at the corresponding rated voltage.	The circuit-breaker opens correctly. The signals are correct.
5 Shunt closing release (if any)	Open the circuit-breaker. Supply the shunt closing release at its rated voltage.	The circuit-breaker closes correctly. The signals are correct.
6 Circuit-breaker lock in the open position (with key or padlocks)	Open the circuit-breaker, turn the key and remove it from its seat. Attempt circuit-breaker closing operation.	Both manual and electrical closing are prevented.
7 Auxiliary contacts of the circuit-breaker	Insert the auxiliary contacts in suitable signalling circuits. Carry out some circuit-breaker closing and opening operations.	The signals are given correctly.
8 Auxiliary contacts for signalling circuit-breaker connected, test isolated and disconnected	Insert the auxiliary contacts in suitable signalling circuits. Then put the circuit-breaker in the connected, test isolated and disconnected position.	The signals due to the relative operations are given correctly.
9 Lock devices for circuit-breakers connected and disconnected. Interlocking devices between circuit-breakers side by side and one on top of another (if any)	Carry out the operating tests.	The locks function correctly.
10 For withdrawable circuit-breakers: racking-in/out device	Carry out some racking-in and out operations.	Racking-in operation: the circuit-breaker racks in correctly. The first turns of the crank handle do not meet with particular resistance.

7. Instructions for use

7.1 Operating and signalling parts

1. Pushbutton for the manual opening operation
2. Lever for manual loading of the closing springs
3. Mechanical indicator for circuit-breaker open "O" and closed "I"
4. Mechanical indicator for protection release tripped (on request)
5. Pushbutton for the manual closing operation
6. Signalling device for springs loaded - unloaded
7. Operation counter (on request)
8. Key lock on the closing operation
9. Mechanical indicator for circuit-breaker connected, test isolated and disconnected
10. Seat for the racking-in/out lever
11. Lever releasing the racking-in/out operation
12. Key lock on the racking-in/out operation (on request)
13. Padlock on the manual closing operation (on request)
14. Padlock on the racking-in/out operation (on request)
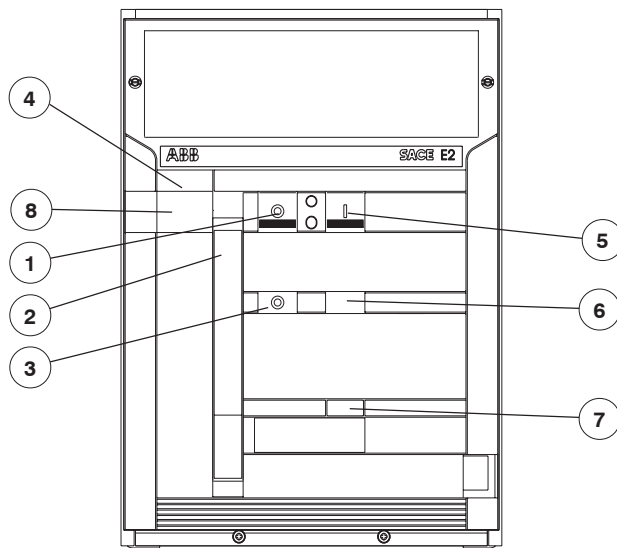
Fixed circuit-breaker   Withdrawable circuit-breaker
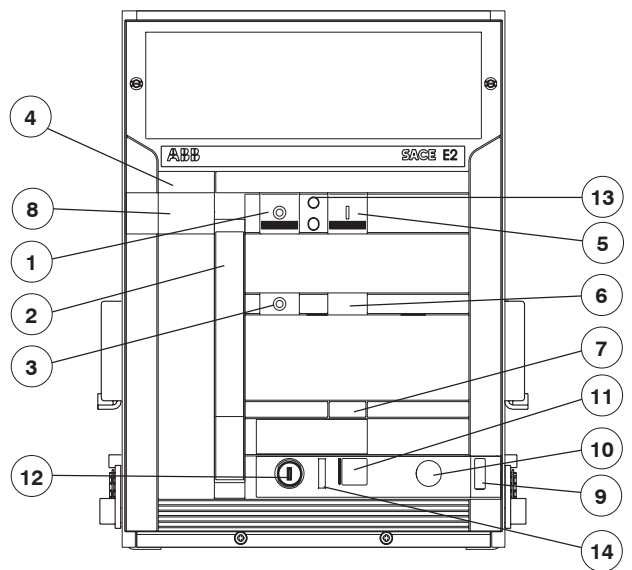
Fig. 23

Note
On request, a transparent cover can be installed on the front of the circuit-breaker to increase the degree of protection to IP54. The cover has a locking key.
As an alternative to the transparent cover, a protection can be mounted on the manual closing and opening controls, which only allows operation of the pushbuttons by means of a special tool.
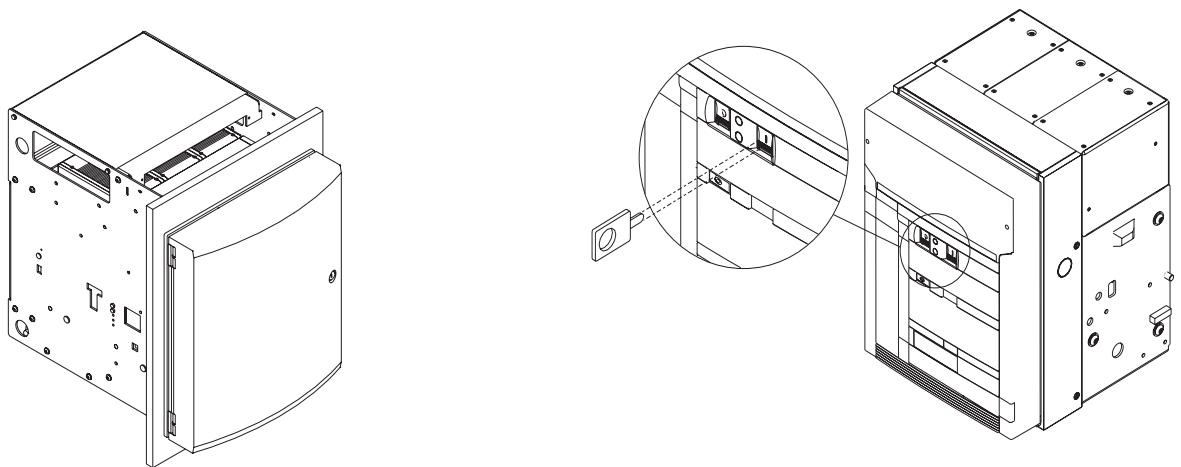
Fig. 24

7.2   Circuit-breaker closing and opening procedures

The operation of the circuit-breaker can be either manual or electrical.

a) Manual loading of the closing springs
- Make sure that the indicator (3) shows "O" (circuit-breaker open)
- Make sure that the indicator (6) is WHITE (springs unloaded)
- Repeatedly activate the lever (2) until the indicator (6) changes its color to YELLOW

b) Electrical loading of the closing springs

The electrical loading of the circuit-breaker is possible when the following accessories (supplied on request) are present:
- geared motor for automatic loading of the closing springs
- shunt closing release
- shunt opening release.

The geared motor automatically reloads the springs after each closing operation until the yellow indicator appears (6, Fig. 25). When the power is cut off during loading, the geared motor stops and automatically starts reloading the springs again when the power returns. It is, in any case, always possible to complete the reloading operation manually.
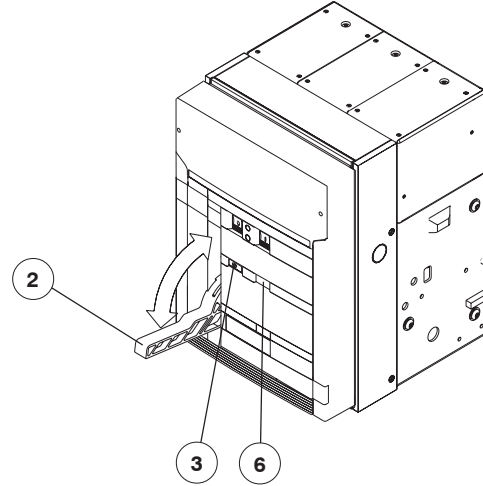
Fig. 25

c) Closing the circuit-breaker

The operation can only be carried out with the closing springs fully loaded. For manual closing, press the pushbutton (5) marked with the letter "I". When there is a shunt closing release, the operation can be carried out remotely by means of the special control circuit. The special indicator (3) changes to indicate "I" to signal that the circuit-breaker has closed. Furthermore, the indicator of the state of the springs (6) goes to the WHITE position. Even with the closing springs unloaded, the operating mechanism retains enough energy for the opening operation. The geared motor, if any, immediately starts the automatic spring reloading operation.
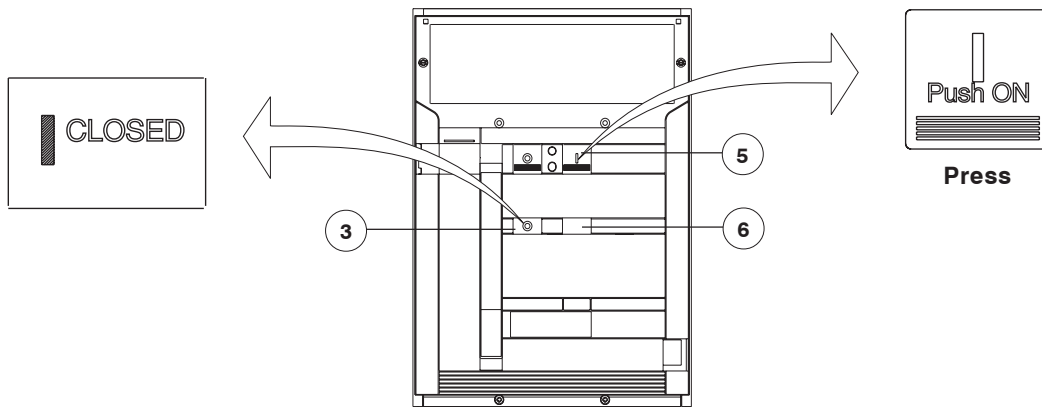
Fig. 26

d) Opening the circuit-breaker

For manual opening of the circuit-breaker, press pushbutton "O" (1). When there is a shunt opening release, the operation can also be carried out remotely by means of the special control circuit. Opening having taken place is signaled by the letter "O" appearing in the indicator (3).
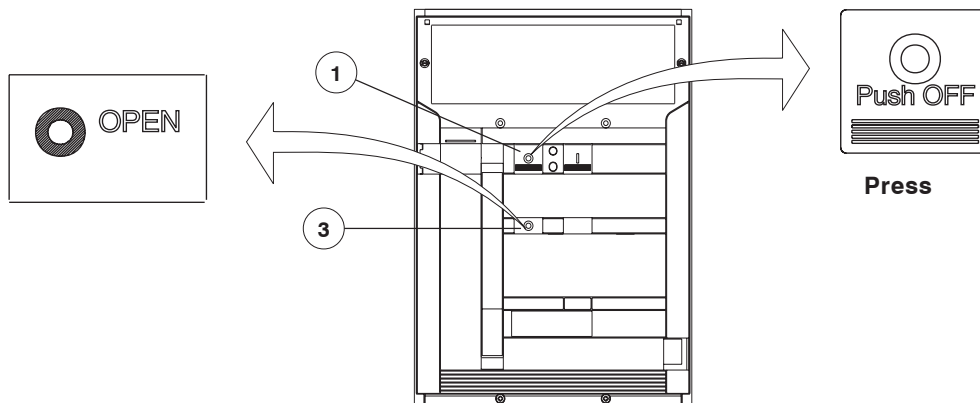
Fig. 27

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7.3 Racking-in/out operation

WARNING

A) Open the circuit-breaker before carrying out any racking-in/out operation.
B) The circuit-breaker (moving part) and fixed part are fitted with a lock which prevents the fixed part from being racked into the circuit-breakers with a different rated current: the congruence of the anti-racking-in lock must be checked by the operator before carrying out the racking-in operation to avoid any unnecessary stress.
C) Before the racking-in operation, remove any padlock on the segregation shutter of the isolation terminals on the fixed part.
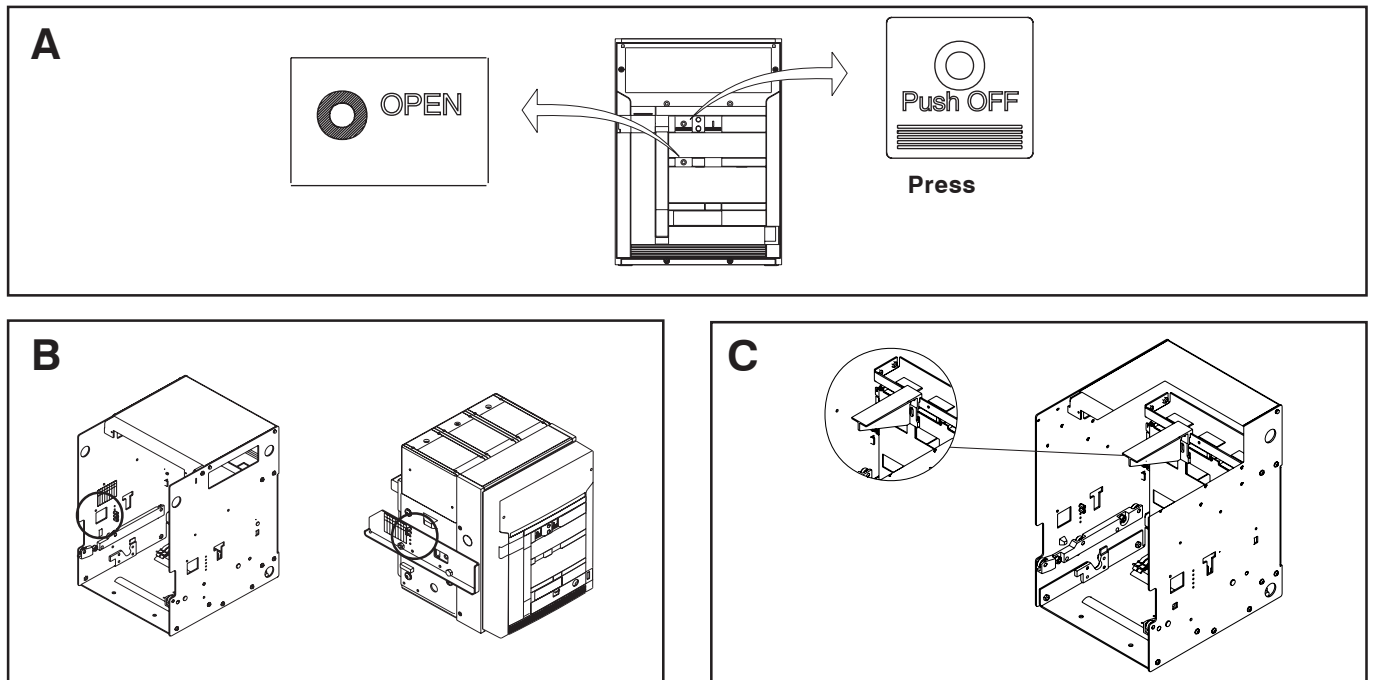
Fig. 28

NOTES

In relation to the fixed part, the circuit-breaker (moving part) can take up different positions, identified as follows:

− DISCONNECTED: the moving part is inserted in the fixed part WITHOUT any connection between the power terminals and WITHOUT coupling the sliding contacts for the auxiliary circuits: in this position all electrical operation of the circuit-breaker is prevented. On the front the indicator (9, Fig. 23) indicates DISCONNECTED. The switchgear compartment door can be closed.
− TEST ISOLATED: the moving part is inserted in the fixed part WITHOUT any connection between the power terminals, but WITH the sliding contacts coupled for the auxiliary circuits. In this position, the circuit-breaker can be operated for the offline tests. The indicator (9, Fig. 23) indicates TEST ISOLATED.
− CONNECTED: the moving part is fully inserted in the fixed part WITH the connection of both the power terminals and the sliding contacts for the auxiliary circuits. The circuit-breaker is operational. The indicator (9, Fig. 23) indicates CONNECTED.

a) Positioning the moving part in the fixed part in the DISCONNECTED position

Lift the moving part as shown in the paragraph (3) and insert it in the fixed part guide, tilting it as shown in figure 29.

The manual connection must allow the edge (E) of the circuit-breaker guide to slide under the blocks (D) of the fixed part. Remove the lifting devices.
The position reached is stable and allows for any inspections of the circuit-breaker.
Push the moving part as far as the stop in the fixed part.
Close the compartment door.
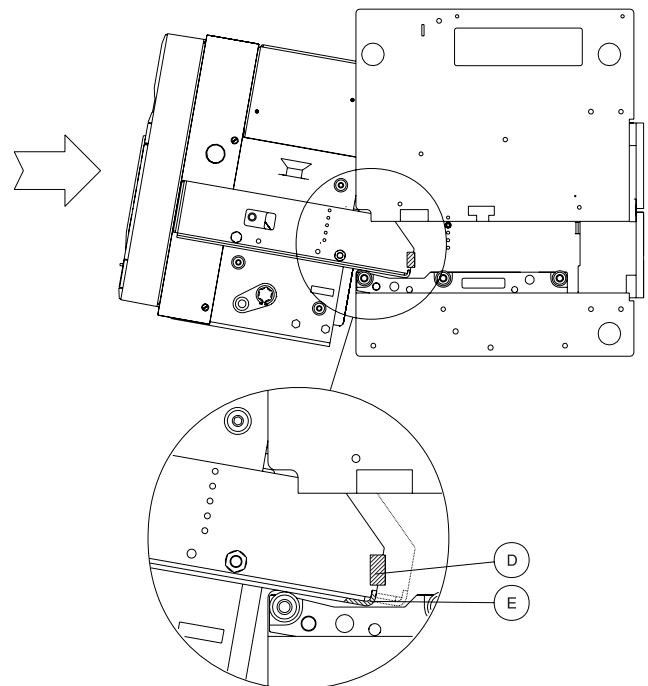
Fig. 29

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b) Passing from the DISCONNECTED to the TEST ISOLATED position

Make sure that the indicator (9) is in the DISCONNECTED position.
For the connection procedure, make sure that the key (12) is in the correct position and/or the padlock (14), if any, has been removed.
Make sure that the circuit-breaker is open.
Push the moving part right into the fixed part.
Lower the releasing lever (11).
Insert the crank handle in the corresponding coupling (10).
Proceed to turn the crank handle clockwise until the TEST ISOLATED indication appears on the indicator (9). During the initial turns, the crank handle must oppose no any particular resistance to rotation.
Should it be necessary to carry out offline circuit-breaker operations, the crank handle must be removed.
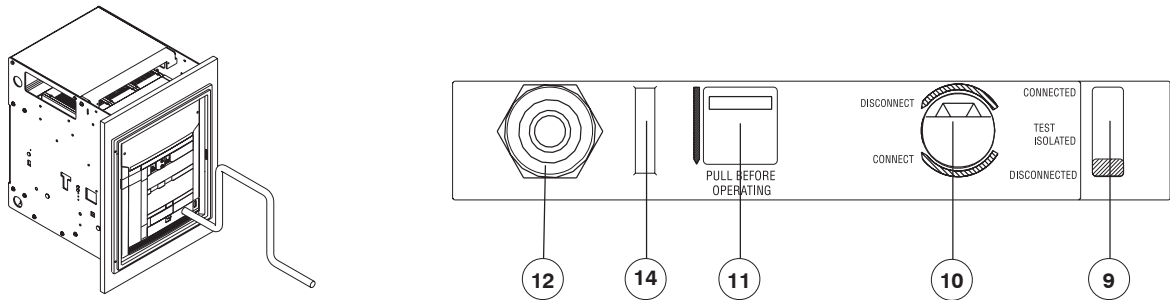
Fig. 30

c) Passing from the TEST ISOLATED position to the CONNECTED position

Make sure that the circuit-breaker is open.
Lower the releasing lever (11).
Insert the crank handle in the corresponding coupling (10).
Proceed to turn the crank handle clockwise until the CONNECTED indication appears on the indicator (9).
Remove the crank handle to enable the circuit-breaker to close.
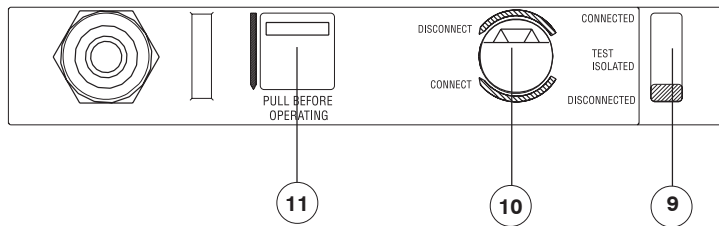
Fig. 31

d) Passing from the CONNECTED position, to the TEST ISOLATED position, to the DISCONNECTED position

Repeat the connection procedures changing the direction for turning the crank handle to anti-clockwise. Open the door in the disconnected position.

8.   Maintenance

8.1   Warning

Before carrying out any maintenance work, it is necessary to complete the following procedure:
– open the circuit-breaker and check that the operating mechanism springs are unloaded
– in the case of withdrawable circuit-breakers, work with the circuit-breaker racked-out of the fixed part
– for action on fixed version circuit-breakers or on fixed parts of withdrawable circuit-breakers, disconnect the supply to the power circuit and to the auxiliary circuits. Furthermore, visibly earth the terminals both on the power supply side and on the load side.
During normal service, the circuit-breakers require limited maintenance.

The table of the maintenance program is given in the following paragraph, indicating the corresponding periodic intervals for action. In particular, with regard to the time intervals, it is advisable to follow the recommendations in the table, at least for the first year of service.
On the basis of the results obtained during the routine checks, establish the best time intervals for the maintenance operations.

It is also advisable to refer to the following rules:
– circuit-breakers which rarely operate, or which remain closed for long periods, must be operated from time to time to avoid any tendency to stick
– during service, routinely inspect the circuit-breaker from the outside to check for any dust, dirt or damage of any kind.
  For circuit-breakers with SACE PR122/DC and SACE PR123/DC releases, check the percentage of wear on the contacts.
  The SACE PR122/DC and SACE PR123/DC releases allow for the number of operations performed by the circuit-breaker in service to be displayed at all times on the special display.

With regular maintenance, SACE Emax circuit-breakers, either with or without a geared motor, can withstand the following operation without replacement of parts.

Rated uninterrupted current	Mechanical life (*)		Electrical life			
Iu (40 °C) [A]	No. of operations x 1000	Frequency operations/hour	500 V No. of operations x 1000	750 V No. of operations x 1000	1000 V No. of operations x 1000	Frequency operations/hour
E2B 800	25	60	15	15	15	30
E2B 1000-1250	25	60	15	15	15	30
E2B/N 1600	25	60	10	10	10	30
E3N 800	20	60	12	12	12	20
E3N 1000-1250	20	60	12	12	12	20
E3N/H 1600	20	60	10	10	10	20
E3N/H 2000	20	60	9	9	9	20
E3N/H 2500	20	60	7	7	7	20
E4S 1600	15	60	7	7	7	20
E4S 2000	15	60	7	7	7	20
E4S 2500	15	60	7	7	7	20
E4S/H 3200	15	60	4	4	4	20
E6H 3200	12	60	5	5	5	10
E6H 4000	12	60	4	4	4	10
E6H 5000	12	60	2	2	2	10

(*) With regular ordinary maintenance

8.2   Maintenance program

Maintenance operations	Interval	
	Installation in normal rooms	Installations in dusty or polluted rooms
General inspection (see par. 8.3.2)	One year or after a short-circuit trip	Six months or after a short-circuit trip
External visual check and inspection of the power section	One year	Six months
Operating mechanism maintenance (par. 8.3.4)	One year or 10000 operations	Six months or 10000 operations
Checking trip of the release	One year	Six months

8.3   Maintenance operations

8.3.1   Preliminary operations
− Remove the flange (1) of the release, turning the screws (2) as shown in the figures
− Remove the front escutcheon plate (3) by removing the four screws (4)
− Remove, if present, one or both side guards (5) by removing the front (6) and lateral (7) screws
− Remove the arcing chambers (8) by removing the screws (9).

E2-E3   E4-E6
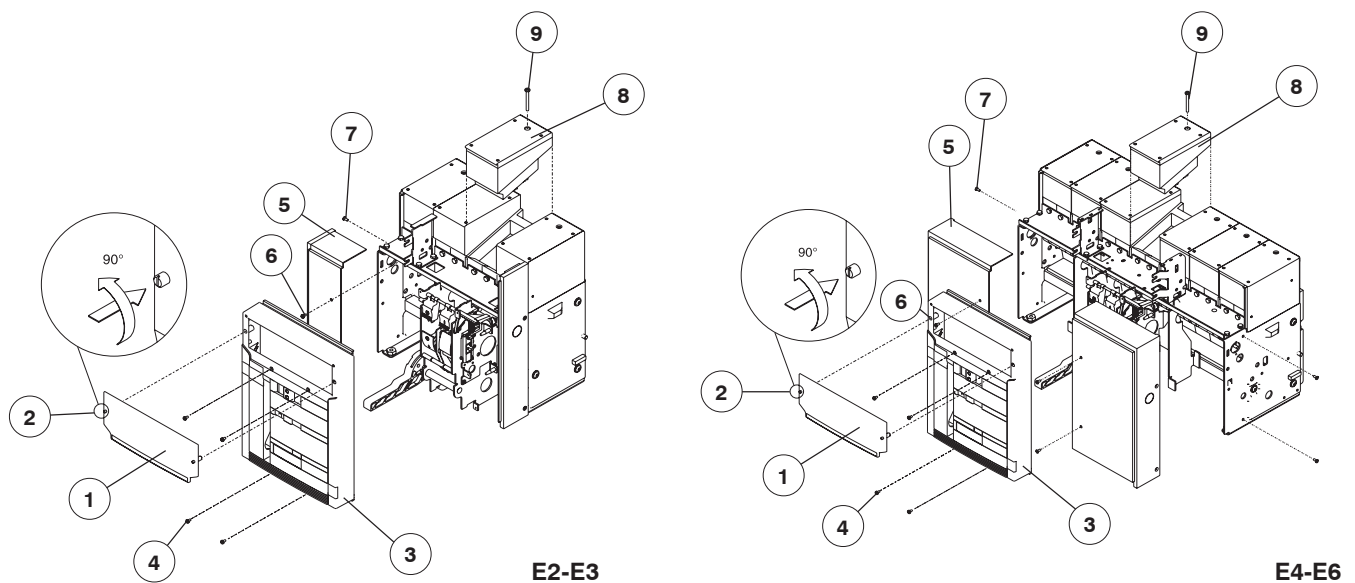
Fig. 32

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8.3.2 General inspection of the circuit-breaker

Item to be inspected	Problem found	Remedy
1 Operating mechanism/Electrical accessories	– Presence of dust on the internal parts – Springs deformed or rusty – Safety rings out of place, nuts or screws loose – Wires and straps detached	– Clean with brushes or dry cloths – Replace damaged springs – Put the rings back in place and tighten screws and nuts appropriately – Replace the straps and connect the detached wires correctly
2 Arcing and main contacts	– Traces of wear – Incorrect adjustments: distance A - Fig. 33 is less than 1 mm for E2-E3 or less than 0.8 mm for E4-E6	– Smooth the contacts with emery cloth – Adjust according to the paragraph 8.3.3
3 Arcing chambers	– Presence of fumes or dust – Presence of cracks in the external plastic structure – Excessive difference in wear between the first and last arc extinguishing plate	– Remove with compressed air and remove the fumes and any slag with a brush – Replace the arcing chamber – Replace the arcing chamber
4 Main circuit - Busbars - Insulating contact	– Presence of dust or dirt on the insulating parts – Safety rings out of place, screws or nuts loose – Deformation or cracks of the insulating parts – Insulating contacts oxidized (only for withdrawable circuit-breaker) – Wear or overheating marks or screws loose on the connections to the terminals of the circuit-breaker (only for fixed circuit-breaker)	– Clean with a brush or dry cloths – Put the rings back in place and tighten screws and nuts appropriately – Ask ABB SACE to replace the damaged parts – Remove the shutters and clean with a rough cloth soaked in a suitable solvent and lubricate moderately with neutral grease – Tighten the screws suitably
5 Earthing contacts (only for withdrawable circuit-breaker)	Presence of rust or loose nuts	Clean with a rough cloth soaked in a suitable solvent and lubricate moderately with neutral grease. Tighten the nuts completely
6 Earth connection (only for fixed circuit-breaker)	Presence of rust and/or loose nuts	Clean with a rough cloth soaked in a suitable solvent, fully tighten the earth connection and cover with neutral grease
7 Auxiliary circuit power supply voltage	Check the power supply voltage of the electrical accessories of the operating mechanism	The releases and locking devices must operate normally for values between 85% and 110% of the corresponding rated voltage
8 Operating and control parts	The operating tests, which must be carried out as shown in paragraph 6.1 have shown defects in the components	Replace the defective parts or those with a faulty operation (if necessary, ask ABB SACE)

8.3.3 Checking contact wear

In order to ensure the gap A indicated in the table, you can adjust the position of the shaft and of the operating mechanism.

1) Open the circuit-breaker
2) Remove the arcing chamber
3a) Adjust the distance of the moving contacts for E2-E3:
  - loosen the screws in pos. 1 and the nuts in pos. 3 (FIG. 33a)
  - proceed in the same way on the screws in pos. 2
  - bring the bushes of the operating mechanism (pos. 5) to rest on the shaft, tacking action on the nuts in pos. 4
  - tighten the screws in pos.1 and the nuts in pos. 3 and 4
  - close the circuit-breaker and check the gap A
3b) Adjust the distance of the moving contacts for E4-E6:
  - loosen the screws in pos. 1 and 6, the nuts in pos. 3 and 8 (FIG. 33a and 33b)
  - proceed in the same way on the screws in pos. 2
  - bring the bushes of the operating mechanism (pos. 5) and the bushes of the intermediate abutments (pos. 9) to rest on the shaft, tacking action on the nuts in pos. 4 and the screws in position 7
  - tighten the screws in pos. 1 and 6, and the nuts in pos. 3, 4 and 8
  - close the circuit-breaker and check the gap A
4) If the gap A is not correct, open the circuit-breaker again and repeat the procedure indicated in item 3a or 3b
5) If the gap A is correct, open the circuit-breaker again, seal with yellow paint and reinstall the arcing chambers.
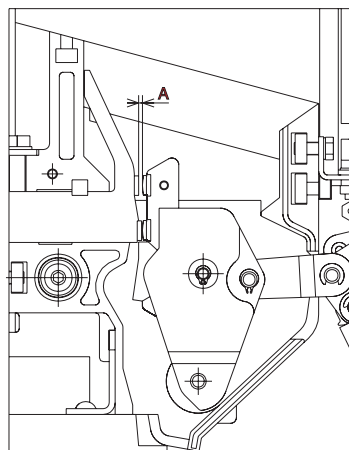
Circuit-breaker	A
E2 - E3	1 ÷ 1.9 mm
E4 - E6	0.8 ÷ 1.5 mm

Fig. 33

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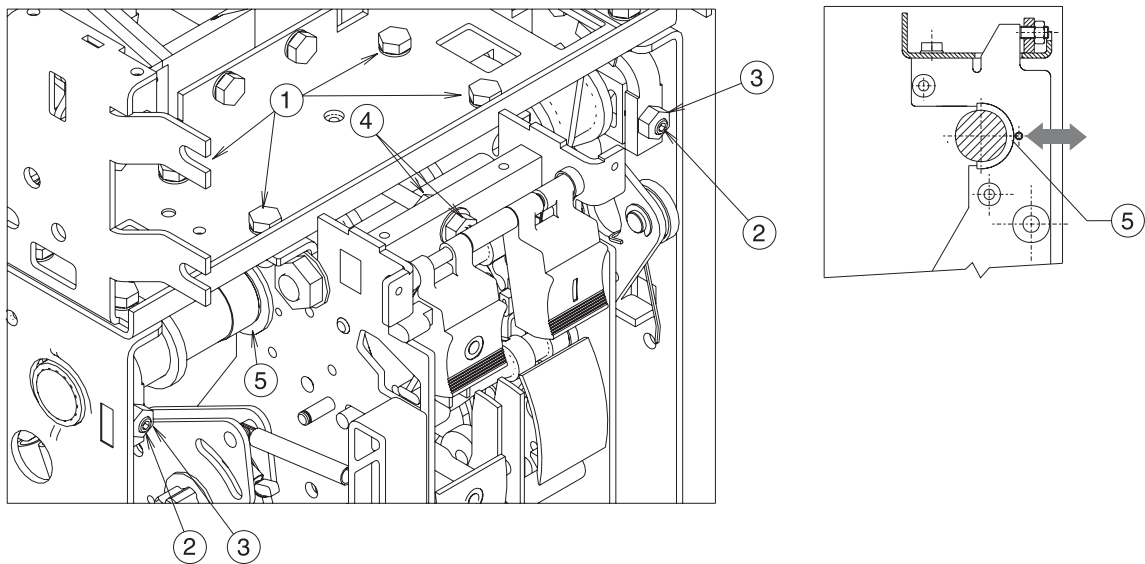
Fig. 33a
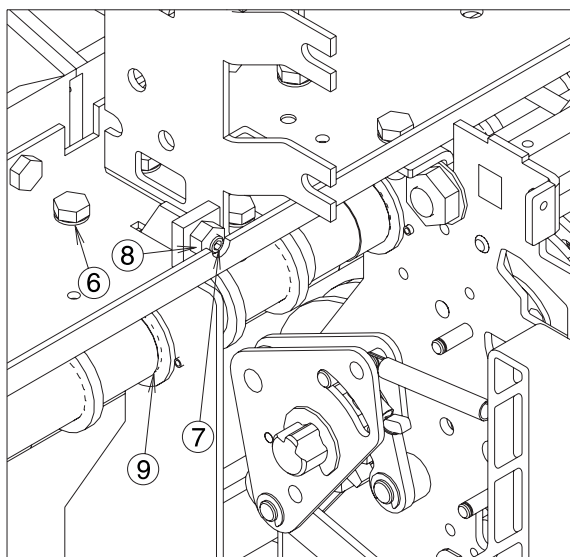
Fig. 33b
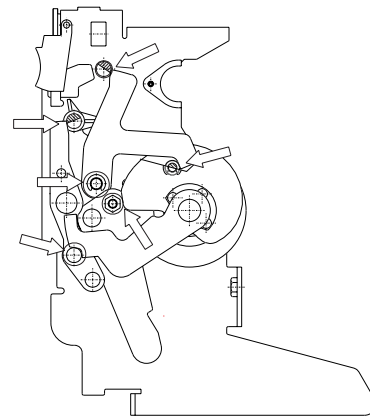
Fig. 33c

8.3.4 Operating mechanism maintenance

− Carry out the checks and take the action listed under item 1 of the table in paragraph 8.3.2.
− Lubricate the bearings of the drive shaft with MU-EP1 (AGIP) grease, including those on the sides of the circuit-breaker. Equivalent greases: ESSO Beacon EP1 - BP LTX1 - SHELL AVANIA GREASE R1 - KLUBER LUBRIFICATION CENTO PLEX 2P
− Lubricate the small opening and closing shafts and the hooks with 5 RX MOLY (OLEOTECNICA) grease (Fig. 33c). Equivalent grease: KLUBER LUBRIFICATION GRAFLOSCON A-G 1 ULTRA.

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9. Measures to be taken for any operating anomalies

Anomalies

Legend of anomaly columns:

1. Pressing the i-Test pushbutton on the PR122/PR123 does not cause circuit-breaker opening
2. The WARNING or ALARM led on the PR122/PR123 release lights up
3. Release coils interrupted or burnt out, geared motor winding interrupted
4. The shunt opening release or shunt closing release does not energize sufficiently
5. The shunt opening release or shunt closing release remains energized
6. The moving part does not rack into the fixed part
7. The moving part does not rack out of the fixed part
8. The circuit-breaker does not close
9. The circuit-breaker does not open

1	2	3	4	5	6	7	8	9	Possible causes	Checks and remedies
●									Connector XO not inserted correctly	Check and insert connector XO correctly
●									Coil of the opening release YO1 interrupted	Replace the YO1 shunt opening release
●									Defect in the electronic circuits of the microprocessor release	Put the circuit-breaker out of service and check the release with the test apparatus
	●								The possible causes of tripping are listed in the part of the manual relating to the releases	Take action according to the cause: in particular, if contact wear is higher than 80% (WARNING led lit up), the circuit-breaker can remain in service, but replacement of the circuit-breaking parts must be scheduled within a short time. If contact wear reaches 100%, the circuit-breaker must be put out of service immediately. Ask ABB SACE about replacement procedures for the circuit-breaking parts
							●		Protections not reset	Press the mechanical pushbutton for signalling protection tripping
						●			Operating mechanism or consent contacts blocked in closing position	Check the state of the contacts in series with the release circuit
●			●				●	●	Auxiliary circuit power supply voltage too low	Measure the voltage: it must not be less than 85% of the rated voltage
●		●	●						Different power supply voltage from the one indicated on the rating plate of the releases	Check the rating plate voltage of the releases
			●				●	●	Operating circuit faulty	Check connections, fuses, interlocks, protection circuit-breakers and consent contacts
		●					●	●	Wire tightening screws loose	Check tightness of the screws connecting the wires
			●				●	●	Incorrect electrical connections in the power supply circuit	Check the connections with the corresponding circuit diagram
							●	●	Release coils interrupted	Replace the coils
	●						●	●	Operating mechanism blocked	Operate by hand. If the fault persists contact ABB SACE
							●		Key not inserted in the opening mechanism lock	Insert and turn the key
							●		Circuit-breaker in intermediate position between connected and disconnected	Complete the operation
							●		Undervoltage release not energized	Check the corresponding power supply circuit
							●		Shunt opening release remains energized	Check the power supply circuit
					●	●			Racking-in or out operation not carried out correctly	See paragraph 7.3

10. Accessories

10.1 Electrical accessories

Shunt opening/closing (YO/YC) and second shunt opening release (Y02)

This allows remote opening or closing control of the apparatus. Given the characteristics of the circuit-breaker operating mechanism, opening (with the circuit-breaker closed) is always possible, whereas closing is only possible when the closing springs are loaded. Most of the releases can operate with either direct or alternating current. This release carries out an instantaneous service (*), but can be supplied permanently (**). In uses where the shunt closing release is supplied permanently, to carry out the circuit-breaker reclosing operation after opening, it is necessary to momentarily de-energize the shunt closing release (the circuit-breaker operating mechanism reclosing is, in fact, fitted with an antipumping device).

In some versions it is necessary to have a very high degree of safety for the remote opening control of the circuit-breaker, and, in particular, the duplication of the control circuit of the shunt opening release is required. In order to achieve this, you can fit the SACE Emax circuit-breakers with a second shunt opening release. The second shunt opening release is located in the same seat as the undervoltage release and its technical characteristics are the same as the standard shunt opening release.

(*)   In the case of instantaneous service, the minimum duration of the current impulse must be 100 ms.

(**) In the case of permanent power supply to the shunt opening release, you must wait for at least 30 ms before giving the opening control to the shunt closing release.

Reference figures in the electrical circuit diagrams: YO (4) - YC (2) - YO2 (8)

Power supply (Un)		Operating limits (CEI EN 60947-2 Standards)	(YO-YO2) : 70…110% Un
	24 V DC		(YC) : 85…110% Un
	30 V AC/DC	Inrush power consumption (Ps)	DC = 200 W
	48 V AC/DC	Inrush power time ~100 ms	AC = 200 VA
	60 V AC/DC	Continuous power (Pc)	DC = 5 W
	110-120 V AC/DC		AC = 5 VA
	120-127 V AC/DC	Opening time (YO - YO2)	(max) 60 ms
	220-240 V AC/DC	Closing time (YC)	(max) 80 ms
	240-250 V AC/DC	Insulation voltage	2500V 50 Hz (for 1 min.)
	380-400 V AC		
	440 V AC		

Undervoltage release (YU)

The undervoltage release opens the circuit-breaker in the case of a considerable drop or lack of its power supply voltage. It can be used for remote tripping (by means of normally closed type pushbuttons), as a lock on closing or to control the voltage in the primary and secondary circuits. The release power supply is therefore branched on the supply side of the circuit-breaker or from an independent source. Circuit-breaker closing is only allowed with the release powered (the closing lock is carried out mechanically). Most of the releases can operate with either direct or alternating current.

Power supply (Un)	
	24 V DC
	30 V AC/DC
	48 V AC/DC
	60 V AC/DC
	110-120 V AC/DC
	120-127 V AC/DC
	220-240 V AC/DC
	240-250 V AC/DC
	380-400 V AC
	440 V AC
Operating limits:	(YO-YO2): 70% ... 110% Un
(CEI EN 60947-2 Standards).	(YC): 85% ... 110% Un

Circuit-breaker opening takes place with power supply voltage values of the release equivalent to 35 - 70% Un.
Circuit-breaker closing is possible with power supply voltage of the release equivalent to 85-110% Un.

It can be fitted with a signalling contact for undervoltage release energized (C. aux YU).

Reference figures in the electrical circuit diagrams: YU (6)

Inrush power consumption (Ps):	DC = 200 W
	AC = 200 VA
Continuous power (Pc):	DC = 5 W
	AC = 5 VA
Opening time (YU):	30 ms
Insulation voltage	2500 V 50 Hz (for 1 min.)

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Time delay device for undervoltage release (D)

The undervoltage release can be combined with an electronic time-delay device for installing outside the circuit-breaker, which enables a delay in the tripping of the release with preset, adjustable times. The use of the delayed undervoltage release is recommended when the power supply network of the release can be subject to power cuts or short-lived voltage drops, in order to avoid trips.
When it is not supplied, circuit-breaker closing is prevented.
The time-delay device has to be combined with an undervoltage release with the same voltage as the time-delay device.
Reference figures in the electrical circuit diagrams: YU + D; (7).

The characteristics of the time-delay device are:

Power supply (D):	24-30 V AC/DC
	48 V AC/DC
	60 V AC/DC
	110-127 V AC/DC
	220-250 V AC/DC
Adjustable opening time (YU+D):	0.5-1-1.5-2-3 s

Geared motor for automatic closing spring loading (M)

This automatically loads the circuit-breaker operating mechanism closing springs. After circuit-breaker closing, the geared motor immediately sees to reloading the closing springs.
When there is no power supply or during maintenance work, the closing springs can still be loaded manually (by means of the special lever on the operating mechanism).

Power supply	24-30 V AC/DC
	48-60 V AC/DC
	100-130 V AC/DC
	220-250 V AC/DC
Operating limits:	85…110% Un (CEI EN 60947-Standards)
Inrush power consumption (Ps):	DC = 500 W
	AC = 500 VA
Rated power (Pn):	DC = 200 W
	AC = 200 VA
Inrush time	0.2 s
Loading time:	4-5 s
Insulation voltage	2500 V 50 Hz (for 1 min.)

It is always supplied with limit contacts and microswitch for signalling closing springs loaded.

Reference figure in the electrical circuit diagrams: M (1)

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Mechanical and electrical trip signalling for overcurrent releases

The following signals are available following tripping of the overcurrent release:

a) Mechanical trip signalling for overcurrent releases

This enables a visual signalling on the operating mechanism by pushing the trip pushbutton in when the circuit-breaker has been opened following tripping of an overcurrent release. The circuit-breaker can only be closed again by putting the pushbutton back into its normal position included in the standard configuration.
Reference figure in the electrical circuit diagrams: S51 (13).

b) Electrical and mechanical trip signalling for overcurrent releases

This enables a visual signalling on the operating mechanism (mechanical) and remotely (electrically by means of a changeover switch) of the circuit-breaker being opened following a trip of the overcurrent releases. To reset the circuit-breaker, it is necessary to reset the mechanical indicator pushbutton.
Reference figure in the electrical circuit diagrams: S51 (13).

c) Coil for resetting the mechanical release trip indicator

This enables a visual signalling on the operating mechanism (mechanical) and remotely (electrically by means of a changeover switch) of the circuit-breaker being opened following a trip of the overcurrent releases. With this accessory, you can reset the mechanical indicator with an electronic relay using a remote control and this enables the circuit-breaker to be reset.

Power supply:	24-30 V AC/DC
	220-240 V AC/DC
	110-130 V AC/DC

Reference figure in the electrical circuit diagrams: S51 (14)

Auxiliary contacts

Auxiliary contacts installed on the circuit-breaker are available to enable an indication of the circuit-breaker's status. A special version of the auxiliary contacts is also available (gold plated contacts) for a rated voltage under 24 V (digital signal).

Un	In max	T		Un	In max	cosφ
125 V DC	0.3 A	10 ms		250 V AC	5 A	0.3
250 V DC	0.15 A	10 ms				

The versions available are:

a) Electrical signalling for circuit-breaker open/closed

It is possible to have electrical signalling of the circuit-breaker status (open/closed) 4, 10 or 15 auxiliary contacts.
The auxiliary contacts can have the following configurations:
- 4 + 2 break/make contacts for PR122/DC-PR123/DC (2 normally open + 2 normally closed + 2 for the release)
- 10 + 2 break/make contacts for PR122/DC-PR123/DC (5 normally open + 5 normally closed + 2 for the release)
- 15 supplementary break/make contacts which can be mounted outside the circuit-breaker.

The basic configuration described above can be modified by the user to indicate normally open or normally closed by repositioning the faston connector on the microswitch. When 10 contacts for PR122/ PR123 are required, zone selectivity and the PR120/K module are not available.
Reference Fig. in the electrical circuit diagrams: Q/1÷10 (21-22)

b) Electrical signalling for circuit-breaker connected/test isolated/disconnected

In addition to mechanical signalling of the position of the circuit-breaker, it is possible to have electrical signalling by means of 5 or 10 auxiliary contacts which are installed on the fixed part.
Only available for circuit-breakers in withdrawable versions for installing on the fixed part.
The auxiliary contacts can have the following configurations:
- 5 contacts; group consisting of 2 connected signalling contacts, 2 disconnected signalling contacts and 1 test position signalling contact (main contacts isolated, but sliding contacts connected)
- 10 contacts; group consisting of 4 connected signalling contacts, 4 disconnected signalling contacts and 2 test position signalling contacts (main contacts isolated, but sliding contacts connected).
Reference figure in the electrical circuit diagrams: S75I (31-32) - S75T (31-32) - S75E (31-32)

c) Contact for signalling closing springs loaded

This consists of a microswitch which allows remote signalling of the state of the circuit-breaker operating mechanism closing springs. The contact is always supplied with the spring loading geared motor.
Reference figure in the electrical circuit diagrams: S33 M/2 - (11)

d) Contact for signalling undervoltage release energized (C.aux YU)

The undervoltage releases can be fitted with a contact (by choise, normally closed or open) for signalling undervoltage energized for remote signalling of the state of the undervoltage release.
Reference figure in the electrical circuit diagrams: (12)

Mechanical operations counter

This is connected to the operating mechanism by means of a simple lever mechanism. It indicates the number of circuit-breaker mechanical operations. The indication is visible on the front of the circuit-breaker from the outside.

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10.2 Mechanical locks

a-b) Lock in open position

Different mechanisms are available which enable the circuit-breaker to be locked in the open position.
These devices can be controlled by:
- a key (a): a special circular lock with different keys (for a single circuit-breaker) or with the same keys (for several circuit-breakers). In the latter case, up to four different key code numbers are available.
- padlocks (b): up to 3 padlocks (not supplied): Ø 4 mm.

c) Circuit-breaker lock in connected - test isolated - disconnected position

This device can be controlled by a special circular lock with different keys (for a single circuit-breaker) or with the same keys (for several circuit-breakers available up to four different key code numbers) and by padlocks (up to 3 padlocks, not supplied - Ø 4 mm).
Only available for circuit-breakers in withdrawable versions for installing on the moving part.

d) Accessories for lock in test isolated - disconnected position

In addition to the circuit-breaker lock in the connected - test isolated - disconnected position, this allows locking only in the disconnected or test isolated positions. Only available for circuit-breakers in withdrawable versions for installing on the moving part.

e) Accessories for shutter padlocks

They enable the shutters to be padlocked (installed on the fixed part) in the closed position.
Only available for circuit-breakers in withdrawable versions for installing on the fixed part.

f) Mechanical lock on compartment door

This prevents the compartment door from being opened when the circuit-breaker is closed (and connected in the case of withdrawable circuit-breakers) and prevents circuit-breaker closing with the compartment door open.

Transparent protection covers

a) Protection covers for opening and closing pushbuttons

These protection covers, applied over the opening and closing pushbuttons, prevent the corresponding circuit-breaker operations except by using a special tool.

b) IP54 door protection

This is provided by means of a transparent plastic escutcheon plate which fully protects the front of the circuit-breaker and ensures a degree of protection to IP54. Mounted on hinges, it is fitted with a key lock.

Interlock between circuit-breakers

This mechanism makes the mechanical interlock between two or three circuit-breakers (even of different sizes and in any fixed/withdrawable version) by means of a flexible cable. The electrical circuit diagram for the electrical changeover by means of a relay (to be provided by the customer) is supplied with the mechanical interlock. The circuit-breakers can be installed vertically or horizontally.
4 types of interlocks are available:
type A: between 2 circuit-breakers (power supply + emergency)
type B: between 3 circuit-breakers (2 power supplies + emergency)
type C: between 3 circuit-breakers (2 power supplies + bus-tie)
type D: between 3 circuit-breakers (3 power supplies / a single closed circuit-breaker)
The emergency power supply is generally supplied in order to substitute the normal power supply in two cases:
- to supply safety services for people.
- to supply essential parts of the installation, other than the safety services.

The change over from the normal supply to the emergency supply, can be done manually (with a local or remote control) or automatically. For the change over, the circuit-breakers must be supplied with the necessary accessories for the electrical remote control and for electrical and mechanical interlocks provided for the changing over.
The accessories can be for example:
- the shunt opening release
- the shunt closing release
- the motor operator
- the auxiliary contacts.
For the change over, the customer can use a suitable electronic relay, whose diagram is supplied by ABB SACE. The mechanical interlocks between two or three circuit-breakers are made by means of cables that can be used for circuit-breakers installed, either side-by-side or one over the other.

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Table of feasible mechanical interlocks between two or three circuit-breakers

Type of interlocks	Number of circuit-breakers	Type of circuit-breaker	Possible interlocks
A	TWO	a normal power supply unit and an emergency unit	the first circuit-breaker can be closed only if the second (emergency) breaker is open
B	THREE	two normal power supply units and an emergency unit	the first and third circuit-breakers can be closed only if the second (emergency) breaker is open. The latter can be closed only if the first and third are open
C	THREE	a unit of 2 supplies and a bus-tie. The two half-busbars can be supplied by a single transformer (bus-tie closed) or simultaneously by both (bus-tie open)	one or two circuit-breakers out of three can be closed at the same time
D	THREE	a unit of 3 supplies / a single closed circuit-breaker. Three supplies (generators or transformers) on the same busbar for which parallel operation is not allowed	only one of the three circuit-breakers can be closed

10.3 Spare parts

The spare parts available are:
− Shields and front escutcheon plate
− Opening solenoid for the PR122/DC-PR123/DC overcurrent release
− Arcing chamber
− Closing springs
− Clamp-type isolating contact for fixed part of the withdrawable circuit-breaker
− Sliding earth contact (for withdrawable version)
− Fixed part shutters
− Operating mechanism
− Transparent protection for PR122/DC and PR123/DC releases
− SACE PR030/B power supply unit
− Tool case
− Front escutcheon plate for Ronis-type key lock
For further details, ask for the ABB SACE spare parts catalogue.

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11. Protection releases - General notes

The Emax series of ABB air circuit-breakers now has a new range of electronic releases for DC applications called PR122/DC and PR123/DC. The new protection releases integrate all the functions of their predecessors, adding new and interesting technical features that are useful for satisfying every current and future system installation need.
Every operational requirement is now met thanks to the different performance levels of the new relays and of the additional modules that can be fitted inside them (PR120/V, PR120/LV, PR120/K, PR120/D-M, PR120/D-BT).

A table can best illustrate the technical features and the mix and matchability of the relays.

Function/Unit	PR122/DC	PR123/DC
Current protections (L, S, I)	S	S
Current protections G	-	S
Additional protections (U)	-	S
Voltage protections (UV, OV, RP)	-	S
Other protections (S2)	-	S
Temperature protection (OT)	S	S
MCR protection	S	S
Thermal memory	S	S
Local bus for separate auxiliary units	S	S
Wire communication (RS485)	S [1]	S [1]
Data Logger	S	S
Compatibility with SD.Pocket	S	S
Compatibility with SD.Testbus	S	S
Compatibility with PR010/T	S	S
Dual setting	-	S
PR120/V Measuring (internal voltages module)	S [2]	S [2]
PR120/LV Measuring (internal voltages module)	S [2]	S [2]
PR120/K Signalling (internal signalling module)	O	O
PR120/D-M Com (internal communication module)	O	O
PR120/DC (override protection module)	S	S
PR021/K (separate signalling unit)	O	O
HMI030 (separate graphics interface)	O	O
PR030/B (separate power supply unit)	S	S
BT030 (separate Bluetooth communication unit)	O	O

Key:
S   : standard function/unit,
O   : optional function/unit,
-       : function/unit unavailable.

Notes:
1.   : with internal PR120/D-BT module
2.   : PR120/V or PR120/LV for standard (see section 14.1)

11.1 Safety notes

⚠️ **WARNING**: this symbol gives information about operations, actions or circumstances that can cause injuries to the personnel, damage to the unit or economic losses.

Read this manual carefully and completely.
The use of this device should be reserved for qualified and expert personnel only.

If in doubt, about its safe usage, the unit must be put out of service to prevent any accidental use.

You must assume that safe usage is impossible if:

1. the unit shows visible signs of damage.
2. the unit does not function (for example with autotest or with the trip test unit).
3. the unit has been damaged in transit.

⚠️ **Prior to servicing and/or replacing, the circuit-breaker must be open.
Also remember to disconnect all power supplies connected.**

11.1.1 Notes for dielectric stiffness tests

⚠️ **Dielectric stiffness tests on the releases, inputs and outputs, are not permitted.**

11.2 Abbreviations and notes

Abbreviations

Abbreviations	Meaning
BA	Opening coil
BC	Closing coil
CB	Circuit-Breaker (for example Emax)
BT030	Power supply and Wireless communication unit, ABB SACE
PDA	Pocket Pc with Bluetooth
Emax	Series of ABB SACE air circuit-breakers
HMI030	Human Machine Interface
HW	Hardware
In	Rated current of the Rating Plug installed in the circuit-breaker
MT	Thermal memory
Pn	Circuit-breaker rated power
PR120/K	Internal signalling unit of alarms and trips of the circuit-breaker
PR120/V-PR120/LV	Measuring module
PR021/K	Signalling unit
PR120/D-M	Communication module
PR010/T	ABB SACE unit test
PR122/DC	Protection relay for CB Emax
PR123/DC	Protection relay for CB Emax
PR030/B	ABB SACE power supply unit
Relay	also called "protection unit" or "protection release"
TC	Trip Coil (opening solenoid)
SdZ	Zone selectivity
SW	Software
i-Test	"i-Test" button on the front of relay
Trip	CB opening, generated by the release
Un	Rated voltage
Vaux	Auxiliary power supply

Notes

A. Use the "Belden 3105A"- type two-wire cable for instance (not supplied by ABB SACE).

B. Use the "Belden 3106A"- type three-wire cable for instance (not supplied by ABB SACE).

C. The unit has a "backup-protection" function; if the first command to the opening solenoid does not open immediately the circuit-breaker (TC partially fault), TRIP commands are repeatedly sent until the circuit-breaker opens.
The "backup" condition can be signalled by configuring the unit relays; using the "YO back" selection, it is possible to command the "opening coil(YO)" accessory as another opening device if TC does not work.

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12. SACE PR122/DC Release - Identification

The PR122/DC units available, in accordance with the IEC standards, together with the various protections and the various standard and optional modules, are illustrated in the following figure:

| For all versions (OT) | | |
Modules available	standard	optional
PR120/V[1] - PR120/LV[1]	X	-
PR120/D-M	-	X
PR120/K	-	X
PR120/DC[2]	X	-
BT030	-	X
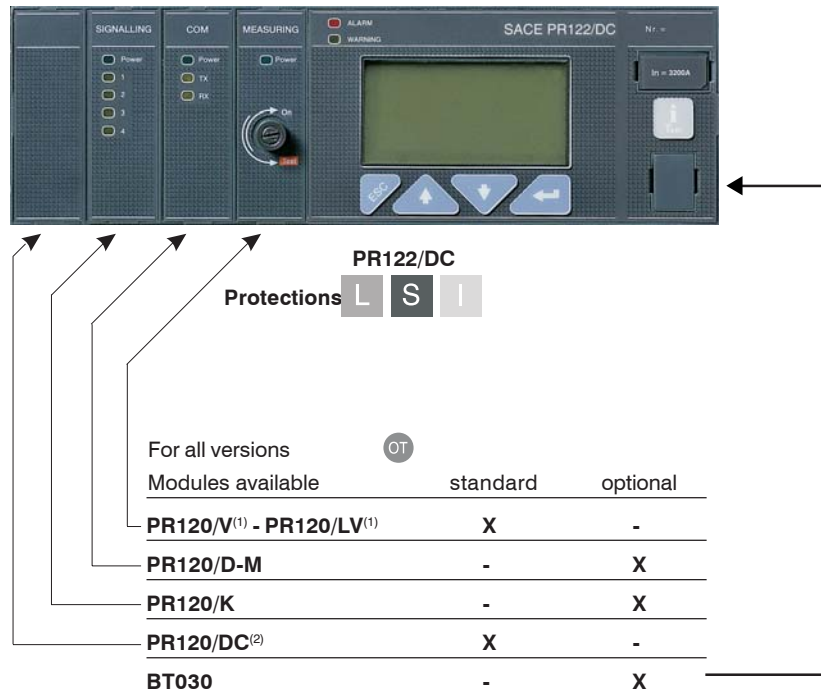
[1] Standard: PR120/V or PR120/LV
[2] Slot inside occupied by PR120/DC

12.1 Standard

The PR122/DC has been designed to work in accordance with the international standard:
IEC 60947-2 Low voltage apparatus. Circuit-breakers.

12.2 Specifications

12.2.1 General

The PR122/DC is a high-performance protection unit with **Protection, Measurement, Data storage, Communication (optional), Self-test, Load control and Zone selectivity** functions for the ABB SACE 'Emax' range of 3- and 4-pole low-voltage air circuit-breakers. The unit's user interface also enables parameter setup and complete the prealarm and alarm management for the protection and watchdog functions.
Complete with an instantaneous override protection that trips when the electronic release is not powered.

The protections available are:

Symbol	Protection against
L	overload with inverse long time delay
S	short-circuit with adjustable delay
I	instantaneous short-circuit
OT	temperature out of range
MCR	closing on short-circuit

The PR122/DC can be installed on 3-pole CBs or on 4-pole CBs.

The unit opens the circuit-breaker in which it is installed by means of the TC, which takes effect directly on the device's mechanical leverism.
The protection unit is self-supplied by primary voltages (PR120/V or PR120/LV module).
The unit is made using digital microprocessor technology and interfaces with the user by means of a graphic display and keyboard.

12.2.2 Auxiliary power supply

The external auxiliary power supply is provided using a galvanically-separated power pack.

> ⚠️ **Since the auxiliary voltage needs to be isolated from the ground, "galvanically separated converters" in accordance with the IEC standard 60950 (UL 1950) or the equivalent IEC 60364-41 and CEI 64-8 have to be used to guarantee a current in common mode or leakage current (as defined in IEC 478/1 and CEI 22/3) no greater than 3.5mA.**

The presence of the auxiliary power supply enables the relay unit to be used even with the circuit-breaker open, as well as powering all the modules. The characteristics of the power pack are given in the table below:

Characteristics	Version PR122/DC
Auxiliary voltage (galvanically separated)	24V DC ±20%
Maximum ripple	5%
Inrush current @ 24V	~10 A for 5ms
Rated power @ 24V	~5W

12.2.2.1 Powered by the PR120/V-PR120/LV module
For a full explanation of the features of the PR120/V-PR120/LV, see par. 14.1.

12.2.3 Environmental characteristics
Operating temperature   -25°C ... +70°C
Storage temperature   -40°C ... +90°C
Relative humidity   0% ... 98% with condensation
Degree of protection (with PR122/DC installed in the CB)   IP 30

12.2.4 Description of inputs/outputs

12.2.4.1 Binary inputs
− **K51/SZin:**   Zone selectivity: input for protection S   (only with Vaux)

12.2.4.2 Binary outputs
− **K51/SZout:**   Zone selectivity: output for protection S   (only with Vaux)
Note: These inputs/outputs should be used between PR122/PR123 series units only.

12.2.5 Communication bus
Local bus on rear connector; RS485 physical interface, Modbus protocol.
External system bus, RS485 physical interface, Modbus RTU protocol, baud rate 9600-19200 bps.
Test bus on front test connector.

12.2.6 Protection functions
The PR122/DC protection unit carries out 7 independent protection functions. In particular:
1. Protection against overload with inverse time "**L**";
2. Protection against short-circuit with adjustable delay "**S**";
3. Protection against instantaneous short-circuit "**I**";
4. Protection against closing on short-circuit "**MCR**";
5. Protection against instantaneous short-circuit at high currents "**Iinst**";
6. Protezione override con relè non alimentato;
7. Protection against overtemperature "**OT**".

A timing indication (message + "alarm" LED) is provided on the unit's display, which is activated during a protection alarm. It is disabled when the alarm condition ceases or when the protection has been tripped. When the circuit-breaker opens, the page with the "Trip" data is displayed (when "i Test" is pressed, or automatically in the presence of Vaux).

12.2.6.1 Circuit-breaker state
The PR122/DC unit records the state of the circuit-breaker by means of specific wiring on the circuit-breaker. In the case where the presence of current is determined with the circuit-breaker in the "OPEN" state, a state error is signaled by a warning message being displayed (see par. 12.6) and the "warning" LED lighting up.
The signal can be combined with a relay of the PR120/K module or with those of the PR021/K unit.

12.2.7 Measurement functions
The current measuring (ammeter) function is available on all versions of the SACE PR122/DC unit.
The display shows histograms with the currents of the polarity on the main page and in numerical form.
- Current;
- Instantaneous current values over a given time interval (data logger).
- Maintenance: number of operations, percentage of contact wear, opening data storage (latest 20 trips and 80 events).
- The protection records the historical data of the maximum current read.

12.2.8 Watchdog
The PR122/DC unit provides some watchdog functions able to guarantee the proper management of relay malfunctions. These functions are as follows:

❑ Watchdog for presence of Auxiliary power supply with "plug" icon displayed.

❑ Rating PLUG validity.

❑ Watchdog for proper connection of the Trip Coil (TC). If it is enabled, any faults are indicated by a special alarm message and the "alarm" LED coming on; if the PR120/D-M module is installed, this activates the coil opening command (YO), thus opening the CB.

❑ Watchdog for protection of Hw Trip. If it is enabled, in the event of CB undefined or Rating Plug error or Installation error, a CB opening command is given by the TC being enabled.

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12.2.9 Description of the protection functions

12.2.9.1 Protection "L"

The "L" is the only protection that cannot be disabled because it is for self-protection against overloading of the relay itself. The types of trip curves settable are divided into two groups according to the IEC standard 60255-8.
The protection trip time - inverse time - is given by the expression:

$$\tau \; \ln \left(\frac{I_f}{I_f^2 - I_1^2} \right) \quad \text{for } I_f \leq 12In \text{ and 1s for } I_f > 12In \qquad \text{where } I_f \text{ is the fault current and } I_1 \text{ the protection threshold and with } \tau = t1/ (\ln 9/8)$$

NB: Time expressed in seconds.

12.2.9.1.1 Thermal memory "L"

The thermal memory can be enabled to protect the cables on the basis of the "hot state" tripping curve in IEC 60255-8.

$$\tau \; \ln \left(\frac{I_f^2 - I_p^2}{I_f^2 - I_1^2} \right) \text{ for } I_f \leq 12In \text{ and 1s for } I_f > 12In$$

where I_p is calculated on the basis of the evolution of the current providing there is no overload condition.

The PR122/DC is fitted with two instruments to make up this thermal memory. The first is only effective when the release is powered (it also records overloads that have not lasted long enough to trip the release), while the second works even when the release is not powered, reducing any trip times in the case of an immediate reclosing and is enabled as soon as the CB is tripped.
It is the PR122/DC release that automatically decides which of the two to use, according to the various situations.

12.2.9.2 Protection "S"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time (t=k/i²); in the latter case, the trip time is given by the expression:

$$\max \left[\frac{100 \cdot t_2}{(I_f)^2}, t_2 \right] \qquad \text{where } I_f > I_2 \quad \text{where } I_f \text{ is the fault current and } I_2 \text{ the protection threshold.}$$

NB: Time expressed in seconds.

12.2.9.2.1 Thermal memory "S"

The thermal memory function can be enabled for cable protection in the case where the curve with inverse time is selected. This is based on the "tS" parameter defined as the trip time of the curve (t2) selected at 1.5xI2. The other characteristics are the same as those for thermal memory "L" (see par. 12.2.9.1.1).

12.2.9.2.2 Start-up threshold "S"

The start-up function can be selected in the case where the curve with fixed time is selected.
The function can be disabled and it is a setting characteristic of the single protection units.

The start-up function enables the protection threshold (S and I) to be changed during a time interval lasting "ts", starting from "start-up". The latter must be intended as follows:
- Passage of the RMS value of the maximum current over one single adjustable threshold (0.1…10In, by 0.1In steps). A new start-up is possible after the current has dropped below this threshold.
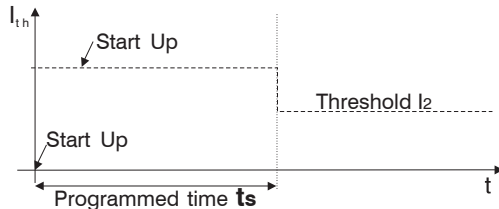
- **Start-up time**

The start-up time is common to all the protections involved. Range: 0.1s … 30s, with steps of 0.01s.

12.2.9.2.3 Zone selectivity "S"

The zone selectivity function, guaranteed only if an auxiliary voltage is provided, enables the area of the fault to be isolated, only isolating the part of plant nearest to the fault, while keeping the rest of the plant operational.
This is done by connecting all the zone selectivity outputs of the releases belonging to the same zone to one another (ZSO=K51/SZout) and taking this signal to the zone selectivity input (ZSI=K51/SZin) of the next release on the supply side. If the wiring has been done correctly, all the zone selectivity inputs of the last circuit-breakers in the chain and all the outputs of the circuit-breakers at the head of each chain must be empty.

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As a practical example, the figure above shows a fault on the load side of the "Relay 1a" isolated by the latter without the "Relay 1" or the "Relay 0" being affected; a fault immediately downstream from the "Relay 1" will be isolated by the latter without the "Relay 0" being affected, thus ensuring that the Areas 2...n remain operational.

The ZSO output can be connected to a maximum of 20 ZSI relays on the supply side in the selectivity chain.

> ⚠️ **The maximum length of cable for zone selectivity, between two units, is 300 meters.**
> **Use corded shielded two-wire cable (see note A to par. 11.2.2).**
> **The shield must only be earthed on the circuit-breaker of the supply-side relay (ZSI side).**

Operation is only guaranteed when there is an auxiliary voltage.
The following logical table is implemented to manage the Zone Selectivity Input (ZSI) and Zone Selectivity Output (ZSO) signals:

Zone selectivity	Imax > I_2	ZSI signal	ZSO signal	Trip T
Excluded	NO	0	0	No trip
Excluded	NO	1	0	No trip
Excluded	YES	0	0	t_2 programmed
Excluded	YES	1	0	t_2 programmed
Inserted	NO	0	0	No trip
Inserted	NO	1	1	No trip
Inserted	YES	0	1	$t_{selectivity}$
Inserted	YES	1	1	t_2 programmed

The time t_2 must be set at a value higher than or equal to $t_{selectivity}$ +50ms, on the CB on the supply side, not required on the first one in the chain.

12.2.9.3   Protection "I"

The protection is enabled/disabled from the menu.
In the case where zone selectivity "S" is active, during the trip of the relay for "I", the ZSO output signal is activated in any case to guarantee correct operation of the relay on the supply side.

12.2.9.3.1 Start-up threshold "I"

The start-up function can be selected.
The function can be enabled from the menu on the protection "I" page.
The function behaves in exactly the same way as the protection "S" (see par. 12.2.9.2.2).

12.2.9.4   Protection "MCR" against closing on short-circuit

The MCR function is used to protect the system against closing, if any, on short-circuit.
This protection goes on when the CB is closed, within a time window ranging from 40 to 500ms and with a threshold as set by customer, using the same algorithm as protection I. This protection can be disabled and is an alternative to protection "I".
This function can be activated through a hand-held PR010/T unit via SD-Testbus2 and SD-Pocket softwares or through a remote system via a system bus. This function has one fixed-time protection curve only.

12.2.9.5   Protection against overtemperature inside the relay "OT"

There is a sensor inside the PR122/DC unit that monitors the temperature of the unit.
This enables the signalling of any abnormal temperature conditions, which could cause temporary or continuous malfunctions of the unit's electronic components.

This protection has two states of operation:

State of **"WARNING TEMPERATURE"** with and the "WARNING" LED flashes at 0.5Hz | $-25\ °C < temp. < -20\ °C$ | *or* | $70\ °C < temp. < 85\ °C$ | : the display is turned off

State of **"ALARM TEMPERATURE"** with | $temp. < -25\ °C$ | or | $temp. > 85\ °C$ | : the display is turned off,

the "WARNING" and "ALARM" Leds flash at 2Hz and the Trip is activated (if enabled by means of the "Over Temper. Trip = On" parameter)

N.B.:
- In the event of Warning and Alarm, the display is turned off, to preserve its functionality.
- The monitored temperature is not visible on the display.

The protection is always active, both with auxiliary supply and in self-supply.

> ⚠️ **Disabling the Trip control of the protection means that the PR122/DC unit could work, with the circuit-breaker closed, in a range of temperatures where correct operation of the electronics is not guaranteed.**

12.2.9.6 Load control function

Single loads can be enabled/disabled on the load side before the overload protection L intervenes and trips the circuit-breaker on the supply side. This is done by contactors or switch-disconnectors (wired outside the release), controlled by the PR122/DC by means of contacts on the PR120/K module or on the PR021/K external unit.

The current thresholds are lower than those available with the protection L, so that the load control can be used to prevent tripping due to overloads.
The function is active when an auxiliary power supply is present, or supply from PR120/V (see par. 14.1.3)
The operating logic involves the activation of three contacts when the preset thresholds LC1, LC2 and I_w are exceeded.
Thresholds LC1 and LC2 are expressed as a percentage of I_1 (current threshold specified for protection L) while the "warning current" I_w is expressed as an absolute value. The allowable values are given in the following table:

Warning current Iw	$0.30 \div 10.0$ step $0.05 \times In$
Threshold LC1	$50\% \div 100\%$ step $1\% \times I_1$
Threshold LC2	$50\% \div 100\%$ step $1\% \times I_1$

From the PR122/DC you can associate each of the PR120/K or PR121/K contacts with a configuration (NO or NC), a delay and the eventual latch.

12.2.9.7 Summary table of the protection function settings for the PR122/DC

Protection	Disabling	Disabling of TRIP only	Zone selectivity	Start-up threshold	Thermal memory	Trip Threshold	Trip Time	Trip threshold tolerance [2]	Trip time tolerance [2]
L curve IEC 60255-8	☐	☐	☐	☐	☒	$0{,}4 \times In \leq I_1 \leq 1 \times In$ step $0{,}01 \times In$	$3\,s \leq t_1 \leq 102s^{(1)}$, step 3 s t1@ $3I_1$	Release between 1,05 and 1,2 xI1	$\pm 10\%$, $I_g \leq 4In$ $\pm 20\%$, $I_g > 4In$
S $(t=k)$	☒	☐	☒	☒	☐	$0{,}6\, \times In \leq I_2 \leq 10 \times In$ step $0{,}1 \times In$ $0{,}6\, \times In \leq I_{2\,start-up} \leq 10 \times In$ step $0{,}1 \times In$	$0{,}05\,s \leq t_2 \leq 0{,}35\,s$, step 0,01s $0{,}10\,s \leq t_{2\,start-up} \leq 30\,s$, step 0,01s $0{,}04\,s \leq t_{2\,sel} \leq 0{,}20\,s$, step 0,01s	$\pm 7\%, I_g \leq 6\,In$ $\pm 10\%, I_g > 6\,In$	The best of the two data $\pm 10\%$ o 40 ms
S $(t=k/i^2)$	☒	☐	☐	☐	☒	$0{,}6 \times In \leq I_2 \leq 10 \times In$ step $0{,}1 \times In$	$0{,}05\,s \leq t_2 \leq 0{,}35\,s$, step 0,01 s at $10 \times In$	$\pm 7\%, I_g \leq 6\,In$ $\pm 10\%, I_g > 6\,In$	$\pm 15\%$, $I_g \leq 4In$ $\pm 20\%$, $I_g > 4In$
I $(t=k)$	☒	☐	☐	☒	☐	$1{,}5 \times In \leq I_3 \leq 10 \times In$ step $0{,}1 \times In$	≤ 30 ms $0{,}10\,s \leq t_{2\,start-up} \leq 30\,s$, step 0,01 s where I>I4	$\pm 10\%$	
MCR $(t=k)$	☒	☐	☐	☐	☐	$6.0 \times In \leq I_5 \leq 10 \times In$ step $0.1 \times In$	≤ 30 ms$^{(3)}$	$\pm 10\%$	
OT $(temp=k)$	☐	☒	☐	☐	☐	Fixed, defined by SACE	Instantaneous	$\pm 5°C$	- - -
Iinst	☐	☐	☐	☐	☐	Automatic, defined by SACE	Instantaneous		
LC1/LC2 loads control	☒	☐	☐	☐	☐	$50\% \div 100\%$ step $0{,}05 \times I_1$			
Warning Iw	☒	☐	☐	☐	☐	$0{,}3 \div 10 I_n$ step $0{,}05 \times I_n$		$\pm 10\%$	$10 \div 40$ ms

(1) The minimum value of this trip is 1s regardless of the type of curve set (self-protection).
(2) These tolerances are based on the following assumptions:
- relay at full power (without start-up)
- preset trip time ≥ 100 ms.
(3) no-trip time

For all cases not covered by the above hypotheses, the following tolerance values apply:

Protections	Trip threshold	Trip time
L	Release between 1,05 e 1,25 x I1	$\pm 20\%$
S	$\pm 10\%$	$\pm 20\%$
I	$\pm 15\%$	≤ 60ms
Others		$\pm 20\%$

12.2.9.7.1 Table of measurements

Type of measurement		Standard operation range		
	Range of values measured by the relay	Range	Tolerance %
Current 0,05 ... 12 In	0,05 ... 12 In	0,3 ... 4 In	± 5

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12.2.10   Trip curves

The trip curves given are for guidance and only show a sub-group of the possible selections (see par. 12.2.9.7).

12.2.10.1   Trip curves for functions L-S(t=k/i²)-I
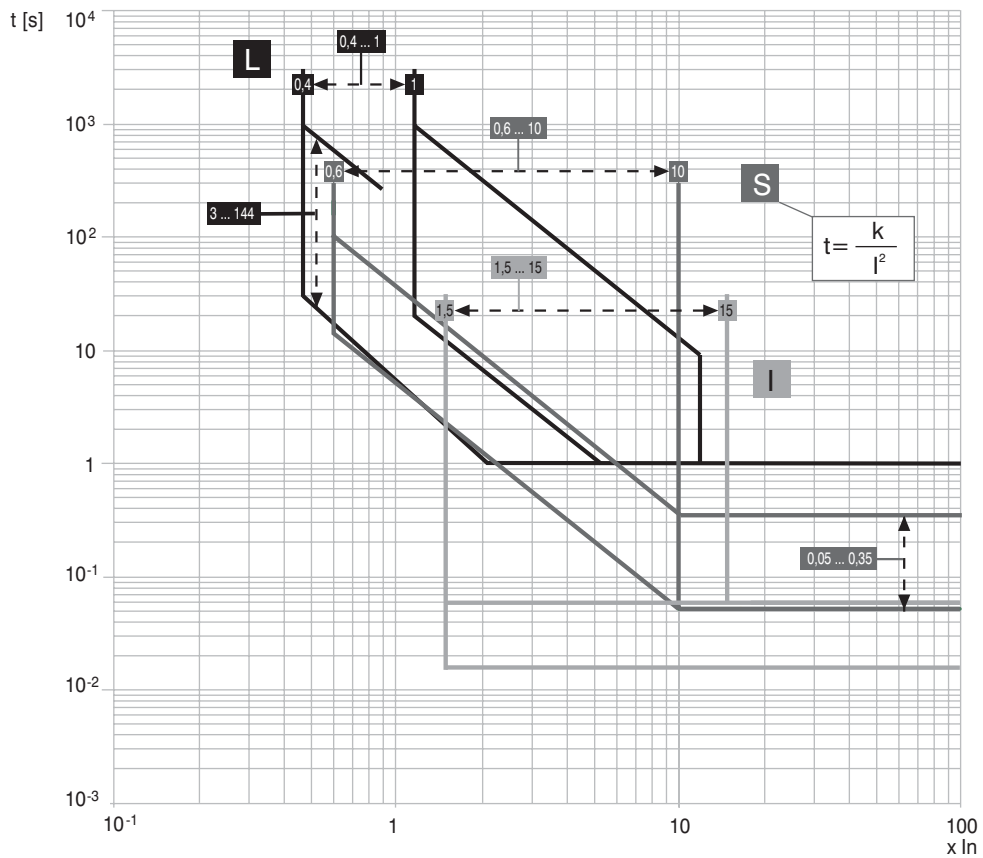
12.2.10.2   Trip curves for functions L-S(t=k)-I
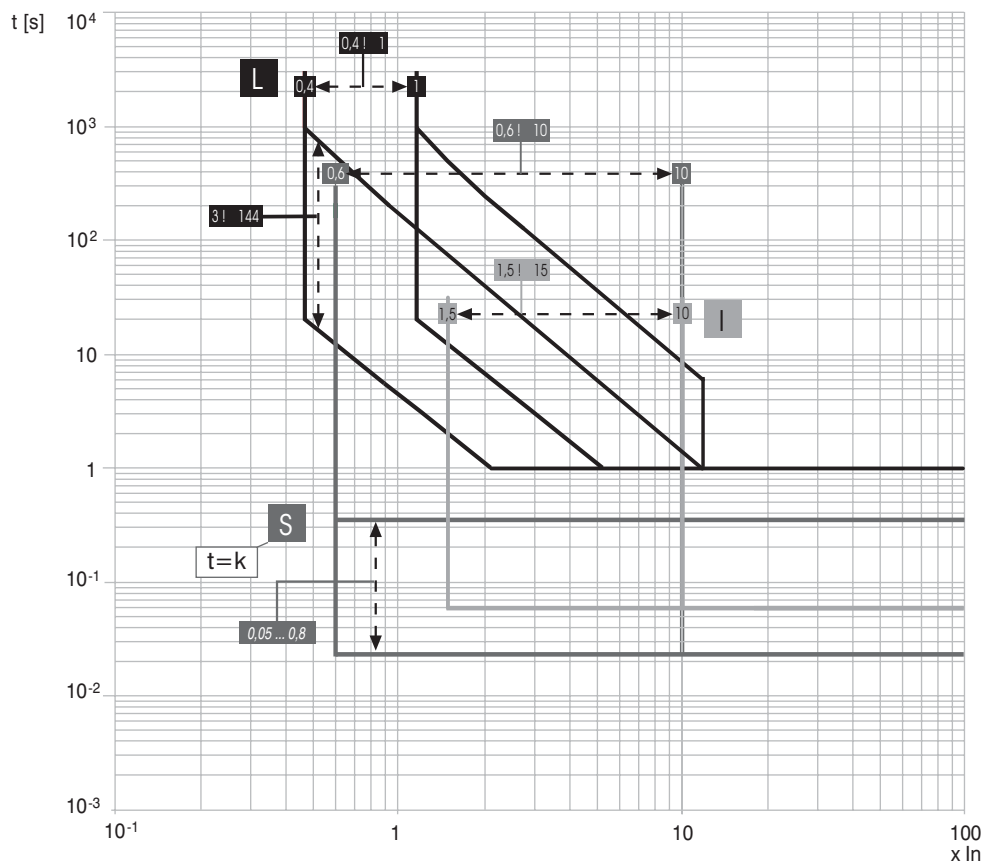
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12.3 Putting into service

12.3.1 TC connection test

⚠️ **If the PR122/DC was installed by the user, it is important, before closing the CB, to check the last line on the display when the relay is turned on for the first time via a PR030/B battery unit. No TC disconnected messages must appear; if they do, do not close the circuit-breaker and make the correct connections.**

12.3.2 Test

Before putting into service, a test can be conducted by means of the specific "Auto test" function which can be activated on the PR122/DC. A positive result is shown on the display.

Then a test can be conducted on the whole TC chain, again using the specific function (Trip test). A positive result is shown by the circuit-breaker opening. To run a Trip Test, press the "i Test" button and the "Enter" button simultaneously.

Check the open or closed state of the circuit-breaker on the same "PR122/DC Test" screen, by checking that is closed and de-energized.

```
Test                    1/6
CB status
Auto Test
Trip Test (disabled)

                    CB open
```

12.3.3 Initial settings

If the PR122/DC is supplied ready installed in the circuit-breaker, it is up to ABB SACE to set all the variables referring to the circuit-breaker or the specific application correctly (e.g. type of circuit-breaker, Rating Plug size ...). For the PR120/V-PR120/LV module, set the Rated Voltage suitably.

Note that ABB SACE defines each possible setting according the content of the paragraph on the default parameters (see par. 12.4.4).

⚠️ **Apart from this, it is absolutely indispensable for the user to modify the password and carefully define each modifiable parameter, before putting the PR122/DC into service.**

12.3.4 Password management

Specify a password? [0*]**

To enter "EDIT" mode it is necessary to enter a four-figure numerical password. The values attributable to the password go from 0000 to 9999. For the default password see par.12.4.4.

Select the value of the first figure (between '0' and '9') by means of the ↑ and ↓ keys and press ↵ to confirm the figure and then move on to enter the next one.

After entering the fourth figure, check the password you have entered. If the password is correct, you go from the "READ" state to the "EDIT" state. If the password is wrong, the message

Wrong password

appears and remains until the **ESC** key is pressed (or until an interval of 5 seconds has elapsed).

It is also possible to interrupt the password entry procedure by pressing the **ESC** key.

The password is valid for a maximum of two minutes from the last time a key was pressed.

Disabling the Password.

By setting the value of the password to [0000] (on the "Unit configuration" menu) the password prompt is disabled. It is therefore always possible to switch from "READ" to "EDIT".

To enter a new password, select the "New Password" item on the "Settings/System" menu.

12.3.5 Replacing an electronic release

12.3.5.1 Installation

To complete the procedure for installing a PR122/DC unit, follow the steps below:

1. With the circuit-breaker open and preferably isolated, install the protection unit on the circuit-breaker
2. Power the unit ONLY from the PR030/B
3. If there are no other errors, the display will show the message ⚠ Configuration (configuration error) accompanied by the yellow LED coming on permanently (warning)
4. Enter the unit's "*Settings*" menu
5. Select "*Circuit-breaker*"
6. Select "*Unit installation*"
7. Input the password
8. Select "*Install*" and press "*ENTER*"
9. When the red led flashes on and off and the message ⚠ Installation (installation error) is displayed, remove the PR030/B
10. Power the relay from any other source
11. Check for the absence of configuration errors.

12.3.5.2 Uninstalling

To complete the procedure for uninstalling a PR122/DC unit, follow the steps below:

1. With the circuit-breaker open and/or isolated power the unit from the PR030/B
2. Enter the unit's "*Settings*" menu
3. Select "*Circuit-breaker*"
4. Select "*Unit installation*"
5. Input the password
6. Select "*Uninstall*" and press "*ENTER*"
7. Remove the PR030/B module
8. Remove the PR122/DC unit from the circuit-breaker
9. The remove the TC connector, proceed as indicated in the figure alongside.
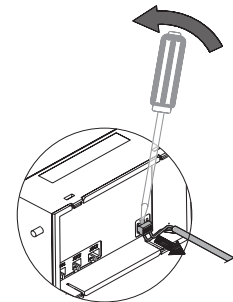
It is not strictly necessary to complete the uninstalling procedure, but this enables the parameters relating to the circuit-breaker, such as contact wear and others, otherwise these data would be lost. The data in question are then transmitted to the new PR122/DC unit installed on the same circuit-breaker.

Ref.	Description
1	Voltage takeoff isolator
2	Busbar voltage LED
3	Pre-alarm indicator LED
4	Alarm indicator LED
5	Graphic display (the word ABB in the bottom left-hand corner indicates normal operation)
6	Serial number of the PR122/DC
7	Rating plug
8	Pushbutton for exiting the sub-menus or for canceling (ESC)
9	Button for the cursor (UP)
10	Button for the cursor (DOWN)
11	ENTER key for confirming the data or changing the page
12	TEST connector for connecting or testing the release by means of an external device (PR030/B battery unit, BT030 wireless communication unit and PR010/T test unit)
13	"I Test" test and info button

Description of the icons displayed

Symbol	Description
⊔	Remote control
A	Dual setting active. Setting A set
D	Fixed icon: data logger activated Flashing icon: triggering
⌐	Vaux installed
⊐	Parameter change stage

12.4.1 Use of pushbuttons

The modifiable fields can be filled in using the ↑ or ↓ keys and confirming with the ↵ key. Once you have entered the page you need, you can move from one value to another by using the ↑ or ↓ keys. To change a value, position the cursor over the value (the modifiable field will appear in reverse, i.e. white on a black background), and use the ↵ key.

To confirm the programming of the previously configured parameters, press the **ESC** key to scroll up the menus till the programming confirmation page will be displayed; select confirmation and press **ENTER** for data programming.

The "**i Test**" key must be used to perform the Trip test to view the information page and to see the last trip, qualora abbia

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12.4.2 Read and Edit modes

The menus map (see par. 12.5.1) shows all the pages which can be obtained and how to move between them from the keyboard, in the "READ" mode (just to read the data) or in the "EDIT" mode (to set the parameters).

Starting from any page displayed, after about 120 sec of inactivity, the default page will be automatically displayed (see par. 12.5.1).

The functions allowed depending on state are:
"READ":
- ✓ Consultation of the measurements and of the historical data
- ✓ Consultation of the unit configuration parameters
- ✓ Consultation of the protection parameters

"EDIT":
- ✓ Everything allowed in READ mode
- ✓ Configuration of the unit
- ✓ Programming of the parameters relative to the protections
- ✓ TEST Functions of the unit

To access the "EDIT" mode, it is necessary to press the ↵ key on a page with fields which can be edited. A password will then be required to enable you to switch to the editing mode.

The use of the keys is summarized in the following table:

Key	Function
	Move between pages Move within menu Change parameter values
	End setting phase and confirm result Choose menu item
	Access to surfing menus from the default page Return to previous level when surfing within the menus, until you return to the default pages Exit the parameter changing phase, aborting the change
	This key is used to re-enable the display after it has gone off within 48 hours of the opening of the circuit-breaker in self-supply mode.

12.4.3 Changing parameters

Moving within the Main Menu you can reach all the pages relating to the configurations and parameter settings with the opportunity to change the values specified for the parameters.
After any programming, you need to Confirm/Cancel/Change any changes you have made. This procedure is not applicable to all the programming activities. Two examples are provided below: one concerns the case in which no confirmation is needed for the changes you have made, while in the other a confirmation window appears.

Procedure not requiring the confirmation of any programming
For instance, to set the System Date, the correct sequence is as follows:

From the default page press ESC
to access the Main Menu

```
                                    10:22:53
                                      400A
```

From the Main Menu, select SETTINGS

press the ↵ key (enter)

```
Menu                          3/5
Protections                    ▲
Measurements
Settings                       ▼
         Protections settings
```

Select SYSTEM

press the ↵ key (enter)

```
Settings                      7/8
Datalogger                     ▲
Measuring interval
System                         ▼
           System settings
```

Select the menu item DATE to change

press the ↵ key (enter)

```
System                        1/4
Date
Time
Language                       ▼
        January 12, 2003
```

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You will be prompted to input a Password
complete the password entry procedure ↓ (par.12.3.4)

press the ↵ key (enter)

```
┌─────────────────────────────────┐
│ Password                         │
│ ─────────────────────────────── │
│                                  │
│               0***               │
│                                  │
│                                  │
│                  Enter password  │
│                                  │
└─────────────────────────────────┘
```

Change the date using the keys ↓ (arrow down)
↑ (arrow up) and confirm by pressing the ↵ key (enter).
Press ESC twice to return to the Main Menu.

```
┌─────────────────────────────────┐
│ Date                             │
│ ─────────────────────────────── │
│                                  │
│          June 12, 2007           │
│                                  │
│                                  │
│                                  │
└─────────────────────────────────┘
```

Procedure requiring the confirmation of any programming

For instance, to change the Threshold of the Protection L, the correct sequence is as follows:

From the default page press ESC
to access the Main Menu

```
┌─────────────────────────────────┐
│                       10:22:53   │
│                         400A     │
│ █                                │
│ █                                │
│ █                                │
│ █                                │
│ I                                │
└─────────────────────────────────┘
```

From the Main Menu select the item PROTECTIONS
press the ↵ key (enter)

```
┌─────────────────────────────────┐
│ Menu                      1/5    │
│ ─────────────────────────────── │
│ Protections                      │
│ Measurements                     │
│ Settings                    ▼    │
│                                  │
│            Protections settings  │
└─────────────────────────────────┘
```

From the Protections Menu select the item PROTECTION L
press the ↵ key (enter)

```
┌─────────────────────────────────┐
│ Protections               1/6    │
│ ─────────────────────────────── │
│ L Protection                     │
│ S Protection                     │
│ I Protection                ▼    │
│                                  │
│                       Overload   │
└─────────────────────────────────┘
```

From the Protection L Menu select the item THRESHOLD
press the ↵ key (enter)

```
┌─────────────────────────────────┐
│ L Protection              1/3    │
│ ─────────────────────────────── │
│ Threshold I1                     │
│ Time t1                          │
│ Thermal memory                   │
│                                  │
│                                  │
└─────────────────────────────────┘
```

You will be prompted to input a Password (par. 12.3.4)
complete the password entry procedure
press the ↵ key (enter)

```
┌─────────────────────────────────┐
│ Password                         │
│ ─────────────────────────────── │
│                                  │
│               0***               │
│                                  │
│                  Enter password  │
│                                  │
└─────────────────────────────────┘
```

Select the value you want from the list
and confirm pressing the ↵ key (enter).

Press ESC twice

```
┌─────────────────────────────────┐
│ Threshold I1                     │
│ ─────────────────────────────── │
│                                  │
│          0,4 In (320A)           │
│ ─────────────────────────────── │
│                                  │
│                                  │
└─────────────────────────────────┘
```

Before accessing the Main Menu, the following box will appear:
Accept the new configuration
Reject the new configuration (the previous configuration is retained)
Change the previously input values.

```
┌─────────────────────────────────┐
│ Programming               1/3    │
│ ─────────────────────────────── │
│ Confirm                          │
│ Abort                            │
│ Modify                           │
│                       Confirm    │
└─────────────────────────────────┘
```

To select the required option use the ↓ (arrow down), ↑ (arrow up) keys, and press ↵ (enter) to confirm.

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12.4.3.1 Modification of basic configuration

No parameter settings can be made if the PR122/DC unit is in alarm conditions.

The configuration of the unit must be done in EDIT mode.

Following the instructions given in par. 12.4.3, view the following on the display:

Change system date
Change system time
Select system language

```
System                    1/4
 Date
 Time
 Language               ▼
                    January 12, 2003
```

```
System                    4/4
 Time                   ▲
 Language
 New Password
                    **** ❶
```

```
Password

        0***

             Enter password
```

To change the system password, select the relevant menu item and press ↵ (enter); then you will be prompted to enter the OLD password, and afterwards you can input the new one twice.
Press ESC twice to return to the Main Menu

Before accessing the Main Menu, the following box will appear:

Accept the new configuration
Reject the new configuration (the previous configuration is retained)
Change the previously input values.

```
Programming               1/3
 Confirm
 Abort
 Modify
                    Confirm
```
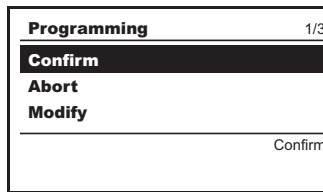
To select the required option, use the ↓ (arrow down), ↑ (arrow up) keys, and press ↵ (enter) to confirm.

Note: To set the system language check that:
- the relay is set to local (when PR120/D-M is installed);
- the CB is open;
If one of the above conditions is not met, the relay does not allow the language to be changed.

12.4.4 Default settings

The PR122/DC is supplied by ABB SACE with the following predefined parameters:

#	Protection	On/Off	Thresholds	Time	Curve	T.M.	ZS	Trip
1	L	–	1 In	102 s	-	Off	–	–
2	S	Off	6 In	50 ms	K	–	Off: 0,04 s	–
3	I	On	4 In	–	–	–	–	–
4	OT	–						Off
5	K LC1	Off	50 % I_1					
6	K LC2	Off	75 % I_1					
7	Language	–	Ingl					
8	PR021/K	Off						
9	S startup	Off	6 In	100 ms				
10	I startup	Off	4 In	100 ms				
11	Password	–	0001					
12	Measuring interval	–	60 min					
13	Iw	Off	3 In					
14	MCR	Off	6 In	40 ms	–	–	–	–

12.5 Operating instructions / Operation in service

12.5.1 Menu

As seen previously, the PR122/DC uses the display to show messages, diagrams and menus. These are organized in a logical and intuitive way. The following is a general layout showing how to access the main menu pages :

```
                                   10:22:53
                                     400A



                              U1
```

ESC

```
Menu                    1/5
Protections
Measurements
Settings                  ▼
              Protections settings
```

```
Menu                    2/5        Measurements
Protections                        Historicals
Measurements                       Contact wear
Settings                  ▼
      Measures, graphics, harmonics
```

```
Menu                    3/5        Settings             1/7
Protections                        Circuit Breaker
Measurements                       Hw Treip
Settings                  ▼         Modules
              General settings
```

```
Test                    1/6        Menu                4/5        Settings             4/9
CB status                          Measurements          ▲        Datalogger
Auto Test                          Settings                        Measurement interval
Trip Test (disabled)               Test                  ▼         System
              CB open                          Device test         Display Contr
```

```
Test                    4/6        Menu                5/5
COM module                         Settings              ▲
SIGNALLING module                  Test
Zone selectivity          ▲         About
              Device test                      Product information
```

```
                                   About               1/2
                                   Protection Unit
                                   Circuit Breaker

                                          Protection Unit
```

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Each time the unit is turned on, or after more than 2 minutes of inactivity on the keyboard, the display indicates the following page (default):

Percentage of the actual currents and voltages with respect to the rated values (100%)

10:22:53
400A ← Current of the phase under the greatest load

12.5.2 Protections menu

From the interface you can press ENTER to access the menu of the various protections available on the display

Menu	1/5
Protections	
Measurements	
Settings ▼	
	Protections settings
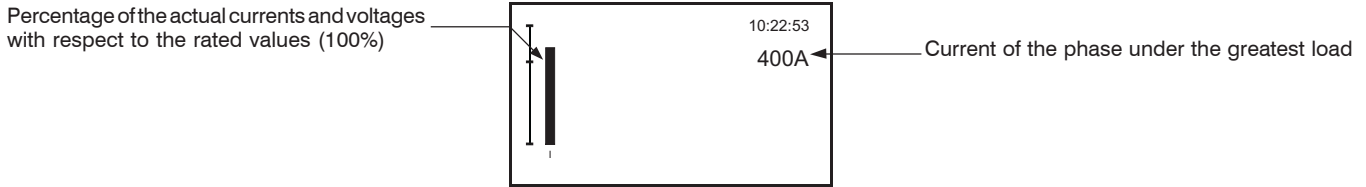
Enter ↵ →

Protections	1/6
L Protection	
S Protection	
I Protection ▼	
	Overload
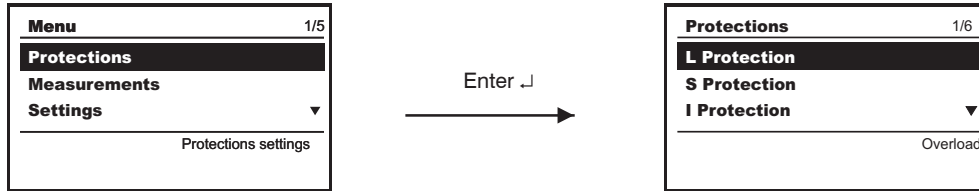
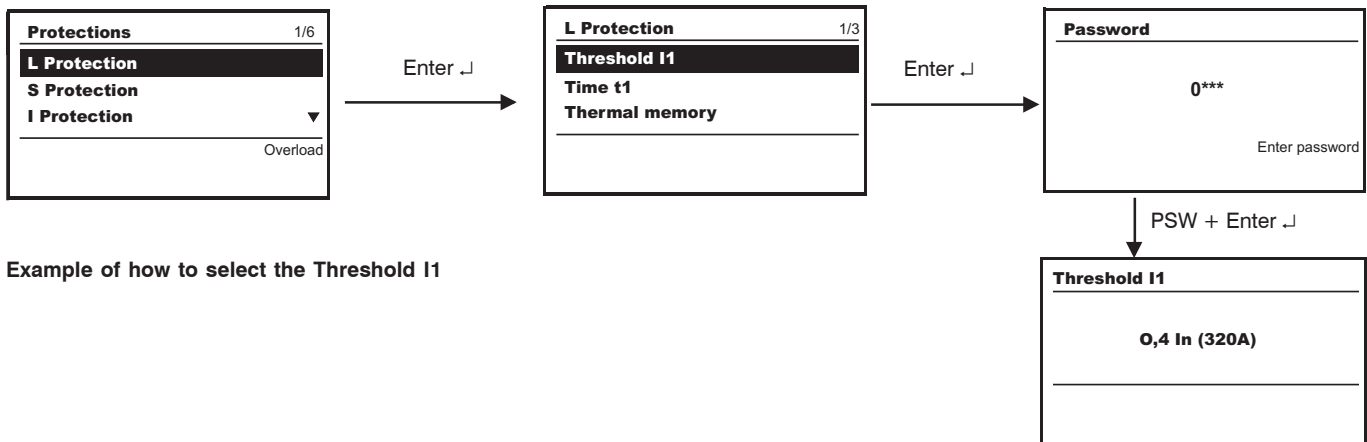Using the "arrow UP" and "arrow DOWN" you can view the various protections.
On the whole, the data that you can display concern the protections:
L, S, I, OT, LOAD PROTECTION.

Example of surfing the Protections menu
From the Protection main page you can press ENTER to go to the Protection L Menu.
You can use "arrow UP" and "arrow DOWN" to select the items on the menu and confirm by pressing ENTER. Pressing this key triggers a Password prompt, then you can select the functions associated with the protection L (as in the example)

Protections	1/6
L Protection	
S Protection	
I Protection ▼	
	Overload

Enter ↵ →

L Protection	1/3
Threshold I1	
Time t1	
Thermal memory	

Enter ↵ →

Password	
	0***
	Enter password

PSW + Enter ↵ ↓

Threshold I1	
	O,4 In (320A)

Example of how to select the Threshold I1

Similarly, to access the menus for the other protections, see the Protections Menu table below.

13.5.2.1 Protections menu table

Protection	Parameter / Function	
L	Curve	
	Threshold I1	
	Thermal memory	ON / OFF
S	Enable	ON / OFF
	Curve	
	Threshold I2	
	Time t2	
	Zone selectivity	ON / OFF
	Selectivity time	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	
I	Enable	ON / OFF
	Threshold I3	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	

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Protection	Parameter / Function		
OT	Enable Trip	ON / OFF	

Load Control			
	Threshold 1 Enable Threshold	ON / OFF	
	Threshold 2 Enable Threshold	ON / OFF	
	Threshold lw Enable Threshold	ON / OFF	

Note: for an explanation of the characteristics of the single protections and their settings and corresponding curves, see par. 12.2.9.

12.5.3 Measurements Menu
The following is a summary of the parameters accessible from the menu in the PR122/DC unit.

12.5.3.1 Measurements Menu table

Setting	Parameter / Function	Values	Notes
Historicals			
	Trips		Last trips (20)
	Events		Events log (80 events max.)
	Measurements		
	I Max		Current
	Reset measurements		
Contact wear			Percentage of wear on CB contacts

12.5.4 Settings Menu

The configuration parameters in the Settings menu are password protected.
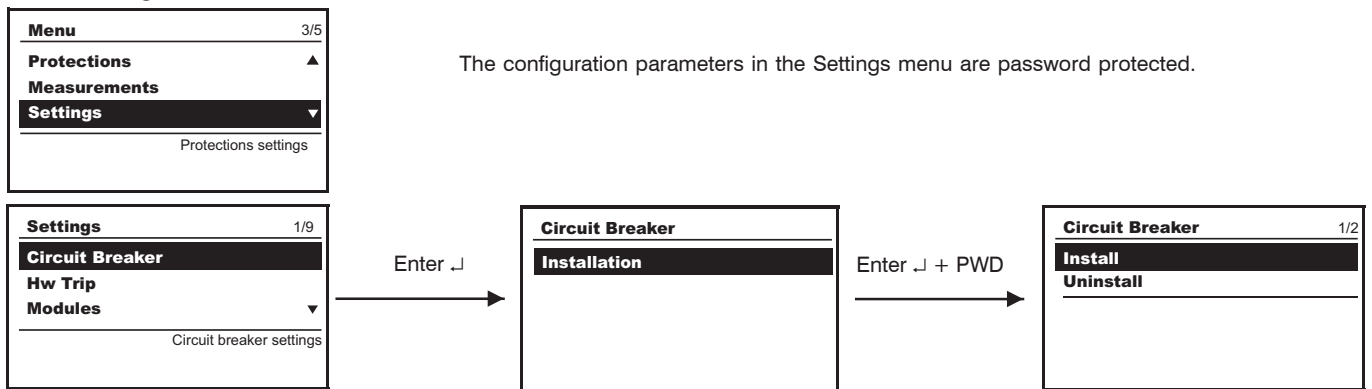
12.5.4.1 Settings Menu table

	Parameter / Function	Values	Notes
Circuit breaker	Installation	Install/Uninstall	
Hw trip		Enable-Disable	
Modules	Module		
	PR120/D-M - COM	if any	see par. 12.5.4.2.1
	PR120/K - Signalling	if any	see par. 12.5.4.2.2
	Local Bus unit	Absent - Present	
Data logger	Enable	ON/OFF	
		Sampling frequency	
		Stop event	
		Stopping delay	
		Restart	
		Stop	
Measurement interval		from 5 to 120 min, step 5 min	
System	Date		
	Time		
	Language	English/Italiano/Français/Deutsch/Español	
	New password		
Display	Contrast		

The summary table relates to the surfing of the pages dedicated to the PR120/K module (see par. 14.3) and to the PR021/K unit (see par. 15.1).

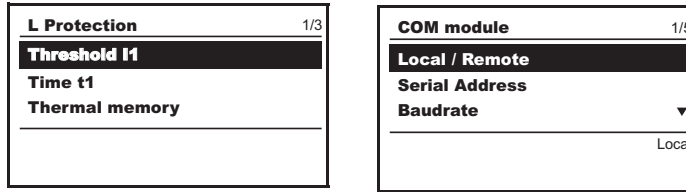| Model	L3447			Apparatus	**Emax DC**	Scale
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12.5.5 Modules

When you access the Settings menu, there is a set of menus available relating to the modules.

12.5.5.1 PR120/V-PR120/LV MEASURING module

The primary voltage values (100... 1000 V) can be selected; see section 14.1.

12.5.5.2 PR120/D-M - COM module

The local or remote modes can be selected after entering a password. The serial address can be displayed after entering a password. The Baud Rate can be set on the values 9600 and 19200 bit/s. The physical protocol provides for the options: (8,E,1), (8,0,1), (8,N,2), (8,N,1). The addressing can be selected as standard Modbus or ABB. For further information on the PR120/D-M communication module, see paragraph 14.2 in this manual.
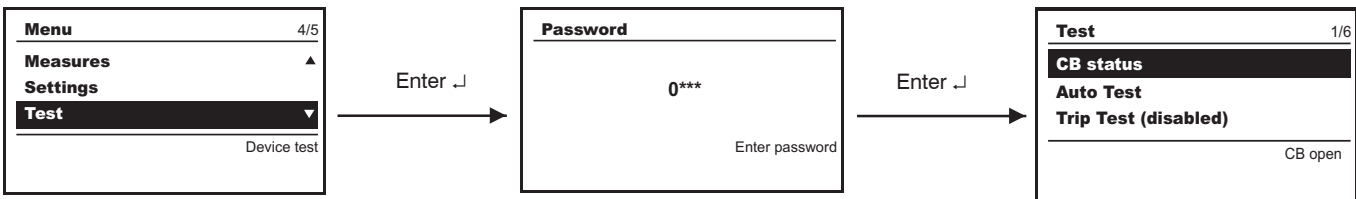
12.5.5.3 PR120/K - SIGNALLING module

For a thorough examination of the signalling module, refer to the corresponding section of the module, paragraph 14.3.

12.5.5.4 Settings for the Local Bus unit

If the PR021/K unit is connected, you need to enable the local bus by selecting present.

12.5.6 Test Menu

Access to the Test menu is password protected.

The menu shows the state of the CB, in the dialog module (COM module) the state of the springs and the position of the CB, and in this submenu you can make the CB open or close.

Using the "Trip Test" function lets you view the disabling/enabling of the Trip. If it is enabled, the circuit-breaker is opened. The function is only available with a busbar current of nil (use Vaux, PR030/B or PR010/T).

On the page, only with Vaux, you can also see the state of the circuitbreaker "STATUS", and thus make sure that the input is correctly wired.
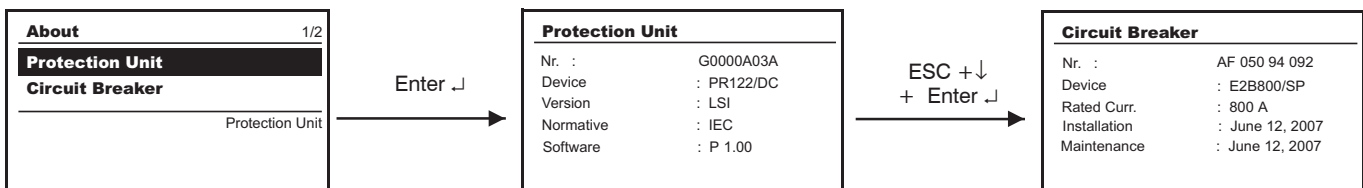
The surfing path is summarized in the following table:

12.5.6.1 Test Menu table

	Parameter / Function	Values	Notes
CB status		Open/Closed/Indefinite	Indefinite in case of fault only
Auto Test			
Trip Test		Enabled/Disabled	
PR120/D-M Module	State of springs	Loaded/Unloaded	
	Position of CB	Isolated/Withdrawn	
	Open CB		
	Close CB		
PR120/K Module	Input	ON	
	Auto Test	- - -	
Zone selectivity	Protection S (status) Input	ON/OFF	
	Force Output		
	Release Output		

13.5.7 Information Menu

The Information Menu enables you to view the data relating to the protection unit and the type of circuit-breaker.

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12.5.7.1 Information on the trip and opening data

The PR122/DC unit saves all the information relating to the type of protection tripped, the opening data, the date and time. Using the "i Test" key makes the release show all these data directly on the display. There is no need for an auxiliary power supply for this function. With an auxiliary power supply, the information is shown immediately on the display without the need to press the "i Test" key and remains displayed indefinitely until you press the key.

Information remains available for 48 hours with the relay de-energized. The data relating to the last 20 trips are stored in the unit's memory. By connecting a PR030/B and PR010/T battery unit or a BT030 wireless communication unit, you can retrieve the information relating to the last 20 trips recorded.

Access to view the opening data is via the Historicals submenu in the Measurements menu. The following is an example of the information provided:

Again in the Measurements menu, you can view the percentage of contact wear, which is an indication of the electrical life of the electrical contacts in the circuit-breaker.

In any case, functionality of the relay is in no way modified by the presence of the wear messages.

The prealarm message (wear > 80%, "warning" LED lighting up) indicates that the wear has reached a high value. The alarm message (100% wear, "alarm" LED lighting up) indicates that it is necessary to check the state of contact wear.

The percentage of wear depends on the number of openings carried out by the circuit-breaker and by the absolute current interrupted during each of them.

12.6 Definition of alarms and signals in the PR122/DC unit

12.6.1 Optical signals

Signaling	Description
Warning Led (fixed yellow light)	• The prealarm threshold has been exceeded; current values in the range $0.9xI_1 < I < 1.05xI_1$; • Contact wear greater than 80% (and less than 100%); • WARNING Threshold Iw exceeded; • Circuit-breaker state error; • Configuration error; • Settings inconsistency.
Warning Led (yellow 0.5Hz)	• Relay's internal temperature exceeding WARNING threshold.
Warning Led (yellow 2Hz)	• Relay's internal temperature exceeding ALARM threshold.
Alarm Led (red)	• Presence of current values $I > 1.3 \, I1$ (timing protection "L")*; • Timing in progress for protection function S; • Contact wear = 100%; • Rating Plug disconnected; • Trip Coil (TC) disconnected; • Key plug error; • CB/release inconsistency • Installation error.

* The IEC 60947-2 Standard defines the timing threshold L for current: $1.05 < I < 1.3 \, I1$.

12.6.2 Electrical signals

K51/p1...p4   Programmable electrical signals if the PR120/K module is installed and there is an auxiliary power supply.
K51/p1...p8   Programmable electric signals if the PR021/K unit is installed and there is an auxiliary power supply.
Pressing the "i Test" key enables resetting the activated contacts.

12.6.3 Table of error and warning messages

All the messages which can be shown on the display relating to incorrect configurations, generic alarms or deriving from the protection functions and linked to useful information are described below.

The following symbols in the warning signals have the following meanings:

⚠ = Warning signal / Protection in alarm mode, with no trip (trip=off).

⚠ = Protection in alarm mode, with trip at end of delay (trip=on).

ⓘ = Information, no action, excepting displaying by the relay.

Alarm message	Description	Notes
⚠ Contact wear	Alarm for contact wear	Contact wear = 100%
⚠ T Alarm	Alarm for protection T	Temperature outside range
⚠ T (TRIP OFF)	Alarm for protection T	
⚠ LC1 Load	Alarm for load control LC1	
⚠ LC2 Load	Alarm for load control LC2	
⚠ Sensor	Alarm for current sensor	Sensor disconnected or faulty
⚠ Warning signal	Protection in alarm, with no trip (trip=off)	
⚠ TC disconnected	Trip Coil disconnected or faulty	
⚠ Rating Plug	Rating Plug Error absent or faulty	
⚠ Invalid date	Clock information lost	
⚠ CB status	CB state error	Probable error in Q26 and/or Q27
⚠ Installation	Key Plug Error	
⚠ CB not defined	State of circuit breaker inconsistent (Open/Closed)	Probable error in Q26 and/or Q27
⚠ Local Bus	Local Bus error	See par. 12.7
ⓘ Contact wear	Contact wear prealarm	Contact wear ≥ 80%
ⓘ L prealarm	Protection L prealarm	
ⓘ T prealarm	Protection T prealarm	
ⓘ Warning Iw	Iw threshold exceeded	
⚠ Timing L	Timing protection L	
⚠ Timing S	Timing protection S	
ⓘ Configuration	Parameters inconsistency	
⚠ Configuration	Relay key plug data inconsistency	

12.6.4 Error messages displayed in pop-up windows

All the messages that appear on the display in a pop-up window are described below.

Error message	Description
⚠ Password error	
⚠ Session impossible	A programming session cannot be started due to a contingency (e.g. a timer-controlled delay still elapsing)
⚠ Value outside range	Value beyond the established limits
⚠ Exception 6	Command temporarily unavailable
⚠ Unavailable	Function temporarily unavailable
⚠ Invalid date	Date has not been set
⚠ Parameters revised	Programming session concluded correctly
⚠ Cancelled	Programming session cancelled
⚠ Failed	Programming session rejected
⚠ Failed 1001	Inconsistent thresholds of protections L and S
⚠ Failed 1002	Inconsistent thresholds of protections I and S
⚠ Failed 3001	Inconsistency as to language change

12.7 Troubleshooting PR122/DC unit

The following table lists a series of typical service conditions, to help you understand and solve hypothetical faults or malfunctions.

Note:
1. Before consulting the following table, check for any error messages appearing for some seconds on the display.
2. FN indicates the normal operation of the PR122/DC.
3. In the case where the suggestions proposed do not lead to a solution of the problem, please contact the ABB SACE assistance service.

No.	Situation	Possible causes	Suggestions
1	The trip test cannot be run	1. The busbar current is > 0. 2. The TC is not connected 3. CB open	1. FN 2. Check the messages on the display
2	Trip times lower than expected	1. Threshold too low 2. Curve too low 3. Thermal memory enabled 4. The SdZ is inserted	1. Correct threshold 2. Correct curve 3. Exclude if not necessary 4. Exclude if not necessary
3	Trip times higher than expected	1. Threshold too high 2. Curve too high 3. Curve I^2t inserted	1. Correct threshold 2. Correct curve 3. Exclude if not necessary
4	Rapid trip, with I3=Off	Iinst tripped	FN with short-circuit with high I
5	Display off	1. Vaux missing and the voltage is below the minimum value. 2. Temperature out of range	1. FN, see 12.2.2.1 2. FN, see 12.2.9.5
6	The display is not back-lit	Volatge below the limit for lighting the display	FN
7	Reading of I incorrect	Current below the minimum threshold that can be displayed	FN
8	" ⚠ Local Bus" message on display	No communication between PR122/DC and PR021/K	1. If not present, disable PR021/K, see 12.5.4.2.3 2. Check bus connection 3. Check PR021/K
9	Message "" instead of expected data	Function disabled or data out of range	FN
10	The expected trip does not occur	Trip function disabled	FN enable trip if necessary
11	No display of the opening data	Vaux missing, the buffer capacitor is discharged	FN, see 12.5.6.1
12	The password is not requested	The password has been disabled	FN, re-enter the password with a value other than 0000.
13	Impossible to change any parameter	PR122/DC in alarm situation	FN
14	" ⚠ Temp. sensor" or " ⚠ Start-up" message	Possible failure inside relay	Contact ABB Sace
15	Invalid date	1. First installation 2. Information lost due to power failure	FN see 12.4.3.1
16	Untimely trip		See 12.6.3
17	Led lighting		See 12.6.1
18	The language cannot be changed	1. The relay is remotely set 2. CB not open	1. Local setting 2. Open CB

12.7.1 In the case of a fault

⚠ **If you suspect that the PR122/DC is faulty, has a malfunction or has generated an unwanted trip, it is advisable to follow the recommendations below very carefully from the Measurements menu ⟶ Historicals ⟶ Trip:**

1. Make a note of the type of protection that has tripped by accessing the LAST TRIP page if there is an external power supply (Vaux or battery) or by pressing "i Test" if in self-supply mode.
2. Note down the type of circuit-breaker, number of poles, any accessories connected, In, Serial Number (see par. 12.4) and the SW version.
3. Prepare a brief description of the opening (what LEDs and/or indications were displayed? when did it happen?, how many times ?, was it always under the same conditions? what type of load? what voltage? what current? is the event reproducible?)
4. Send/communicate all the information collected, together with the circuit diagram for the circuit-breaker, to your nearest ABB Customer Support service.

The completeness and accuracy of the information given to the ABB Assistance service will facilitate technical analysis of the problem encountered, and will allow us to carry out all actions useful for the user rapidly.

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12.8   Accessories

12.8.1 ABB SACE PR010/T test and configuration unit

Testing by the SACE PR010/T unit allows checking correct operation of thresholds and trip times of L, S, I protection functions. The test unit is connected to the relay through a dedicated connector (see par. 12.4).

12.8.2 BT030 communication unit

Through a BT030 wireless communication unit, the PR122/DC can be connected via wireless to a Pocket PC (PDA) or a standard PC, extending the range of information available to user. By means of the ABB SACE SD-Pocket communication software, the values of the currents flowing through the circuit-breakers, the value of the latest 20 interrupted currents and protection settings, can be read.

12.8.3   PR021/K and HMI030 units

The PR122/DC can also be connected to the optional external PR021/K unit (see par. 15.1) to indicate through potential-free power contacts alarms and protection trips, and to the HMI030 switchboard front unit to display a number of information.

12.8.4 PR030/B power supply unit

The PR030/B power supply unit is an external unit allowing powering of Relay, Autotest and Trip Test, checking with CB open and installation of new replacement units.

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13 SACE PR123/DC Release - Identification

The PR123/DC units available, in accordance with the IEC standards, together with the various protections and the various standard and optional modules, are illustrated in the following figure:
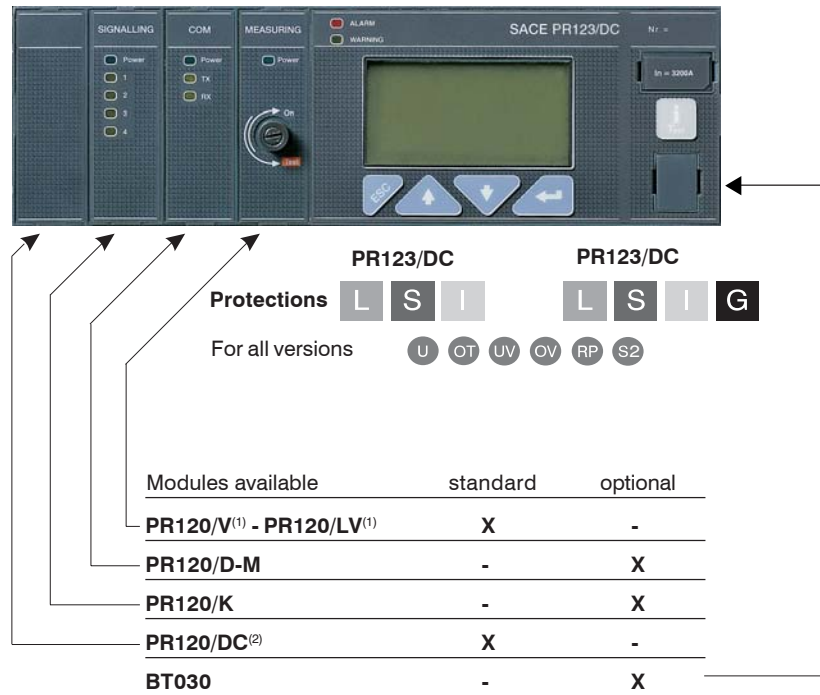
(1) Standard: PR120/V or PR120/LV
(2) Slot inside occupied by PR120/DC

13.1 Standard

The PR123/DC has been designed to work in accordance with the international standard:
IEC 60947-2 Low voltage apparatus. Circuit-breakers.

13.2 Specifications

13.2.1 General

The PR123/DC is a high-performance self-supplied protection unit with **Protection, Measurement, Data storage, Communication** (optional), **Self-test, Load control and Zone selectivity** functions for the ABB SACE 'Emax' range of 3- and 4-pole low-voltage air circuit-breakers. The unit's user interface also enables parameter setup and completes the prealarm and alarm management for the protection and watchdog functions.

The protections available are:

Symbol	Protection against
L	overload with inverse long time delay
S, S2	short-circuit with adjustable delay
I	instantaneous short-circuit
G	earth fault with adjustable delay
U	phase current unbalance
OT	temperature out of range
UV	undervoltage
OV	overvoltage
RP	reverse active power
MCR	closing on short-circuit

The PR123/DC can be installed on 3-pole CBs or on 4-pole CBs.

The unit opens the circuit-breaker in which it is installed by means of the TC, which takes effect directly on the device's mechanical leverism.

The protection unit is self-supplied by primary voltages via the PR120/V-PR120/LV module.
The unit is made using digital microprocessor technology and interfaces with the user by means of a graphic display and keyboard.

13.2.2 Auxiliary power supply

The external auxiliary power supply is provided using a galvanically-separated power pack.

> ⚠ Since the auxiliary voltage needs to be isolated from the ground, "galvanically separated converters" in accordance with the IEC standard 60950 (UL 1950) or the equivalent IEC 60364-41 and CEI 64-8 have to be used to guarantee a current in common mode or leakage current (as defined in IEC 478/1 and CEI 22/3) no greater than 3.5mA.

The presence of the auxiliary power supply enables the relay unit to be used even with the circuit-breaker open, as well as powering all the modules, with the exception of the PR120/V-PR120/LV MEASURING module, which is powered by means of a connection to the busbars.
The characteristics of the power pack are given in the table below:

Characteristics	Version PR123/DC
Auxiliary voltage (galvanically separated)	24V DC ±20%
Maximum ripple	5%
Inrush current @ 24V	~10A for 5ms
Rated power @ 24V	~5W

13.2.2.1 Powered by the PR120/V-PR120/LV module

For a full explanation of the features of the PR120/V-PR120/LV, see par. 14.1.

13.2.3 Environmental characteristics

Operating temperature	-25°C ... +70°C
Storage temperature	-40°C ... +90°C
Relative humidity	0% ... 98% with condensation
Degree of protection (with PR123/DC installed in the CB)	IP 30

13.2.4 Description of inputs/outputs

13.2.4.1 Binary inputs
- **K51/SZin (K51/DFin):** Zone selectivity: input for protection S (only with Vaux)
- **K51/Gzin (K51/DBin):** Zone selectivity: input for protection G (only with Vaux)

13.2.4.2 Binary outputs

- **K51/SZout (K51/DFout):** Zone selectivity: output for protection S (only with Vaux)
- **K51/GZout (K51/DBout):** Zone selectivity: output for protection G (only with Vaux)

Note: These inputs/outputs can be used between PR122/PR123 series units only.

13.2.5 Communication bus
Local internal bus on rear connector; RS485 physical interface, Modbus protocol.
External system bus, RS485 physical interface, Modbus RTU protocol, baud rate 9600-19200 bps.
Test bus on front test connector.

13.2.6 Protection functions
The PR123/DC protection unit carries out 12 independent protection functions. In particular:
1. Protection against overload with inverse time "**L**";
2. Protection against short-circuit with adjustable delay "**S**" and "**S2**";
3. Protection against instantaneous short-circuit "**I**";
4. Protection against closing on short-circuit "**MCR**"
5. Protection against earth fault with adjustable delay "**G**";
6. Protection against instantaneous short-circuit at high currents "**I inst**";
7. Protection against phase unbalance "**U**";
8. Protection against overtemperature "**OT**";
9. Protection against undervoltage "**UV**";
10. Protection against overvoltage "**OV**";
11. Protection against reverse active power "**RP**";
12. Override protection when release is not powered.

A timing indication (message + "alarm" LED) is provided on the unit's display, which is activated during a protection alarm. It is disabled when the alarm condition ceases or when the protection has been tripped. When the circuit-breaker opens, the page with the "Trip" data is displayed (when "i Test" is pressed, or automatically in the presence of Vaux).

13.2.6.1 Circuit-breaker state
The PR123/DC unit records the state of the circuit-breaker by means of specific wiring on the circuit-breaker. In the case where the presence of current is determined with the circuit-breaker in the "OPEN" state, a state error is signaled by a warning message being displayed (see par. 13.6) and the "warning" LED lighting up.

The signal can be combined with a relay of the PR120/K module or with those of the PR021/K unit.

13.2.7 Measurement functions

The current measuring (ammeter) function is available on all versions of the SACE PR123/DC unit.
The display shows histograms of the polarity on the main page. In addition, the current of the phase under the greatest load is given in numerical form. Where applicable, the earth fault current is displayed on a separate page.

The PR123/DC release provides a complete set of measurements:
- Current
- Voltage
- Instantaneous voltage values over a given time interval (data logger)
- Active power
- Energy
- Maintenance: number of operations, percentage of contact wear, opening data storage.
- Data Logger: see par. 15.2

The PR123/DC can provide the trend of the measurements of certain quantities over an interval P, established by the user; these include: mean active power, maximum active power, maximum current, maximum voltage and minimum voltage. The last 24 P intervals (adjustable from 5 to 120 min) are stored in a non-volatile memory and displayed in a bar graph.
To examine the Measurement functions, see the relevant paragraphs (par. 14.1 and par. 13.5.3) for the PR120/V-PR120/LV - MEASURING module.

13.2.8 Watchdog

The PR123/DC unit provides some watchdog functions able to guarantee the proper management of relay malfunctions. These functions are as follows:

❑ Watchdog for presence of Auxiliary power supply with "plug" icon displayed.

❑ Rating PLUG validity.

❑ Watchdog for proper connection of the trip coil (TC). If it is enabled, any anomalies are indicated by a special alarm message and the "alarm" LED coming on. If the PR120/D-M module is installed, this activates the coil opening command (YO), thus opening the CB.

❑ Watchdog for protection of Hw Trip. If it is enabled, in the event of CB undefined or a Rating Plug error or an Installation error, a CB opening command is given by the TC being enabled.

13.2.9 Description of the protection functions

13.2.9.1 Protection "L"

The "L" is the only protection that cannot be disabled because it is for self-protection against overloading of the relay itself.
Only one type of curve can be specified, as defined in the IEC standard 60255-8.
The protection trip time − inverse time - is given by the expression:

$$\tau \ \ln\left(\frac{I_r}{I_f^2 - I_1^2}\right) \quad \text{for } I_r \le 12In \text{ and } 1s \text{ for } I_r > 12In \qquad \text{where } I_f \text{ is the fault current and } I_1 \text{ the protection threshold.}$$

NB: Time expressed in seconds.

13.2.9.1.1 Thermal memory "L"

The thermal memory can be enabled to protect the cables on the basis of the "hot state" tripping curve in IEC 60255-8

$$\tau \ \ln\left(\frac{I_f^2 - I_p^2}{I_f^2 - I_1^2}\right) \text{ for } I_r \le 12In \text{ and } 1s \text{ for } I_r > 12In$$

where I_p is calculated on the basis of the evolution of the current providing there is no overload condition
The PR123/DC is fitted with two instruments to make up this thermal memory. The first is only effective when the release is powered (it also records overloads that have not lasted long enough to trip the release), while the second works even when the release is not powered, reducing any trip times in the case of an immediate reclosing and is enabled as soon as the CB is tripped.
It is the PR123/DC release that automatically decides which of the two to use, according to the various situations.

13.2.9.2 Protection "S"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time (t=k/i²) type. In the latter case, the trip time is given by the expression:

$$\max\left[\frac{100 \cdot t_2}{(I_f)^2}, \ t_2\right] \text{ where } I_f > I_2 \text{ where } I_f \text{ is the fault current and } I_2 \text{ the protection threshold.}$$

13.2.9.2.1 Thermal memory "S"

The thermal memory function can be enabled for cable protection in the case where the curve with inverse time is selected. This is based on the "tS" parameter defined as the trip time of the curve (t2) selected at 1.5xI2. The other characteristics are the same as those for thermal memory "L" (see par. 13.2.9.1.1).

13.2.9.2.2 Start-up threshold "S"

The start-up function can be selected in the case where the curve with fixed time is selected.
The function can be disabled and it is a setting characteristic of the single protection units.
The start-up function enables the protection threshold (S, I and G) to be changed during a time interval lasting "ts", starting from "start-up". The latter must be intended as follows:
- Passage of the RMS value of the maximum current over one single adjustable threshold (0.1…10In, by 0.1In steps). A new start-up is possible after the current has dropped below this threshold.
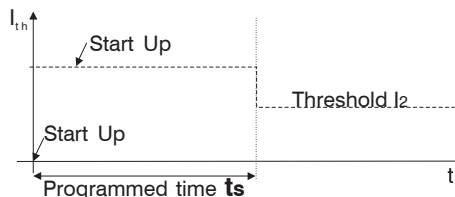
- **Start-up time**

The start-up time is common to all the protections involved. Range: 0.1s ... 30s, with steps of 0.01s.

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13.2.9.2.3 Zone selectivity "S"

The zone selectivity function, guaranteed only if an auxiliary voltage is provided, enables the area of the fault to be isolated, only isolating the part of plant nearest to the fault, while keeping the rest of the plant operational.

This is done by connecting all the zone selectivity outputs of the releases belonging to the same zone to one another (ZSO=K51/SZout) and taking this signal to the zone selectivity input (ZSI=K51/SZin) of the next release on the supply side. If the wiring has been done correctly, all the zone selectivity inputs of the last circuit-breakers in the chain and all the outputs of the circuit-breakers at the head of each chain must be empty.

As a practical example, the figure above shows a fault on the load side of the "Relay 1a" isolated by the latter without the "Relay 1" or the "Relay 0" being affected; a fault immediately downstream from the "Relay 1" will be isolated by the latter without the "Relay 0" being affected, thus ensuring that the Areas 2...n remain operational.

The ZSO output can be connected to a maximum of 20 ZSI relays on the supply side in the selectivity chain.

> **The maximum length of cable for zone selectivity, between two units, is 300 meters.**
> **Use corded shielded two-wire cable (see note A to par. 11.2.2).**
> **The shield must only be earthed on the circuit-breaker of the supply-side relay (ZSI side).**

Wiring and enabling zone selectivity "S" is an alternative to using protection "D" and operation is only guaranteed when there is an auxiliary voltage.
The following logical table is implemented to manage the Zone Selectivity Input (ZSI) and Zone Selectivity Output (ZSO) signals:

Zone selectivity	Imax > I_2	ZSI signal	ZSO signal	Trip T
Excluded	NO	0	0	No trip
Excluded	NO	1	0	No trip
Excluded	YES	0	0	t_2 programmed
Excluded	YES	1	0	t_2 programmed
Inserted	NO	0	0	No trip
Inserted	NO	1	1	No trip
Inserted	YES	0	1	$t_{selectivity}$
Inserted	YES	1	1	t_2 programmed

The time t_2 must be set at a value corresponding to at least $t_{selectivity}$ +50ms, on CB on supply side, not required on the first one in the chain.

13.2.9.3 Double S

Thanks to the new PR123/DC release that enables two independent and simultaneously active protection S thresholds to be specified, selectivity can assured even in critical conditions.
This function enables a better selectivity level to be obtained than using a release without a "double S". This function is valid for t=K only.

13.2.9.4 Protection "I"

The protection is enabled/disabled from the menu.
In the case where zone selectivity "S" is active, during the trip of the relay for "I", the ZSO output signal is activated in any case to guarantee correct operation of the relay on the supply side (and on the load side).
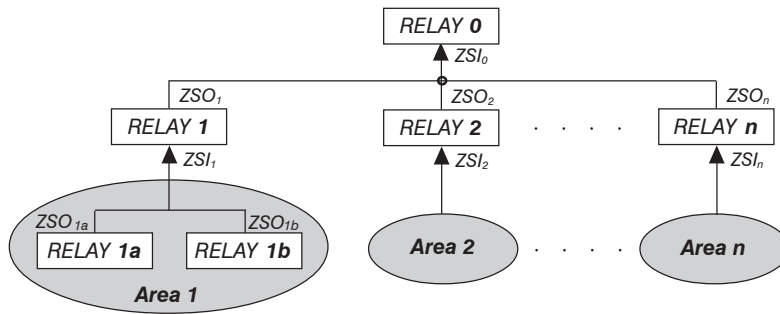
13.2.9.4.1 Start-up threshold "I"

The start-up function can be selected.
The function can be enabled from the menu on the protection "I" page.
The function behaves in exactly the same way as the protection "S" (see par. 13.2.9.2.2).

13.2.9.5 Protection against closing on short-circuit "MCR"

The MCR can be used to protect the system from any closing on short-circuit.
This protection goes on when the CB is closed, within a time window ranging from 40 to 500ms and with a threshold as set by customer, using the same algorithm as protection I. This protection can be disabled and is an alternative to protection "I".
This function can be activated through a hand-held PR010/T unit via an SD-Testbus2, SD-Pocket software or through a remote system via the system bus. This function has one single fixed-time protection curve.

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13.2.9.6   Protection "G"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time (t=k/i²) type. In the latter case, the trip time is given by the expression

$$\max\left(\frac{2}{I^2}, t_4\right)$$ where $I = I_f/I_4$, I_f is the fault current and I_4 is the protection threshold.

NB: Time expressed in seconds.

> ⚠ **It is possible to disable the trip control of the protection ("Enable Trip: Off").**
> **For the whole duration of the earth fault, circuit-breaker opening does not take place, but only the alarm condition is signaled ("Alarm" LED lit and alarm message).**

This is provided inside the release by calculating the vectorial sum of the currents of the two polarities. The fault current is defined by the following formula:

$$\vec{I}_G = \vec{I}_A + \vec{I}_B$$

In the case when the circuit does not show any fault, the module of the sum of these currents is always nil; vice versa the value of the fault current will take on an increasingly large value depending on the size of the fault. This operating mode is enabled by default.

13.2.9.6.1 Start-up threshold "G"

The start-up function can be selected in the case where the curve with fixed time is selected.
The function can be enabled and disabled on the protection "G" page.
The function behaves in exactly the same way as the protection "S" (see par. 13.2.9.2.2).

13.2.9.6.2 Zone selectivity "G"

The zone selectivity function can be enabled providing the fixed time curve, and the function is assured only if auxiliary voltage is provided.

Zone selectivity "G" can be active at the same time as zone selectivity "S".
The behavior and wiring of the function are identical to those indicated for zone selectivity "S" (see par. 13.2.9.2.3).

13.2.9.7   Protection against phase unbalance "U"

The protection with fixed time, which can be excluded, trips in the case when, for a time greater than or the same as the time **t6** set, an unbalance is determined between two or more phases higher than the set threshold **I6**. Range: 2 … 90% by 1% steps.

The percentage of unbalance is therefore calculated $\%Unb = \dfrac{I_{\max} - I_{\min}}{I_{\max}} \cdot 100$ where $I_{\max}$ is the maximum and $I_{\min}$ is the minimum phase current.

> ⚠ **It is possible to disable the trip control of the protection ("Enable Trip: Off").**
> **In that case, for the whole duration of the unbalance the CB will not be opened, but only the condition will be signaled by means of the "warning" LED lit up and a warning message.**
> **When the value of the phase current is above 6xIn, the function "U" excludes itself because, in this case, the other protections intervene because the fault is considered as a phase fault.**
> **The protection is not enabled for maximum phase current values lower than 0.3xIn.**

13.2.9.8   Protection against overtemperature inside the relay "OT"

There is a sensor inside the PR123/DC unit that monitors the temperature of the unit.
This enables the signalling of any abnormal temperature conditions, which could cause temporary or continuous malfunctions of the unit's electronic components.

This protection has two states of operation:

State of **"WARNING TEMPERATURE"** with $\boxed{-25°C < temp. < -20°C}$ *or* $\boxed{70°C < temp. < 85°C}$: the display is turned off and the "WARNING" LED flashes at 0.5Hz.

State of **"ALARM TEMPERATURE"** with $\boxed{temp. < -25°C}$ or $\boxed{temp. > 85°C}$: the display is turned off,

the "WARNING" and "ALARM" leds flash at 2Hz and Trip is activated (if enabled by means of the "Over Temper. Trip = On" parameter).

N.B.:
- In the event of Warning and Alarm, the display is momentarily turned off, to preserve its functionality.
- The monitored temperature is not visible on the display.

The protection is always active, both with auxiliary supply and in self-powering.

> ⚠ **Disabling the Trip control of the protection means that the PR123/DC unit could work, with the circuit-breaker closed, in a range of temperatures where correct operation of the electronics is not guaranteed.**

13.2.9.9 Load control function

Single loads can be enabled/disabled on the load side before the overload protection L intervenes and trips the circuit-breaker on the supply side. This is done by contactors or switch-disconnectors (wired outside the release), controlled by the PR123/DC by means of contacts on the PR120/K module or on the PR021/K external unit.

The current thresholds are lower than those available with the protection L, so that the load control can be used to prevent tripping due to overloads. The function is active when an auxiliary power supply or power by PR120/V-PR120/LV module is present (see par. 14.1.3).
The operating logic involves the activation of three contacts when the preset thresholds LC1, LC2 and I_w are exceeded.
Thresholds LC1 and LC2 are expressed as a percentage of I_1 (current threshold specified for protection L) while the "warning current" I_w is expressed as an absolute value. The allowable values are given in the following table:

Warning current Iw	0.30 ÷ 10.00 step 0.05xIn
Threshold LC1	50% ÷ 100% step 1% xI$_1$
Threshold LC2	50% ÷ 100% step 1% xI$_1$

From the PR123/DC you can associate each of the PR120/K or PR121/K contacts with a configuration (NO or NC), a delay and any latch.

13.2.9.10 Voltage protections "UV", "OV"

The PR123/DC unit provides 2 voltage protections, which can be disabled, with fixed adjustable time (t = k), active both with self-powering and with auxiliary supply:
− Undervoltage "UV"
− Overvoltage "OV"

Apart from the normal timing and "TRIP" operation, the voltage protections can be in a state defined as "alarm" (with the "emergency" led on and an alarm message displayed) providing there is an auxiliary or PR120/V module power supply. In fact, in the case where the circuit-breaker is open and no current is detected, the timing leads to the "alarm" state and not to "TRIP". This is because the fault linked to the voltages can persist even with the circuit-breaker open and the unit would therefore always be under "timing". When the circuit-breaker is closed or the passage of a current is detected, you pass immediately from the state of "alarm" to "TRIP" without timing.

13.2.9.10.1 Protection "UV"
When the minimum phase voltage drops below the set threshold U_8 the protection counts down the preset time interval t_8 and then opens.

13.2.9.10.2 Protection "OV"
When the maximum phase voltage exceeds the set threshold U_9 the protection counts down the preset time interval t_9 and then opens.

13.2.9.11 Protection against reverse active power "RP"

The PR123/DC unit provides protection (which can be disabled) with an adjustable fixed time (t = k), against reverse active power, active both with self-powering and auxiliary supply.
When the total reverse active power (sum of the power of the 2 polarity) exceeds the set reverse active power threshold P_{11} the protection counts down the preset time interval t_{11} and then opens.
The minus sign ('-') in front of the threshold and power indicates reverse power. The threshold is indicated as a percentage of "Pn", where "Pn" is the nominal power of the circuit-breaker.

13.2.9.12 Double protections setting

Using the double protections setting, the PR123/DC can save a set of alternative parameters for all the protections. The second set of parameters (set B) can replace the default set (set A) by means of an external command. The passage from set A to set B can be made when there is a change in the mains configuration or when there is an emergency capable of changing the load capacity and the short-circuit levels.

The second set of parameters (set B) can be enabled by:
- digital input provided with the PR120/K module. For instance, it can be connected to an auxiliary contact of a bus-tie;
- communication network, by means of the PR120/D-M (e.g. when the switch is scheduled);
- directly from the user interface on the PR123/DC (see settings menu par. 13.5.4);
- with a time that can be specified by set A or set B after the circuit-breaker has closed;
- depending on a Vaux being installed.
In operation, the state (set A and set B) is indicated on the display.
The double setting is disabled by default. To enable it, see par. 13.5.4.1.

13.2.9.13 Summary table of the protection function settings for the PR123/DC

Protection	Disabling	Disabling TRIP only	Zone selectivity	Start-up threshold	Thermal memory	Threshold range	Time range	Threshold tolerance [2]	Time Tolerance [2]
L curve IEC60255-3	☐	☐	☐	☐	☒	$0.4xIn \leq I_1 \leq 1xIn$ step 0.01xIn	$3s \leq t_1 \leq 102s^{(1)}$, step 3s $t1@ 3I_1$	Release between 1.05 and 1.2xI1	$\pm 10\%, I_f \leq 4\ In$ $\pm 20\%, I_f > 4\ In$
S$_1$ (t=k)	☒	☐	☒	☒	☐	$0.6\ xIn \leq I_2 \leq 10xIn$ step 0.1xIn $0.6\ xIn \leq I_{2\ start-up} \leq 10xIn$ step 0.1xIn	$0.05s \leq t_2 \leq 0.35s$, step 0.01s $0.10s \leq t_{2start-up} \leq 30s$, step 0.01s $0.04s \leq t_{2sel} \leq 0.20s$, step 0.01s	$\pm 7\%, I_g \leq 6\ In$ $\pm 10\%, I_g > 6\ In$	The best of the two data $\pm 10\%$ or 40 ms
S$_1$ (t=k/I²)	☒	☐	☐	☐	☒	$0.6xIn \leq I_2 \leq 10xIn$ step 0.1xIn	$0.05s \leq t_2 \leq 0.35s$, step 0.01 at 10xIn	$\pm 7\%, I_g \leq 6\ In$ $\pm 10\%, I_g > 6\ In$	$\pm 15\%, I_g \leq 6\ In$ $\pm 20\%, I_g > 6\ In$
S$_2$ (t=k)	☒	☐	☒	☒	☐	$0.6xIn \leq I_2 \leq 10xIn$ step 0.1xIn	$0.05s \leq t_2 \leq 0.35s$, step 0.01s $0.10s \leq t_{2start-up} \leq 30s$, step 0.01s $0.04s \leq t_{2sel} \leq 0.40s$, step 0.005s	$\pm 7\%, I_g \leq 6\ In$ $\pm 10\%, I_g > 6\ In$	The best of the two data $\pm 10\%$ or 40 ms
I (t=k)	☒	☐	☐	☒	☐	$1,5xIn \leq I_3 \leq 10xIn$ step 0.1xIn	≤ 30 ms $0.10s \leq t_{2\ start-up} \leq 30s$, step 0.01s where I>I4	$\pm 10\%$	
MCR (t=k)	☒	☐	☐	☐	☐	$6.0xIn \leq I_5 \leq 15xIn$ step 0.1xIn	≤ 30 ms$^{(3)}$	$\pm 10\%$	
G$^{(4)}$ (t=k)	☒	☒	☒	☒	☐	$0.20xIn \leq I_4 \leq 1xIn$ step 0.02xIn	$0.1s \leq t_4 \leq 1s$, step 0.05s $0.1s \leq t_{4start-up} \leq 1s$, step 0.02s $0.04s \leq t_{4sel} \leq 0.2s$, step 0.01s where I>I4	$\pm 7\%$	The best of the two data $\pm 10\%$ or 40 ms
G$^{(4)}$ (t=k/I²)	☒	☒	☐	☐	☐	$0.20xIn \leq I_4 \leq 1xIn$ step 0.02xIn	$0.1s \leq t_4 \leq 1s$, step 0.05s $@I_g > 4In$	$\pm 7\%$	$\pm 15\%$
U (t=k)	☒	☒	☐	☐	☐	$2\% \leq I_6 \leq 90\%$ step 1%	$0.5s \leq t_6 \leq 60s$, step 0.5s	$\pm 10\%$	The best of the two data $\pm 10\%$ or 40 ms
OT (temp=k)	☐	☒	☐	☐	☐	Fixed, defined by SACE	Instantaneous	$\pm 5°C$	_____
Iinst	☐	☐	☐	☐	☐	Automatic, defined by SACE	Instantaneous		
UV (t=k)	☒	☒	☐	☐	☐	$0.5xUn \leq U_8 \leq 0.95xUn$ step 0.01xUn	$0.1s \leq t_8 \leq 5s$, step 0.1s	$\pm 5\%$	The best of the two data $\pm 10\%$ or 40 ms
OV (t=k)	☒	☒	☐	☐	☐	$1.05xUn \leq U_9 \leq 1.2xUn$ step 0.01xUn	$0.1s \leq t_9 \leq 5s$, step 0.1s	$\pm 5\%$	The best of the two data $\pm 10\%$ or 40 ms
RP (t=k)	☒	☒	☐	☐	☐	$-0.3xPn \leq P_{11} \leq -0.1xPn$ step 0.02 Pn	$0.5s \leq t_{11} \leq 25s$, step 0.1s	$\pm 10\%$	The best of the two data $\pm 10\%$ or 40 ms
LC1/LC2 loads control	☒	☐	☐	☐	☐	$50\% \div 100\%$ step $0.05xI_1$			
Warning Iw	☒	☐	☐	☐	☐	$0,3 \div 10I_n$ step $0,05xI_n$		$\pm 10\%$	$10 \div 40$ ms

[1] The minimum value of this trip is 1s regardless of the type of curve set (self-protection).

[2] These tolerances are based on the following assumptions:
- relay at full power (without start-up)
- preset trip time ≥ 100 ms

[3] no-trip time

[4] the protection G is disabled for current values greater than 4In, where I4 < 0.5 In, greater than 6 In, where 0.5 In ≤ I4 < 0.8 In and greater than 8 In where I4 ≥ 0.8 In.

For all cases not covered by the above hypotheses, the following tolerance values apply:

Protections	Trip threshold	Trip time
L	Release between 1.05 and 1.25 x I1	$\pm 20\%$
S	$\pm 10\%$	$\pm 20\%$
I	$\pm 15\%$	$\leq 60ms$
G	$\pm 10\%$	$\pm 20\%$
Others		$\pm 20\%$

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13.2.9.14 Table of measurements

Type of measurement	Range of values measured by the relay	Standard operation range	
		Range	Tolerance %
Currents	0,05 ... 12 In	0,3 ... 4 In	± 5
Ground fault current	0,05 ... 4 In	0,3 ... 4 In	± 5
Voltages	(PR120/V) 10 V ... 1000 V (PR120/LV) 10 V ... 48 V	70V ... 1000 V 24 V... 48V	± 1 ± 1
Active power	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5

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13.2.10   Trip curves

The trip curves given are for guidance and only show a sub-group of the possible selections (see par. 13.5.2).

13.2.10.1   Trip curves for functions L-S(t=k/I²)-I
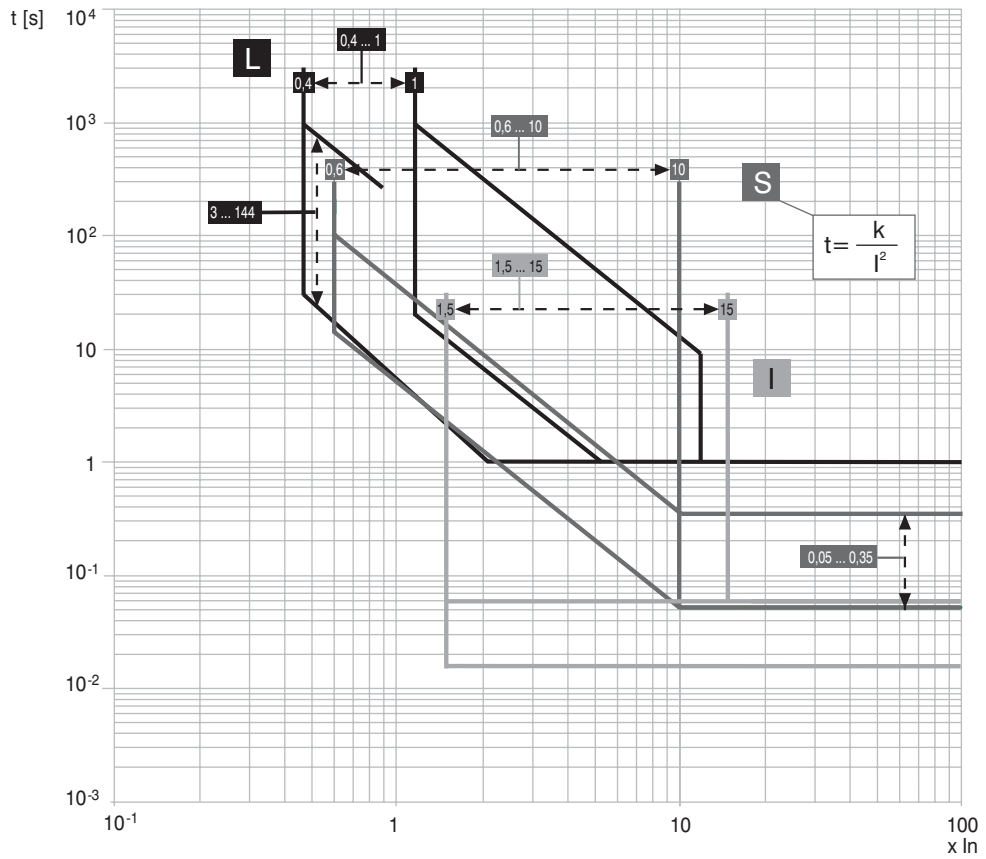
13.2.10.2   Trip curves for functions L-S(t=k)-I
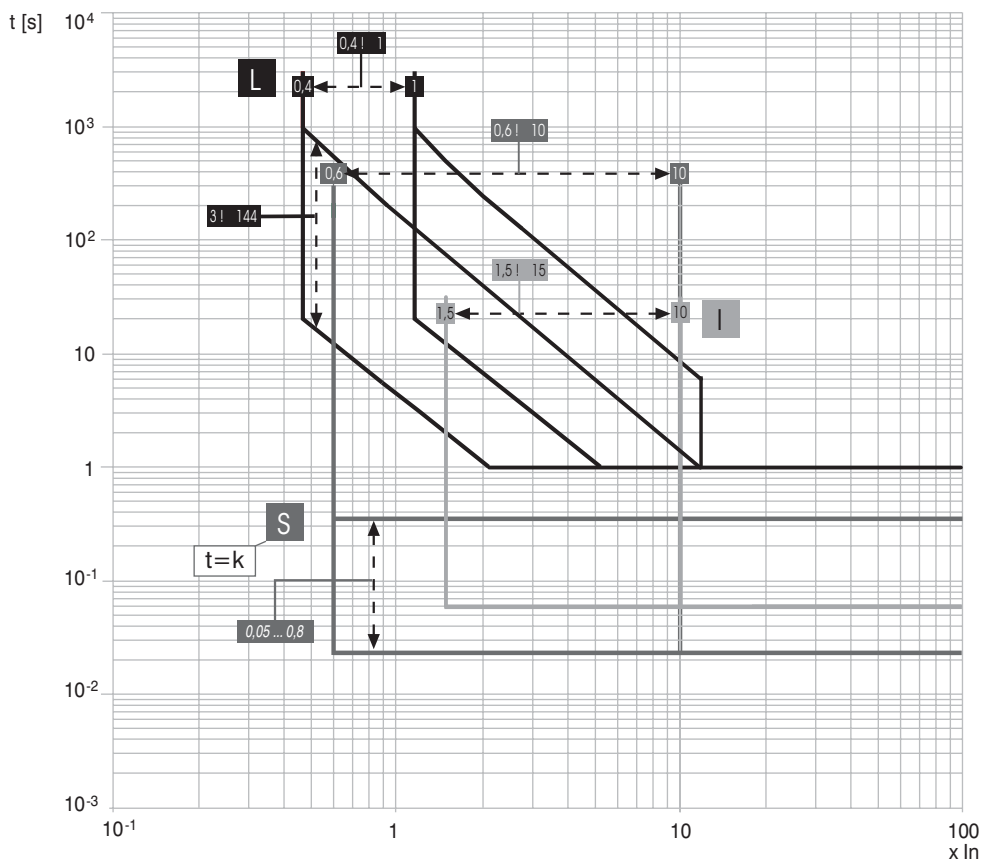
Model	L3447			Apparatus	**Emax DC**	Scale
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13.2.10.3 Trip curves for function G
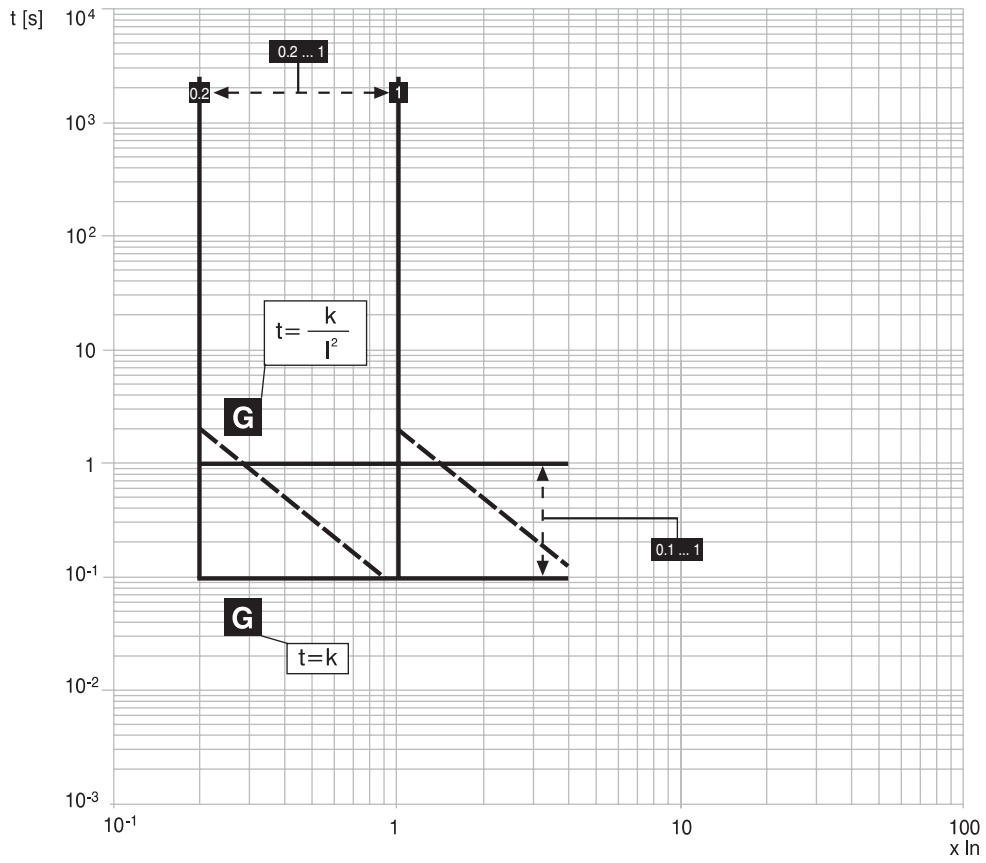
13.2.10.4 Trip curves for function U
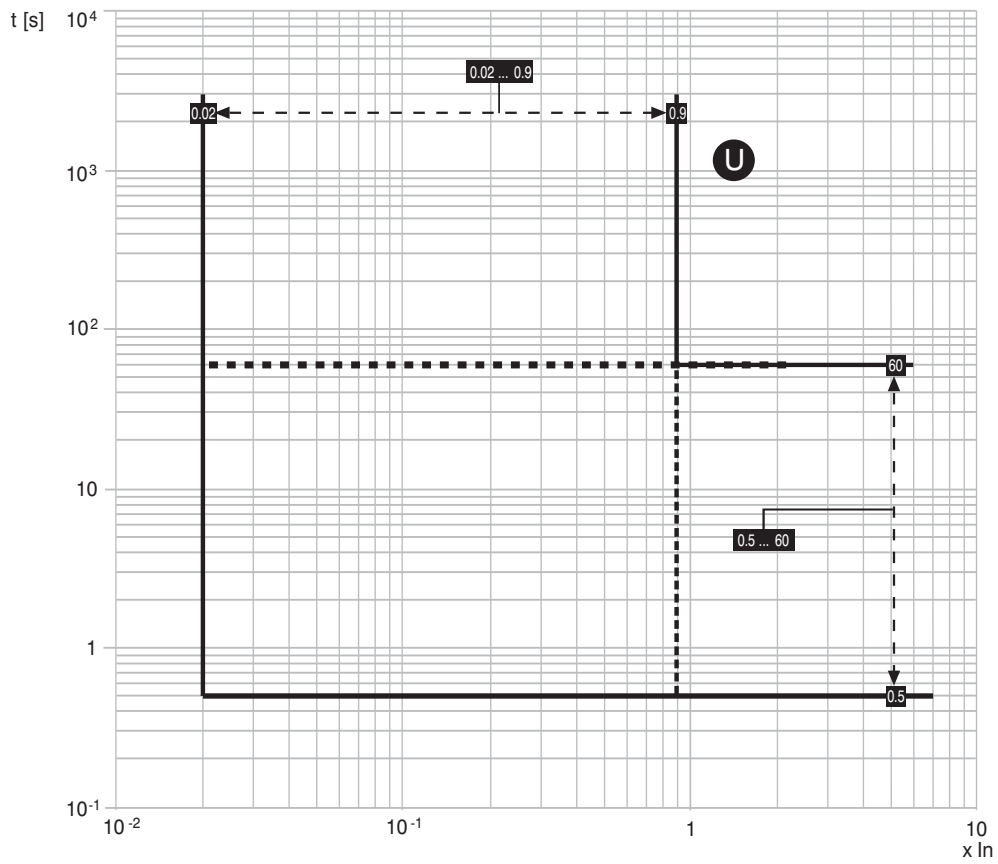
Model	L3447			Apparatus	**Emax DC**	Scale
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13.2.10.5 Trip curves for function UV
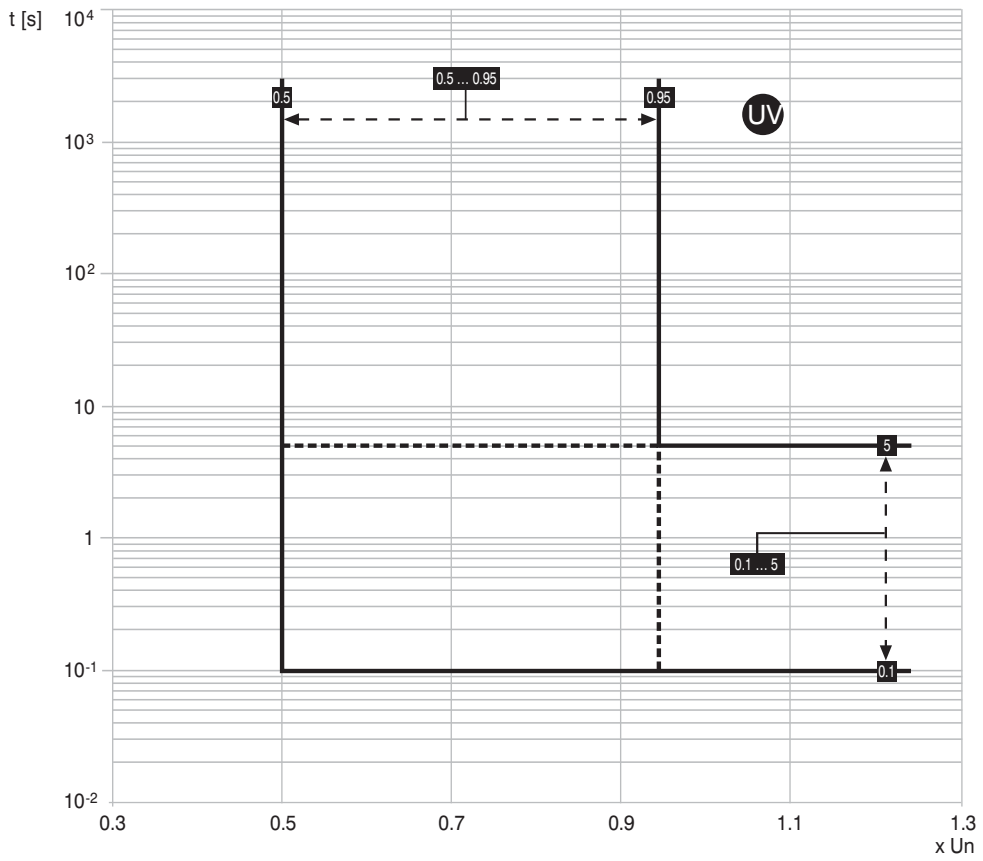
13.2.10.6 Trip curves for function OV
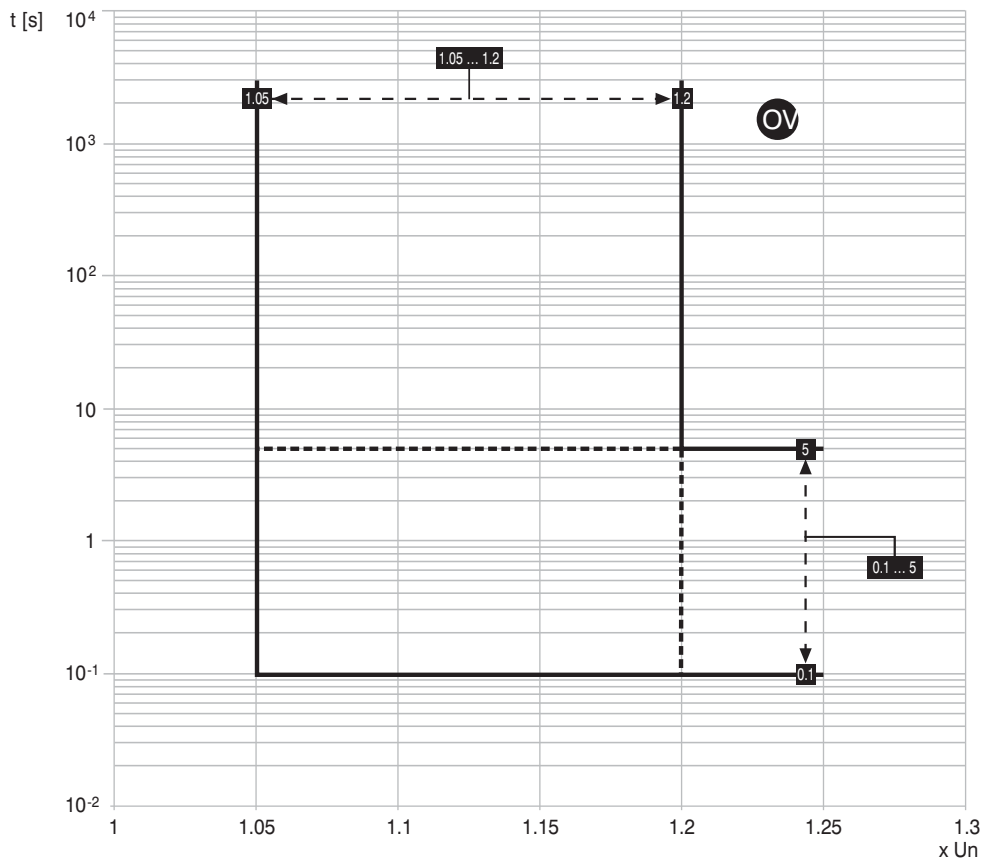
Model	L3447			Apparatus	**Emax DC**		Scale
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13.2.10.7 Trip curves for function RP
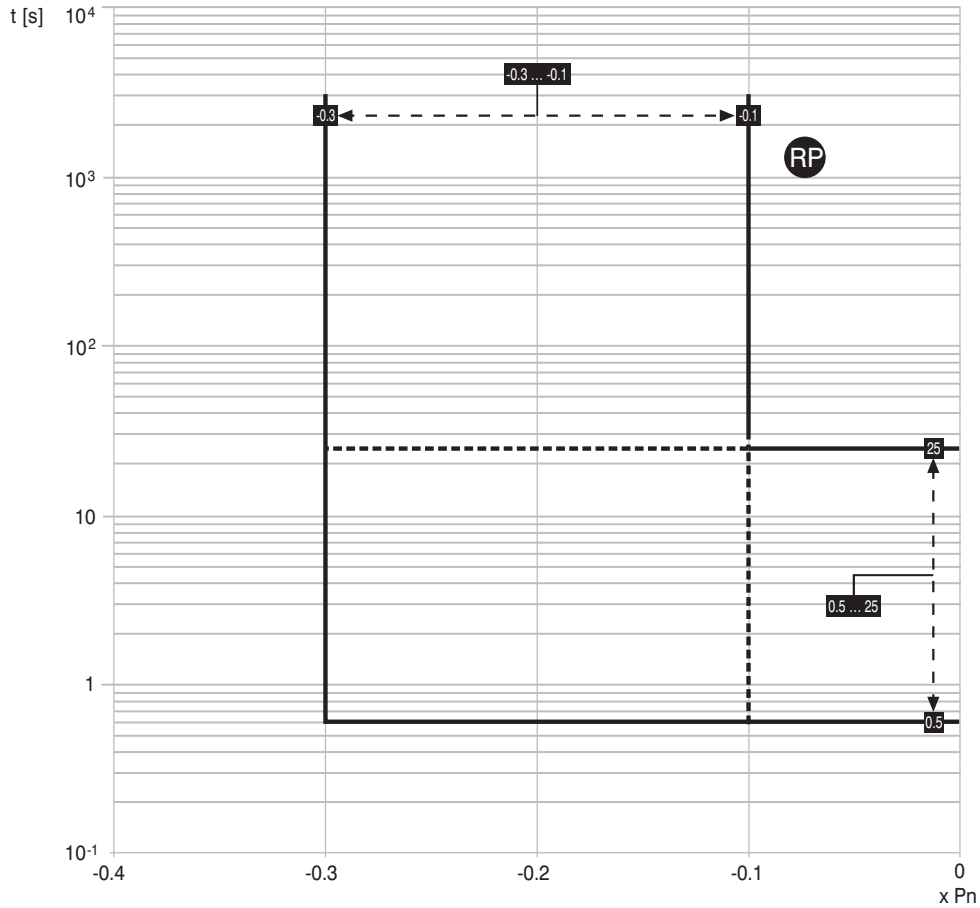
13.3 Putting into service

13.3.1 Connections

⚠️ **For the connections provided by the user, it is recommended that you comply strictly with the recommendations contained in this document.This will enable us to satisfy all the international reference standards and guarantee perfect operation of the relay even under severe environmental and electromagnetic conditions.**
Pay particular attention to the types of cable, the connections to earth and the recommended maximum distances.

13.3.2 TC connection test

⚠️ **If the PR123/DC was installed by the user, it is important, before closing the CB, to check the last line on the display when the relay is turned on for the first time via a PR030/B battery unit. No TC disconnected messages must appear; if they do, do not close the circuit-breaker immediately and make the correct connections.**

13.3.3 Test

Before putting into service, a test can be conducted by means of the specific "Auto test" function which can be activated on the PR123/DC. A positive result is shown on the display.
Then a test can be conducted on the whole TC chain, again using the specific function (Trip test). A positive result is shown by the circuit-breaker opening.To run a Trip Test, press the "i Test" button and the "Enter" button simultaneously.
Check the open or closed state of the circuit-breaker on the same "PR123/DC Test" screen, checking that the CB is closed and de-energized.

Test	1/6
CB status	
Auto Test	
Trip Test (disabled)	
	CB open

13.3.4 Initial settings

If the PR123/DC is supplied ready installed in the circuit-breaker, it is up to ABB SACE to set all the variables referring to the circuit-breaker or the specific application correctly (e.g. type of circuit-breaker, Rating Plug size...). When the PR120/V module is installed, user must properly set the rated voltage.

Vice versa, if the PR123/DC is supplied separately, it will be up to the user to set all the necessary parameters correctly.

Note that ABB SACE defines each possible setting according the content of the paragraph on the default parameters (see par. 13.4.4).

> ⚠️ **Apart from this, it is absolutely indispensable for the user to modify the password and carefully define each modifiable parameter, before putting the PR123/DC into service.**

13.3.5 Password management

Specify a password? [0*]**

To enter "EDIT" mode it is necessary to enter a four-figure numerical password. The values attributable to the password go from 0000 to 9999. For the default password see par. 13.4.4.

Select the value of the first figure (between '0' and '9') by means of the ↑ and ↓ keys and press ↵ to confirm the figure and then move on to enter the next one. After entering the fourth figure, check the password you have entered. If the password is correct, you go from the "READ" state to the "EDIT" state.

If the password is wrong, the message

Wrong password

appears and remains until the **ESC** key is pressed (or until an interval of 5 seconds has elapsed).
It is also possible to interrupt the password entry procedure by pressing the **ESC** key.

Disabling the Password.

By setting the value of the password to [0000] (on the "Unit configuration" menu) the password prompt is disabled. It is therefore always possible to switch from "READ" to "EDIT".

To enter a new password, select the "New Password" item on the "Settings/System" menu.

13.3.6 Replacing an electronic release

13.3.6.1 Installation

To complete the procedure for installing a PR123/DC unit, follow the steps below:

1. With the circuit-breaker open and preferably isolated, install the protection unit on the circuit-breaker
2. Power the unit ONLY from the PR030/B
3. If there are no other errors, the display will show the message ⚠ Configuration (configuration error) accompanied by the yellow LED coming on permanently (warning)
4. Enter the unit's "*Settings*" menu
5. Select "*Circuit-breaker*"
6. Select "*Unit installation*"
7. Input the password
8. Select "*Install*" and press "*ENTER*"
9. When the red led flashes on and off and the message ⚠ Installation (installation error) is displayed, remove the PR030/B
10. Power the relay from any other source
11. Check for the absence of configuration errors.

13.3.6.2 Uninstalling

To complete the procedure for uninstalling a PR123/DC unit, follow the steps below:

1. With the circuit-breaker open and/or isolated power the unit from the PR030/B
2. Enter the unit's "*Settings*" menu
3. Select "*Circuit-breaker*"
4. Select "*Unit installation*"
5. Input the password
6. Select "*Uninstall*" and press "*ENTER*"
7. Remove the PR030/B
8. Remove the PR123/DC unit from the circuit-breaker
9. The remove the TC connector, proceed as indicated in the figure alongside.
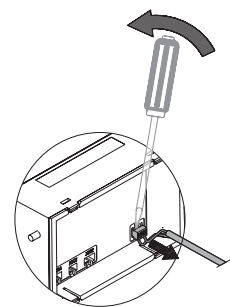
It is not strictly necessary to complete the uninstalling procedure, but this enables the parameters relating to the circuit-breaker, such as contact wear and others, to be saved, otherwise these data would be lost. The data in question are then transmitted to the new PR123/DC unit installed on the same circuit-breaker.

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13.4   User interface

Ref.	Description
1	Voltage takeoff isolator
2	Busbar voltage LED
3	Pre-alarm indicator LED
4	Alarm indicator LED
5	Graphic display (the word ABB in the bottom left-hand corner indicates normal operation)
6	Serial number of the PR123/DC
7	Rating plug
8	Pushbutton for exiting the sub-menus or for canceling (ESC)
9	Button for the cursor (UP)
10	Button for the cursor (DOWN)
11	ENTER key for confirming the data or changing the page
12	TEST connector for connecting or testing the release by means of an external device (PR030/B battery unit, BT030 wireless communication unit and PR010/T test unit)
13	"i Test" test and info button

Description of icons displayed

Symbol	Description
⊔	Remote control
A	Dual setting active. Setting A set
D	Fixed icon: data logger active Flashing icon: triggered
⌐⊏	Vaux installed
⊐	Parameter change stage

13.4.1 Use of pushbutton

The modifiable fields can be filled in using the ↑ or ↓ keys and confirming with the ↵ key. Once you have entered the page you need, you can move from one value to another by using the ↑ or ↓ keys. To change a value, position the cursor over the value (the modifiable field will appear in reverse, i.e. white on a black background), and use the ↵ key.

To confirm the programming of the previously configured parameters, press the **ESC** key to scroll up through the menus until the programming confirmation page is displayed; select confirmation and press **ENTER** for data programming.

The "**i Test**" key must be used to perform the Trip test to view the information page and to see the last trip within 48 hours of the CB opening in self-powering mode.

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13.4.2 Read and Edit modes

The menus map (see par. 13.5.1) shows all the pages which can be obtained and how to move between them from the keyboard, in the "READ" mode (just to read the data) or in the "EDIT" mode (to set the parameters).

Starting from any page displayed, the default page will be automatically displayed after about 120 sec inactivity (see par. 13.5.1).

The functions allowed depending on the state are:
"READ":
  ✓ Consultation of the measurements and of the historical data
  ✓ Consultation of the unit configuration parameters
  ✓ Consultation of the protection parameters

"EDIT":
  ✓ Everything allowed in READ mode
  ✓ Configuration of the unit
  ✓ Programming of the parameters relative to the protections
  ✓ TEST functions of the unit

To access the "EDIT" mode, it is necessary to press the ↵ key on a page with fields which can be edited. A password will then be required to enable you to switch to the editing mode.
The use of the keys is summarized in the following table:

Key	Function
↑ ↓	Move between pages Move within menu Change parameter values
↵	End setting phase and confirm result Choose menu item
ESC	Access to surfing menus from the default pages Return to previous level when surfing within the menus, until you return to the default pages Exit the parameter changing phase, aborting the change
i Test	This key is used to re-enable the display after it has gone off within 48 hours of the opening of the circuit-breaker in self-powering mode.

13.4.3   Changing parameters

Moving within the Main Menu you can reach all the pages relating to the configurations and parameter settings with the opportunity to change the values specified for the parameters.
After any programming, you need to Confirm/Cancel/Change any changes you have made. This procedure is not applicable to all the programming activities.
Two examples are provided below: one concerns the case in which no confirmation is needed for the changes you have made, while in the other a confirmation window appears.

Procedure not requiring the confirmation of any programming
For instance, to set the System Date, the correct sequence is as follows:

Press ESC to access the Main Menu.

```
                                    10:22:53
                                       400A
                                       690V


                 I  V
```

From the Main Menu, select SETTINGS

press the ↵ key (enter)

```
Menu                        1/5
Protections                  ▲
Measurements
Settings                     ▼
               Protections settings
```

Select SYSTEM

press the ↵ key (enter)

```
Settings                    8/9
Dual Set                     ▲
Measuring interval
System                       ▼
                   System settings
```

Select the menu item DATE to change

press the ↵ key (enter)

```
System                      1/4
Date
Time
Language                     ▼
                 January 12, 2004
```

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You will be prompted to input a Password
complete the password entry procedure (par. 13.3.5)

press the ↵ key (enter)

```
Password
─────────────────────────────

          0***

                   Enter password
```

Change the date using the keys ↓ (arrow down)

↑ (arrow up) and confirm by pressing the ↵ key (enter).

Press ESC twice to return to the Main Menu.

```
Date
─────────────────────────────

        June 12, 2007

```

Procedure requiring the confirmation of any programming

For instance, to change the Threshold of the Protection L, the correct sequence is as follows:

Press ESC to access the Main Menu.

```
                    10:22:53
                      400A
                      690V

  I  V
```

From the Main Menu select the item PROTECTIONS

press the ↵ key (enter)

```
Menu                   1/5
Protections
Measurements
Settings                 ▼
─────────────────────────────
            Protections settings
```

From the Protections Menu select the item PROTECTION L

press the ↵ key (enter)

```
Protections           1/15
L Protection
S Protection
S2 Protection            ▼
─────────────────────────────
                    Overload
```

From the Protection L Menu select the item THRESHOLD

press the ↵ key (enter)

```
L Protection           1/3
Threshold I1
Time t1
Thermal memory

```

You will be prompted to input a Password

complete the password entry procedure (par. 13.3.5)

press the ↵ key (enter)

```
Password
─────────────────────────────

          0***

                   Enter password
```

Select the value you want from the list
and confirm pressing the ↵ key (enter).

Threshold I1

O,4 In (320A)

Press ESC twice

Before accessing the Main Menu, the following box will appear:

Programming   1/3
Confirm
Abort
Modify
                              Confirm

Accept the new configuration
Reject the new configuration (the previous configuration is retained)
Change the previously input values.
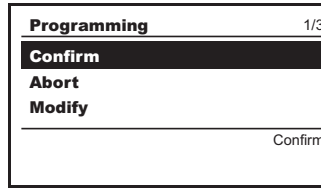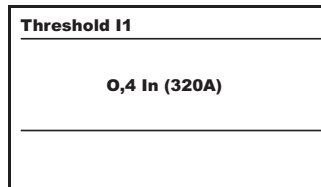
To select the required option use the ↓ (arrow down), ↑ (arrow up) keys, and press ↵ (enter) to confirm.

13.4.3.1   Modification of basic configuration
No parameter settings can be made if the PR123/DC unit is in alarm conditions.

The configuration of the unit must be done in EDIT mode.

Following the instructions given in par. 13.4.3, view the following on the display:

Change system date
Change system time
Select system language

System   1/4
Date
Time
Language   ▼
                    January 12, 2004

System   4/4
Time   ▲
Language
New Password
                          **** ❶

Password

0***

                    Enter password

To change the system password, select the relevant menu item and press ↵ (enter); then you will be prompted to enter the OLD password, and afterwards you can input the new one twice.
Press ESC twice to return to the Main Menu

Before accessing the Main Menu, the following box will appear:

Programming   1/3
Confirm
Abort
Modify
                              Confirm

Accept the new configuration
Reject the new configuration (the previous configuration is retained)
Change the previously input values.

Note: To set the system language, check that:
- the relay is set to local (when PR120/D-M is installed);
- the CB is open;
When anyone of these conditions is not complied with, the relay does not allow the language to be changed.

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13.4.4 Default settings

The PR123/DC is supplied by ABB SACE with the following predefined parameters (Set A and Set B):

#	Protection	On/Off	Thresholds	Time	Curve	T.M.	ZS	Trip
1	**L**	–	1 In	102s	I²t	Off	–	–
2	**S**	Off	6 In	50 ms	K	–	Off: 0.04 s	–
3	**I**	On	4 In	–	–	–	–	–
4	**G**	Off	0.2 In	0.4 s	K	–	Off: 0.04 s	On
5	**U**	Off	50 %	5 s				Off
6	**OT**	–						Off
7	**K LC1**	Off	50 % I$_1$					
8	**K LC2**	Off	75 % I$_1$					
9	**UV**	Off	0.9 Un	5 s				Off
10	**OV**	Off	1.05 Un	5 s				Off
11	**RP**	Off	- 0,1 Pn	10 s				Off
12	**Language**	–	Engl					
13	**PR021/K**	Off						
14	**Measuring module type**	–	HIGH VOLTAGE					
15	**Rated Voltage**	–	500V					
16	**S startup**	Off	6 In	100 ms				
17	**I startup**	Off	4 In	100 ms				
18	**G startup**	Off	1 In	100 ms				
19	**Password**	–	0001					
20	**Measuring interval**	–	60 min					
21	**Iw**	Off	3 In					
22	**Power direction**	–	NORMAL					
23	**MCR**	Off	6In	40 ms	–	–	–	–

13.5.1 Menu

As seen previously, the PR123/DC uses the display to show messages, diagrams and menus. These are organized in a logical and intuitive way. The following is a general layout showing how to access the main menu pages.

```
                    ┌─────────────────────┐
                    │              10:22:53│
                    │  ▌▌          400A     │
                    │  ▌▌          690V     │
                    │  I  V                │
                    └─────────────────────┘
                              ↕
                         ┌─────────┐
                         │   ESC   │
                         └─────────┘
                              ↕
                    ┌─────────────────────┐
                    │ Menu            1/5 │
                    │ Protections         │
                    │ Measurements        │
                    │ Settings          ▼ │
                    │      Protections settings│
                    └─────────────────────┘
                              ↕
┌─────────────────────┐     ┌─────────────────────┐     ┌─────────────────────┐
│                     │     │ Menu            2/5 │     │ Measurements        │
│                     │     │ Protections         │ ←→  │ Historicals         │
│                     │     │ Measurements        │     │ Contact wear        │
│                     │     │ Settings          ▼ │     │                     │
│                     │     │ Measures, graphics, harmonics│     │                     │
│                     │     └─────────────────────┘     └─────────────────────┘
│                     │               ↕
│                     │     ┌─────────────────────┐     ┌─────────────────────┐
│                     │     │ Menu            3/5 │     │ Settings        1/7 │
│                     │     │ Protections         │     │ Circuit Breaker     │
│                     │     │ Measurements        │ ←→  │ Hw Treip            │
│                     │     │ Settings          ▼ │     │ Modules             │
│                     │     │ General settings    │     │                     │
│                     │     └─────────────────────┘     └─────────────────────┘
│                     │               ↕                           ↕
┌─────────────────────┐     ┌─────────────────────┐     ┌─────────────────────┐
│ Test            1/6 │     │ Menu            4/5 │     │ Settings        4/9 │
│ CB status           │ ←→  │ Measurements      ▲ │     │ Datalogger          │
│ Auto Test           │     │ Settings            │     │ Measurement interval│
│ Trip Test (disabled)│     │ Test              ▼ │     │ System              │
│          CB open    │     │ Device test         │     │ Display Contr       │
└─────────────────────┘     └─────────────────────┘     └─────────────────────┘
          ↕                           ↕
┌─────────────────────┐     ┌─────────────────────┐
│ Test            4/6 │     │ Menu            5/5 │
│ COM module          │     │ Settings          ▲ │
│ SIGNALLING module   │     │ Test                │
│ Zone selectivity  ▲ │     │ About               │
│          Device test│     │ Product information │
└─────────────────────┘     └─────────────────────┘
                                      ↕
                            ┌─────────────────────┐
                            │ About           1/2 │
                            │ Protection Unit     │
                            │ Circuit Breaker     │
                            │                     │
                            │     Protection Unit │
                            └─────────────────────┘
```

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Each time the unit is turned on, or after more than 2 minutes of inactivity on the keyboard, the display indicates the following page (default):

Percentage of the actual currents and voltages with respect to the rated values (100%)
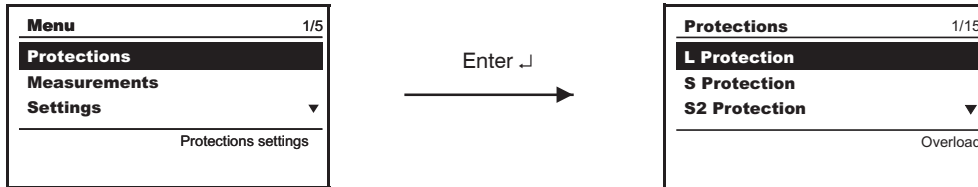
10:22:53
400A
690V
I V

Current of the phase under the greatest load

Voltage of the phase under the greatest load

13.5.2 Protections Menu

From the interface you can press ENTER to access the menu of the various protections available on the display.

Menu	1/5
Protections	
Measurements	
Settings	▼
	Protections settings

Enter ↵

Protections	1/15
L Protection	
S Protection	
S2 Protection	▼
	Overload

Using the "arrow UP" and "arrow DOWN" you can view the various protections.
On the whole, the data that you can display concern the protections:
L, S, S2, I, G, U, UV, OV, RP, OT, LOAD PROTECTION.

Example of surfing the Protections menu
From the Protection main page you can press ENTER to go to the Protection L Menu.
You can use "arrow UP" and "arrow DOWN" to select the items on the menu and confirm by pressing ENTER. Pressing this key triggers a Password prompt, then you can select the functions associated with the protection L (as in the example).

Protections	1/15
L Protection	
S Protection	
S2 Protection	▼
	Overload

Enter ↵

L Protection	1/3
Threshold I1	
Time t1	
Thermal memory	

Enter ↵

Password	
0***	
	Enter password

Example of how to select the Threshold I1

PSW + Enter ↵
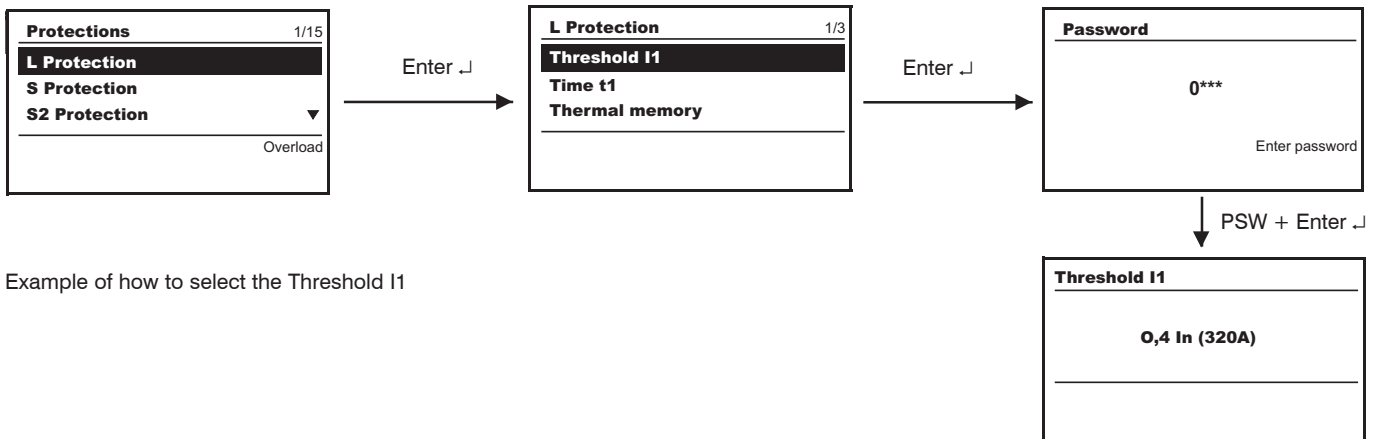
Threshold I1	
O,4 In (320A)	

Similarly, to access the menus for the other protections, see the Protections Menu table below.

13.5.2.1   Protections Menu table

Protection	Parameter / Function	
L	Threshold I1	
	Time t1	
	Thermal memory	ON / OFF
S	Enable	ON / OFF
	Curve	
	Threshold I2	
	Time t2	
	Zone selectivity	ON / OFF
	Selectivity time	

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Protection	Parameter / Function		
	Enable StartUp	ON / OFF	
	StartUp threshold		
	StartUp time		
S2	Enable	ON / OFF	
	Threshold I2		
	Time t2		
	Zone selectivity	ON / OFF	
	Selectivity time		
	Enable StartUp	ON / OFF	
	StartUp threshold		
	StartUp time		
I	Enable	ON / OFF	
	Threshold I3		
	Enable StartUp	ON / OFF	
	StartUp threshold		
	StartUp time		
G	Enable	ON / OFF	
	Curve		
	Threshold I4		
	Time t4		
	Enable Trip	ON / OFF	
	Zone selectivity	ON / OFF	
	Selectivity time		
	Enable StartUp	ON / OFF	
	StartUp threshold		
	StartUp time		
U	Enable	ON / OFF	
	Function	Currents/Voltages	
	Threshold I6		
	Time t6		
	Enable Trip	ON / OFF	
UV	Enable	ON / OFF	
	Threshold U8		
	Time t8		
	Enable Trip	ON / OFF	
OV	Enable	ON / OFF	
	Threshold U9		
	Time t9		
	Enable Trip	ON / OFF	
RP	Enable	ON / OFF	
	Threshold P11		
	Time t11		
	Enable Trip	ON / OFF	

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Protection	Parameter / Function	
OT	Enable Trip	ON / OFF

Load control		
	Threshold 1 Enable Threshold	ON / OFF
	Threshold 2 Enable Threshold	ON / OFF
	Threshold lw Enable Threshold	ON / OFF

Note: for an explanation of the characteristics of the single protections and their settings and corresponding curves, see par. 13.2.9.

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13.5.3 Measurements Menu

For a complete description of the functions of the PR120/V module, see par. 14.1.
The following is a summary of the parameters accessible from the menu in the PR123/DC unit.

13.5.3.1   Measurements Menu table

Setting	Parameter / Function	Values	Notes
Historicals			
	Trips		Last trip (20)
	Events		Events log (max 80 events)
	Measurements		
	I Max		Maximum active current
	P Max		Maximum active power
	P Mean		Mean active power
	U Max		Maximum voltage
	U Min		Minimum voltage
	Reset measurements		
Energy	Energy meters		
	Reset meters		
Contact wear			Percentage of wear on CB contacts

13.5.4 Settings Menu

The configuration parameters in the Settings menu are password protected.
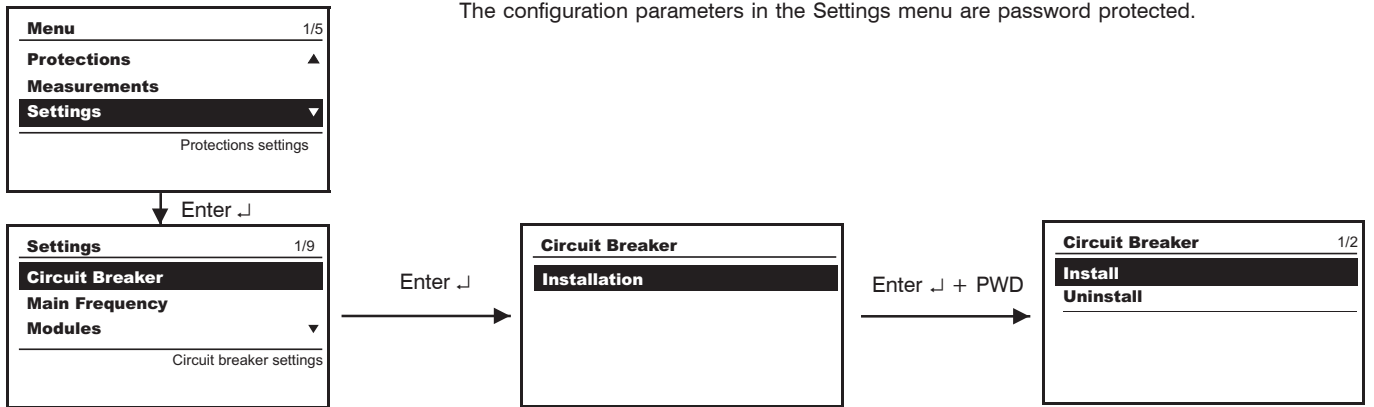
13.5.4.1   Settings Menu table

	Parameter / Function	Values	Notes
Circuit breaker	Installation	Install/Uninstall	
Modules	Module		
	PR120/D-M - COM	if any	see par. 13.5.4.2.2
	PR120/K - Signalling	if any	see par. 13.5.4.2.3
	Local Bus unit	Absent - Present	
Data Logger	Enable	ON/OFF	See Annex par. 15.2
		Sampling frequency	
		Stop event	
		Stopping delay	
		Restart	
		Stop	
Dual setting	Enable	ON/OFF	
	Default setting	SET A / SET B	
	Dual Set CB closure		
	Dual Set with Vaux		
Measurement interval		from 5 to 120 min, step 5 min	
System	Date		
	Time		
	Language	English/Italiano/Français/Deutsch/Español	
	New password		
Display	Contrast		

The summary table relates to the surfing of the pages dedicated to the PR120/K module (see par. 14.3) and to the PR021/K unit (see par. 15.1).

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13.5.5 Modules

When you access the Settings menu, there is a set of menus available relating to the modules.

13.5.5.1 PR120/V-PR120/LV MEASURING module

The primary voltage values (100... 1000 V) can be selected; see section 14.1.

13.5.5.2 PR120/D-M - COM module
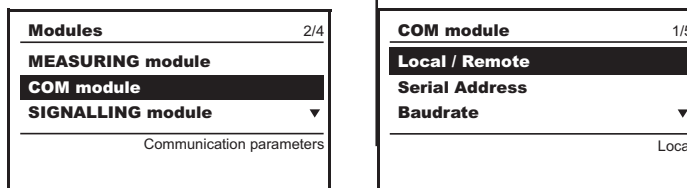
Modules	2/4
MEASURING module	
COM module	
SIGNALLING module	▼
	Communication parameters

COM module	1/5
Local / Remote	
Serial Address	
Baudrate	▼
	Local

The local or remote modes can be selected after entering a password. The serial address can be displayed after entering a password. The Baud Rate can be set on the values 9600 and 19200 bit/s. The physical protocol provides for the options: (8,E,1), (8,0,1), (8,N,2), (8,N,1). The addressing can be selected as standard Modbus or ABB. For further information on the PR120/D-M communication MODULE, see paragraph 14.2 in this manual.

13.5.5.3 PR120/K - SIGNALLING module

For a thorough examination of the signalling module, refer to the corresponding section of the module, paragraph 14.3.

13.5.5.4 Settings for the Local Bus unit

If the PR021/K unit is connected, you need to enable the local bus by selecting present.

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13.5.6 Test Menu

Access to the Test menu is password protected.
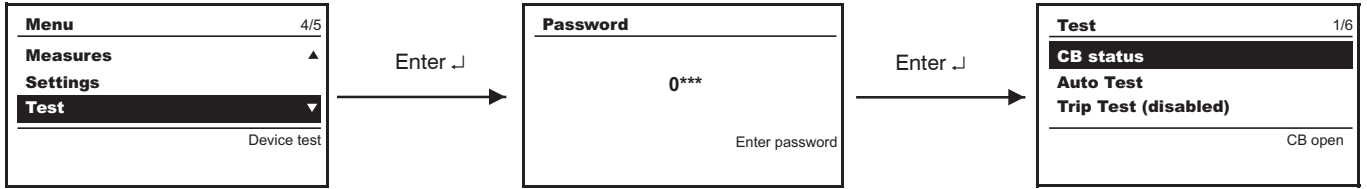
```
Menu                      4/5          Password                         Test                    1/6
Measures              ▲                                                 CB status
Settings                                         0***                   Auto Test
Test                  ▼                                                 Trip Test (disabled)
              Device test                         Enter password                         CB open
```

Enter ↵ → Password → Enter ↵ → Test

The menu shows the state of the CB, in the dialog module (COM module) the state of the springs and the position of the CB, and in this submenu you can make the CB open or close. Using the "Trip Test" function lets you view the disabling/enabling of the Trip. If it is enabled, the circuit-breaker is opened. The function is only available with a busbar current of nil (use Vaux, PR030/B or PR010/T).
On the page only with Vaux, you can also see the state of the circuit-breaker "STATUS", and thus make sure that the input is correctly wired.

The surfing path is summarized in the following table:

13.5.6.1 Test Menu table

Parameter / Function		Values	Notes
CB status		Open/Closed/Indefinite	Indefinite in case of fault only
Auto Test		Display test	
Trip Test		Enabled/Disabled	
PR120/D-M Module	State of springs Position of CB Open CB Close CB	Loaded/Unloaded Isolated/Withdrawn	
PR120/K Module	Input Auto Test	ON - - -	
Zone selectivity	Protection S (status) Input Force Output Release Output	ON/OFF	
	Protection G (status) Input Force Output Release Output	ON/OFF	

13.5.7 Information Menu

The Information Menu enables you to view the data relating to the protection unit and the type of circuit-breaker.

```
About                     1/2         Protection Unit                   Circuit Breaker
Protection Unit                       Nr.    :     G0000A03A            Nr.    :     AF 050 94 092
Circuit Breaker                       Device  : PR123/DC               Device  : E2B800/SP
                                      Version : LSIG                   Rated Curr. : 800 A
              Protection Unit         Normative : IEC                  Installation : June 12, 2007
                                      Software : P 1.00                Maintenance : June 12, 2007
```

Enter ↵ → Protection Unit → ESC +↓ + Enter ↵ → Circuit Breaker
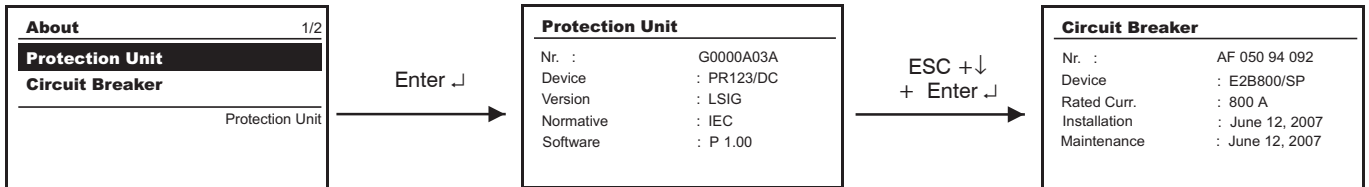
13.5.7.1 Information on the trip and opening data

The PR123/DC unit saves all the information relating to the type of protection tripped, the opening data, the date and time. Using the "i Test" key makes the release show all these data directly on the display. There is no need for an auxiliary power supply for this function. With an auxiliary power supply, the information is shown immediately on the display without the need to press the "i Test" key and remains displayed indefinitely until you press the key.
The information remains available for 48 hours with dead relay. The data relating to the last 20 trips are stored in the unit's memory. By connecting a PR030/B battery unit and PR010/T or a BT030 wireless communication unit, you can retrieve the information relating to the last 20 trips recorded. Access to view the opening data is via the Historicals submenu in the Measurements menu. The following is an example of the information provided:

```
Last Trip              N.02
June 12, 2007      8:52:11:733
L Protection
I1:      625A
```

◄— Number of openings due to the protections and to the TRIP tests.

◄— Indication for protection tripped.

- Value of the current interrupted if the LSIU has tripped.
- Value of the current G if G has tripped.
- Value of the voltage if OV, UV have tripped.
- Value of the current and power if the Rp has tripped.

Again in the Measurements menu, you can view the percentage of contact wear, which is an indication of the electrical life of the electrical contacts in the circuit-breaker.
In any case, functionality of the relay is in no way modified by the presence of the wear messages.
The prealarm message (wear > 80%, "warning" LED lighting up) indicates that the wear has reached a high value. The alarm message (100% wear, "alarm" LED lighting up) indicates that it is necessary to check the state of contact wear.
The percentage of wear depends on the number of openings carried out by the circuit-breaker and by the absolute current interrupted during each of them.

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13.6 Definition of alarms and signals in the PR123/DC unit

13.6.1 Optical signals

Signalling	Description
Warning (yellow) led	• The prealarm threshold has been exceeded; with current values in the range $0.9xI_1 < I < 1.05xI_1$; • Presence, between two polarity, of unbalance above the value programmed for the "U" protection, with protection trip disabled; • Contact wear greater than 80% (and less than 100%); • WARNING Threshold I_w exceeded; • Circuit-breaker state error; • Configuration error; • Settings inconsistency.
Warning Led (yellow 0.5Hz)	• WARNING threshold of relay's internal temperature exceeded.
Warning Led (yellow 2Hz)	• ALARM threshold of relay's internal temperature exceeded.
Alarm (red) led	• Presence of current values I >1.3 I1 (timing protection "L")*; • Timing in progress for protection function S; • Timing in progress for protection function G; • Timing in progress for the voltage (UV, OV) protection functions; • Timing in progress for the reverse active power protection function (RP); • Timing in the case of unbalance between the phases (protection U) above the value set in the configuration with protection trip set to on; • Contact wear = 100%; • Rating Plug disconnected; • Trip Coil (TC) disconnected; • Key plug error; • Current sensors disconnected; • Installation error.

* The IEC 60947-2 Standard defines the timing threshold L for current: 1.05 < I < 1.3 I1.

13.6.2 Electrical signals

K51/p1...p4   Programmable electrical signals if the PR120/K module or the PR021/K unit are installed and there is an auxiliary power supply.
K51/p1...p8   Programmable electrical signals if the PR021/K unit is installed and there is an auxiliary power supply.
Pressing the "i Test" key enables you to reset the activated contacts.

13.6.3 Table of error and warning messages

All the messages which can be shown on the display relating to incorrect configurations, generic alarms or deriving from the protection functions and linked to useful information are described below.

The following symbols in the warning signals have the following meanings:

⚠ = Warning signal / Protection in alarm mode, with no trip (trip=off)

⌛ = Protection in alarm mode, with trip at end of delay (trip=on)

ℹ = Information, no action, except for displaying by the relay.

Error message	Description	Notes
⚠ Contact wear	Alarm for contact wear	Contact wear = 100%
⚠ G (TRIP OFF)	Alarm for protection G	
⌛ T Alarm	Alarm for protection T	Temperature outside range
⚠ T (TRIP OFF)	Alarm for protection T	
⚠ U Alarm	Alarm for protection U	Protection U delay counting down
⚠ UV Alarm	Alarm for protection UV	
⚠ OV Alarm	Alarm for protection OV	
⚠ RP Alarm	Alarm for protection RP	
⚠ Load LC1	Alarm for load control LC1	
⚠ Load LC2	Alarm for load control LC2	
⚠ IA Sensor	Alarm for IA phase current sensor	Phase IA sensor disconnected or faulty
⚠ IB Sensor	Alarm for IB phase current sensor	Phase IB sensor disconnected or faulty
⚠ TC disconnected	Trip Coil disconnected or faulty	
⚠ Rating Plug	Rating Plug Error absent or faulty	
⚠ Invalid date	Clock information lost	
⚠ CB status	CB status error	Probable error in Q26 and/or Q27
⚠ Installation	Key plug error	
⚠ CB not defined	State of circuit-breaker inconsistent (Open/Closed)	Probable error in Q26 and/or Q27

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Error message	Description	Notes
⊥ Local Bus	Local Bus error	See par. 13.7
⦿ Contact wear	Contact wear prealarm	Contact wear ≥ 80%
⦿ L prealarm	Protection L prealarm	
⦿ T prealarm	Protection T prealarm	
⦿ Warning Iw	Iw threshold exceeded	
⦿ Timing L	Timing protection L	
⊠ Timing S	Timing protection S	
⊠ Timing S2	Timing protection S2	
⊠ Timing G	Timing protection G	
⊠ Timing U	Timing protection U	
⊠ Timing UV	Timing protection UV	
⊠ Timing OV	Timing protection OV	
⊠ Timing RP	Timing protection RP	

13.6.4 Error messages displayed in pop-up windows

All the messages that appear on the display in a pop-up window are described below.

Error message	Description
⊥ Password error	
⊥ Session impossible	A programming session cannot be started due to a contingency (e.g. a timer-controlled delay still elapsing)
⊥ Value outside range	Value beyond the established limits
⊥ Failed 1001/2001	Incongruence between thresholds of protections L and S (SET1/SET2)
⊥ Failed 1002/2002	Incongruence between thresholds of protections I and S (SET1/SET2)
⊥ Failed 1003/2003	Incongruence between thresholds of protections L and S2 (SET1/SET2)
⊥ Failed 1004/2004	Incongruence between thresholds of protections I and S2 (SET1/SET2)
⊥ Failed 3001	Inconsistency as to language change
⊥ Exception 6	Control temporarily unavailable
⊥ Unavailable	Function temporarily unavailable
⊥ Invalid date	Date has not been set
⊥ Parameters revised	Programming session concluded correctly
⊥ Cancelled	Programming session cancelled
⊥ Failed	Programming session rejected

13.7 Troubleshooting PR123/DC unit

The following table lists a series of typical service conditions, to help you understand and solve hypothetical faults or malfunctions.

Note:
1. Before consulting the following table, check for any error messages appearing for some seconds on the display.
2. FN indicates the normal operation of the PR123/DC.
3. In the case where the suggestions proposed do not lead to a solution of the problem, please contact the ABB SACE assistance service.

No.	Situation	Possible causes	Suggestions
1	The trip test cannot be run	1. The busbar current is > 0 2. The TC is not connected	1. FN 2. Check the messages on the display
2	Trip times lower than expected	1. Threshold too low 2. Curve too low 3. Thermal memory enabled 4. The SdZ is inserted	1. Correct threshold 2. Correct curve 3. Exclude if not necessary 4. Exclude if not necessary
3	Trip times higher than expected	1. Threshold too high 2. Curve too high 3. Curve I²t inserted	1. Correct threshold 2. Correct curve 3. Exclude if not necessary
4	Rapid trip, with I3=Off	Iinst tripped	FN with short-circuit with high I
5	High earth I, but no trip happens	Function G prevented with I>4In	FN
6	Display off	1. Vaux missing and the voltage is below the minimum value. 2. Temperature out of range	1. FN, see 13.2.2 2. FN, see 13.2.9.8
7	The display is not back-lit	Voltages below the limit for lighting the display	FN

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No.	Situation	Possible causes	Suggestions
8	Reading of I incorrect	Current below the minimum threshold that can be displayed	FN
9	Reading of V or W incorrect	Voltage parameter setting error	Set correct parameters
10	" ⚠ Local Bus" message on display	No communication between PR123/DC and PR021/K	1. If not present, disable PR021/K, see 13.5.4.2.4 2. Check bus connection 3. Check PR021/K
11	Message "" instead of expected data	Function disabled or data out of range	FN
12	The expected trip does not occur	Trip function disabled	FN enable trip if necessary
13	No activation of the Unbalance U protection	Values of I out of range	FN, see 13.2.9.4
14	No display of the opening data	Vaux missing,the buffer capacitor is discharged	FN, see 13.5.6.1
15	The password is not requested	The password has been disabled	FN, re-enter the password with a value other than 0000
16	Impossible to change any parameter	PR123/DC in alarm situation	FN
17	" ⚠ Temp. sensor" or " ⚠ Start-up" message	Possible failure inside relay	Contact ABB Sace
18	Invalid date	1. First installation 2. Information lost due to power failure	FN see 13.4.3.1
19	Untimely trip		see 13.6.3
20	LED lighting		see 13.6.1
21	The language cannot be changed	1. Relay remotely set 2. CB not open	1. Set locally 2. Open CB

13.7.1 In the case of a fault

⚠ **If you suspect that the PR123/DC is faulty, has a malfunction or has generated an unwanted trip, it is advisable to follow the recommendations below very carefully from the Measurements menu, ⟶ Historicals ⟶ Trip:**

1. Make a note of the type of protection that has tripped by accessing the LAST TRIP page if there is an external power supply (Vaux or battery) or by pressing "i Test" if in self-powering mode.
2. Note down the type of circuit-breaker, number of poles, any accessories connected, In, Serial Number (see par. 13.4) and the SW version.
3. Prepare a brief description of the opening (what LEDs and/or indications were displayed? when did it happen?, how many times ?, was it always under the same conditions? what type of load? what voltage? what current? is the event reproducible?)
4. Send/communicate all the information collected, together with the circuit diagram for the circuit-breaker, to your nearest ABB Customer Support service.

The completeness and accuracy of the information given to the ABB Assistance service will facilitate technical analysis of the problem encountered, and will allow us to carry out all actions useful for the user rapidly.

13.8   Accessories

13.8.1 ABB SACE PR010/T test and configuration unit
The test with the SACE PR010/T unit enables to check the proper operation of thresholds and tripping times of the protection functions L, S, I, G, OV, UV, U. The test unit is connected to the relay by means of the dedicated connector (see par. 13.4).

13.8.2 BT030 communication unit
Through the BT030 wireless communication unit, the PR123/DC can be connected via wireless to a Pocket PC (PDA) or a standard PC, extending the information range available to the user. Through the ABB SACE SD-Pocket communication software, the values of the currents flowing through the CB, the value of the last 20 interrupted currents and protection settings, can be read.

13.8.3 PR021/K and HMI030 units
The PR123/DC can also be connected to the PR021/K optional external indication unit (see par. 15.1), to signal through potential-free power contacts, the protection and trip alarms, and to the HMI030 switchboard front unit to display a number of information.

13.8.4 PR030/B power supply unit
This unit is an external unit allowing powering of Relay, Autotest and Trip Test, checking with CB open and installation of new replacement units.

14   Modules

14.1 PR120/V-PR120/LV MEASURING Module

14.1.1 General characteristics

The MEASURING module records and processes the voltages. The measurements are sent by the module to the protection release, enabling the implementation of a set of protection and measurement functions. The module comes with a "Power" LED and a sealable isolator for dielectric stiffness tests. The module also enables the relay to be powered. The PR120/V-PR120/LV is used for voltages from 100V to 1000V, the PR120/LV is used for voltages from 24V to 48V.

14.1.2 Front view

- "Power Line" LED (lit when busbar voltage is On, see 14.1.3)
- Isolator
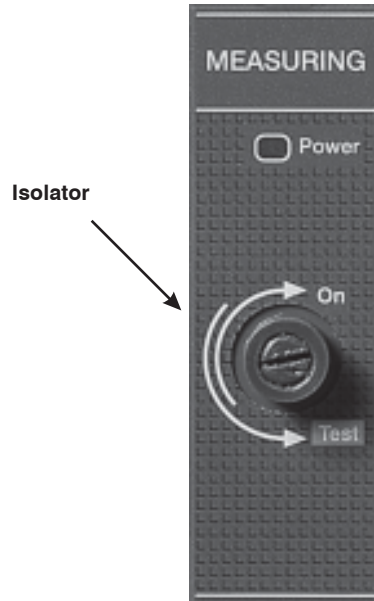
Isolator

! **Before performing the dielectric stiffness test it is essential to turn the isolator into the Test position mode by turning the screw anticlockwise until you reach the end of stroke position.**

! **After performing a dielectric stiffness test, restore the isolator to its original position by turning it clockwise until you reach the opposite end of stroke, because all the voltage protections are disabled while the isolator is in the test position.**

At the end of the procedure, make sure that the Power line LED is on.

14.1.3 Powering the PR122/DC and PR123/DC units via the PR120/V-PR120/LV module

The PR122/DC and PR123/DC units are powered by the MEASURING module via the busbar voltage.
The following tables show the voltage values at the MEASURING module's input for which the relays and modules are enabled:

PR122/DC and PR123/DC Relay + PR120/K Module

ENABLING			Enabling threshold (Voltage)	
PR122-PR123/DC Relay	PR120/K	Relay display backlighting	PR120/V	PR120/LV
☒			60V	18V
☒	☒	☒	90V	24V

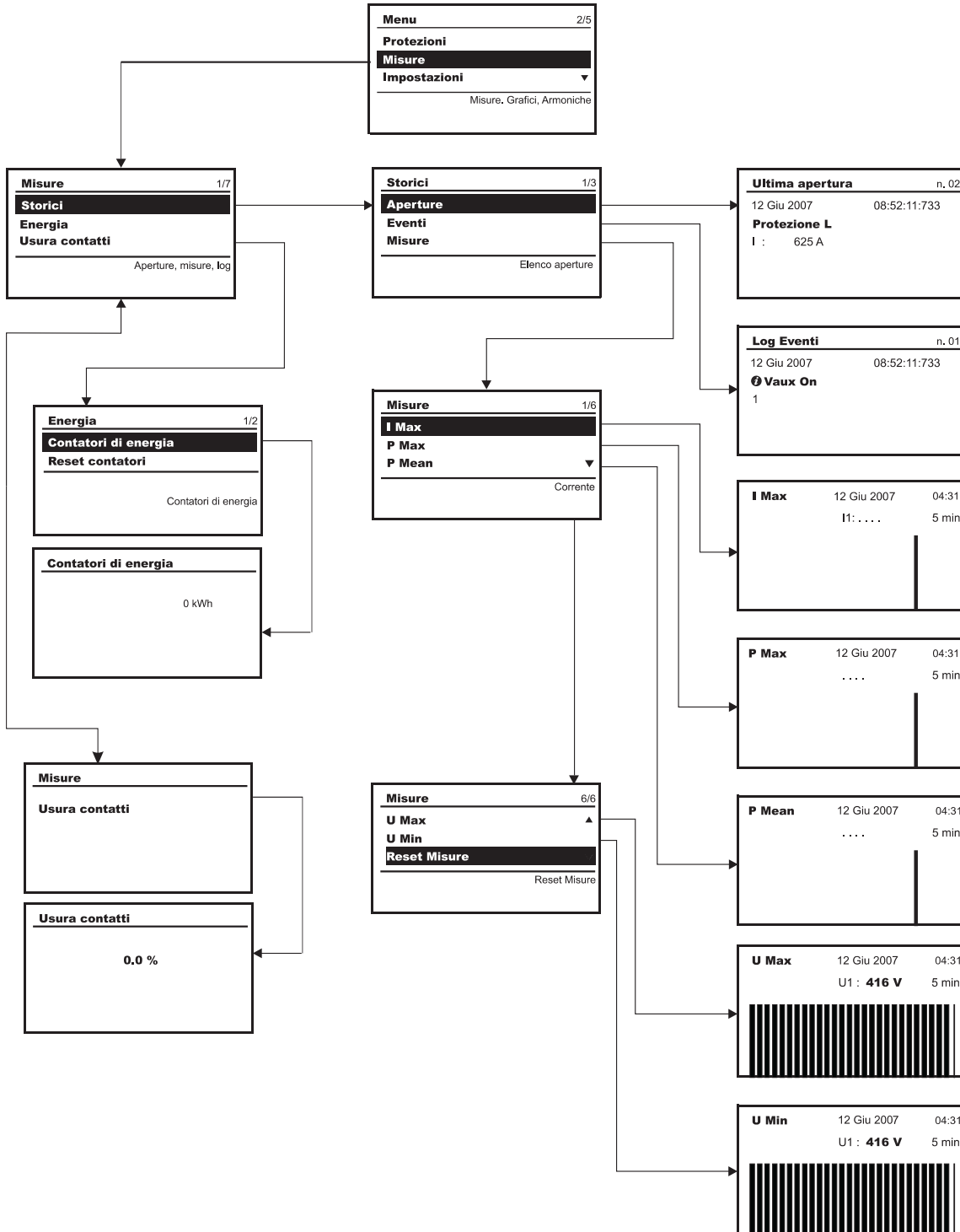N.B. The PR120/V-PR120/LV module does not need any connections to be made by the customer.

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14.1.4 Operating instructions / Operation in service

14.1.4.1 Using the Measurement submenus with the PR120/V-PR120/LV

The menu for accessing the functions of the module is illustrated below.

14.1.4.2 Table of submenus for the PR120/V-PR120/LV module
This menu is accessible using the path "Settings/Modules/ PR120/V module"

Parameter / Function	Values	Notes
Rated Voltage	100 V-1000 V Step 10	
Power flow	Normal Reverse	

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14.1.4.3   Measurements Menu table

For the sake of simplicity the table refers to the Measurements menu .

	Parameter / Function	Values	Notes
Historicals	Trips		List of trips
	Events		Events log
	Measurements		
	Maximum current		
	Maximum active power		
	Mean active power		
	Maximum voltage		
	Minimum voltage		
	Reset measurements		
	Mean power		
Energy	Energy meters		
	Reset meters		
Contact wear			Percentage of contact wear

14.1.4.4   Measurements Menu

14.1.4.4.1   Historicals

| Measures	1/7
Historicals	
Energy	
Contact wear	
	Trip, measures, log
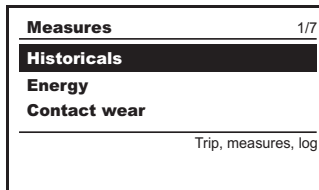
A whole range of measurements is accessible from the "Measurements/Historicals" menu.

14.1.4.4.2   Trips

The following is an example of a page showing the latest trip. You can access said page by selecting Trips via the path Measurements / Historicals / Trips. The page shows the values for the type of protection that has been tripped (L in the example).

Last Trip	n. 02
Jan 06, 2007	08:52:11:733
L Protection	
I1: 625 A	
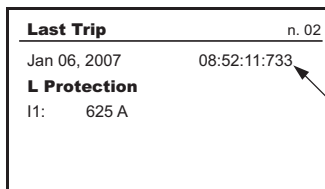
Meter: counts progressively (0 … 65,535) as of the date of the latest trips reset. It shows the latest 20 trips which can still be selected.

Time (in hours and minutes) when CB opened

14.1.4.4.3   Events

The following table shows a typical page concerning the latest events Log. You can access said page by selecting Events via the path Measurements / Historicals / Events.

Events Log	n. 01
Jan 10, 2007	08:52:11:733
❶ **Vaux On**	
1	
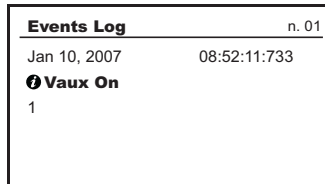
Meter: indicates "Last" and measures the previous ones according to a -1, -2 up to -80 progression (e.g. second-last -1)
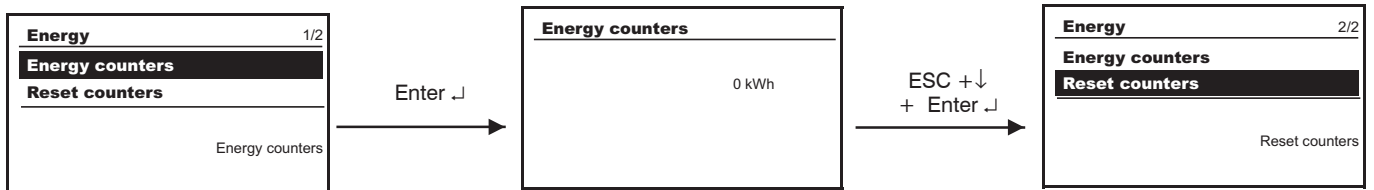
14.1.4.4.4   Measurements

This menu is for showing the following measurements:

I Max   -   Maximum current
P Max   -   Maximum active power
P Mean   -   Mean active power
U Max   -   Max line voltage
U Min   -   Min line voltage
Reset   -   Reset measurements

14.1.4.4.5   Energy

The unit also provides meter readings of the total active energy of the system. The minimum value that can be displayed is 0.001 MWh .
The energy meters' end of scale is approximately 2.15 billion kWh.
The meter can also be reset by pressing the "Reset meters" key on the menu.
For the ranges and precisions see par.13.2.9.14.

Energy	1/2
Energy counters	
Reset counters	
	Energy counters

Enter ↵ →

Energy counters	
	0 kWh

ESC +↓
+ Enter ↵ →

Energy	2/2
Energy counters	
Reset counters	
	Reset counters

14.1.4.4.6   Contact wear

This submenu shows the percentage of wear on the CB contacts.

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14.2   PR120/D-M - COM communication module

14.2.1   General characteristics

Dedicated communication module for connecting the relay to a Modbus net, and for remote supervisory and control activities on the circuit-breakers.

14.2.2   Front view

- "Power" LED (lit when Vaux is installed)
- LED RX/TX (data send/receive signal).
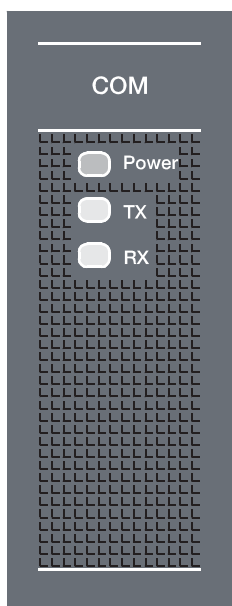
14.2.3   Releases complete with the module
- optional for PR122/DC
- optional for PR123/DC

14.2.4   Power supply
The PR120/D-M - COM communication module is only powered by the relay if there is a 24V auxiliary voltage available.

14.2.5   Connection
Refer to fig. 45 in the wiring diagram provided in this manual.

14.2.6   Communication functions available
The communication function on the PR122/DC, PR123/DC releases with PR120/D-M - COM is listed in the table:

PR122/DC or PR123/DC + PR120/D-M - COM

Protocol	Modbus RTU
Physical interface	RS-485
Baud rate	9600 - 19200 bit/s

14.2.7   PR120/D-M - COM module menu

Parameter / Function	Values	Notes
Local/remote	Local/remote	
Serial address	1 ... 247	247 default address
Baudrate	9600 bit/s 19200 bit/s	
Physical protocol	8,E,1 - 8,0,1 - 8,N,2 - 8,N,1	
Addressing	Modbus standard ABB	

14.3 PR120/K signalling module

14.3.1 General characteristics

The module enables the local signalling of alarms and circuit-breaker trips.
There are two possible configurations for the SIGNALLING module:
- default configuration: 1 digital input, 3 contacts with pole in common, 1 independent contact;
- alternative configuration: 4 independent contacts. In this case, the digital input is wired, but not brought up to the terminal block.
The two configurations are alternative to each other. You can switch from one configuration to the other without changing the module, by using a different wiring, as illustrated in the wiring diagrams in figs. 46 or 47.

14.3.2 Front view

- "Power" LED (lit when Vaux or PR120/V - PR120/LV are installed)
- N° 4 LED: associated with the signalling contacts.
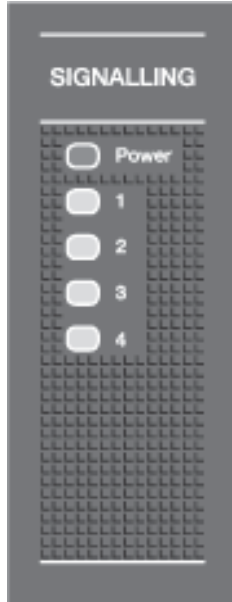
14.3.3 Releases complete with the module

- optional for PR122/DC
- optional for PR123/DC

14.3.4 Characteristics of the digital input

The unit enables the digital input to be associated with the following functions:
- enabling of an alternative set of parameters, set B (PR123/DC only);
- outside trip control;
- zeroing release trips;
- resetting PR120/K contacts;
- local/remote enabling;
- resetting energy meters.
The digital input is activated by a 24VDC + 20% voltage.
For the load control function, the module can be used as an actuator.

14.3.5 Characteristics of the signalling contacts

The following data are defined for resistive loads

Type of contact	SPST	
Max switching voltage	130 VDC	380 VAC
Max switching current	5 A	8 A
Max switching power	175 W	2000 VA
Breaking capacity at 35 VDC	5 A	----
Breaking capacity at 120 VDC	0.2 A	----
Breaking capacity at 250 VAC	----	8 A
Breaking capacity at 380 VAC	----	5.2 A
Contact/coil insulation		4000 Veff
Contact/contact insulation		1000 Veff

14.3.6 Power supply

The PR120/K signalling module is powered in auxiliary mode by the relay and/or by the PR120/V-PR120/LV as specified in chapter 14.1.

14.3.7 PR120/K module menu

The PR120/K is fitted with four relays having contacts named K51/p1, K51/p2, K51/p3 and K51/p4 which can signal different situations selectable by the user from among those given in the standard list, whereas customizations can be programmed by selecting "custom" on the menu and setting the signal required with a PDA, SD-Testbus or PR010/T.
See Appendix 15.3.

	Parameter / Function	Values	Notes
Relay no. 1...4			
(K51/p1...p4)	Signal source	Standard or custom	- see par. 15.3
	Delay	0...100s step 0.01s	- Deliberate delay before activating the contact
	NO/NC	NO/NC	- Contact normally-open (NO) or normally-closed
	Latch	ON/OFF	- With the contact "ON", once it has been activated it stays switched. A specific reset action is needed to reset it
Input			
	Polarity	Active low Active high	
	Function	Generic	- no associated action
		Outside trip	- releases the circuit-breaker
		Reset trip	- resets the data after a trip
		Set B	- switches from set A to set B (for PR123/DC only)
		Local	- forces the local status of the protection (local/remote)
		Signal reset	- programmable contact reset
		Energy reset	- energy meter reset
	Delay	0…100s step 0.01s	- performs action after t is set

14.3.8 Configurable input

There is an input with a configurable function in the Signalling module. The figure shows two cases, A and B, in which the input's status is active; in case A the input does not stay valid beyond the enabling delay so the associated action does not take place, whereas in case B the action takes place after the preset delay.
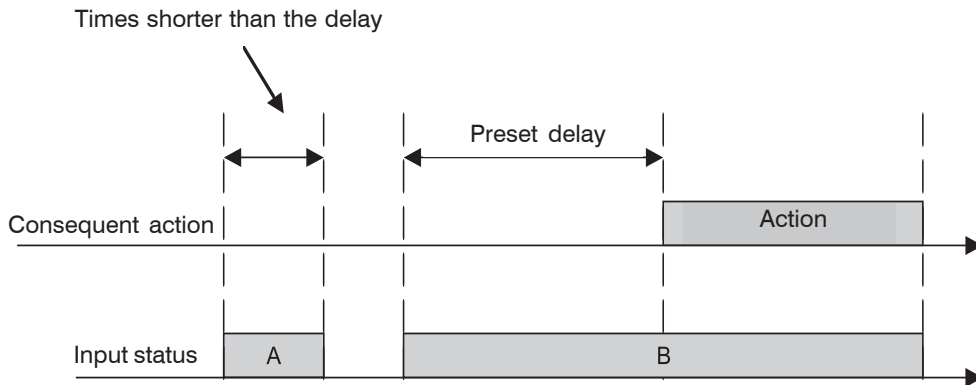
14.3.8.1 Input configuration settings

You can select the level at which to consider the input enabled:
1. low input enabling level
2. high input enabling level

14.3.8.2 Input function settings (ACTION)

You can select the action associated with the input, i.e. the action that takes place after the programmed delay, when the input is enabled (on high or low level).
You can select one of the following actions:
1. Generic: no specific action is associated with the input. The status of the input is shown on the available display and remotely via the bus
2. Trip test: when the input is enabled for the specified delay, a trip test is performed
3. Trip reset: when the input is enabled for the specified delay a trip reset is performed
4. Set B: when the input is enabled for the specified delay, the Set B is enabled
5. Dial Local: when the input is enabled for the specified delay, there is a forcing of the dialogue local mode
6. Signalling module reset: when the input is enabled for the specified delay, the status of the relays in the PR120/K module is reset
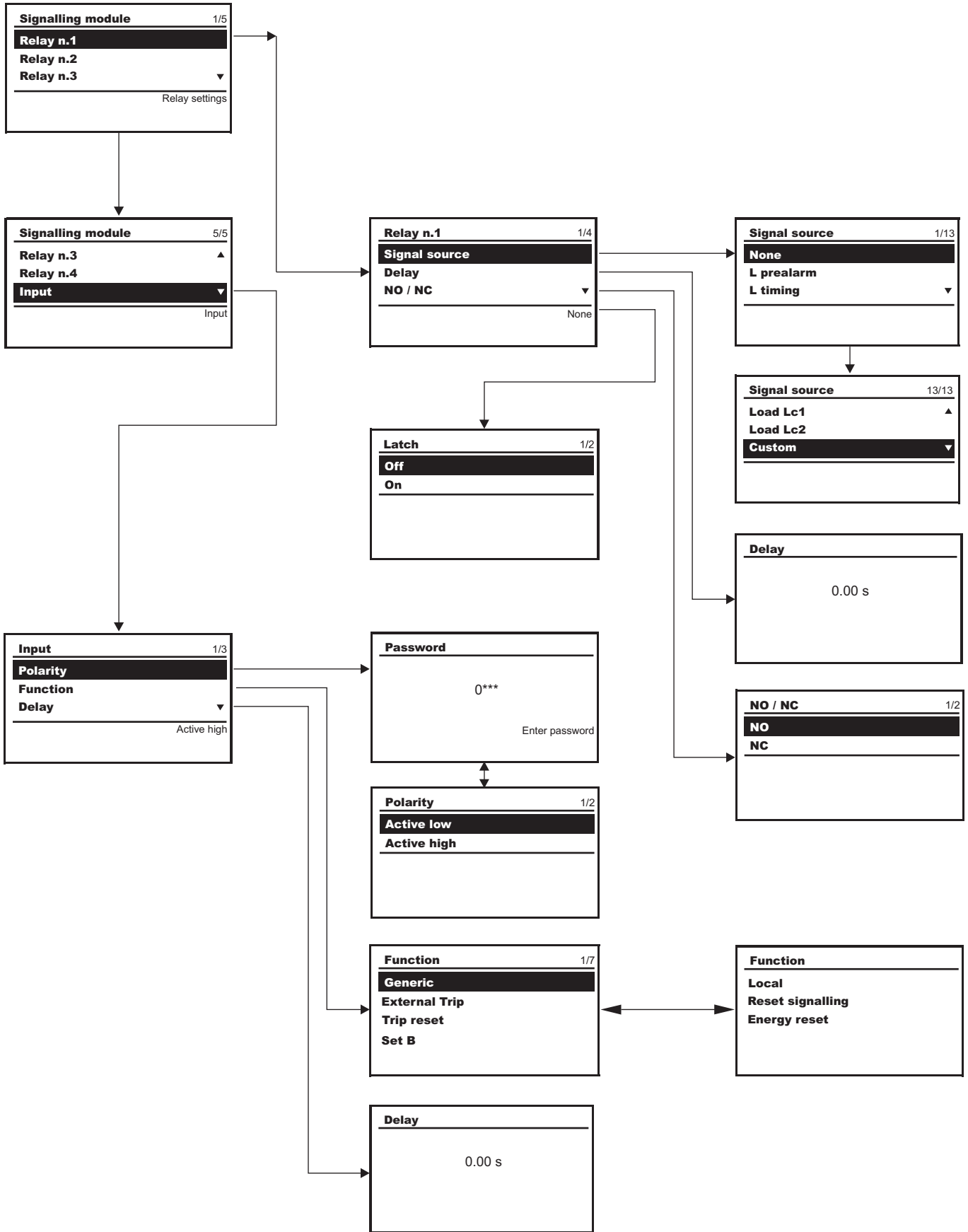7. Energy reset: when the input is active for the specified delay, the energy meters are reset.

14.3.8.3 Setting the input enabling delay

By means of the "Delay" parameter, you can specify the time elapsing before the input is enabled in the range 0.00 [s] to 100.00 [s] with 0.01[s] steps.

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14.3.9   PR120/K module menu layout

The menu layout relating to relay no. 1 (K51/p1) is shown below as an example; the same applies to the menus for the other relays.

Signalling module	1/5
Relay n.1	
Relay n.2	
Relay n.3	▼
	Relay settings

Signalling module	5/5
Relay n.3	▲
Relay n.4	
Input	▼
	Input

Relay n.1	1/4
Signal source	
Delay	
NO / NC	▼
	None

Signal source	1/13
None	
L prealarm	
L timing	▼

Signal source	13/13
Load Lc1	▲
Load Lc2	
Custom	▼

Latch	1/2
Off	
On	

Delay
0.00 s

NO / NC	1/2
NO	
NC	

Input	1/3
Polarity	
Function	
Delay	▼
	Active high

Password
0***
Enter password

Polarity	1/2
Active low	
Active high	

Function	1/7
Generic	
External Trip	
Trip reset	
Set B	

Function
Local
Reset signalling
Energy reset

Delay
0.00 s

Model	L3447			Apparatus	**Emax DC**	Scale
				Doc. No.	**1SDH000635R0002**	Page No. **83**/108

14.4 PR120/DC "override" protection module

PR120/DC

14.4.1 General characteristics

This module is always included in the releases PR122/DC and PR123/DC and it serves as an override protection when the release is not powered. The value of the threshold depends on the circuit breaker, as shown in the table below:

CB	Threshold (kA)
E2	25
E3	85
E4	100
E6	100

N.B. : There is no need for the customer to make any connections or adjustments.

15 Appendices

15.1 PR021/K outside signalling unit

15.1.1 General information
The signalling unit converts the digital signals provided by the protection units into electrical signals by means of normally-open electric contacts. Information on the status of the protection functions transits on a dedicated serial line connected to the release.
The following signals/contacts are available:
- L overload prealarm (the alarm signal remains enabled throughout the overload, until the release has been tripped)
- protections timing and trip (the protections trip signal remains enabled during the timing-controlled phase and after the release has been tripped)
- I protection trip
- timing and overheating threshold overrun
- two contacts for load control
- release trip
- communication error on serial line (connections between protection and signalling units)
- phase unbalance.

By setting the DIP switches, you can configure the signals of 7 programmable contacts, This can be done by selecting them directly in the PR122/DC or PR123/DC relay via PR010/T, SD-Testbus 2 or SD-Pocket, choosing from a long list.

Two contacts available on the SACE PR021/K (load control) unit enable you to control a release for opening and closing the circuit-breaker. These contacts enable various applications, including load control, alarms, signals, electric cutouts.
A Reset button enables you to zero the status of all the front optical signals and return the relays' contacts to the resting position.
The unit also contains ten LEDs to display the following information:
- Power ON: auxiliary power supply on
- Tx(int Bus): flashing synchronized with dialogue with the Internal Bus
- Eight LEDs associated with the signaling contacts.

15.1.2 Power supply

Auxiliary power supply	24 V DC +/-20%
Maximum ripple	5%
Rated power @ 24 V	4.4 W

15.1.3 General characteristics of the signalling relays

The following data are defined for resistive loads

Type of contact	SPST	
Maximum switching voltage	130 VDC	380 VAC
Maximum switching current	5 A	8 A
Maximum switching power	175 W	2000 VA
Breaking capacity @ 35 VDC	5 A	----
Breaking capacity @ 120 VDC	0.2 A	----
Breaking capacity @ 250 VAC	----	8 A
Breaking capacity @ 380 VAC	----	5.2 A
Contact/coil insulation		4000 Veff
Contact/contact insulation		1000 Veff

15.1.4 Relay functions
The available contacts can be used to manage the respective relays indicating an event (a given situation in the state of the device) that prompts the required relays to be independently enabled after the delay specified by the user. The function is entirely similar to the one described in the PR120/K signalling module in par. 14.3 and 15.3 of this manual.

15.1.5 PR021/K signalling unit menu
The unit's functions are accessible from the operator panel (PR123/DC and PR122/DC where applicable)
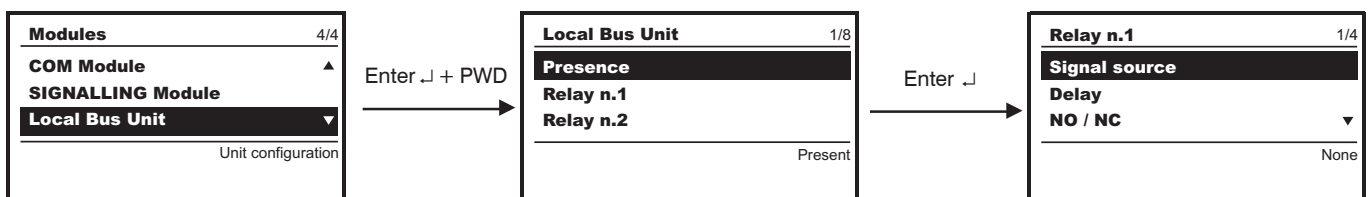
Model	L3447			Apparatus	**Emax DC**		Scale
				Doc. No.	**1SDH000635R0002**		Page No. 85/108

15.1.5.1 PR021/K unit menu table

Protection	Parameter / Function	Values	Notes
PR021K unit		Present Absent	Leave as Absent if there is no PR021/K
	Relay no. 1 / 2 / 3 / 4 / 6 / 7 / 8 Signal source function	None L Prealarm L Timing S Timing L Trip S Trip G Trip I Trip Any trip Custom	 - See par. 15.3

	Delay
	NO/NC
	Latch
		0...100 s step 0.01 s
		NO/NC
		ON/OFF
			- Deliberate delay before activating the contact
			- Contact normally-open (NO) or normally-closed (NC)
			- With the contact "ON", once it has been activated it
			  stays switched.
			  A specific reset action is needed to reset it

15.1.5.2 Important note

The unit must be connected to the PR122/DC or PR123/DC by means of an internal busbar with a shielded, corded two-wire cable (see note A, par. 11.2.2) no more than 15 m long.
The shield must be earthed both on the circuit-breaker side and on the PR021/K side. For the installation and operation of the PR021/K accessory, refer to the specific user manual.

Model	L3447			Apparatus	**Emax DC**	Scale
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15.2 Data logger (recorder)

The data logger function is available on the PR122/DC and PR123/DC units and it can be used to save the instantaneous values of certain analog and digital measurements automatically in a large-sized memory buffer. The data can easily be downloaded from the unit using either the SD-Pocket application with a Bluetooth port, or the SD-TestBus application via a Modbus bus, and transferred to any personal computer for processing. The function stops the recording every time a trip occurs in order to facilitate failure analysis.

15.2.1 General characteristics

Number of analogue channels: 7
Number of digital events: 64
Maximum sampling frequency: 4800 Hz
Maximum sampling time: 27s (- sampling frequency 600 Hz)

15.2.2 Description of the Data Logger menu

You can access the data logger menu from the Settings menu in the PR122/DC and PR123/DC units:
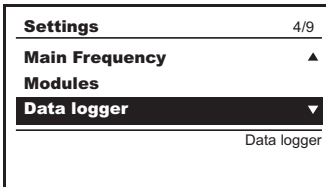
15.2.2.1 Enabling the Data Logger

The data logger can be enabled by inputting a password:
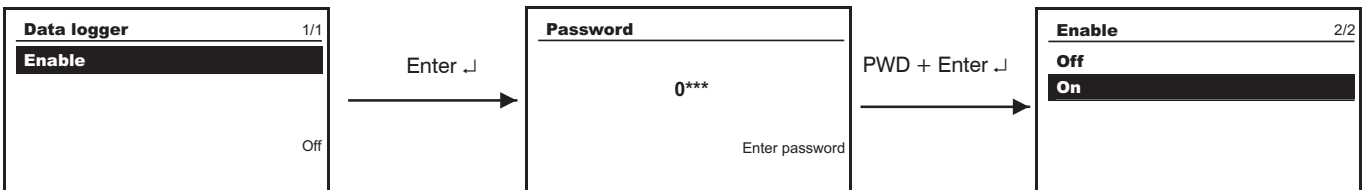
15.2.2.2 Setting the sampling frequency

On the menu, you can specify the frequency with which the measurements are saved, choosing from 4 fixed frequencies, i.e. 600 Hz, 1200 Hz, 2400 Hz or 4800 Hz.
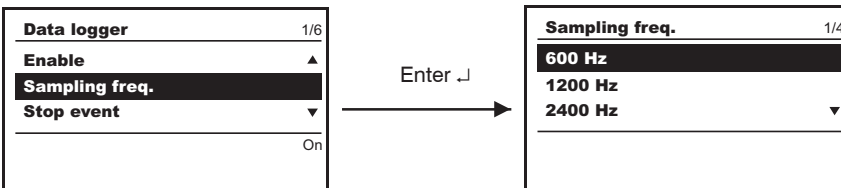
The maximum data recording times (see also par. 15.2.3) depend on the selected frequency and are illustrated in the following table:

Frequency	RECORDING TIME
600 Hz	27.3 s
1200 Hz	13.6 s
2400 Hz	6.8 s
4800 Hz	3.4 s

Note: Selecting sampling frequency is an important step. In fact, presence of high-order harmonic waves may cause aliasing on processing of collected data. Use maximum frequency when a harmonic distortion is available, otherwise data processing may give results which do not match actual system conditions.

15.2.2.3 Setting the standard stop events (triggers)

You can select one of the following stop events (triggers), see also par.15.3.2:

1. **None**
2. **Any alarm**
3. **L timing**
4. **Any trip**
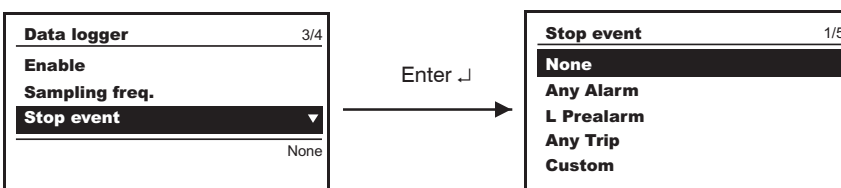
Model	L3447			Apparatus	**Emax DC**	Scale
				Doc. No. **1SDH000635R0002**		Page No. **87/108**

If you select "None" for the stop event, the data logger can be stopped only by a stop command from the operator panel, from the system or following a trip generated by the relay.

15.2.2.4 Setting and viewing customized stop events (triggers)

From the system, you can set customized stop events (triggers) to coincide with the events shown in paragraph 15.3.
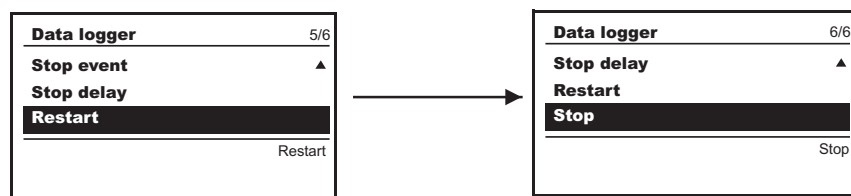In the event of a customized trigger point, the following window is displayed:

```
Stop event            5/5
L Prealarm             ▲
Any Trip
Custom
```
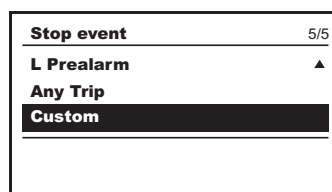
15.2.2.5 Setting the stopping delay

The stopping delay can be set between 0.00 [s] and 10.00 [s], in 0.01 [s] steps.

```
Data logger           4/6
Sampling freq.         ▲
Stop event
Stop delay
                  0.00 s
```
Enter ↵ →
```
Stop delay

        0.00 s
```
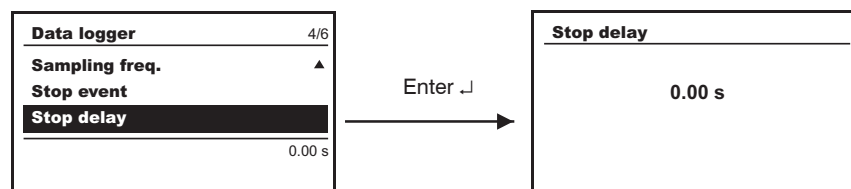
⚠ In the event of a trip, this data storage process is stopped after 10 ms, even if a longer stopping delay has been selected.

15.2.2.6 Restart/Stop Data Logger

Using the Restart/Stop options, you can restart or stop the recording by the data logger:

```
Data logger           5/6
Stop event             ▲
Stop delay
Restart
                 Restart
```
→
```
Data logger           6/6
Stop delay             ▲
Restart
Stop
                    Stop
```

15.2.3 Recording time windows

The data logger's measurements are recorded in a time window, the duration of which is defined and synchronized by an event (trigger/stop event) of your choice.
The following figure displays the time window, the trigger and the samples available in gray:
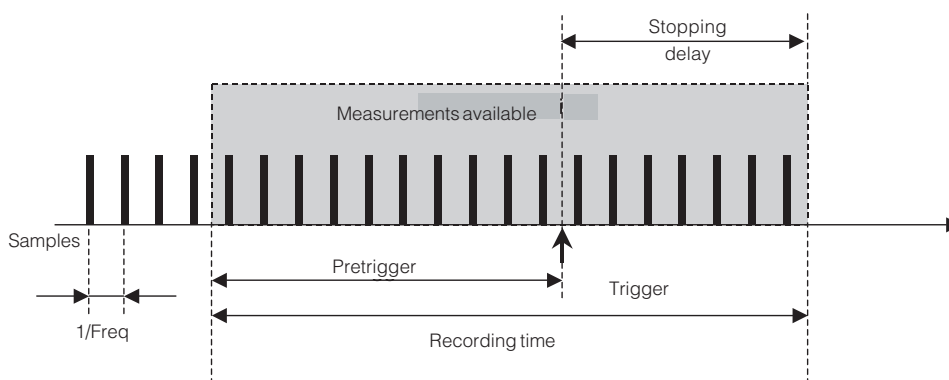
The user can select the sampling frequency (see par. 15.2.2.2), the type of stop event (trigger) (see par. 15.2.2.3) and the stopping delay (see par. 15.2.2.4) so as to obtain the required pre-trigger with respect to the selected event.
Depending on the selection you make, the stopping delay may be nil, or it may be lower or higher than the recording time, as illustrated in the following figure:
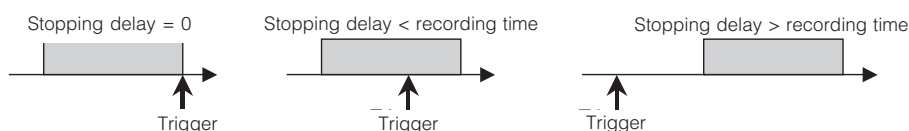
Model	L3447			Apparatus	Emax DC	Scale
				Doc. No.	1SDH000635R0002	Page No. 88/108

Maximum recording time is established by the sampling frequency set only, as described in the table in paragraph 15.2.2.2; recording time may be lower than maximum time attainable when the sum of stopping delay and time elapsing between a restart trigger and a trigger is lower than the maximum value, as described in the figure below:
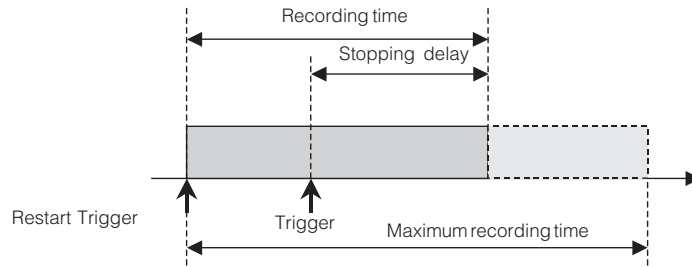
! If the parameters relating to the data logger are changed while it is operating, the recording underway is terminated and a new recording begins (after a restart trigger command) on the basis of the new parameters.

15.2.4 Description of the information given by the Data Logger system

15.2.4.1 Combination of devices for reading/setting data from the Data Logger system

By connecting to the release's outside bus, you can set certain data logger parameters, triggers or commands, or read certain types and sequences of data in its memory.

The combinations of devices and the consequent software combinations that enables these functions are as follows:

1) **PR122/DC + BT030+SD-Pocket**
2) **PR122/DC + PR120/D-M + SD-Testbus or remote system**
3) **PR123/DC + BT030+SD-Pocket**
4) **PR123/DC + PR120/D-M + SD-Testbus or remote system**
5) **PR122/DC + PR010/T ***
6) **PR123/DC + PR010/T ***

* With these combinations it is impossible to download sequences of stored data

In this manual, the term "from the system" is used to define both the operations that are carried out using one of the combinations with SD-Pocket or SD-Testbus, and the operations that involve connecting to a remote system.

15.2.4.2 Access to saved data from the system

When the event associated with the stop event occurs or a stop command is received, the following data are saved in the recording block:

- Data logger Trigger, which indicates the type of stop event (trigger) that has prompted the stoppage of the data logger;
- Time-stamp of the stop event (trigger) (day/hour + minutes/seconds/milliseconds) (4 words);
- Data logger max file, which indicates which is the max file with consistent data;
- Data logger max address, which indicates the max address number of a block with consistent data.

The following information is recorded in the block for each sampling period:

1. **current sample IA**
2. **current sample IA$_2$ (available only with E4/E6)**
3. **current sample IB (available only with PR123/DC)**
4. **current sample IB$_2$ (available only with PR123/DC and E4/E6)**
5. **unavailable**
6. **unavailable**
7. **unavailable**
8. **voltage sample U**
9. **digital inputs/outputs (among 16 possible options, e.g. inputs/outputs for Zone Selectivity, PR120/K contact status, ...)**
10. **alarms1 (among 16 possible options, e.g. L timing, G alarm, Prealarm)**
11. **alarms2 (among 16 possible options, e.g. OV timing, RP timing)**
12. **trips (among 16 possible options, e.g. tripping of L, S, I, G, UV ...)**

15.2.4.3 Information from the system on the configuration and status of the Data Logger

The following information is provided on the status of the data logger:

STATUS	
Waiting trigger:	this means that the data logger is enabled and waiting for the occurrence of the event selected as the trigger
Data Logger triggered:	this indicates that the trigger event has occurred and the data logger is still recording
Data Logger stopped:	this means that the recording has been terminated either because it has been completed or because a data logger stop command has been received, or because a trip has occurred

CONFIGURATION	
Data Logger Config:	indicates whether or not the data logger is active
Data Logger Trigger Type:	indicates the stop event (trigger) setting
Data logger stopping delay:	indicates the delay for the stop

15.2.5 Data logger commands from the system

When a data logger stop command is given, the recording is stopped from the system. The subsequent recording is enabled by a Restart trigger command. The same applies to the operator panel, as illustrated in par. 15.2.2.6.

Example of data logger operation

The following figure shows an example of how a trigger works, the data logger's function, the effect of the stopping delay and of the restart and subsequent stop commands on the data saving procedure.
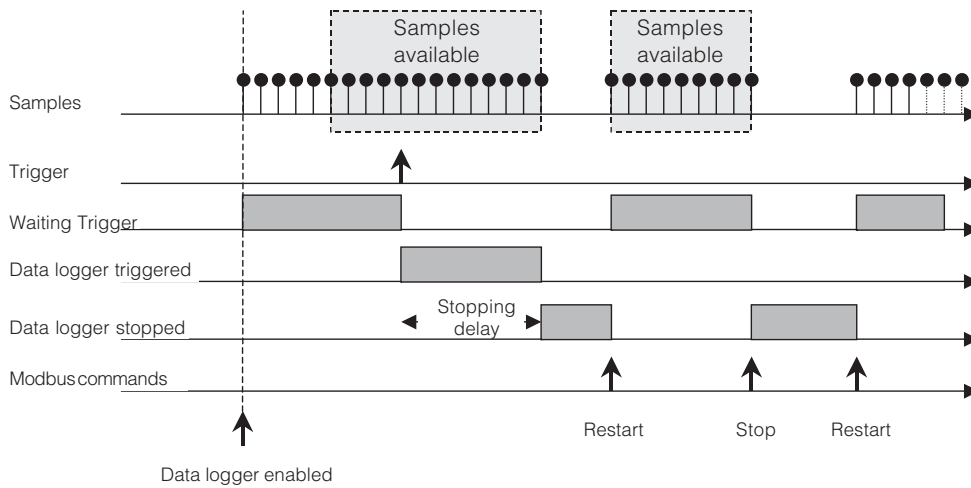
Model	L3447			Apparatus	**Emax DC**	Scale
				Doc.No.	**1SDH000635R0002**	Page No. **90/108**

15.3 Table showing list of events

15.3.1 "Standard" events for PR120/K and for PR021/K selectable from the relay

Event no.	Description	
0.	None	(none enabled)
1.	L prealarm	(L protection prealarm)
2.	L timing	(L protection timing)
3.	S timing	(S protection timing)
4.	L trip	(L protection trip)
5.	S trip	(S protection trip)
6.	I trip	(I protection trip)
7.	G trip	(G protection trip)
8.	Any trip	(tripping of any protection)
9.	Any alarm	(timing of any protection)
10.	Load LC1	(load control LC1 alarm)
11.	Laod LC2	(load control LC2 alarm)

15.3.2 Examples of "Custom" events for the Data Logger function, for PR120/K and PR021/K

No. (decimal)	Event	Notes	PR122	PR123
1920	G timing		x	x
2910	IA, IA2, IB, IB2, sensor error or Trip Coil error		x	x
2688	LC1 alarm		x	x
2049	G alarm		x	x
2306	UV timing		x	x
4124	UV or OV tripped		x	x
33672	CB connected and springs charged		x	x

You can combine the status bits with "and" / "or" logical functions within the same group of events (byte). For more detailed information, refer to the Modbus Interface document.

15.3.3 "Standard" events for the Data Logger function, selectable from the relay

Event no.	Description	
0.	None	(free running)
1.	Any alarm	(any alarm)
2.	L timing	(L protection timing)
3.	Any trip	(tripping of any protection)

15.3.4 Combining the devices needed to customize settings

The "custom" events can be selected using a remote control system, SD-Pocket, or SD-TestBus.
The devices you need to enable you to do so can be selected from among the following:

1) PR122/DC + BT030 + SD-Pocket

2) PR122/DC + PR120/D-M + SD-Testbus or remote system

3) PR122/DC + PR010/T

4) PR123/DC + BT030 + SD-Pocket

5) PR123/DC + PR120/D-M + SD-Testbus or remote system

6) PR123/DC + PR010/T

16. Overall dimensions

Fixed circuit-breaker

Basic version with rear terminals
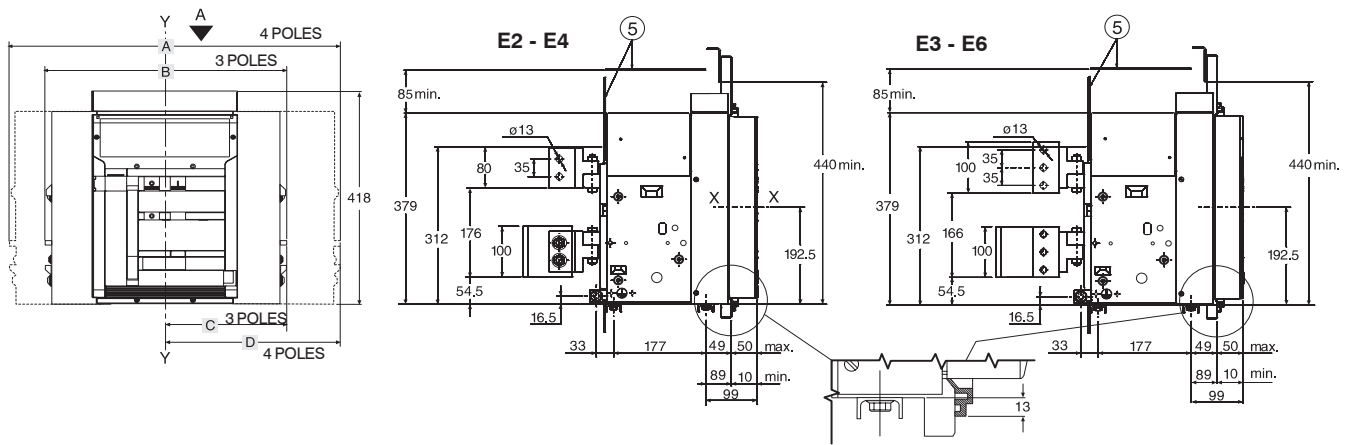
Legend

1. Inside edge of compartment door

2. Segregation (where foreseen)

3. Circuit-breaker M10 fixing drilling (use M10 screws)

4. N° 1 M12 screw (E2, E3) or n° 2 M12 screws (E4, E6) for earthing (included in the supply)

5. Insulating or metal-insulated wall

E2 III View A

E2 IV View A
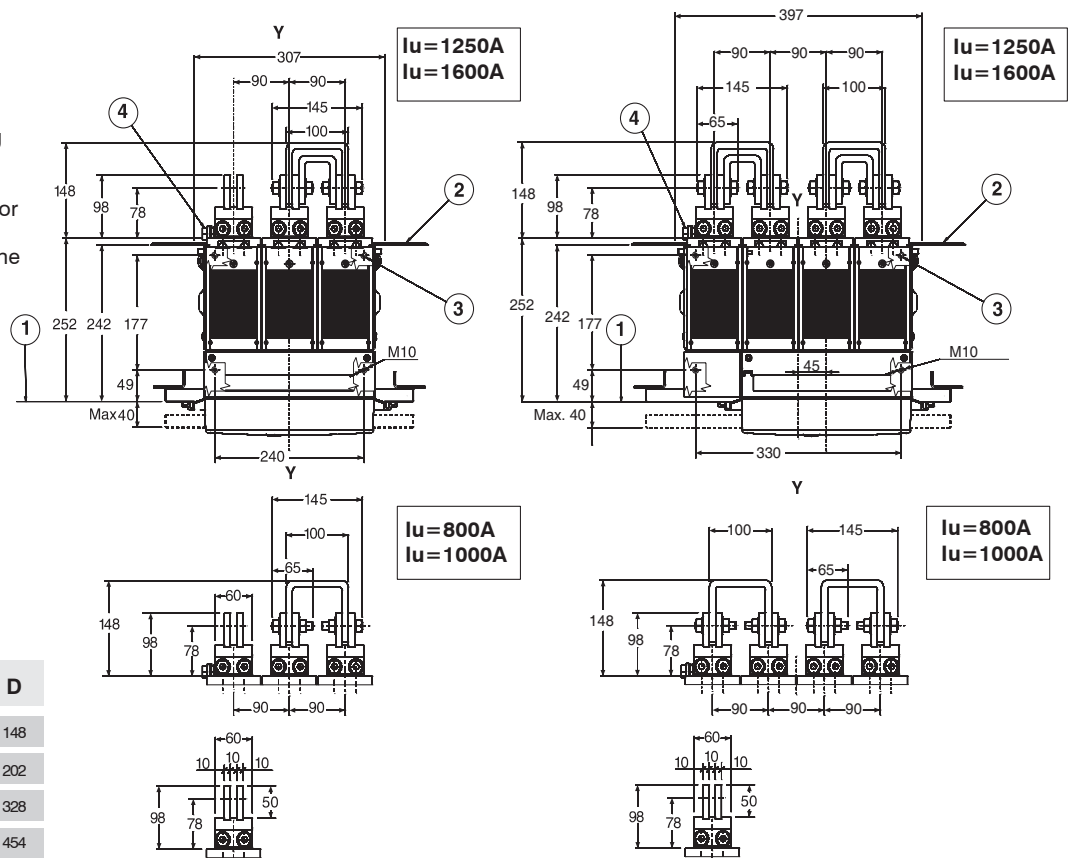
	A	B	C	D
E2	386	296	148	148
E3	530	404	202	202
E4	746	566	238	328
E6	1034	782	328	454

Tightening torque of the main terminals: Nm 70
Tightening torque of the earthing screw: Nm 70

Fig. 35

Mod.	L3447			Apparecchio	**Emax DC**	Scala
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Fixed circuit-breaker
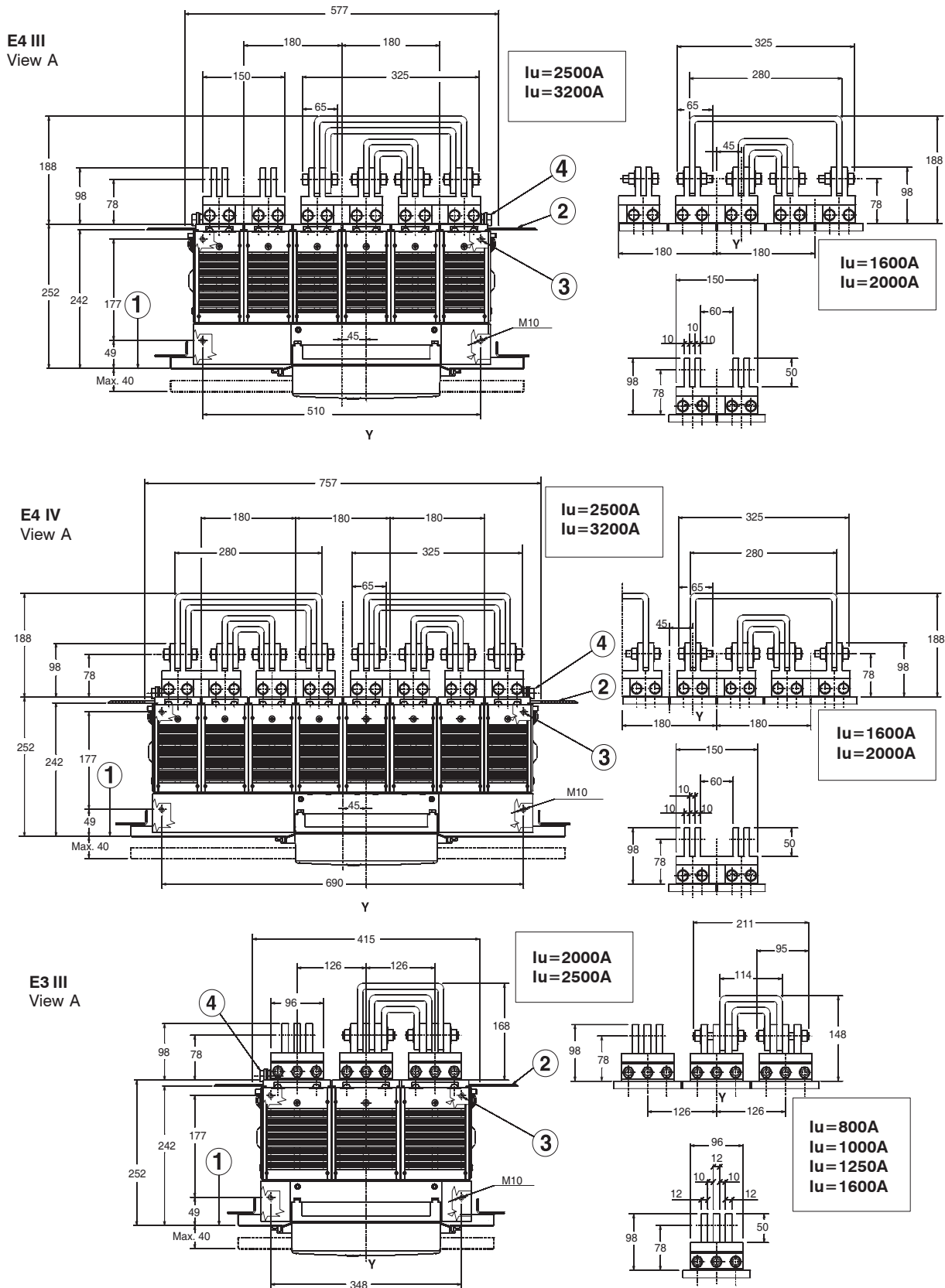
Basic version with rear terminals

E4 III
View A

Iu=2500A
Iu=3200A

Iu=1600A
Iu=2000A

E4 IV
View A

Iu=2500A
Iu=3200A

Iu=1600A
Iu=2000A

E3 III
View A

Iu=2000A
Iu=2500A

Iu=800A
Iu=1000A
Iu=1250A
Iu=1600A

Tightening torque of the main terminals: Nm 70
Tightening torque of the earthing screw: Nm 70

Fig. 36

Mod.	L3447			Apparecchio	**Emax DC**	Scala
				N° Doc.	**1SDH000635R0002**	N° Pag. **93/108**

Fixed circuit-breaker
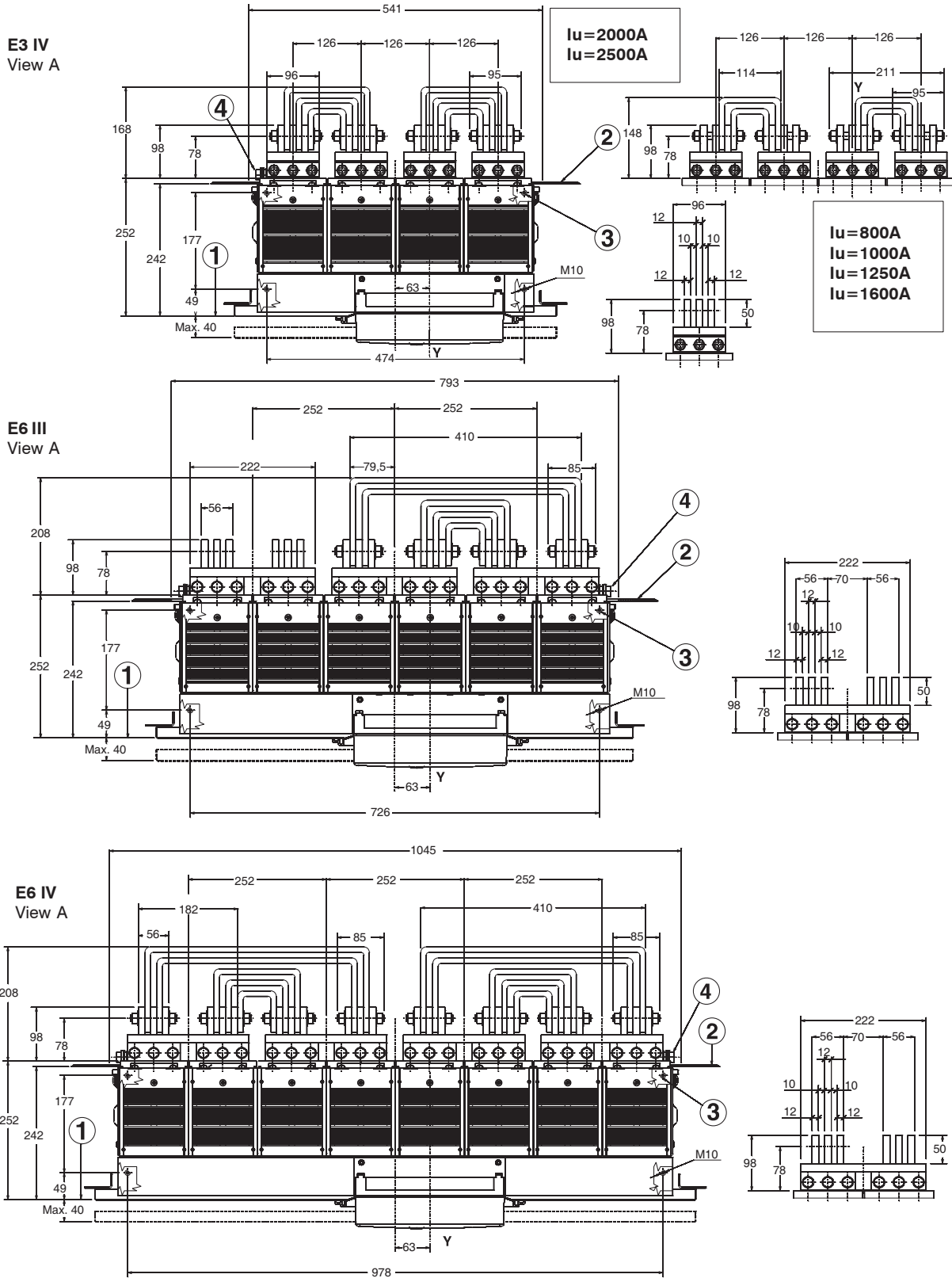
Basic version with rear terminals

E3 IV
View A

Iu=2000A
Iu=2500A

Iu=800A
Iu=1000A
Iu=1250A
Iu=1600A

E6 III
View A

E6 IV
View A

Tightening torque of the main terminals: Nm 70
Tightening torque of the earthing screw: Nm 70

Fig. 37

Mod.	L3447			Apparecchio	**Emax DC**	Scala
				N° Doc.	**1SDH000635R0002**	N° Pag. **94/108**

Compartment dimensions

	A	B
E2	400	490
E3	500	630
E4	700	880
E6	1000	1260

oles for passing through flexible cables for mechanical interlocks

Compartment door drilling

Fig. 38

Mod.	L3447			Apparecchio	**Emax DC**	Scala
				N° Doc.	**1SDH000635R0002**	N° Pag. **95/108**

Withdrawable circuit-breaker

Basic version with rear terminals

E2-E4

E3-E6
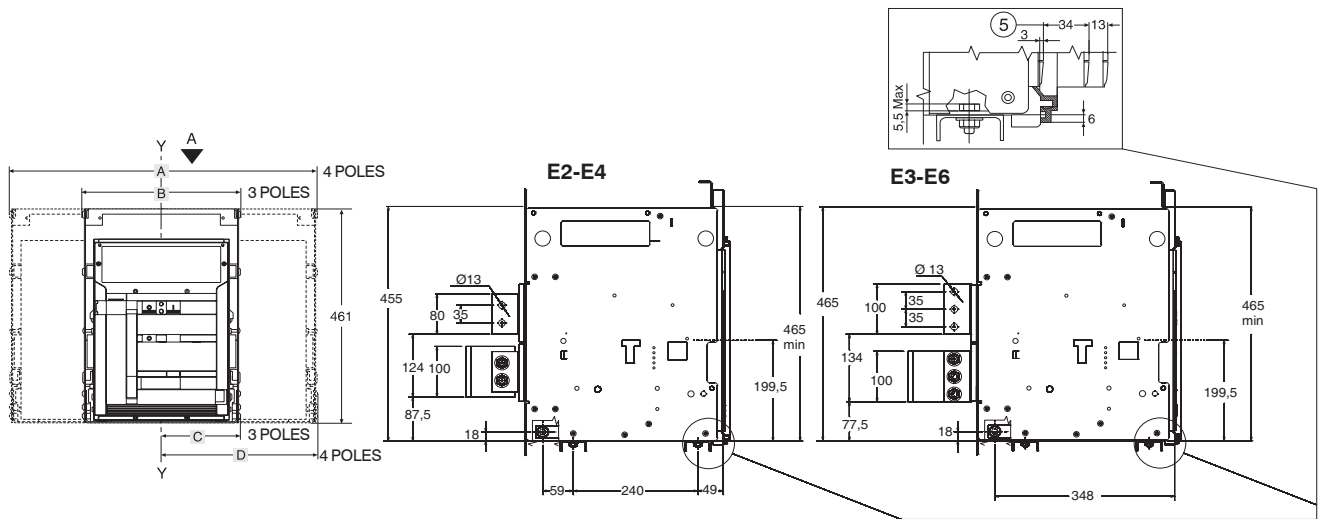
Legend

1. Inside edge of compartment door
2. Segregation (where foreseen)
3. Fixing fixed part Ø 10 drilling (use M8 screws)
4. N° 1 M12 screw (E2, E3) or n° 2 M12 screws (E4, E6) for earthing (included in the supply)
5. Run from connected for a TEST to isolated
6. Alternative drilling with 25mm pitch for fixing fixed part
7. Ventilation drilling on the switchgear

E2 III
View A
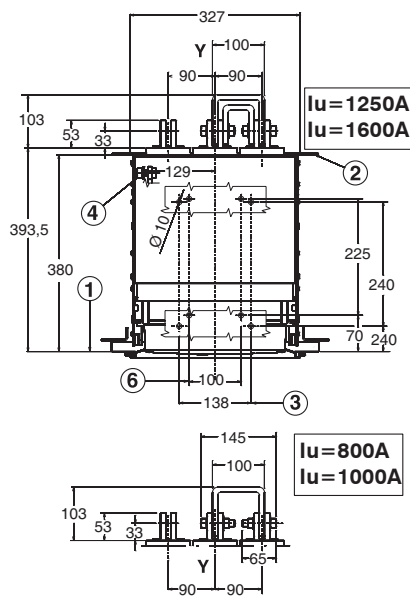
E2 IV
View A
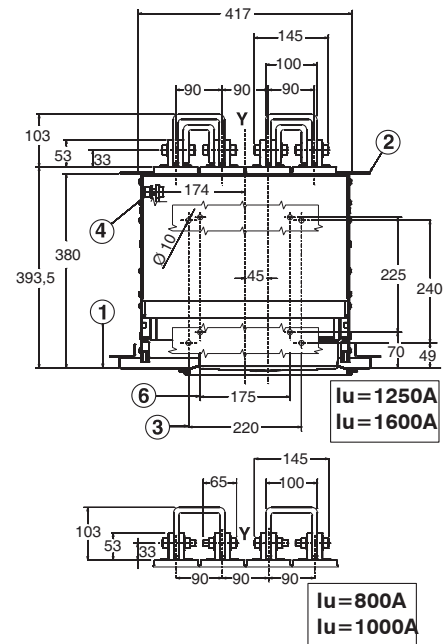
	A	B	C	D
E2	414	324	162	162
E3	558	432	216	216
E4	774	594	252	342
E6	1062	810	342	468

Tightening torque of the fixing screws: 20 Nm
Tightening torque of the main terminals: 70 Nm
Tightening torque of the earthing screw: 70 Nm

Fig. 39

Withdrawable circuit-breaker

Basic version with rear terminals

Tightening torque of the fixing screws: 20 Nm
Tightening torque of the main terminals: 70 Nm
Tightening torque of the earthing screw: 70 Nm

E4 III
View A

Iu=2500A
Iu=3200A

Iu=1600A
Iu=2000A

E4 IV
View A

Iu=2500A
Iu=3200A

Iu=1600A
Iu=2000A

E3 III
View A

Iu=2000A
Iu=2500A

Iu=800A
Iu=1000A
Iu=1250A
Iu=1600A

Fig. 40

Mod.	L3447			Apparecchio	**Emax DC**	Scala
				N° Doc.	**1SDH000635R0002**	N° Pag. **97/108**

Withdrawable circuit-breaker

Basic version with rear terminals

Tightening torque of the fixing screws: 20 Nm
Tightening torque of the main terminals: 70 Nm
Tightening torque of the earthing screw: 70 Nm

E3IV
View A

Iu=2000A
Iu=2500A

Iu=800A
Iu=1000A
Iu=1250A
Iu=1600A

E6 III
View A

E6 IV
View A
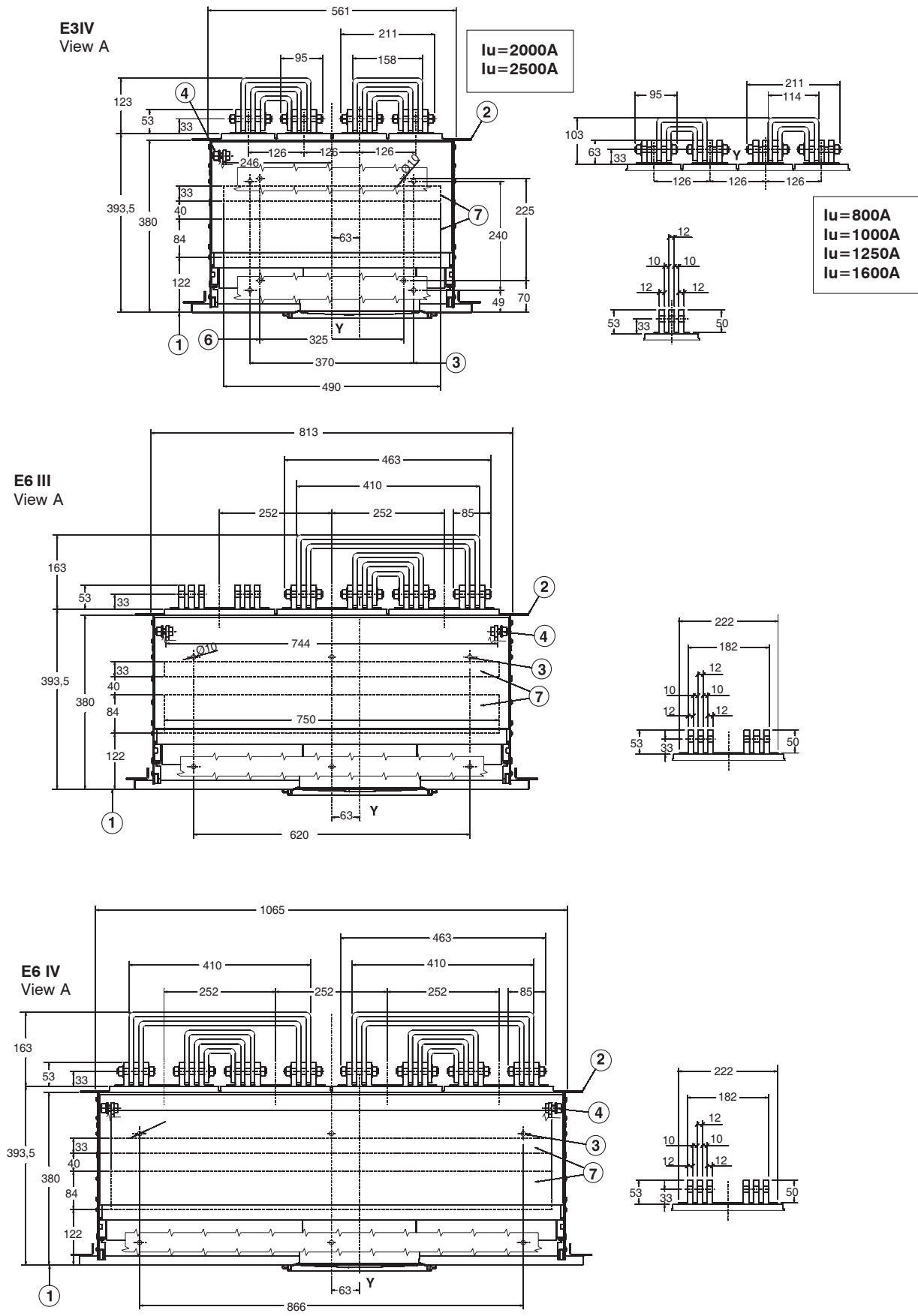
Fig. 41

Mod.	L3447			Apparecchio	**Emax DC**	Scala
				N° Doc.	**1SDH000635R0002**	N° Pag. **98/108**

Compartment dimensions
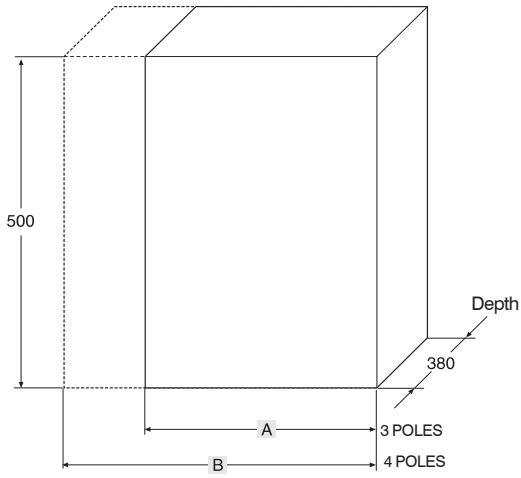
	A	B
E2	400	490
E3	500	630
E4	700	880
E6	1000	1260

Holes for passing through flexible cables for mechanical interlocks
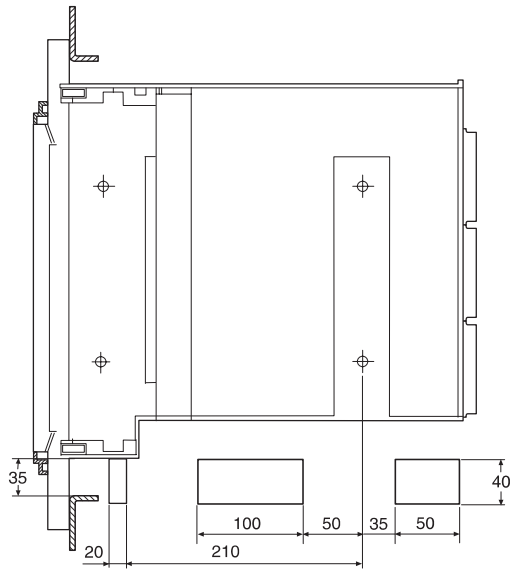
Compartment door drilling
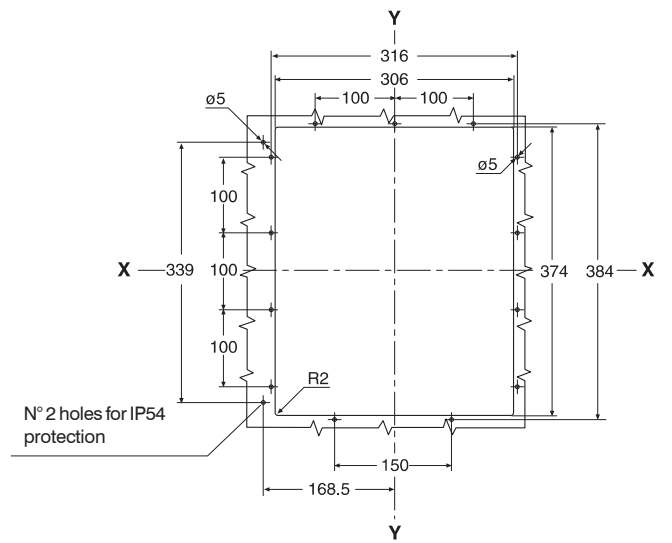
Fig. 42

Mod.	L3447			Apparecchio	**Emax DC**	Scala
				N° Doc.	**1SDH000635R0002**	N° Pag. **99/108**

Compartment door mechanical lock

Door drilling

Minimum distance between the circuit-breaker and the switchgear wall

Fixed version

Withdrawable version

31,5

20

ø6

A

73.5

35
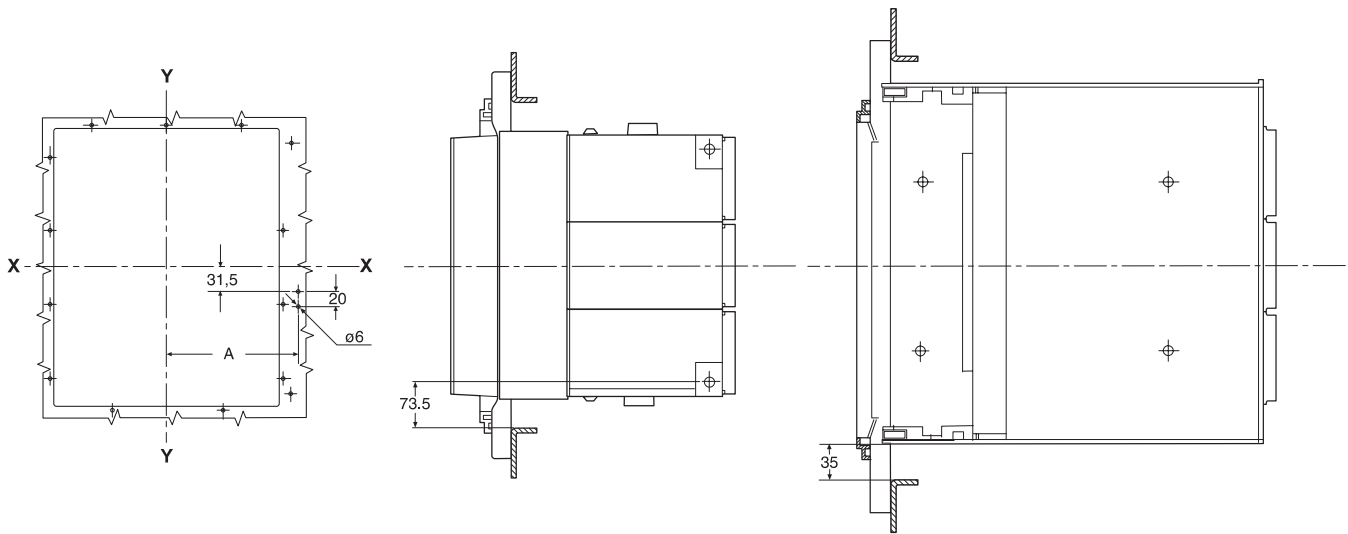
	A	
	3POLES	**4POLES**
E2	180	180
E3	234	234
E4	270	360
E6	360	486

Fig. 43

Mod.	L3447			Apparecchio	**Emax DC**	Scala
				N° Doc.	**1SDH000635R0002**	N° Pag. **100/108**

17. Circuit diagrams

Warning
Before installing the circuit-breaker, carefully read note F on the circuit diagrams.

Operating status shown
The circuit diagram is for the following conditions:
- withdrawable circuit-breaker, open and racked-in
- circuits de-energised
- releases not tripped
- motor operating mechanism with springs unloaded.

Versions
The diagram shows a circuit-breaker in withdrawable version; it can be applied to a fixed version circuit-breaker as well.

Fixed version
The control circuits are fitted between terminals XV (connector X is not supplied).
With this version, the applications indicated in figures 31 and 32 cannot be provided.

Withdrawable version
The control circuits are fitted between the poles of connector X (terminal box XV is not supplied).

Version with PR122/DC electronic release

Version with PR123/DC electronic release

Caption

□	= Circuit diagram figure number
*	= See note indicated by the letter
A1	= Circuit-breaker accessories
A3	= Accessories applied to the fixed part of the circuit-breaker (for withdrawable version only)
A4	= Example switchgear and connections for control and signalling, outside the circuit-breaker
A13	= PR021/K signalling unit (outside the circuit-breaker)
D	= Electronic time-delay device of the undervoltage release, outside the circuit-breaker
F1	= Delayed-trip fuse
K51	= PR122/DC, PR123/DC electronic release with the following protection functions:
	- L overload protection with inverse long time-delay trip-setting I1
	- S short-circuit protection with inverse or definite short time-delay trip-setting l2
	- I short-circuit protection with instantaneous time-delay trip-setting l3
	- G earth fault protection with inverse short time-delay trip-setting l4 (only PR123/DC)
K51/1...8	= Contacts for the PR021/K signalling unit
K51/GZin(DBin)	= Zone selectivity: for protection G (only with Vaux and PR123/DC release)
K51/GZout(DBout)	= Zone selectivity: for protection G (only with Vaux and PR123/DC release)
K51/IN1	= Digital programmable input (available only with Vaux and release PR122/DC or PR123/DC with indicator module PR120/K)
K51/P1...P4	= Programmable electrical signalling (available only with Vaux and release PR122/DC or PR123/DC with indicator module PR120/K)
K51/SZin(Dfin)	= Zone selectivity: input for protection S (only with Vaux and PR122/DC or PR123/DC release)
K51/SZout(DFout)	= Zone selectivity: output for protection S (only with Vaux and PR122/DC or PR123/DC release)
K51/YC	= Closing control from PR122/DC or PR123/DC electronic release with communication module PR120/D-M
K51/YO	= Opening control from PR122/DC or PR123/DC electronic release with communication module PR120/D-M
M	= Motor for loading the closing springs
Q	= Circuit-breaker
Q/1...27	= Circuit-breaker auxiliary contacts
S33M/1...3	= Limit contacts for spring-loading motor
S43	= Switch for setting remote/local control
S51	= Contact for electrical signalling of circuit-breaker open due to tripping of the overcurrent release. The circuit-breaker may be closed only after pressing the reset pushbutton, or after energizing the coil for electrical reset (if available)
S75E/1.4	= Contacts for electrical signalling of circuit-breaker in disconnected position (only with withdrawable circuit-breakers)
S75I/1..5	= Contacts for electrical signalling of circuit-breaker in connected position (only with withdrawable circuit-breakers)
S75T/1..4	= Contacts for electrical signalling of circuit-breaker in test isolated position (only with withdrawable circuit-breakers)
CS	= Pushbutton or contact for closing the circuit-breaker
SO	= Pushbutton or contact for opening the circuit-breaker
SO1	= Pushbutton or contact for opening the circuit-breaker with delayed trip
SO2	= Pushbutton or contact for opening the circuit-breaker with instantaneous trip
SR	= Pushbutton or contact for electrical circuit-breaker reset
Vaux	= Auxiliary power supply voltage (see note F)
W1	= Serial interface with control system (external bus): EIA RS485 interface (see note E)
W2	= Serial interface with the accessories of PR122/DC and PR123/DC releases (internal bus)
X	= Delivery connector for auxiliary circuits of withdrawable version circuit-breaker
X1...X7	= Connectors for the accessories of the circuit-breaker
XF	= Delivery terminal box for the position contacts of the withdrawable circuit-breaker (located on the fixed part of the circuit-breaker)
XK1	= Connector for power circuits of PR122/DC and PR123/DC releases
XK2 - XK3	= Connectors for auxiliary circuits of PR122/DC and PR123/DC releases
XK4	= Connector to signal open/close
XO	= Connector for YO1 release
XV	= Delivery terminal box for the auxiliary circuits of the fixed circuit-breaker
YC	= Shunt closing release
YO	= Shunt opening release

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YO1   = Overcurrent shunt opening release (trip coil)
YO2   = Second shunt opening release (see note Q)
YR   = Coil to electrically reset the circuit-breaker
YU   = Undervoltage release (see notes B and Q)

Description of figures

Fig. 1   = Motor circuit to load the closing springs.
Fig. 2   = Circuit of shunt closing release.
Fig. 4   = Shunt opening release.
Fig. 6   = Instantaneous undervoltage release (see notes B and Q).
Fig. 7   = Undervoltage release with electronic time-delay device, outside the circuit-breaker (see notes B and Q)
Fig. 8   = Second shunt opening release (see note Q).
Fig. 11   = Contact for electrical signalling of springs loaded.
Fig. 12   = Contact for electrical signalling of undervoltage release energized (see notes B and S).
Fig. 13   = Contact for electrical signalling of circuit-breaker open due to tripping of the overcurrent release. The circuit-breaker may be closed
            only after pressing the reset pushbutton.
Fig. 14   = Contact for electrical signalling of circuit-breaker open due to tripping of the overcurrent release and electrical reset coil. The circuit-
            breaker may be closed only after pressing the reset pushbutton or energizing the coil.
Fig. 21   = First set of circuit-breaker auxiliary contacts.
Fig. 22   = Second set of circuit-breaker auxiliary contacts (see note V)
Fig. 23   = Third set of supplementary auxiliary contacts outside the circuit-breaker.
Fig. 31   = First set of contacts for electrical signalling of circuit-breaker in connected, test isolated, disconnected position.
Fig. 32   = Second set of contacts for electrical signalling of circuit-breaker in connected, test isolated, disconnected position.
Fig. 42   = Auxiliary circuits of PR122/DC and PR123/DC releases (see notes F, M and V).
Fig. 45   = Circuits of the communication module PR120/D-M of the PR122/DC and PR123/DC releases (optional) (see note E).
Fig. 46   = Circuits of the indicator module PR120/K of the PR122/DC and PR123/DC releases - connection 1 (optional) (see note V).
Fig. 47   = Circuits of the indicator module PR120/K of the PR122/DC and PR123/DC releases - connection 2 (optional) (see note V).
Fig. 62   = Circuits of the signalling unit PR021/K (outside the circuit-breaker).

Incompatibilities

The circuits indicated in the following figures cannot be supplied simultaneously on the same circuit-breaker:
6 - 7 - 8
13 - 14
22 - 46 - 47
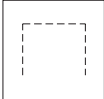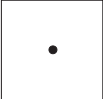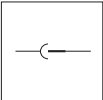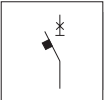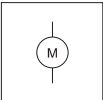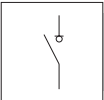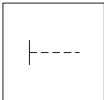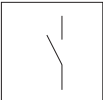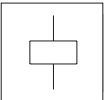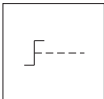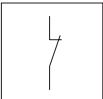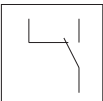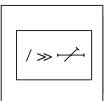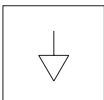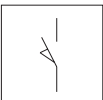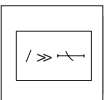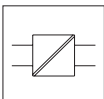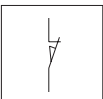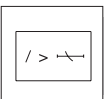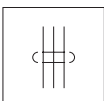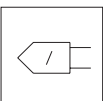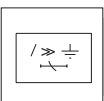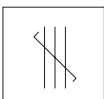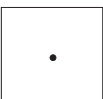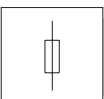
Notes

A) The circuit-breaker is only fitted with the accessories specified in the ABB SACE order acknowledgement. Consult this catalogue for information
    on how to make out an order.
B) The undervoltage release is supplied for operation using a power supply branched on the supply side of the circuit-breaker or from an
    independent source. The circuit-breaker can only close when the release is energized (there is a mechanical lock on closing).
    If the same power supply is used for the closing and undervoltage releases and the circuit-breaker is required to close automatically when
    the auxiliary power supply comes back on, a 30 ms delay must be introduced between the undervoltage release accept signal and the
    energizing of the closing release. This may be achieved using an external circuit comprising a permanent make contact, the contact shown
    in fig. 12 and a time-delay relay.
E) For the EIA RS485 serial interface connection see document RH0298 regarding MODBUS communication.
F) The auxiliary voltage Vaux allows actuation of all operations of the PR122/DC and PR123/DC releases.
    Having requested a Vaux insulated from earth, one must use "galvanically separated converters" in compliance with IEC 60950 (UL 1950)
    or equivalent standards that ensure a common mode current or leakage current (see IEC 478/1, CEI 22/3) not greater than 3.5 mA, IEC 60364-
    41 and CEI 64-8.
N) With releases PR122/DC and PR123/DC, the connections to the zone selectivity inputs and outputs must be made with a two-pole shielded
    and stranded cable (type BELDEN 3105A/3105B), no more than 300m long. The shield must be earthed on the selectivity input side.
P) With releases PR122/DC and PR123/DC with communication module PR120/D-M, the coils YO and YC are controlled directly from contacts
    K51/YO and K51/YC with maximum voltages of 110-120 VDC and 240-250 VAC.
Q) The second shunt opening release may be installed as an alternative to the undervoltage release.
S) Also available in the version with normally-closed contact
U) The measuring module PR120/V is always supplied with relay PR123/DC.
V) If fig. 22 is present (second set of auxiliary contacts) simultaneously as relay PR122/DC (or PR123/DC), the contacts for the zone selectivity
    in fig. 42 (K51/Zin, K51/Zout, K51/Gzin and K51/Gzout) are not wired. In addition, the indicator module PR120/K in figures 46 and 47 cannot
    be supplied.

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Circuit diagram symbols (IEC 60617 and CEI 3-14 ... 3-26 Standards)

|		
Shield (may be drawn in any shape)	Terminal	Change-over position contact with momentary circuit breaking (limit contact)
Time delay	Plug and socket (male and female)	Power isolator with automatic breaking action
Mechanical or electrical connection	Motor (general symbol)	Switch-disconnector
Manual mechanical control (general case)	Make contact	Control coil (general symbol)
Rotating control	Break contact with automatic circuit breaking	Instantaneous overcurrent relay
Pushbutton control	Change-over contact	Overcurrent relay with adjustable short time-delay trip
Equipotentiality	Make position contact (limit contact)	Overcurrent relay with inverse short time-delay trip
Galvanically separated converter	Break position contact (limit contact)	Overcurrent relay with inverse long time-delay trip
Shielded cable conductors (i.e., 3 conductors shown)	Current sensor	Earth fault overcurrent relay with inverse short time delay
Conductors or stranded cables (i.e., 3 conductors shown)	Connection of conductors	Fuse (general symbol)

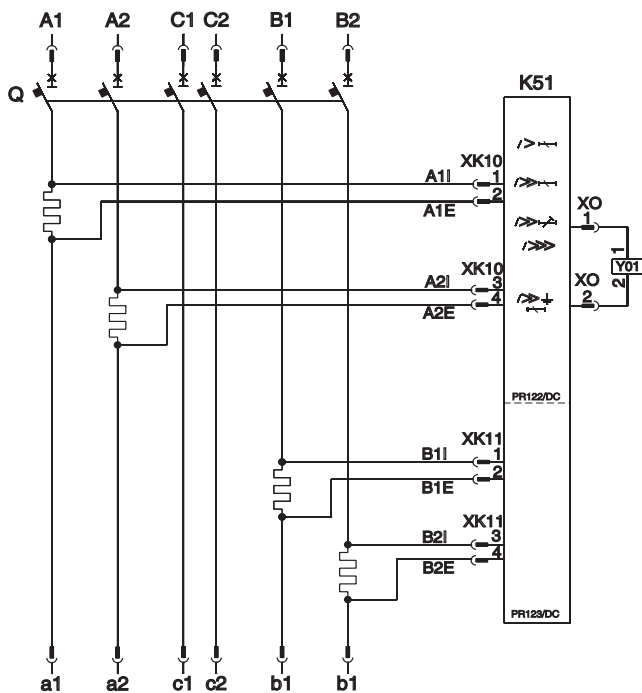| Model	L3447			Apparatus	Emax DC	Scale
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Circuit diagram - Operating status

Three-pole E2-E3 circuit-breaker with PR122/DC or PR123/DC electronic release
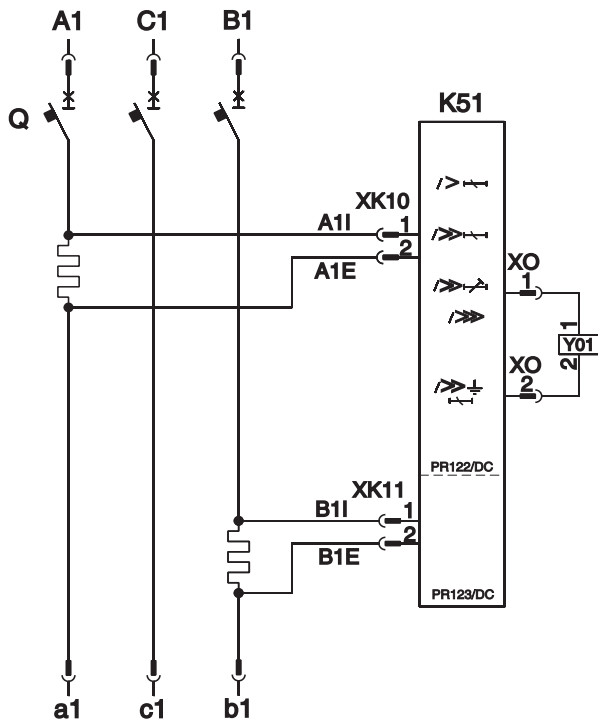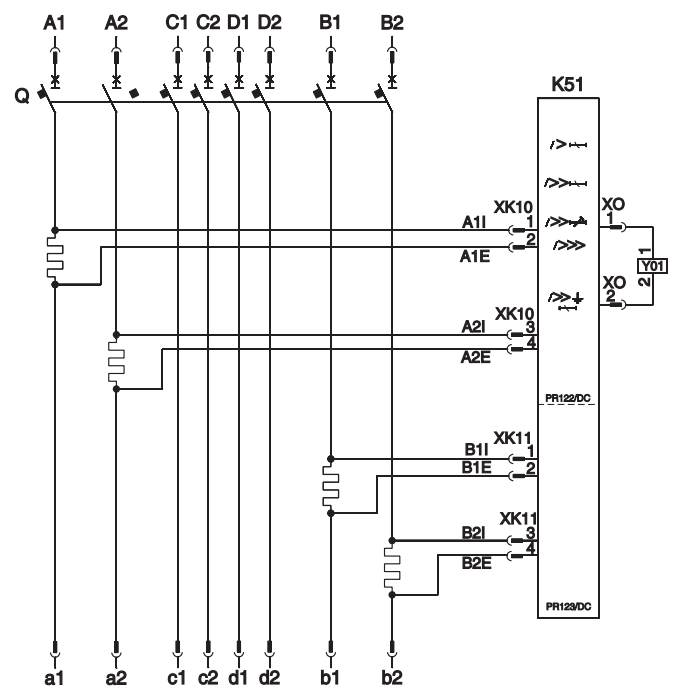
Four-pole E2-E3 circuit-breaker with PR122/DC or PR123/DC electronic release
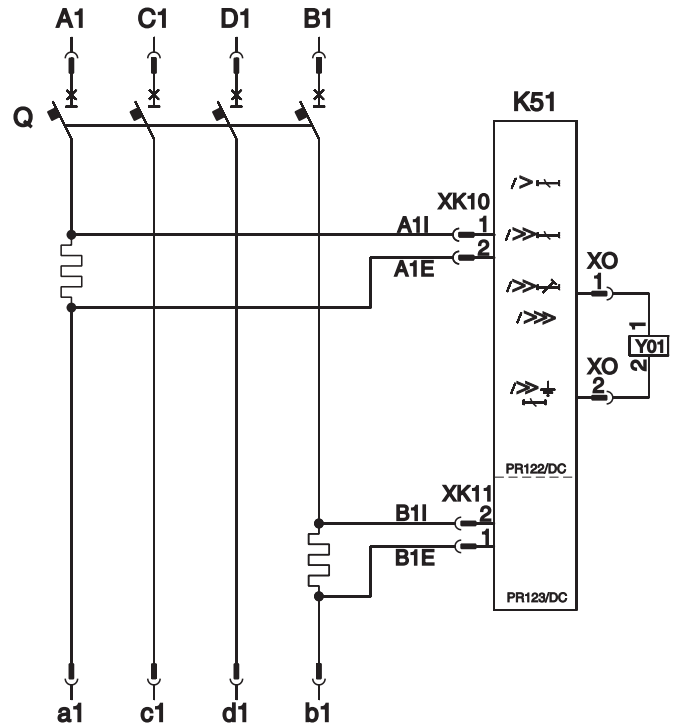
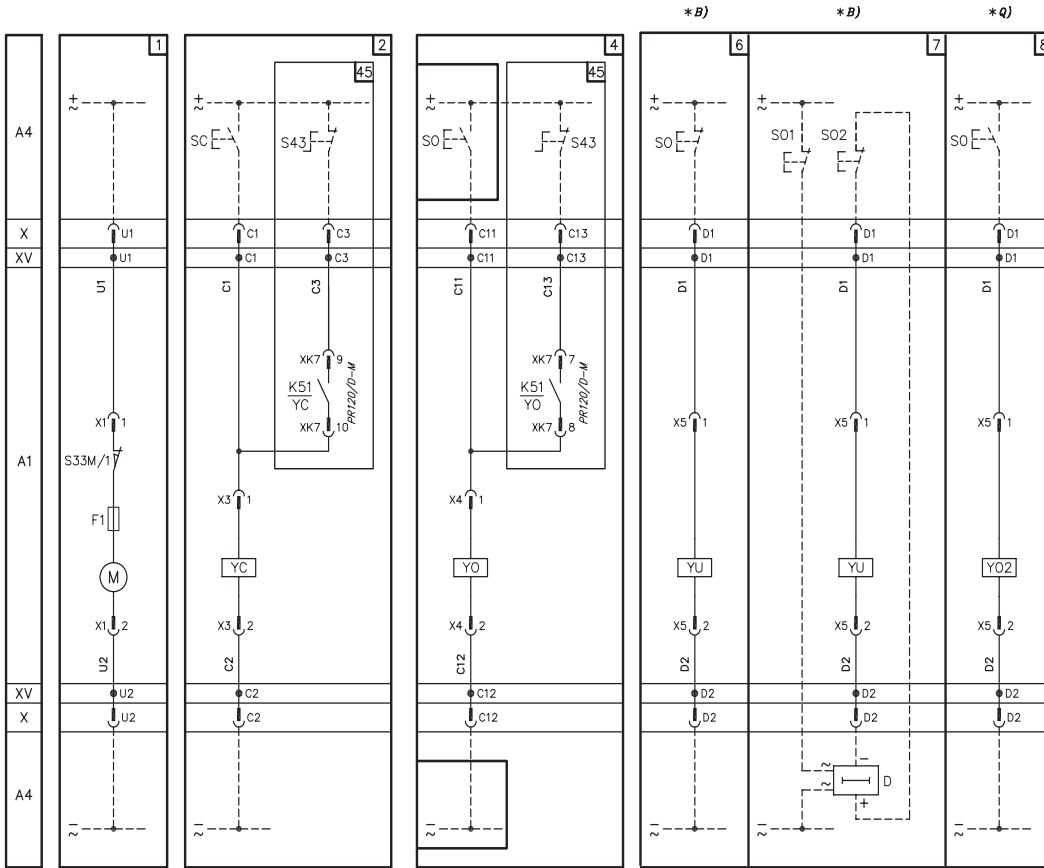Three-pole E4-E6 circuit-breaker with PR122/DC or PR123/DC electronic release

Four-pole E4-E6 circuit-breaker with PR122/DC or PR123/DC electronic release
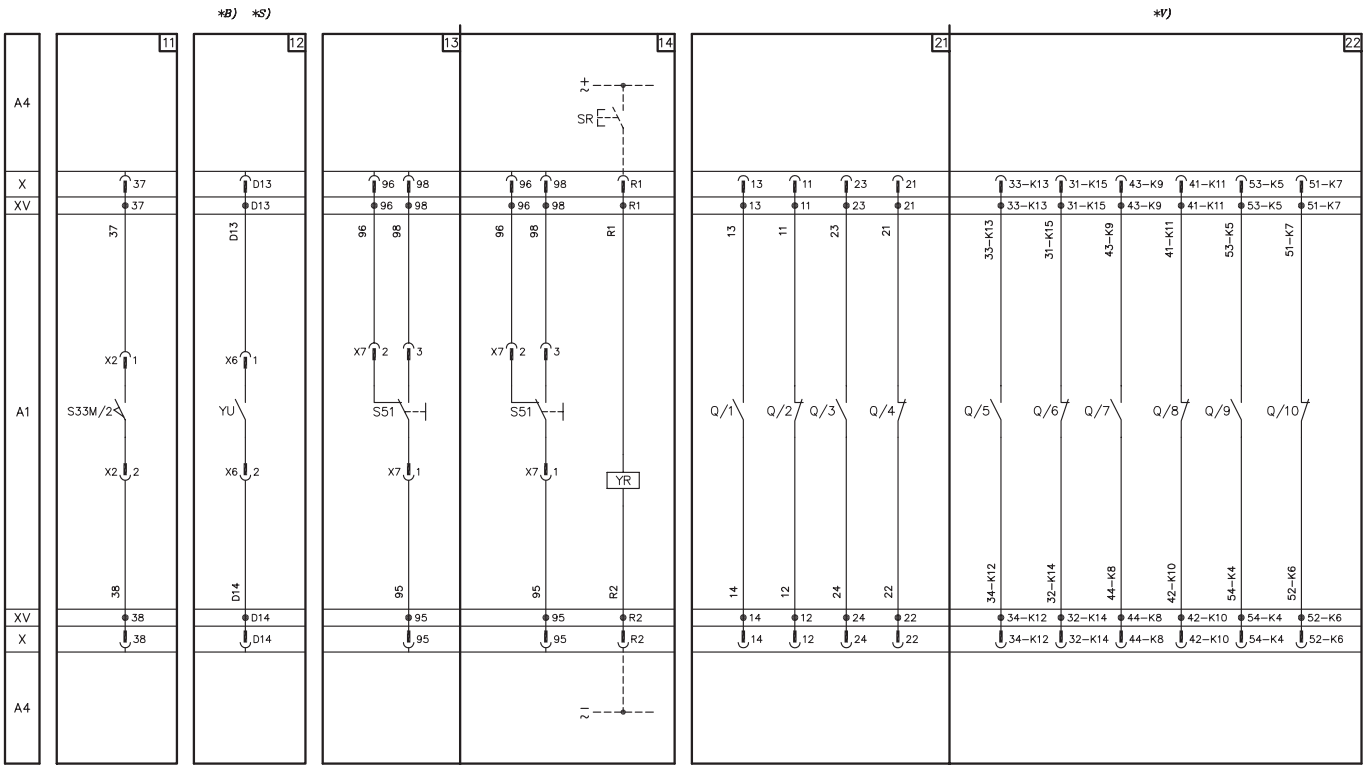

Model	L3447			Apparatus	**Emax DC**	Scale
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Motor operating mechanism, opening, closing and undervoltage releases

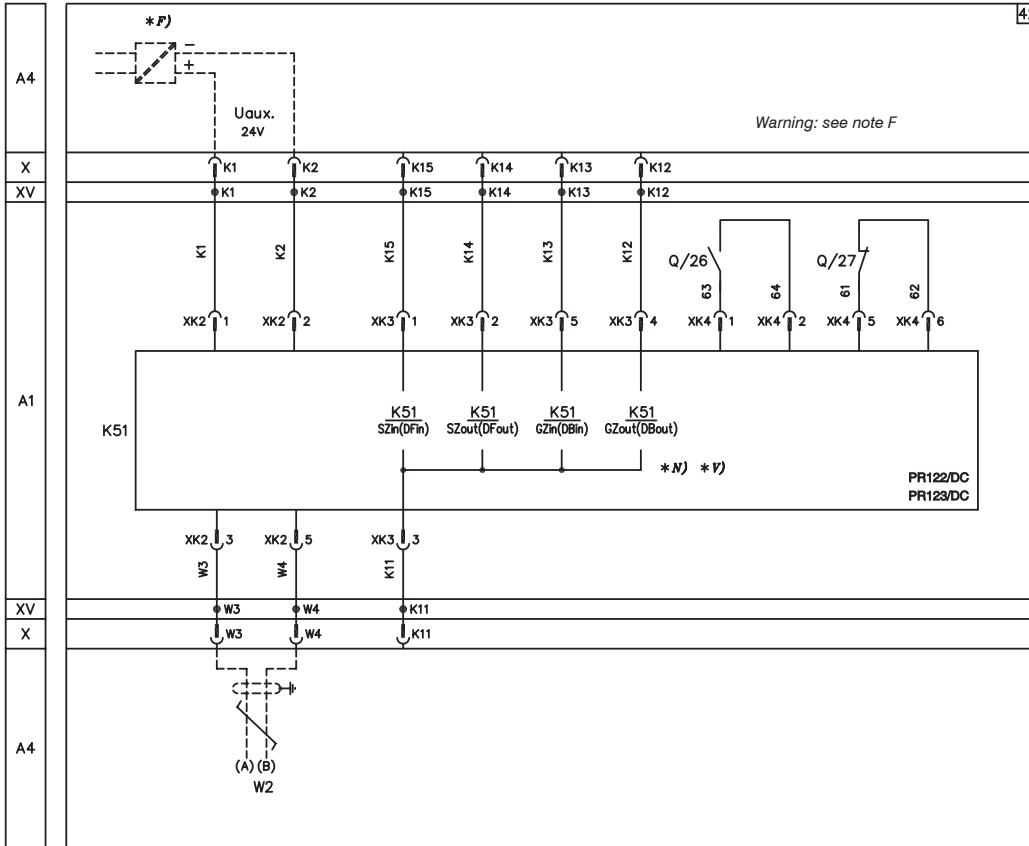**Signalling contacts**

Model	L3447			Apparatus	**Emax DC**	Scale	
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Signalling contacts

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| 202 | 204 | 212 | 214 | 222 | 224 | 232 | 234 | 242 | 244 | 252 | 254 | 262 | 264 | 272 | 274 | 282 | 284 | 292 | 294 | 302 | 304 | 312 | 314 | 322 | 324 | 332 | 334 | 342 | 344 |

Q/11 Q/12 Q/13 Q/14 Q/15 Q/16 Q/17 Q/18 Q/19 Q/20 Q/21 Q/22 Q/23 Q/24 Q/25

201 211 221 231 241 251 261 271 281 291 301 311 321 331 341

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31   32

A4

XF

104   112   124   134   142   154   162   174   184   192

104   112   124   134   142   154   162   174   184   192

A3

S75I/1 S75I/2   S75I/3 S75I/4

S75T/1   S75T/2

S75E/1 S75E/2   S75E/3 S75E/4

101   111   121   131   141   151   161   171   181   191

XF

101   111   121   131   141   151   161   171   181   191

A4

Model	L3447			Apparatus	**Emax DC**	Scale
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Auxiliary circuits of the PR122/DC and PR123/DC releases

PR120/D-M communication module
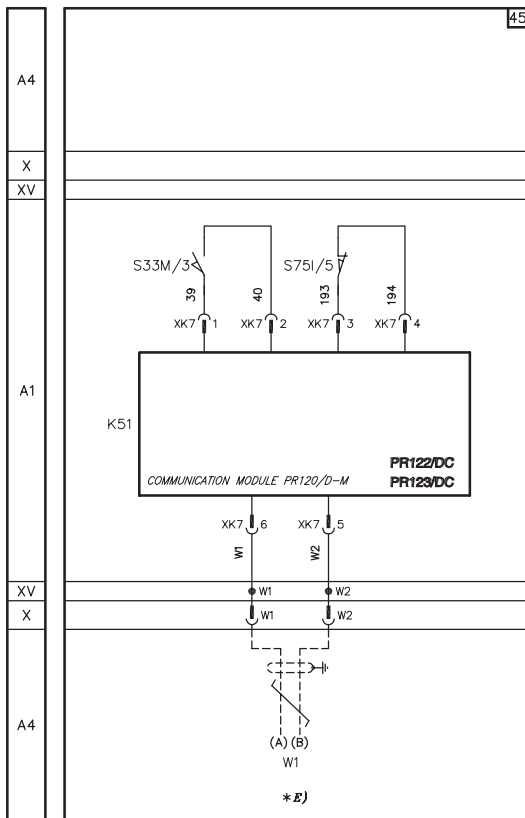
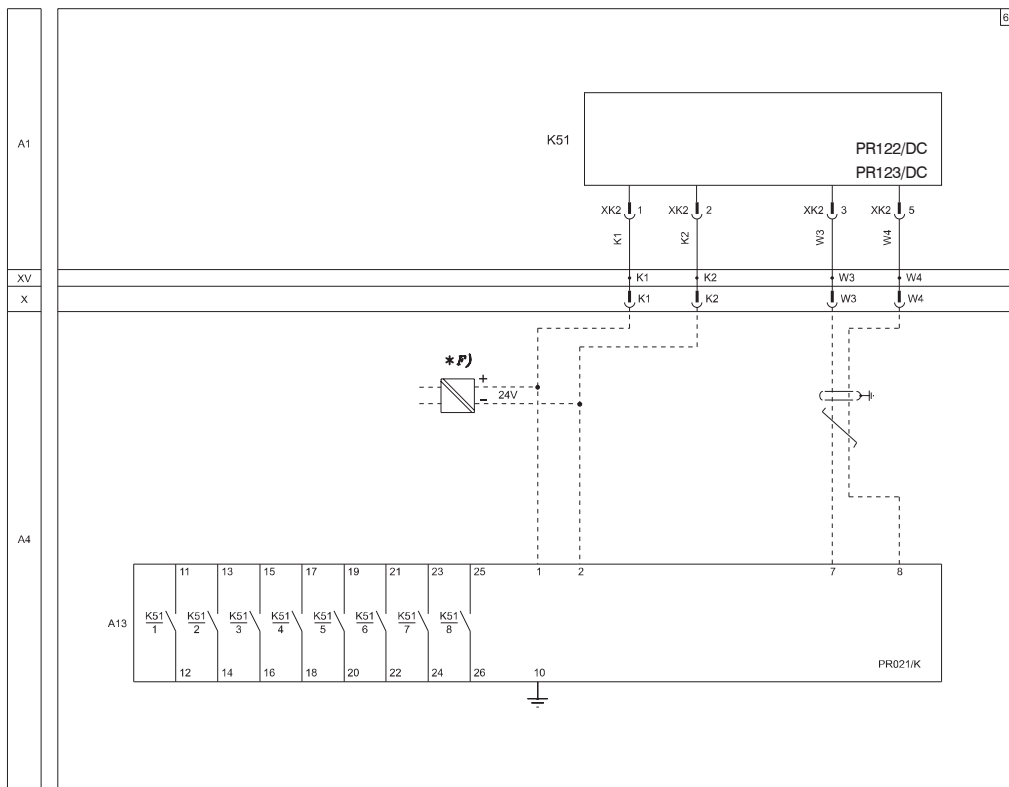| Model	L3447			Apparatus	**Emax DC**	Scale
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PR120/K signalling module

PR021/K signalling unit

ABB