

RH0288002 L0849

Emax



Dwg.		Resp.Off.		Title Installation, service and maintenance instructions for low voltage air circuit-breakers	Language
App.		Take-over Off.			en
Model	L0849			Apparatus Emax	Scale
ABB		ABB SACE		Doc. N° RH0288002	

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1. Description

1.1 General characteristics

The SACE Emax series of circuit-breakers consist of a steel sheet structure which houses the operating mechanism, the poles and the auxiliary parts. Each pole, insulated from the others, contains the interrupting parts and the current transformer of the corresponding phase. The structure of the poles differs according to whether the circuit-breaker is selective or current limiting. The fixed version circuit-breaker has its own terminals for connection to the power circuit. In the withdrawable version, the circuit-breaker makes up the moving part of the apparatus, which is completed with a fixed part fitted with the terminals for connection to the power circuit of the installation. Coupling between moving part and fixed part takes place by means of special pliers mounted in the fixed part.

1.2 External front view of the circuit-breaker

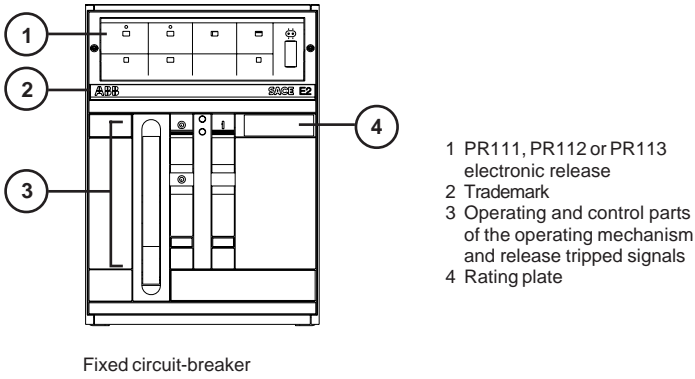


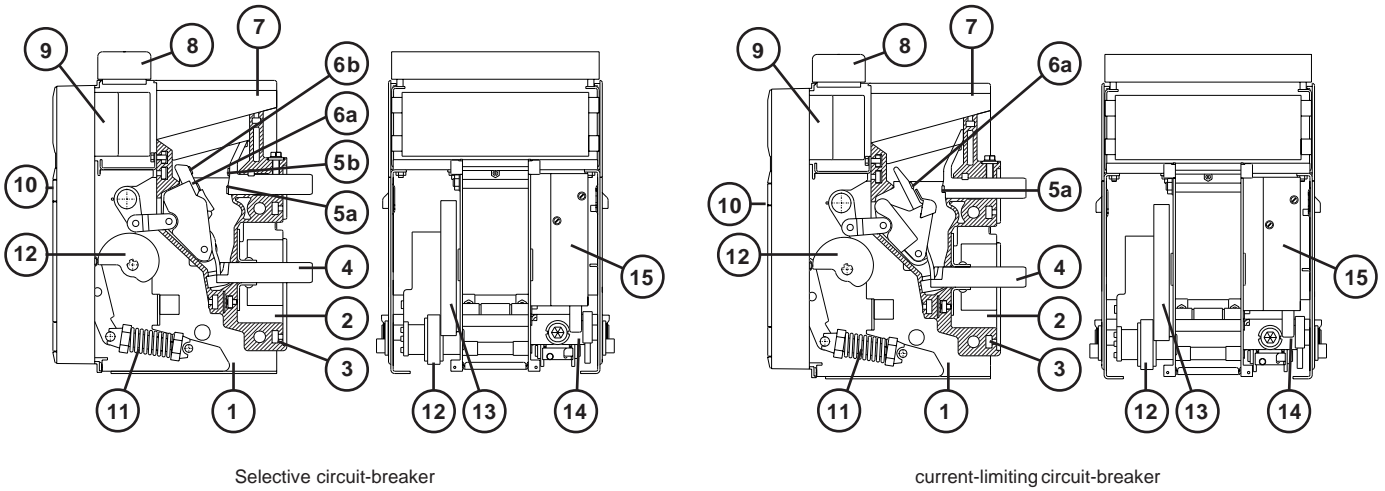
Fig. 1

1.3 Circuit-breaker rating plate

SACE E3S 12		I _U = 1250A U _e = 690V I _{cw} = 75kA x 1s					
cat. B		50-60 Hz					CEI EN 60947-2
U _e (V)	230	415	440	500	690	250	IEC 947-2
I _{cu} (kA)	75	75	75	75	75	75	
I _{cs} (kA)	75	75	75	75	75	75	

Fig. 2

1.4 Moving part construction characteristics



- 1 Supporting structure made of steel sheet
- 2 Current transformer for release
- 3 Terminal support 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 Release
- 10 Circuit-breaker closing and opening operating mechanism
- 11 Closing springs
- 12 Spring charging geared motor (on request)
- 13 Lever for manually charging the closing springs
- 14 Racking-out device (only for withdrawable circuit-breaker)
- 15 Service releases (shunt closing release, shunt opening release, undervoltage), on request

Fig. 3

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1.5 Fixed part construction characteristics

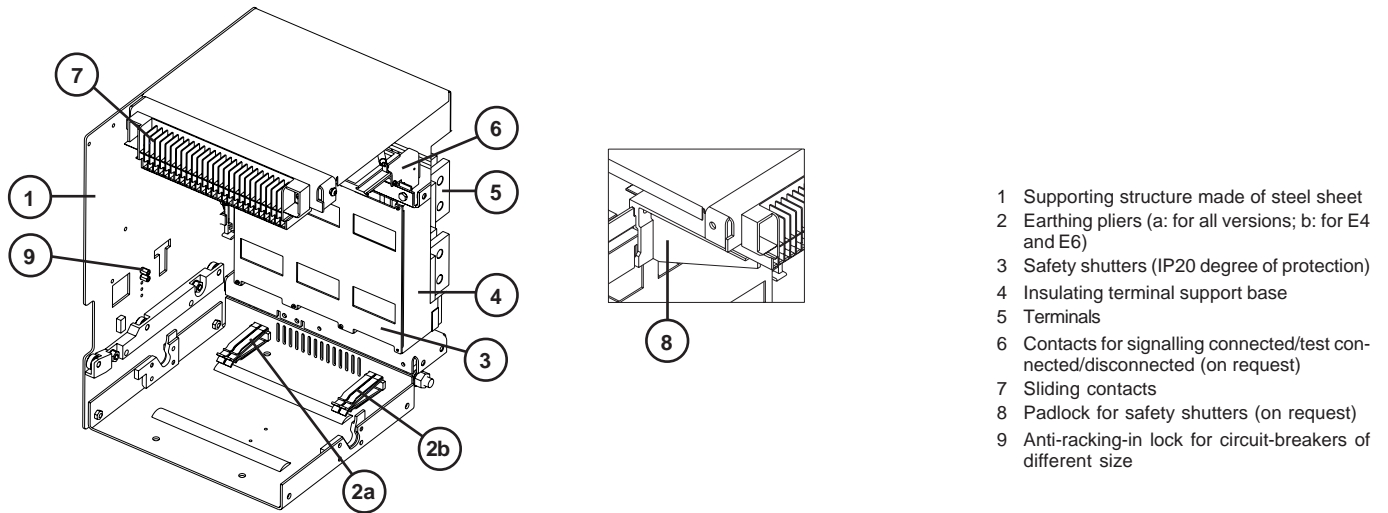


Fig. 4

2. Checking on receipt

Examine the state of the material received and its correspondence with what was foreseen at the time of ordering. Should any damage or irregularity be found on unpacking, which must be carried carefully, make the relative notification within and not over 5 days from 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 housing, is fixed by means of screws to the transport plate 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 the storage room
- Position the circuit-breaker on a horizontal surface, not in direct contact with the floor, but on a suitable support surface (Fig. 6)
- The maximum number of stackable circuit-breakers is indicated in figure 7.
- Keep the circuit-breaker in the open position and with the closing springs discharged to avoid unnecessary stresses and risk of accidents to the personnel.

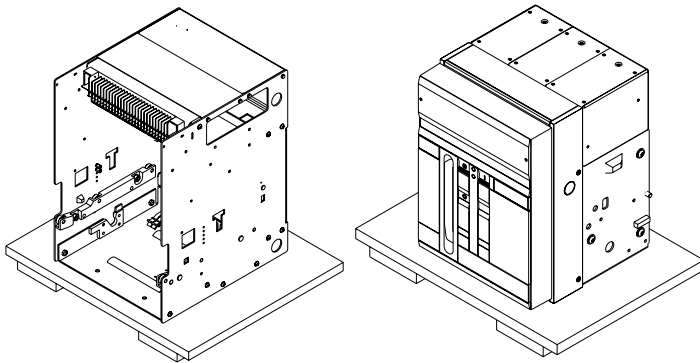


Fig. 6

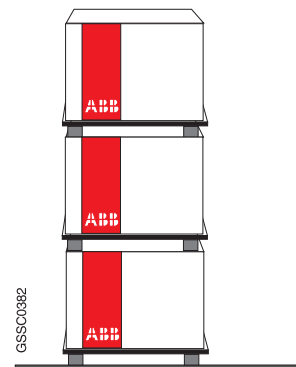


Fig. 7

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With regard to lifting, follow these instructions: the circuit-breakers must be placed on a sturdy resting 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).

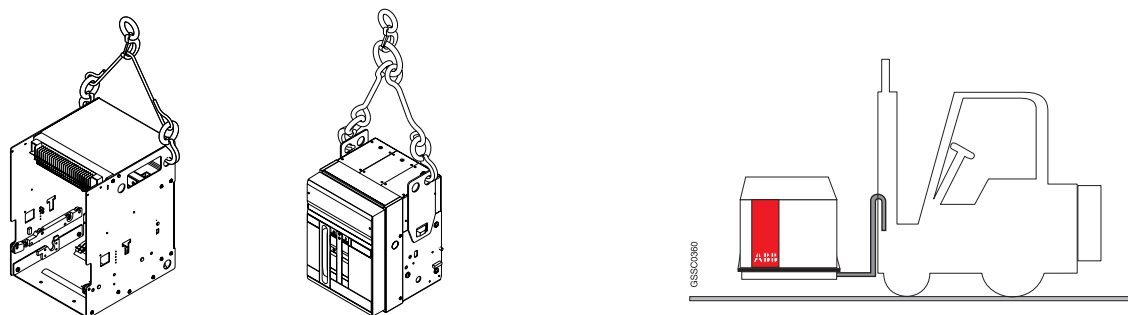


Fig. 8

Table of the circuit-breaker weights

Selective circuit-breaker	Fixed version		Withdrawable version	
	3 poles	4 poles	3 poles	4 poles
E1	45	54	70	82
E2	50	61	78	93
E3	66	80	104	125
E4	97	117	147	165
E4/f		120		170
E6	140	160	210	240
E6/f		165		250

Current-limiting circuit-breaker	Fixed version		Withdrawable version	
	3 poles	4 poles	3 poles	4 poles
E2L	52	63	80	95
E3L	72	83	110	127

Notes

The weights indicated in the table are intended for circuit-breakers complete with PR111, PR112 or PR113 releases and relative current transformers, with exclusion of the accessories.
The withdrawable version includes the moving part in the same conditions as above, and the fixed part with horizontal rear terminals.

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, use assembly in switchgear with a suitable degree of protection.

For 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 operation of installation, put in service and eventually ordinary and extraordinary maintenance have to be done by skilled personnel, that has the 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.).

4.3 Installation of the withdrawable circuit-breaker fixed part

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 of circuit-breakers with different electrical characteristics from those of the fixed part itself. Should the anti-racking-in lock have 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 two hexagonal-head screws (1) in the holes found in the previous point as shown in the figure
- Fix the two screws with the washers (2) and the hexagonal stops (3).

Check 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).

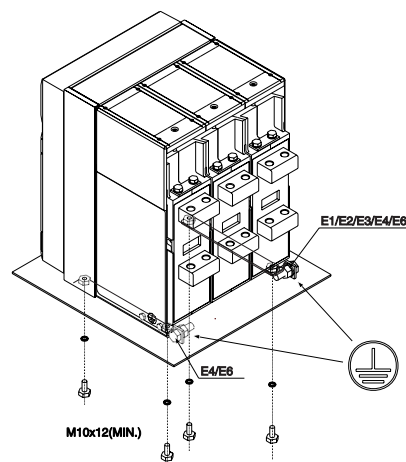


Fig. 9

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Example for E1B 08 according to the nameplate diagram

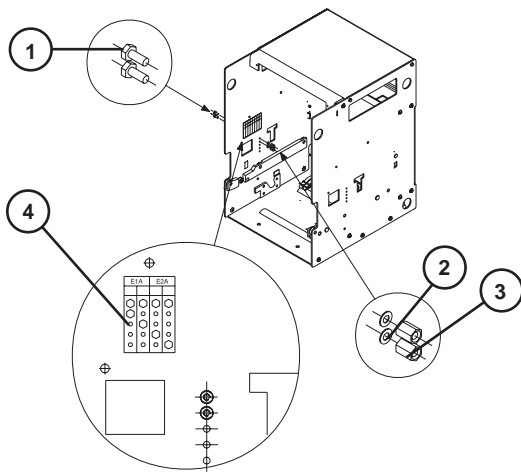


Fig. 10

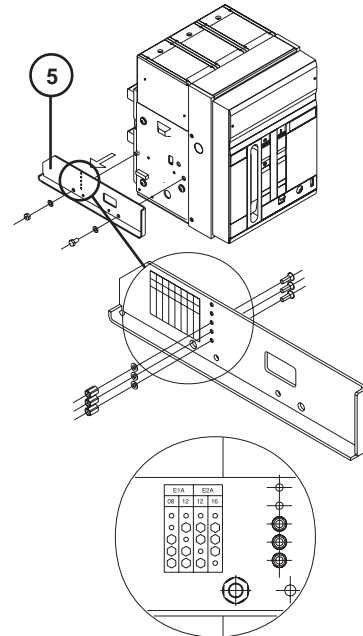


Fig. 11

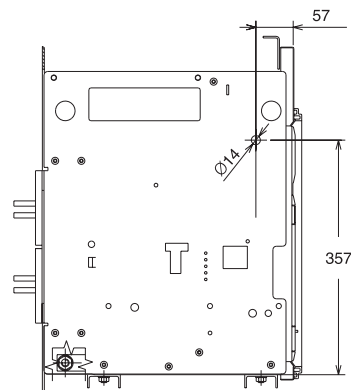
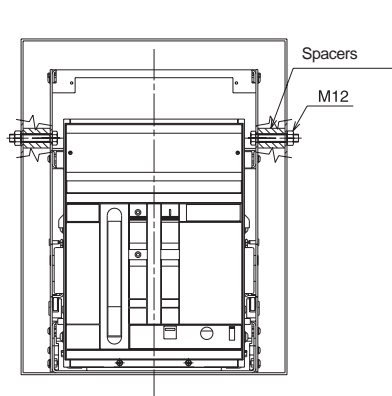
4.3.2 Installation of the fixed part (Fig. 12b)

Fix 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, check 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. 12a)

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).

E1 - E2 - E3



E4 - E6

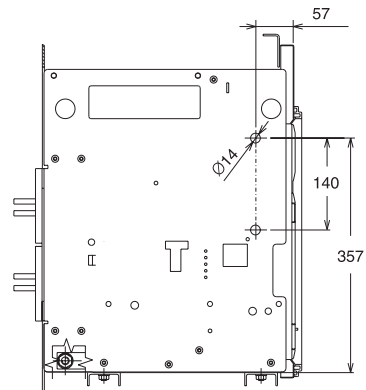
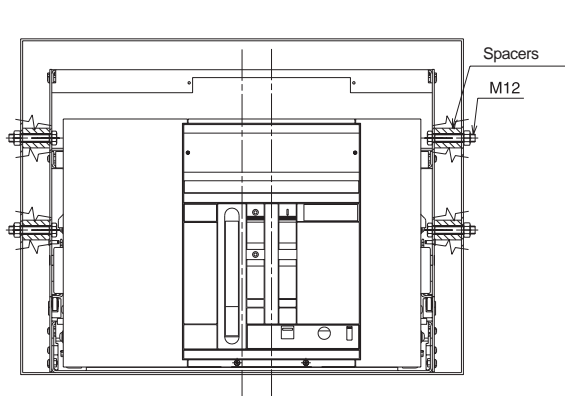
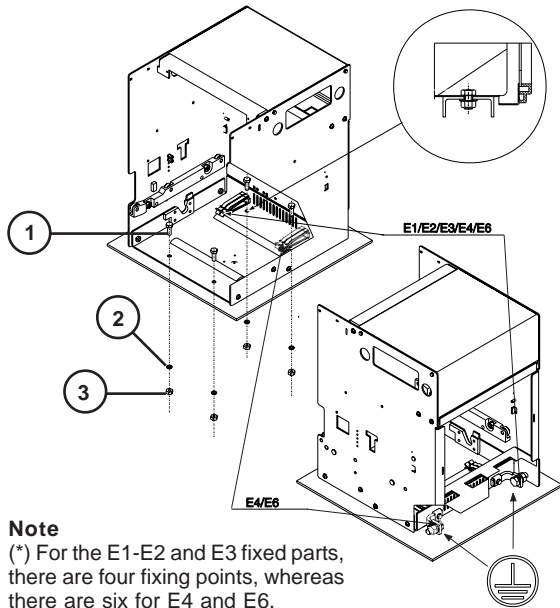


Fig. 12a

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

- Make the compartment door drillings foreseen in the "Overall dimensions" paragraph.
- Apply the flange (1) onto the front of the compartment door, fixing it from the inside by means of the self-threading screws (2).



Note
 (*) For the E1-E2 and E3 fixed parts, there are four fixing points, whereas there are six for E4 and E6.

Fig. 12b

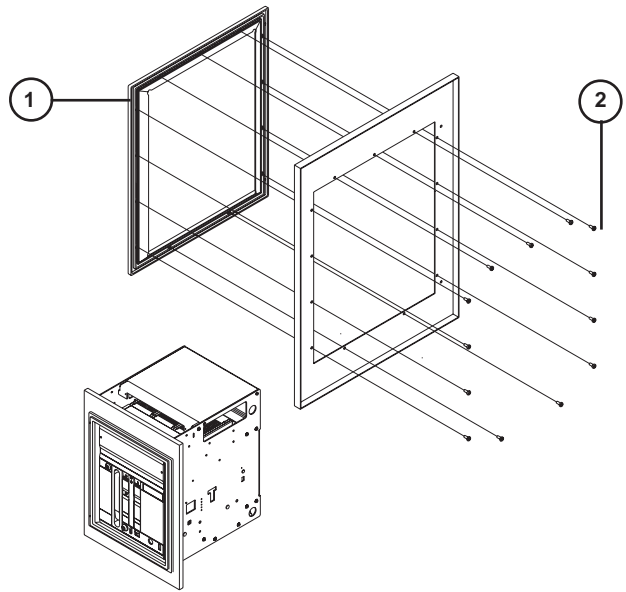


Fig. 13

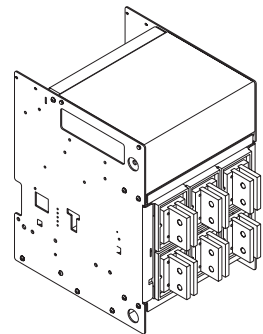
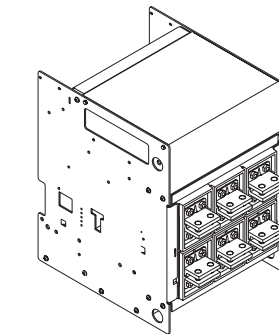
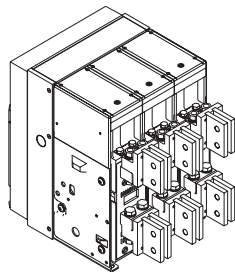
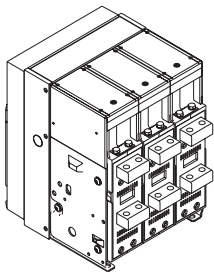
5. Electrical connections

5.1 Connections to the power circuit

5.1.1 Shapes of the terminals

Fixed circuit-breaker

Fixed part for withdrawable circuit-breaker

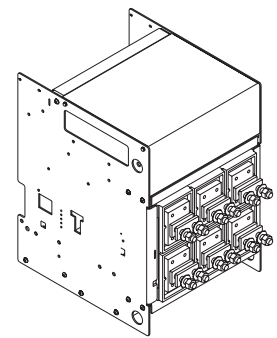
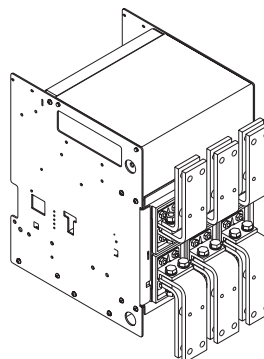
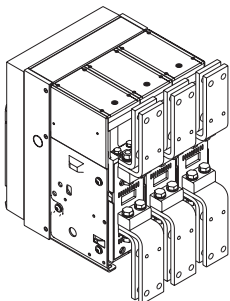


Horizontal rear terminals

Vertical rear terminals

Horizontal rear terminals

Vertical rear terminals



Front terminals

Front terminals

Flat terminals

Fig. 14

Fig. 15

Note

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

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Front terminals

5.1.2 Examples of positioning the connection busbars according to the types of terminals

The connection busbars allow 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 in relation to the shape and size of the circuit-breaker terminals are given in this paragraph. The various types of terminals are of constant dimensions per size of circuit-breaker: it is normally advisable to exploit the whole contact surface of the terminal, so the width of the connection busbar should be the same as that of the terminal. Different capacities for the connections can be made by working on the thickness and on the number of busbars in parallel. In some cases, reductions in the width of the connection in relation to that of the terminal are allowed as shown in the following examples.

	I _u [A]	Vertical terminals			Busbar cross-section [mm ²]	Horizontal and front terminals			Busbar cross-section [mm ²]
		Continuous current-carrying capacity [A]				Continuous current-carrying capacity [A]			
		35°C	45°C	55°C		35°C	45°C	55°C	
E1B/N 08	800	800	800	800	1x(60x10)	800	800	800	1x(60x10)
E1B/N 12	1250	1250	1250	1250	1x(80x10)	1250	1250	1200	2x(60x8)
E2N 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E2B/N 16	1600	1600	1600	1600	2x(60x10)	1600	1600	1530	2x(60x10)
E2B/N 20	2000	2000	2000	1800	3x(60x10)	2000	2000	1750	3x(60x10)
E2L 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E2L 16	1600	1600	1600	1500	2x(60x10)	1600	1490	1400	2x(60x10)
E3S/H 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E3S/H 16	1600	1600	1600	1600	1x(100x10)	1600	1600	1600	1x(100x10)
E3S/H 20	2000	2000	2000	2000	2x(100x10)	2000	2000	2000	2x(100x10)
E3N/S/H 25	2500	2500	2500	2500	2x(100x10)	2500	2490	2410	2x(100x10)
E3N/S/H 32	3200	3200	3100	2800	3x(100x10)	3000	2880	2650	3x(100x10)
E3L 20	2000	2000	2000	2000	2x(100x10)	2000	2000	1970	2x(100x10)
E3L 25	2500	2500	2390	2250	2x(100x10)	2375	2270	2100	2x(100x10)
E4H 32	3200	3200	3200	3200	3x(100x10)	3200	3200	3020	3x(100x10)
E4S/H 40	4000	4000	3980	3500	4x(100x10)	3600	3510	3150	6x(60x10)
E6V 32	3200	3200	3200	3200	3x(100x10)	3200	3200	3200	3x(100x10)
E6V 40	4000	4000	4000	4000	4x(100x10)	4000	4000	4000	4x(100x10)
E6H/V 50	5000	5000	4850	4600	6x(100x10)	4850	4510	4250	6x(100x10)
E6H/V 63	6300	6000	5700	5250	7x(100x10)	-	-	-	-

Fig. 16

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

Anchoring to the switchgear

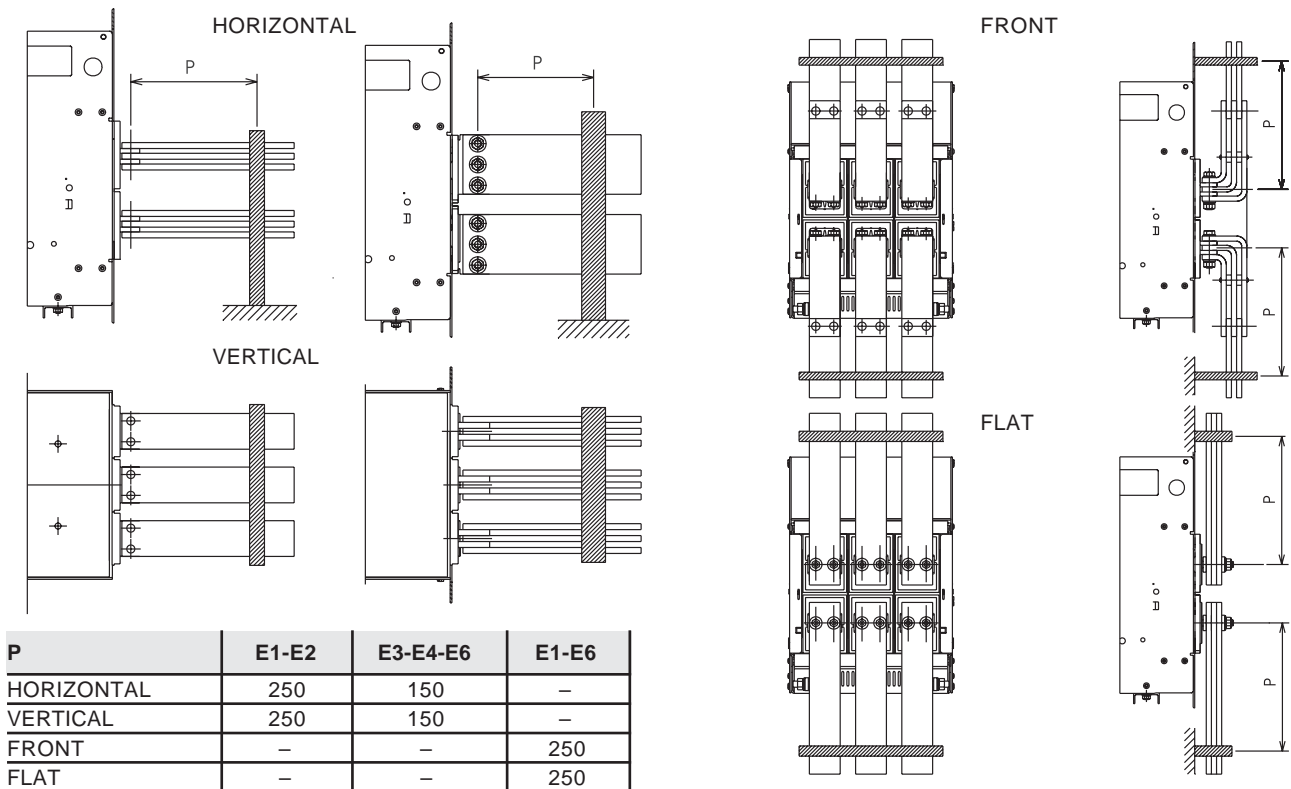


Fig. 17

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5.1.3 Assembly procedures for the connection busbars

Check the state of the contact surfaces of the connections very carefully: these must be very clean and free of burrs, dents or traces of oxidation, 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 force on the terminals in any direction. Always interpose a flat washer of good diameter and a spring washer between them (to spread the tightening pressure over a greater area). Make the contact between connection and terminal and fully tighten the fixing screws. Always use two wrenches (so as not to stress the insulating parts excessively), applying the tightening torque indicated in Fig. 18. Check tightening after 24 hours.

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

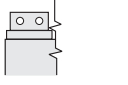
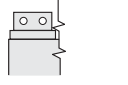
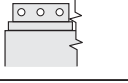
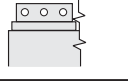
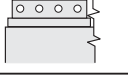
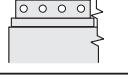
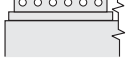
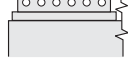
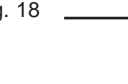
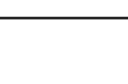
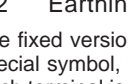
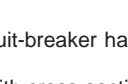
Fixed part terminals	No. screws for phase	No. screws for neutral	Fixed circuit-breaker terminals	No. screws for phase	No. screws for neutral
	E1/E2 → 2	2		E1/E2 → 2	2
	E3 → 3	3		E3 → 3	3
	E4 → 4	2		E4 → 4	2
	E4/f → 4	4		E4/f → 4	4
	E6 → 6	3		E6 → 6	3
	E6/f → 6	6		E6/f → 6	6

Fig. 18

5.2 Earthing

The fixed version 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 cross-section conforming to the Standards in force must be used for the connection. Before assembling the connection, clean and degrease the area around the screw. After assembly, tighten the bolt with a torque of 70 Nm.

5.3 Cabling the circuit-breaker auxiliary circuits

5.3.1 Interfacing elements for fixed circuit-breaker

A special terminal box is provided fitted with screw terminals for connection of the auxiliary circuits. The terminals are marked with alphanumeric identification codes as per the electrical circuit diagram. The terminal box is identified by code XV on the electrical circuit diagram. There is immediate access to the terminal box when the compartment door is open.

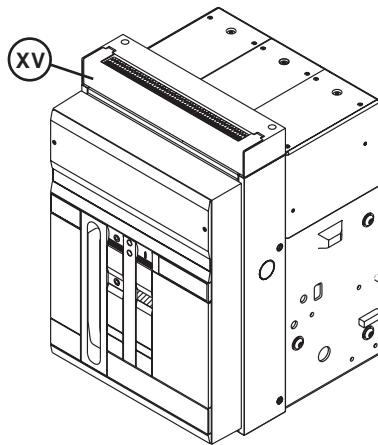


Fig. 19

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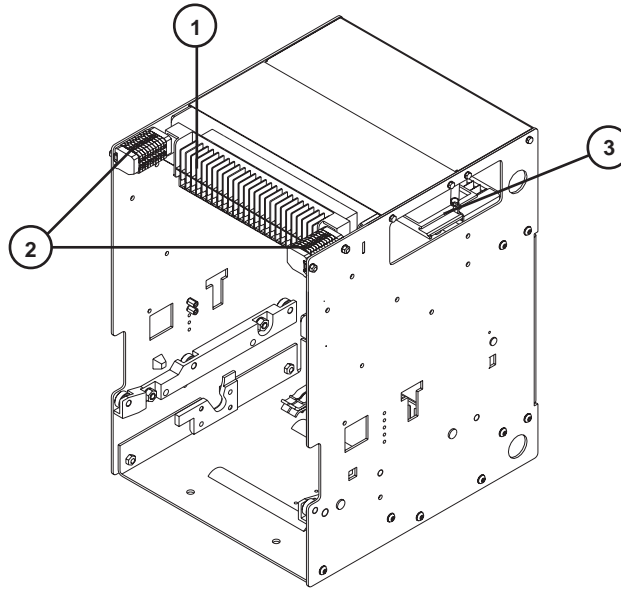
5.3.2 Withdrawable circuit-breaker

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

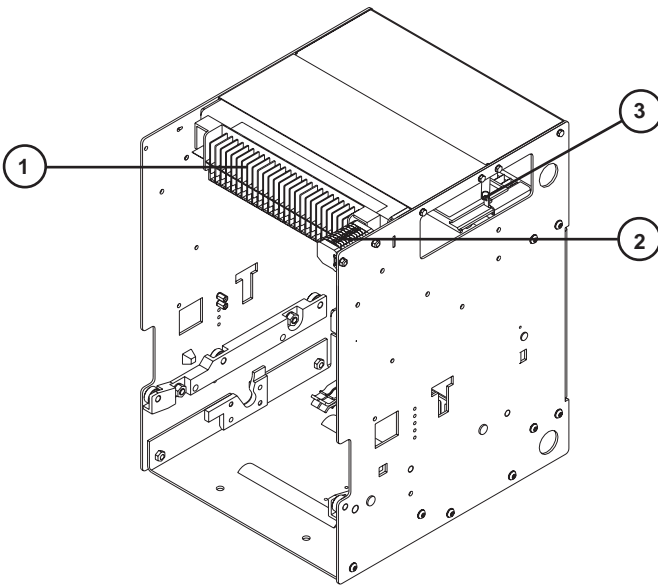
There is immediate access to the terminals of the fixed connector when the compartment door is open.

Furthermore, for connection of the position contacts of the moving part in relation to the fixed part, a terminal box is available, identified by code XF.

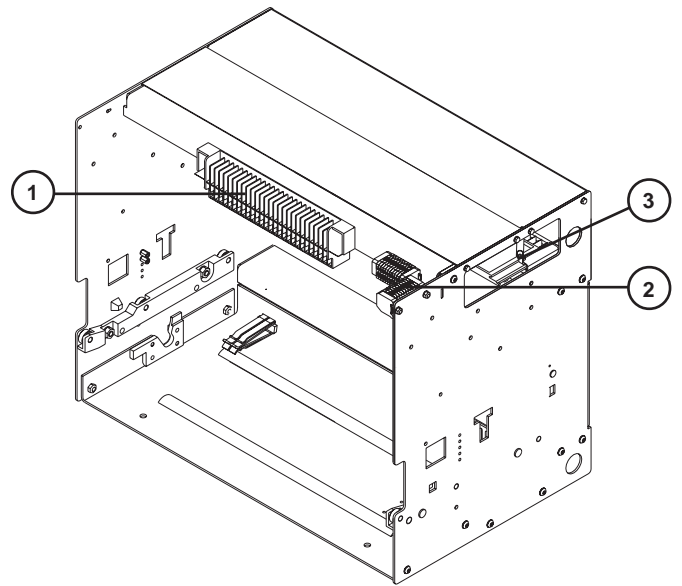
The connector and terminal box have screw terminals.



E1 - E2 - E3
10 contacts in position



E1 - 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 or position contacts from normally closed (opening) to normally open (closing) or vice versa
 The contacts are cabled in the factory as is shown on the electrical circuit diagram. Should it be necessary to modify the 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 working on the blocks (1) as shown in the figure
- remove the release (4) by removing the side nuts (2) and sliding it out from the front of the circuit-breaker.

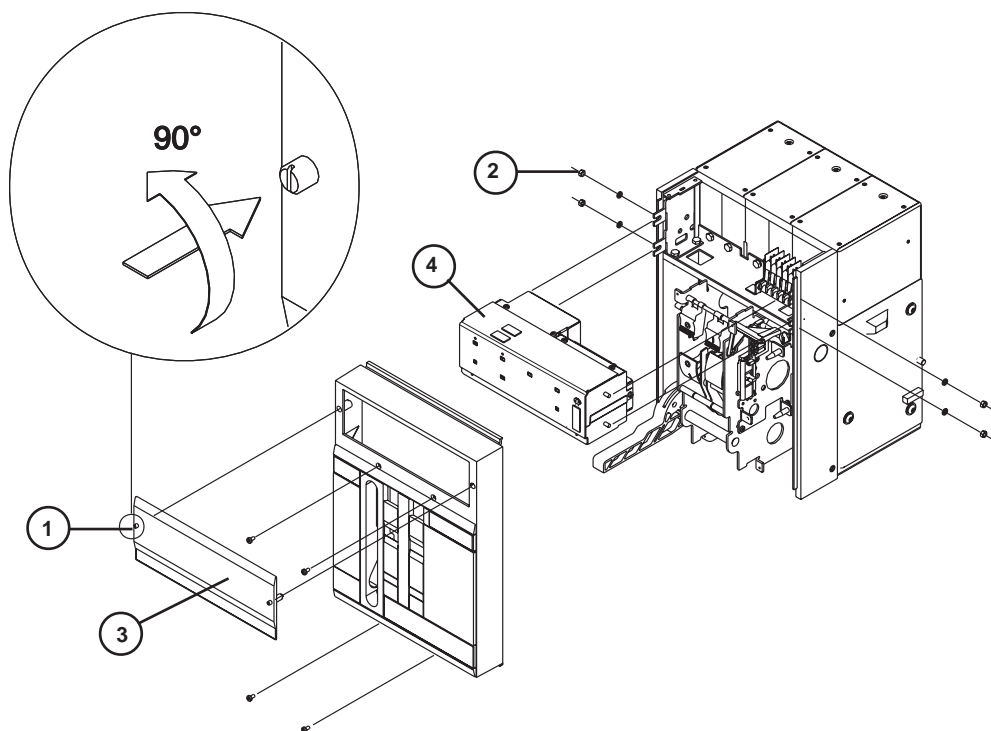
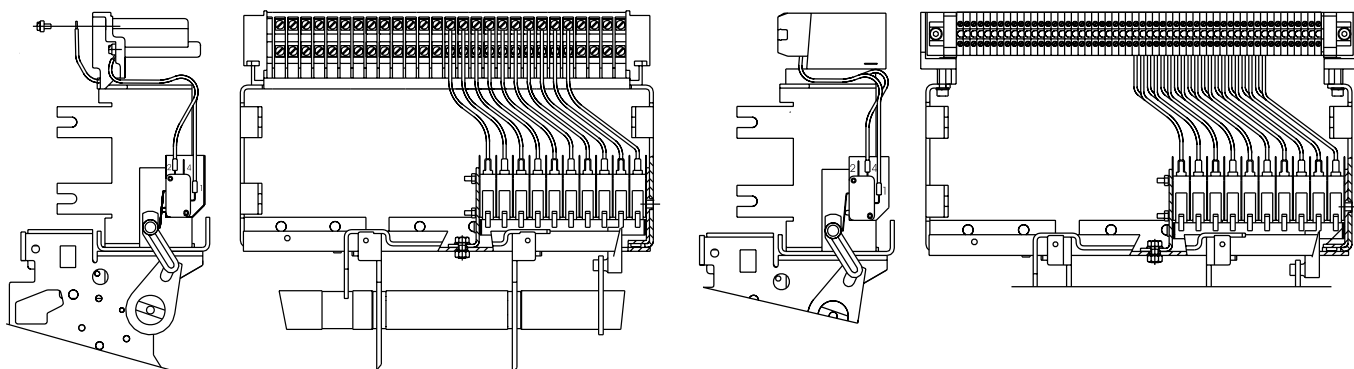


Fig. 21

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) Position contacts

To change the state of the position contact, proceed in the same way as the one indicated for the auxiliary contacts (see Fig. 21-22).

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6. Putting into service

6.1 General procedures

- Check tightening of the power connections at the circuit-breaker terminals
- Carry out all the preparation operations of the release
- Check that the value of the auxiliary circuit power supply voltage is between 85 and 110% of the rated voltage of the electrical applications
- Check that there is sufficient air exchange in the place of installation to avoid overtemperatures
- Also carry out the checks indicated in the following table.

Item inspected	Procedure	Positive check
1 Manual operating mechanism	<p>Carry out some opening and closing operations (see the cap. 7.2).</p> <p>CAUTION</p> <p>When there is an undervoltage release, the circuit-breaker can only be closed after having electrically energized the release itself.</p>	The spring charging lever moves correctly.
2 Geared motor (if provided)	<p>Supply the spring charging geared motor at the relative rated voltage.</p> <p>Carry out some closing and opening operations.</p> <p>Note. Supply the undervoltage release at the relative rated voltage (if provided)</p>	<p>The springs are charged correctly. The signals are correct. The geared motor stops with the springs charged.</p> <p>The geared motor recharges the springs after each closing operation.</p>
3 Undervoltage release (if provided)	<p>Supply the undervoltage release at the relative rated voltage and carry out the circuit-breaker closing operation.</p> <p>Remove voltage to the release. Supply the undervoltage release at the relative rated voltage and carry out the circuit-breaker closing operation.</p>	<p>The circuit-breaker closes correctly. The signals are correct.</p> <p>The circuit-breaker opens. The signalling changes over.</p>
4 Shunt opening release (if provided)	<p>Close the circuit-breaker.</p> <p>Supply the shunt opening release at the relative rated voltage</p>	The circuit-breaker opens correctly. The signals are correct.
5 Shunt closing release (if provided)	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 the 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 connected and disconnected	Insert the auxiliary contacts in suitable signalling circuits. Then put the circuit-breaker in the connected, test connected and disconnected position.	The signals two to the relative operations are given correctly.
9 Lock devices for circuit-breaker racked-in and racked-out. Interlocking devices between circuit-breakers side by side and on top of each other (if provided)	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 any particular resistance.

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7. Instructions for use

7.1 Operating and signalling parts

- 1 Pushbutton for the manual opening operation
- 2 Lever for manual charging of the closing springs
- 3 Mechanical indicator for circuit-breaker open "O" and closed "I"
- 4 Mechanical indicator for release tripped (on request)
- 5 Pushbutton for the manual closing operation
- 6 Signalling device for springs charged - discharged
- 7 Operation counter (on request)
- 8 Key lock on the closing operation (on request)
- 9 Mechanical indicator for circuit-breaker connected, test connected, 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

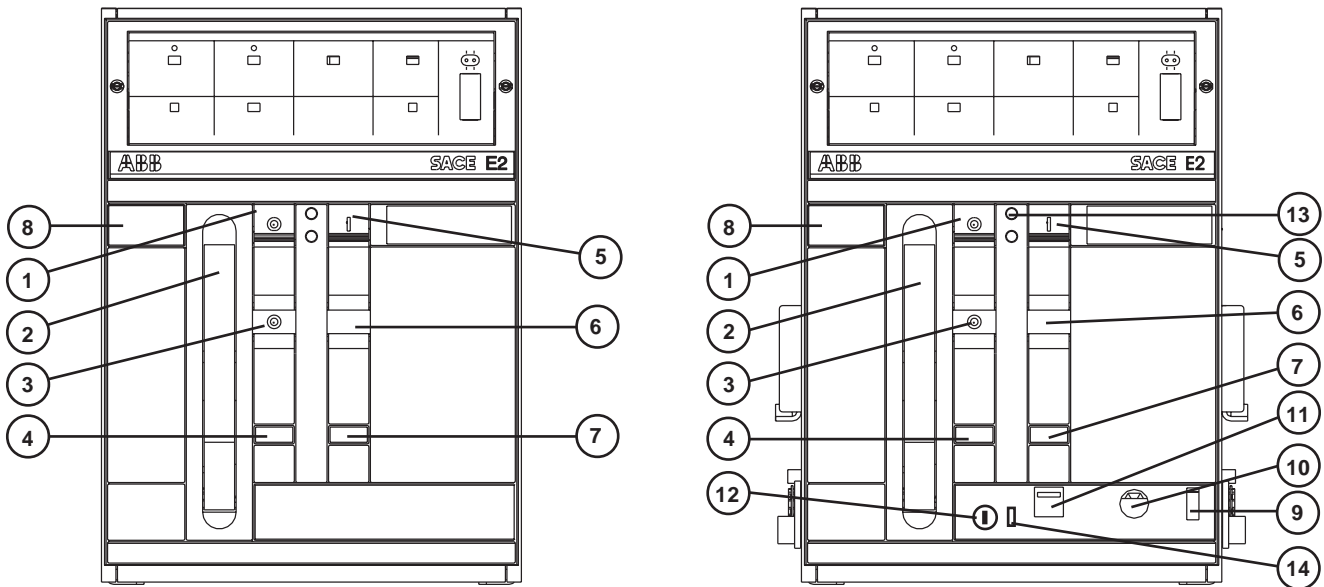


Fig. 23

Notes

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 covering, 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.

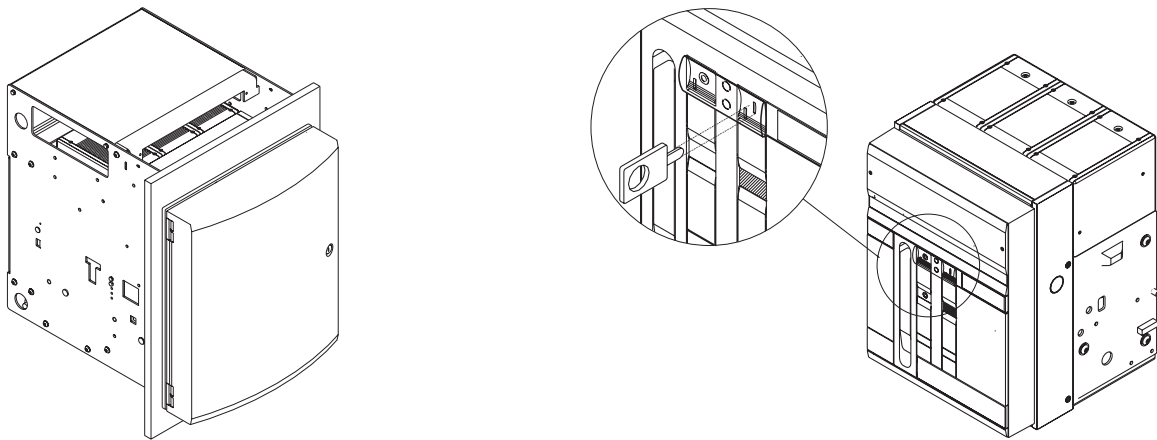


Fig. 24

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7.2 Closing and opening operations of the circuit-breaker

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

a) Manual charging operation of the closing springs

- Make sure that the indicator (3) shows "O" (circuit-breaker open)
- Make sure that the indicator (6) is WHITE (springs discharged)
- Repeatedly activate the lever (2) until the indicator (6) changes its colour to YELLOW

b) Electrical charging operation of the closing springs

The electrical operation of the circuit-breaker is possible when the following accessories (supplied on request) are present:

- geared motor for automatic charging of the closing springs
- shunt closing release
- shunt opening release.

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

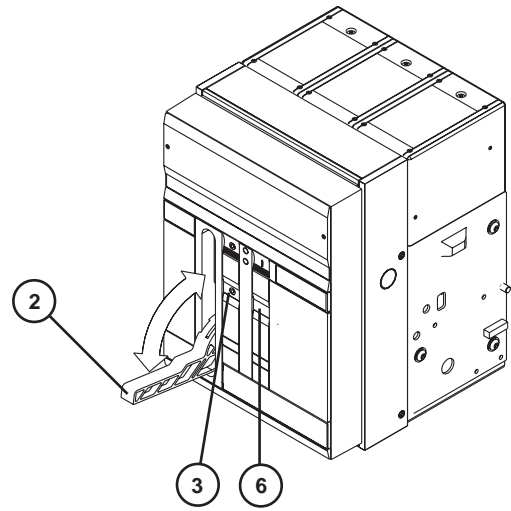


Fig. 25

c) Closing the circuit-breaker

The operation can only be carried out with the closing springs fully charged.

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. Closing having taken place is signalled by the special indicator (3) which goes to indication "I". Furthermore, the indicator of the state of the springs (6) goes to the WHITE position. Even with the closing springs discharged, the operating mechanism conserves enough energy for the opening operation. The geared motor, if present, immediately starts the automatic spring recharging operation.

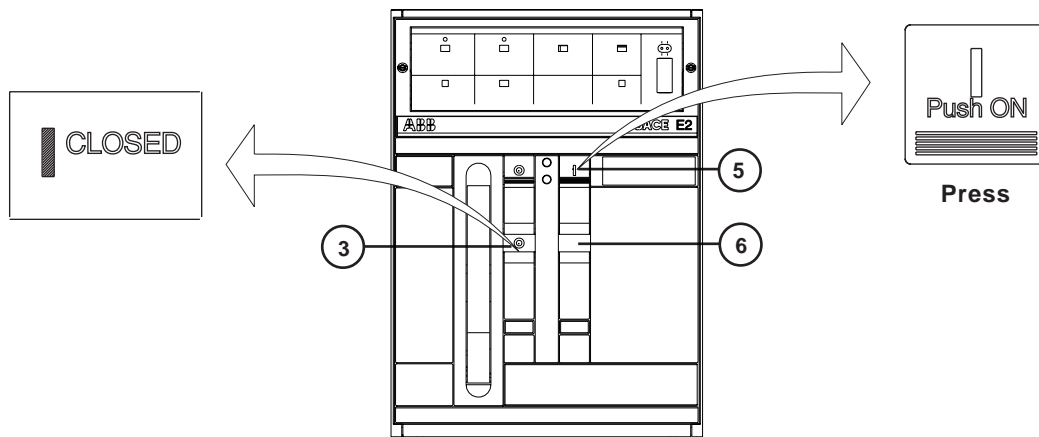


Fig. 26

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 signalled by the letter "O" appearing in the indicator (3).

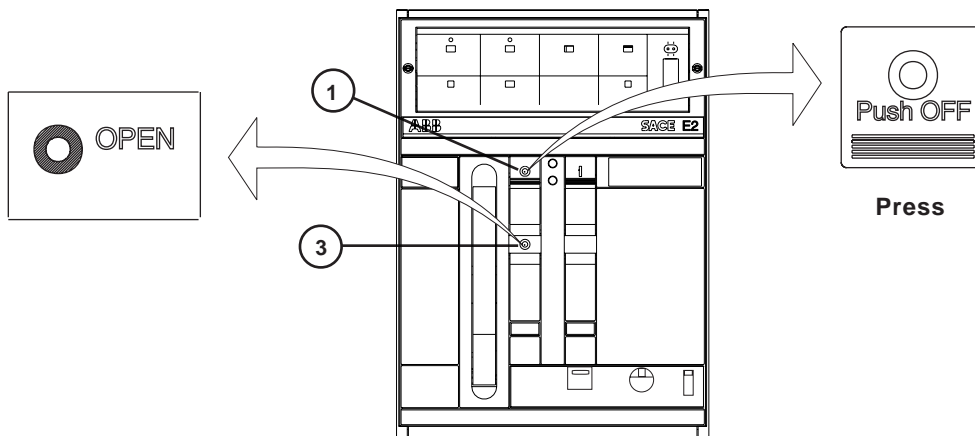


Fig. 27

Mod.	L0849		Apparatus	Emax	Scale
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7.3 Racking-in/out operation

WARNINGS

- Open the circuit-breaker before carrying out any racking-in/out operation.
- The circuit-breaker (moving part) and fixed part are fitted with a lock which prevents the fixed part being racked into circuit-breakers with a different rated current: 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.
- Before the racking-in operation, remove any padlock on the segregation shutters of the isolation terminals on the fixed part.

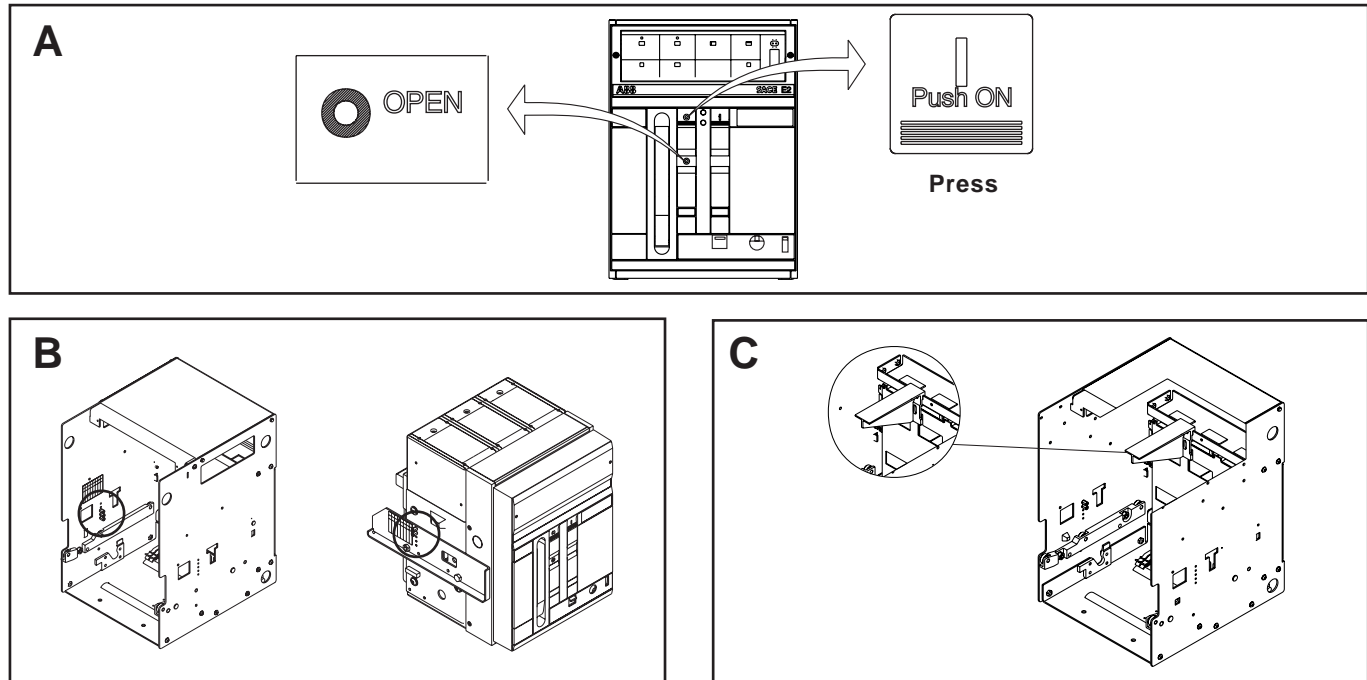


Fig. 28

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** connection between the power terminals and **WITHOUT** coupling of 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 CONNECTED:** the moving part is inserted in the fixed part **WITHOUT** the connection between the power terminals, but **WITH** coupling of the sliding contacts for the auxiliary circuits. In this position, the circuit-breaker can be operated for the blank tests. The indicator (9, Fig. 23) indicates **TEST ISOLATED**
- **CONNECTED:** the moving part is fully inserted in the fixed part **WITH** connection of both the power terminals and the sliding contacts for the auxiliary circuits. The circuit-breaker is operative. The indicator (9, Fig. 23) indicates **CONNECTED**.

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

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

The manual connection operation must allow edge (E) of the circuit-breaker guide to slide under blocks (D) of the fixed part. Remove the lifting devices.

The position reached is stable and allows any inspections of the circuit-breaker.

Fully push in the moving part as far as the stop in the fixed part. Close the compartment door.

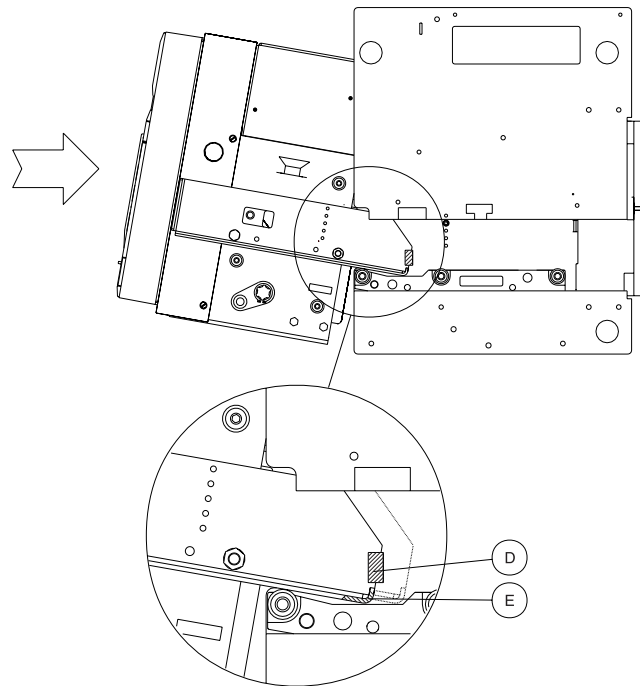


Fig. 29

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b) Passing from the DISCONNECTED position to the TEST ISOLATED position.

Make sure that the indicator (9) is in the DISCONNECTED position.
 For the connection operation, make sure that the key (12) is in the correct position and/or the padlock (14) has been removed, if present.
 Make sure that the circuit-breaker is open.
 Fully push the moving part into the fixed part.
 Lower the releasing lever (11).
 Insert the crank handle in the relative coupling (10).
 Proceed to rotate the crank handle clockwise until the TEST ISOLATED indication appears on the indicator (9). During the initial turns, the crank handle must not show any particular resistance to rotation.
 Should it be necessary to carry out blank operations of the circuit-breaker, the crank handle must be removed.

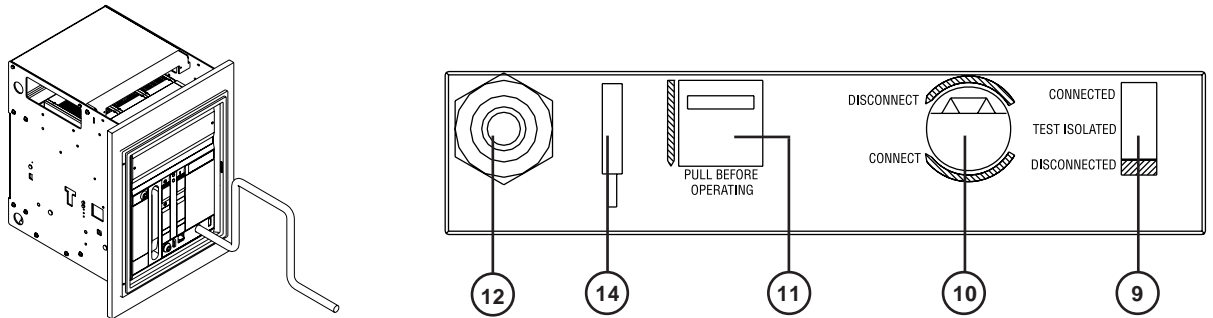


Fig. 30

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 relative coupling (10).
 Proceed to rotate the crank handle clockwise until the CONNECTED indication appears on the indicator (9).
 Remove the crank handle to be able to close the circuit-breaker.

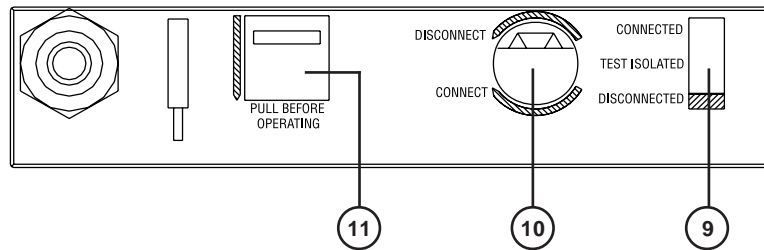


Fig. 31

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

Repeat the connection operations with the variation of rotating the crank handle anticlockwise. Open the door in the disconnected position.

8. Maintenance

8.1 Warnings

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 discharged.
- in the case of withdrawable circuit-breakers, work with the circuit-breaker racked-out of the fixed part
- for interventions on fixed version circuit-breakers or on fixed parts of withdrawable circuit-breakers, remove 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 relative periodic intervals for intervention. In particular, with regard to the time intervals, it is advisable to follow what is specified in the table, at least for the first year of service.

On the basis of the results obtained during the periodic 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 in any case remain closed for long periods, must be operated from time to time to avoid any tendency to stick.
- during service, visually inspect the circuit-breaker from the outside to find any dust, dirt or damage of any kind.

For circuit-breakers with SACE PR112 and SACE PR113 releases, check the percentage of wear of the contacts.

- For the circuit-breakers fitted with SACE PR111 releases, installation of the mechanical operation counter (supplied on request) is recommended.

The SACE PR112 and SACE PR113 release allows the number of operations carried out by the circuit-breaker in service to be displayed at all times on the special display. This latter release also makes various useful pieces of information available for controlling the status of the circuit-breaker.

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

Rated uninterrupted current I _u (40°C) [A]	Mechanical life (*)		Electrical life			
	N° of operations x 1000	Frequency operations/hour	440 V ~ N° of operations x 1000	690 V ~ N° of operations x 1000	Frequency operations/hour	
E1 B-N	800	25	60	10	10	30
	1250	25	60	10	8	30
E2 B-N	1250	25	60	15	15	30
	1600	25	60	12	10	30
	2000	25	60	10	8	30
E2 L	1250	20	60	4	3	20
	1600	20	60	3	2	20
E3 N-S-H	1250	20	60	12	12	20
	1600	20	60	10	10	20
	2000	20	60	9	9	20
	2500	20	60	8	7	20
	3200	20	60	6	5	20
E3 L	2000	15	60	2	1,5	20
	2500	15	60	1,8	1,3	20
E4 S-H	3200	15	60	7	7	10
	4000	15	60	5	4	10
E6 H-V	3200	12	60	5	5	10
	4000	12	60	4	4	10
	5000	12	60	3	2	10
	6300	12	60	2	1,5	10

(*) With regular ordinary maintenance

8.2 Maintenance program

Maintenance operations	Interval	
	Installations 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 intervention 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).

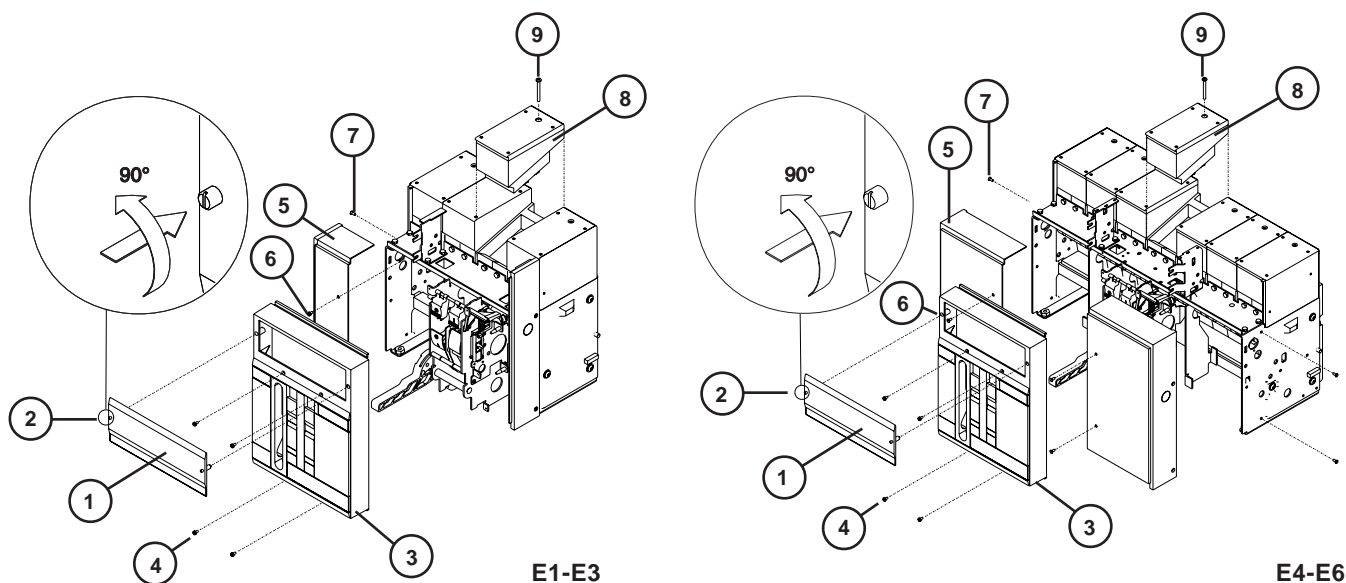


Fig. 32

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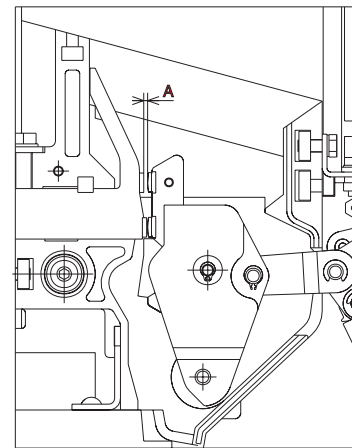
8.3.2 General inspection of the circuit-breaker

Item to be inspected	Problem found	Remedy
1 Operating mechanism/Electrical accessories	<ul style="list-style-type: none"> - Presence of dust on the internal parts - Springs deformed or oxidized - Safety rings out of place, nuts or screws loose - Wires and straps detached 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Traces of wear - Incorrect adjustments: distance A Fig. 33 is less than 1mm for E1-E2-E3 or less than 0.8 mm for E4-E6 	<ul style="list-style-type: none"> - Smooth the contacts with emery cloth - Adjust according to the paragraph 8.3.3
3 Arcing chambers	<ul style="list-style-type: none"> - Presence of fumes or dusts - Presence of cracks on the external plastic structure - Excessive difference in wear between the first and last arc extinguishing plate 	<ul style="list-style-type: none"> - 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 - Isolating contacts	<ul style="list-style-type: none"> - 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 - Isolating contacts oxidized (only for withdrawable circuit-breaker) - Signs of wear or overheating or screws loose on the connections to the terminals of the circuit-breaker (only for fixed circuit-breaker) 	<ul style="list-style-type: none"> - Clean with a brush or dry cloths - Put the rings back in place and tighten screws and nuts appropriately - Ask ABB SACE for replacement of 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 pliers (only for withdrawable circuit-breaker)	Presence of oxidation or loose nuts	Clean with a rough cloth soaked in a suitable solvent and lubricate moderately with neutral grease. Tighten the nuts fully
6 Earth connection (only for fixed circuit-breaker)	Presence of oxidation and/or loose nut	Clean with a rough cloth soaked in a suitable solvent, fully tighten the earth connection and cover with neutral grease again
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 relative 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 defective operation (if necessary, ask ABB SACE)

8.3.3 Checking contact wear

In order to obtain distance A indicated in the table, it is possible to adjust the position of the shaft and of the operating mechanism comando.

- 1) Open the circuit-breaker
- 2) Remove the arcing chamber
- 3a) Adjustment of moving contact detachment for E1-E2-E3:
 - loosen the screws in pos.1 and the nuts in pos. 3 (FIG 33 a)
 - work in a similar way on the screws in pos. 2
 - take the bushes of the operating mechanism (pos. 5) to rest on the shaft, working 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 distance A
- 3b) Adjustment of moving contact detachment for E4-E6:
 - loosen the screws in pos.1 and 6, and the nuts in pos. 3 and 8 (FIG 33 a and 33 b)
 - work in a similar way on the screws pos. 2
 - take the bushes of the operating mechanism (pos. 5) and the bushes of the intermediate shoulders (pos. 9) to rest on the shaft, working 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 distance A
- 4) If the distance is not correct, open the circuit-breaker again and repeat the operation indicated under point 3a or 3b
- 5) If distance A is correct, open the circuit-breaker again, seal with a yellow paint and remount the arcing chambers.



Circuit-breaker	A
E1 - E2 - E3	1 ± 1.9 mm
E4 - E6	0.8 ± 1.5 mm

Fig. 33

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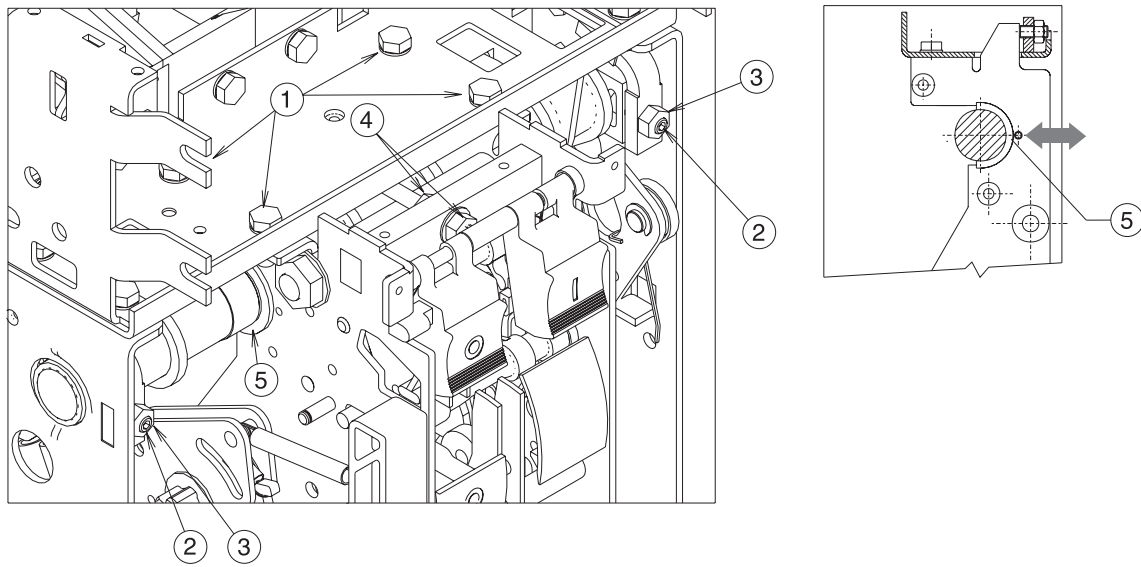


Fig. 33a

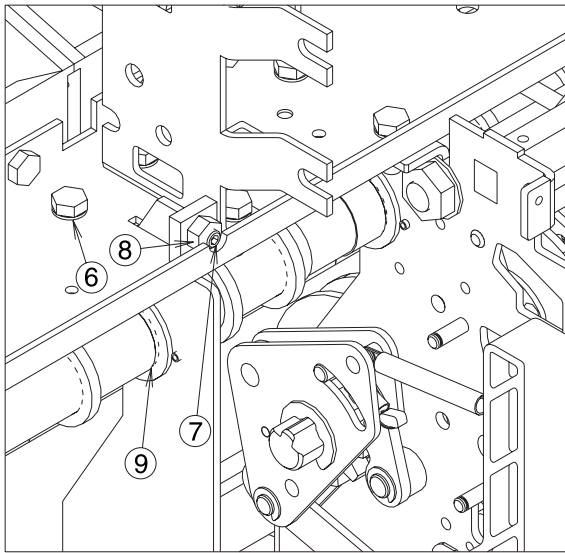


Fig. 33b

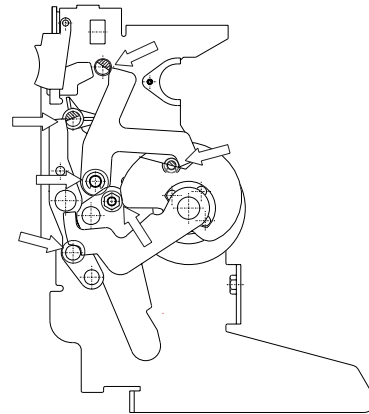


Fig. 33c

8.3.4 Operating mechanism maintenance

- Carry out the checks and interventions listed under point 1 of the table in paragraph 8.3.2.
- Lubricate the supports 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

The power supply to the TEST (15 V DC) connection bosses of the PR111 release does not open the circuit-breaker										Anomalies	
Pressing the TEST pushbutton on the PR112/PR113 does not cause circuit-breaker opening											
Intervention of the μ P Fault signal on the PR112/PR113 release											
The WARNING or EMERGENCY LEDs on the PR112/PR113 release light up											
Release coils interrupted or burnt out, geared motor winding interrupted											
The shunt opening release or shunt closing release does not energize sufficiently											
The shunt opening release or shunt closing release remains energized											
The moving part does not rack into in the fixed part											
The moving part does not rack out of the fixed part											
The circuit-breaker does not close											
The circuit-breaker does not open											
										Possible causes	Checks and remedies
●	●									Connector XO not inserted correctly	Check and insert connector XO correctly
●	●									Coil of shunt opening release YO1 interrupted	Replace the YO1 shunt opening release
●	●	●								Defect in the electronic circuits of the electronic 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 relative to the releases	Intervene 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 interrupting parts must be programmed within a short time. If contact wear reaches 100%, the circuit-breaker must be put out of service immediately. Ask ABB SACE about replacement operations of the interrupting parts.
							●			Protections not reset	Press the mechanical pushbutton for signalling protection intervention
								●		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 than the one indicated on the rating plate of these releases	Check the rating plate voltage of the releases
								●	●	Operating circuit faulty	Check connections, fuses, interlock, protection circuit-breakers and consent contacts
								●	●	Wire tightening screws loose	Check tightening of the screws connecting the wires
								●	●	Incorrect electrical connections in the power supply circuit	Check the connections with the relative circuit diagram
									●	Release coils interrupted	Replace the coils
									●	Operating mechanism blocked	Operate by hand. If the fault persists, consult ABB SACE
									●	Key not inserted in the operating mechanism key lock	Insert and turn the key
									●	Circuit-breaker in intermediate position between racked-in and racked-out	Complete the operation
									●	Undervoltage release not energized	Check the relative 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 release (YO - YO2 - YC)

This allows remote opening or closing control of the apparatus. Given the circuit-breaker operating mechanism characteristics, opening (with the circuit-breaker closed) is always possible, whereas closing is only possible when the closing springs are charged. 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 the use 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 is, in fact, fitted with an antipumping device).

(*) 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 a time of at least 30 ms before giving the opening control to the shunt closing release.

Reference figures in the electrical circuit diagrams: YO 4 - 5 - YC 2 3; YO2 8

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 (CEI EN 60947-2 Standards)
Inrush power consumption (Ps)	DC = 200 W
Inrush power time \approx 100 ms	AC = 200 VA
Continuous power (Pc)	DC = 5 W
	AC = 5 VA
Opening time (YO - YO2)	(max) 60 ms
Closing time (YC)	(max) 80 ms
Undervoltage release	2500V 50 Hz (per 1 min.)

Undervoltage release (YU)

The undervoltage release carries out circuit-breaker opening in the case of considerable lowering 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 supplied (the closing lock is carried out mechanically). Most of the releases can operate either with 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: CEI EN 60947-2 Standards

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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	2500V 50 Hz (for 1 min.)

Time delay device for undervoltage release (D)

The undervoltage release can be combined with an electronic time-delay device to be mounted outside in relation to the circuit-breaker, which allows a delay in intervention of the release with established and adjustable times. The use of the delayed undervoltage release is recommended when the power supply network of the release can be subject to interruptions or short time drops in voltage, in order to avoid trips.

When it is not supplied, circuit-breaker closing is prevented.

The time-delay device is 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 charging (M)

This carries out automatic closing spring charging of the circuit-breaker operating mechanism. After circuit-breaker closing, the geared motor immediately sees to recharging the closing springs.

When there is no power supply voltage or during maintenance work, the closing springs can, in any case, be charged manually (by means of the special lever of 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 (Norme CEI EN 60947-2)
Inrush power consumption (Ps):	DC = 500 W
	AC = 500 VA
Nominal power (Pn):	DC = 200 W
	AC = 200 VA
Inrush time	0,2 s
Charging time:	4-5 s
Insulation voltage	2500V 50 Hz (for 1 min.)

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

Reference figure in the electrical circuit diagrams: M

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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 allows visual signalling on the operating mechanism by means of 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.

b) Electrical and mechanical trip signalling for overcurrent releases

This allows visual signalling on the operating mechanism (mechanical) and remotely (electrical by means of a changeover switch) of the circuit-breaker being open following a trip of the overcurrent releases. To reset the circuit-breaker, it is necessary to reset the pushbutton for mechanical indication. The SACE PR112 and SACE PR113 releases are already provided with an internal overcurrent signalling contact.

Reference figures in the electrical circuit diagrams: S51 12

Auxiliary contacts

Auxiliary contacts installed on the circuit-breaker are available which allow signalling of the circuit-breaker status (are also available in gold plated contact version for digital signal).

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

Un	In max	cos φ
250 V AC	5 A	0.3

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 or 10 auxiliary contacts. The auxiliary contacts take up the following configurations:

- 4 break/make contacts (2 normally open + 2 normally closed)
- 10 break/make contacts (5 normally open + 5 normally closed) - not available when the SACE PR112 and SACE PR113 overcurrent releases are required.

A group of 15 supplementary break/make contacts is also available, which can be mounted outside the circuit-breaker. The basic configuration described above can be modified by the user for indication of normally open or normally closed by repositioning the faston connector on the microswitch.

Reference figures in the electrical circuit diagrams: Q/1÷10 21 22; Q/11÷25 23

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-breaker in withdrawable version to be installed on the fixed part.

The auxiliary contacts take up the following configurations:

- 5 contacts: group consisting of 2 connected signalling contacts, 2 disconnected signalling contacts and 1 test position signalling contact (main pliers isolated, but sliding contacts connected)
- 10 contacts: group consisting of 4 connected signalling contacts, 4 disconnected signalling contacts and 2 test isolated signalling contacts (main pliers isolated, but sliding contacts connected).

Reference figures in the electrical circuit diagrams: S75I 31-32 - S75T 31-32 - S75E 31-32

c) Contact for signalling closing springs charged

This consists of a microswitch which allows remote signalling of the state of the circuit-breaker operating mechanism closing springs. (It is always supplied with the spring charging geared motor).

Reference figures in the electrical circuit diagrams: S33 M/2 - 11

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

The undervoltage releases can be fitted with a contact (by choice, normally closed or open) for signalling undervoltage energized for remote signalling of the state of the undervoltage release.

Reference figures in the electrical circuit diagrams: 12

Current transformer for the neutral conductor outside the circuit-breaker

Only for three-pole circuit-breakers. Allows neutral protection to be carried out by means of connection to the overcurrent release. (It is supplied on request).

Reference figures in the electrical circuit diagrams: TI/N 51-52 - UI/N 51-52

Homopolar toroid for the main power supply earthing conductor (star center of the transformer)

SACE PR112 and PR113 microprocessor-based electronic releases may be used in combination with an external toroid located on the conductor, which connects the star center of the MV/LV transformer (homopolar transformer) to earth. In this case, the earth protection is defined as Source Ground Return.

The homopolar transformer is available in four different versions in terms of rated current (but keeping the same overall dimensions in any case).

Reference figure in the electrical circuit diagrams: TI/O (51-52)

Characteristics				
Rated current	100 A	250 A	400 A	800 A

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10.2 Mechanical accessories

Mechanical operation counter

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

Mechanical locks

a) Lock in open position

Different mechanisms are available which allow the circuit-breaker to be locked in the open position.

These devices can be controlled by:

- A key: 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 numberings are available.
- Padlocks: up to 3 padlocks (not supplied): Ø 4 mm.

b) 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 (up to four different key numberings are available) and by padlocks (up to 3 padlocks, not supplied - Ø 4 mm). Only available for circuit-breaker in withdrawable version to be installed on the moving part.

c) 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-breaker in withdrawable version to be installed on the moving part.

d) Accessories for shutter padlocks

Allow the shutters to be padlocked (installed on the fixed part) in the closed position. Only available for circuit-breaker in withdrawable version to be installed on the fixed part.

e) Mechanical lock on compartment door

Does not allow the compartment door to be opened with the circuit-breaker closed (and circuit-breaker connected for withdrawable circuit-breakers) and locks 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 relative circuit-breaker operations except by using a special tool.

b) IP54 door protection (NEMA 3/3S/13)

This is carried out by means of a transparent plastic escutcheon plate which fully protects the front of the circuit-breaker and allows IP54 degree of protection to be obtained. 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 release (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 group)

type B: between 3 circuit-breakers (of 2 power supplies + emergency group)

type C: between 3 circuit-breakers (2 power supplies + bus-tie group)

type D: between 3 circuit-breakers (3 power supplies / a single closed circuit-breaker group)

10.3 Spare parts

- Shields and front escutcheon plate
- Opening solenoid for the PR111 / PR112 / PR113 overcurrent release
- Arcing chamber
- Closing springs
- Jaw-type isolating contact for fixed part of the withdrawable circuit-breaker
- Sliding earth contact
- Fixed part shutters
- Complete pole
- Operating mechanism
- Connection cables between releases and current transformers

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11. Releases – General notes

The SACE Emax series circuit-breakers can be equipped with SACE PR111, PR112 or PR113 electronic releases.

The SACE PR111 releases carry out the protection function and local and test signalling.

Apart from the functions of the PR111 which can be carried out with a wider range of possibilities, the SACE PR112 and PR113 releases in the configuration fitted with the protection unit only (PR112/P, PR113/P), also carry out the functions of remote watchdog signals and measurement. Both the releases normally receive their power supply from the current transformers mounted in each pole. All the adjustment and control parts available to the user are arranged on the front of the release.

Their installation in the circuit-breaker is simple: the mechanical fixing is carried out by means of four nuts, whereas some connectors are available for the electrical connections, whose references are indicated on the electrical circuit diagram.

XK1: connector for connection of the PR111, PR112/P and PR113/P releases to the current sensors

XK2 and XK3: connectors for the auxiliary circuits of the PR112/P and PR113/P releases (for functions such as remote signals and circuits for zone selectivity)

X0: connector for the Y01 shunt opening release which makes the circuit-breaker open following intervention of the release.

Accessory units normally provided, and others supplied on request, allow the auxiliary power supply and tests to check functionality of the release.

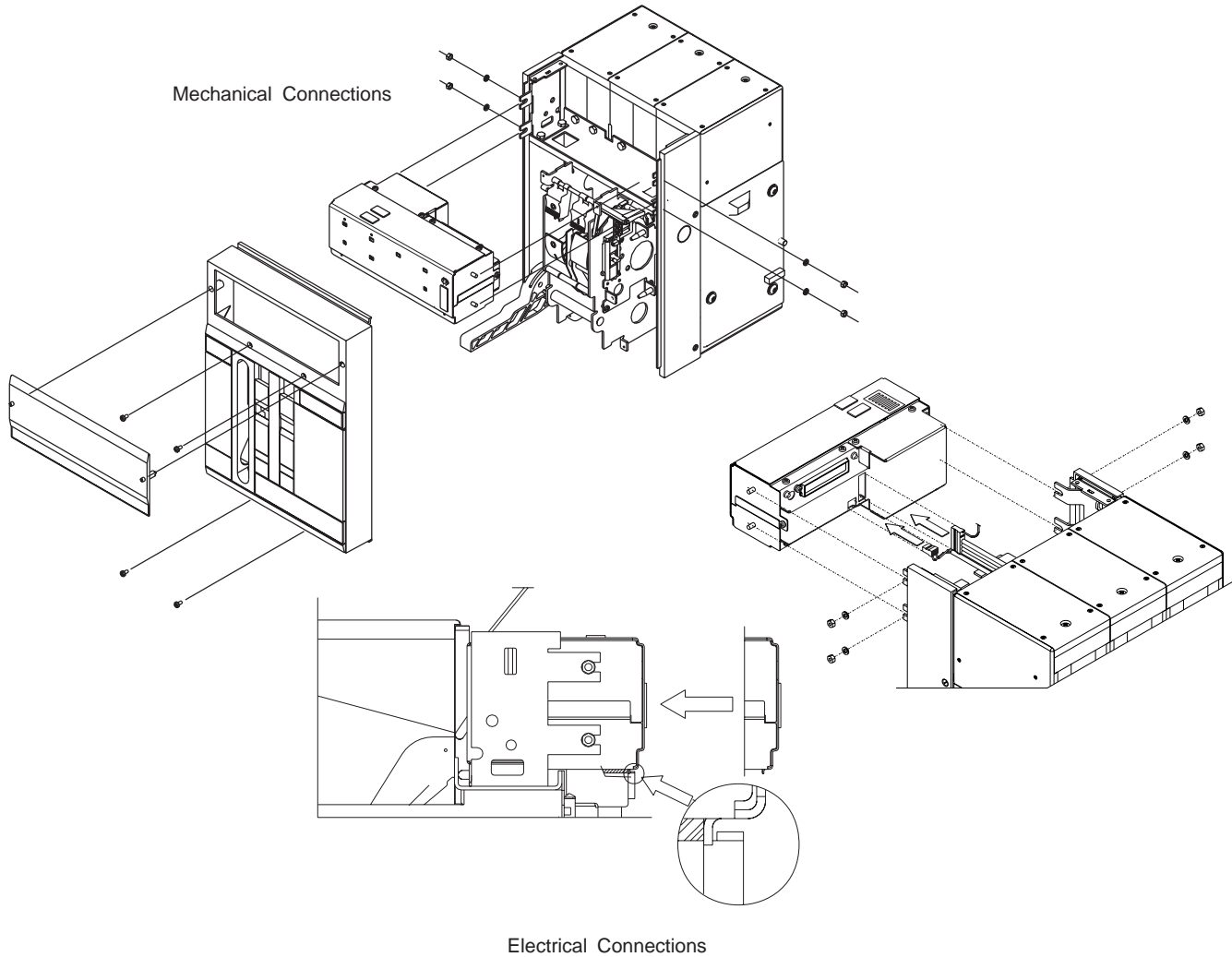


Fig. 34e

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11.1 Safety notes



CAUTION: this symbol identifies information on the procedures, actions or circumstances which can lead to wounds or injuries of the personnel, damage to the unit or economic losses.

Read right through this manual carefully.
This device should only be used by qualified and competent personnel.

In case of any doubts regarding its safe use, the unit must be put out of service, ensuring that it is not used unintentionally.

It must be presumed that safe use is not possible if:

1. the unit shows visible damage.
2. the unit does not work (for example, with the auto-test or by means of the TT1 trip test unit).
3. the unit has undergone damage during transport.

11.1.1 Notes for dielectric strength tests



Dielectric strength tests are not allowed on the inputs and outputs of the releases.

11.2 Abbreviations and various notes

11.2.1 Abbreviations

Abbreviation	Meaning
BA	Opening coil
BC	Closing coil
CB	Circuit-breaker (Circuit-breaker. For example, Emax)
CS	Current Sensor (also see CT)
CT	Current Transformer (also see CT)
Emax	ABB SACE Emax series of air circuit-breakers
HMI	Human Machine Interface
HW	Hardware
In	Current transformer rated current (CT) installed in the circuit-breaker
MT	Thermal memory
Pn	Circuit-breaker nominal power ($3 * V_n * I_n$)
Pn _{phase}	Nominal power of phase ($V_n * I_n$)
PR020/K	ABB SACE signalling unit
PR010/T	ABB SACE test unit
PR111/P	Release for Emax circuit-breaker
PR112/P	Release for Emax circuit-breaker
PR112/PDM	Release for Emax circuit-breaker
PR113/P	Release for Emax circuit-breaker
PR113/PDM	Release for Emax circuit-breaker
PR120/B	ABB SACE power supply unit
Release	Also called "Protection unit" or "Release"
RMS	r.m.s. value
SA	Opening Solenoid
SdZ	Zone selectivity
SRE	Contact protection tripped (Release tripped)
SW	Software
TA	Current transformer (also see CS)
Trip	Action of opening of the circuit-breaker, generated by trip unit
TV	Voltage transformer (also see VS)
Un	Rated voltage of voltage transformers installed (phase voltage)
Vaux	Auxiliary power supply
VS	Voltage Sensor (also see VT)

11.2.2 Various notes

- A. For example, use two-wire "Belden" type cable (not supplied by ABB SACE) as described in ABB SACE RU4602.001 drawing.
- B. For example, use three-wire "Belden" type cable (not supplied by ABB SACE) as described in ABB SACE RU4602.002 drawing.
- C. The unit is fitted with "backup protection" function. Should the first strike on the opening solenoid not immediately open the circuit-breaker (SA partially faulty), TRIP commands are sent repeatedly until the circuit-breaker opens (when Vaux is present) or until disappearance of the current (if under in self-supply). With Vaux present, in the "backup protection" condition, the "emergency LED flashes with the "Last Trips" page displayed, and the keyboard is disabled. The "backup" condition can be signalled by configuring the release. By using the "YO back" selection, it is possible to control the accessory "opening coil (YO)" as a further opening device when the SA does not work.

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12. SACE PR111/P release – Identification

The PR111 units available according to the ANSI/UL Standards are:

- PR111/P (LI)
- PR111/P (LSI)
- PR111/P (LSIG)

12.1 Standard

PR111/P 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 PR111 unit is a high performing self-supplied protection unit with **Protection, Watchdog and Test functions.**

The protections available are:

Protections available

Symbol	Protection against...
L	overload with inverse long time-delay
S	short-circuit with adjustable delay
I	instantaneous short-circuit
G	earth fault with adjustable delay
linst	ultra rapid instantaneous short-circuit (for high currents)

The PR111 can be installed on three-pole, three-pole with external neutral or four-pole circuit-breakers.

It should be noted that the reference current, for the PR111, is the I_n (rated current of the CTs mounted in the circuit-breaker) and not the I_u (uninterrupted rated current of the circuit-breaker itself). Example: the E1B 800 circuit-breaker with 250 A CT, has an I_u of 800A and an I_n of 250 A.

The unit carries out opening of the circuit-breaker, in which it is integrated, by means of the SA which acts directly on the mechanical lever device of the apparatus.

The CTs supply both the energy for self-supply and the signal to calculate the current circulating in the circuit-breaker busbars. Operation with self-supply is guaranteed for any protection function and setting which can be defined by the user.

The unit is made using digital microprocessor technology and interfaces with the user by means of dip-switches. The protection parameters and in general the mode of operation of the unit can be completely set by the user.

12.2.2 Electrical characteristics

Nominal service frequency	50/60 Hz $\pm 10\%$
Pass band	600 Hz max
Peak factor	2.1 max @ 2,8 I_n
MTBF	15 years @ 45°C

12.2.3 Self-supply

All the Protection functions (see par. 12.2.1) are operative without any external auxiliary power supply. In fact, self-supply is guaranteed from the CTs installed in the circuit-breaker.

Minimum busbar current for turning the release on:

- 0.30x I_n with single-phase current
- 0.20x I_n with two-phase current
- 0.15x I_n with three-phase current

12.3 Environmental characteristics

Operating temperature	-25°C ... +70°C
Storage temperature	-40°C ... +90°C
Relative Humidity	0% ... 98%
Degree of protection (with PR111 installed in the circuit-breaker)	IP 30

12.4 Protection functions

The PR111 protection unit carries out 5 independent protection functions. In particular:

1. Protection against overload with inverse long time-delay “**L**”;
2. Protection against short-circuit with adjustable delay “**S**”;
3. Protection against instantaneous short-circuit “**I**”;
4. Protection against earth fault with adjustable delay “**G**”;
5. Protection a fixed threshold against instantaneous short-circuit “**linst**”;

The unit is fitted with “backup protection” function. Should the first strike on the opening solenoid not immediately open the circuit-breaker (SA partially faulty), TRIP commands are sent repeatedly until the circuit-breaker opens or until disappearance of the current

The PR111 unit allows the neutral pole current signal to be processed with different relationships with regard to the value of the phases (see 12.9.1). Two luminous indicators (LEDs) are provided on the front of the unit, which are activated during an alarm for protection “**L**” or “**S**”. They are deactivated when the alarm ends or when a protection has tripped.

For the protections with fixed time with adjustable delay, the relationship implemented is the following: $t = k$.

For the protections with inverse time, the relationship between trip time and overcurrent is given by the formula: $t = k / I^2$.

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RMS and Peak calculation

The protection allows the current signal to be processed in the following way:

- with rms value up to a current of $2xI_n$ and with a peak factor ≤ 3 for protection function "L"
- with peak value for currents $\leq 2xI_n$ and for protection functions "S", "I" and "Iinst" (*).
- with mean value for earth fault protection function "G".

If the waveform has a deformation above the declared limit (2.1 @ 2.8 In), the calculation tolerance of the true rms value will increase.

(*) Processing is carried out taking into account the peak value divided $\sqrt{2}$ (the sinusoidal wave form is therefore considered). This is because of incompatibility between the trip time and the rms value calculation time.

12.4.1 Protection "L"

Protection "L" is the only one which cannot be disabled since it carries out self-protection against overloads of the release itself.

The type of curve settable is $t=k/I^2$.

The trip time of the protection, inverse time, is given by the following expression:

$$\max \left[\frac{36 \cdot t_1}{(I_f / I_1)^2}, 0.75 \right] \text{ for } I_f \leq 12I_n, 0.75 \text{ for } I_f > 12I_n$$

I_f is the fault current and I_1 is the protection threshold, set by the user.

NB: Time expressed in seconds.

12.4.2 Protection "S"

The protection, which can be disabled, can either be with fixed time ($t=k$) or inverse time ($t=k/I^2$). In the latter case the trip time is given

by the expression $\max \left[\frac{64 \cdot t_2}{(I_f)^2}, t_2 \right]$ for $I_f > I_2$ I_f is the fault current and I_2 the protection threshold, set by the user.

NB: Time expressed in seconds.

12.4.3 Protection "I"

The protection, which can be disabled, with fixed time ($t=k$) is carried out with nil intentional delay.

12.4.4 Protection "G"

The protection, which can be disabled, is of the inverse time type ($t=k/I^2$).

The trip time is given by the expression $\max \left(\frac{1}{(I_f / I_4)^2}, t_4 \right)$ I_f is the fault current and I_4 the protection threshold, set by the user.

NB: Time expressed in seconds.

The PR111 unit is able to provide earth fault protection, carried out inside the release, vectorially summing the phase and neutral currents. The fault current is defined by the following formula:

$$\vec{I}_G = \vec{I}_1 + \vec{I}_2 + \vec{I}_3 + \vec{I}_{NE}$$

In the case when there is no fault in the circuit, the module of the sum of these currents is always nil. Vice versa, the value of the fault current will always take on a higher value depending on the size of the fault.

When the value of the phase current is above $4xI_n$, function "G" excludes itself since, in this case, there are other protections which intervene as the fault is considered to be a phase fault.

12.4.5 Protection against "Iinst" instantaneous short-circuit

This function has a single protection curve with fixed time.

When the protection trips, the circuit-breaker opens by means of the opening solenoid (SA).

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12.4.5.1 Selection of the threshold value

For correct setting of protection linst, linked to the size of the circuit-breaker, work on the 10 relative dip-switches located on the top part of the release (see Figure 35), consulting the label placed to their side.

The protection, which can only be set by ABB personnel, cannot be excluded.

In the diagrams of the label relative to the settings, the position of the dip-switch is indicated by the white part.

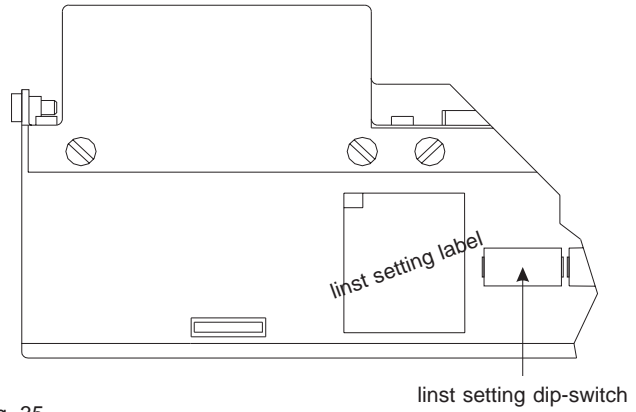
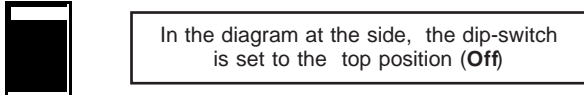


Fig. 35

! Modification of the set threshold can lead to permanent damage of the circuit-breaker and of the installation itself, with consequent damage to the operator.

12.5 Other functions

12.5.1 Watchdog

Operation of the management circuits of the PR111/P, and the relative SW, are constantly monitored from a special control circuit (inside the microcontroller) in order to prevent it blocking during operation.

12.5.2 Simple test of the release

Using the TT1 test unit (see par. 12.11.1) connected to the special dedicated test connector (see ref. G Fig. 36), it is possible to check correct operation of the activation chain (microprocessor, cabling and SA). In the case of a positive outcome, the circuit-breaker is opened. The function is only available with nil busbar current.

12.5.3 Complex test of the release

Using the PR010/T test unit (see par. 12.11.2) connected to the release by means of the front TEST connector (see ref. H Fig. 36), it is possible to carry out a complete series of tests, with reports which can be downloaded to a PC.

12.6 User interface

Caption for the front of the PR111unit:

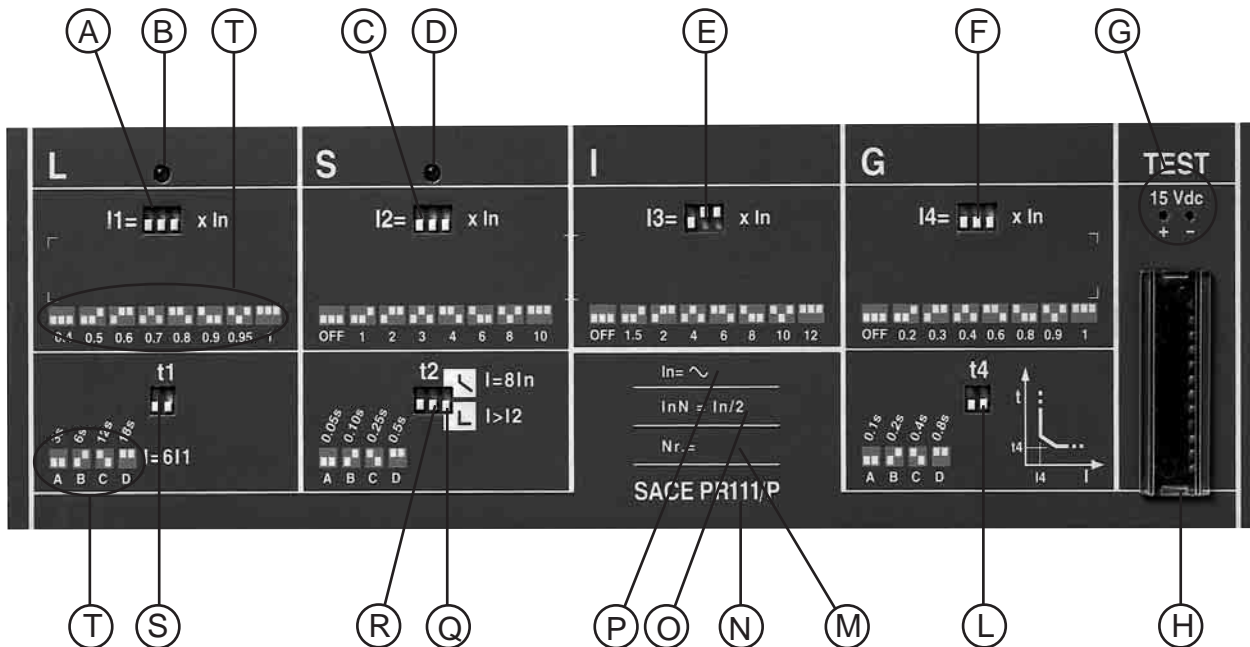


Fig. 36

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Ref. Fig. 36	Description
A	Dip-switch for setting protection function "L" threshold
B	LED for signalling protection function "L" under timing.
C	Dip-switch for setting protection function "S" threshold
D	LED for signalling protection function "S" under timing.
E	Dip-switch for setting protection function "I" threshold
F	Dip-switch for setting protection function "G" threshold
G	TEST connection for application of the TT1 accessory.
H	TEST connector for application of the PR010/T accessory.
L	Dip-switch for setting the protection curve function "G"
M	Serial number of the unit.
N	SACE Logo identifying the product.
O	Setting the Neutral protection
P	In (Rated current of the CTs installed).
Q	Dip-switch for setting the type of protection curve function "S"
R	Dip-switch for setting the protection curve function "S"
S	Dip-switch for setting the protection curve function "L"
T	Dip-switch setting diagram for setting the required value.

12.7 Default settings

The PR111/P is supplied by ABB SACE with the following preset parameters:

Default settings (preset by ABB SACE)

#	Protection	Threshold	Time	Curves
1	L	1 In	D (18s)	k/I ²
2	S	Off	A (0.05s)	k
3	I	4 In	—	—
4	G	Off	A (0.1s)	k
5	linst	E1 (*)	—	—
6	Neutral sel.	50 % (°)	—	—

- (*) Parameters set with these values only for PR111 sold as a loose piece.
- (°) Setting can only be modified by ABB SACE

12.8 Putting into service

12.8.1 Connections



For the connections to be carried out by the user, it is advisable to strictly follow what is indicated in this document. This means that we shall be able to satisfy all the international reference Standards and guarantee perfect operation of the release even under severe environmental and electromagnetic conditions. Take particular care with the earthing connections.

12.8.2 CT and SA connection check



If installation of the PR111 has been carried out by the user, before putting the circuit-breaker into service, it is advisable to check correct connection of the CT and/or SA cables, and if this has not been done, immediately open the circuit-breaker and make the connections.

12.8.3 Test

Before putting into service it is advisable carry out a test ("Trip test") of the whole SA chain by using the TT1 accessory. Positive outcome is shown by the circuit-breaker opening (see 12.5.2).

12.8.4 Initial settings

If the PR111 is supplied directly installed in the circuit-breaker, ABB SACE will see to applying the adhesive labels for all the variables relative to the circuit-breaker (e.g. Type of circuit-breaker, CT size, etc.).

Vice versa, if the PR111 is supplied as a loose piece, it will be up to the user to apply the adhesive labels relative to all the necessary parameters. It should be noted that ABB SACE defines each possible setting in a sensible way (see default parameters).



Apart from this, it is absolutely indispensable for the user to carefully define each modifiable parameter, before putting the PR111 into service.

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12.9 Operating instructions/Service operation

12.9.1 Modification of basic configuration

It is possible to select the setting value relative to protection of the neutral conductor (percentage expressed according to the phase current). The selectable values are 50% and 100%. Modification must only be carried out by ABB SACE.

12.9.2 Modification of protection functions

This paragraph allows the user to set of the protection functions implemented in the PR111 unit. Here only the setting methods and which values are selectable are given. For all the other information regarding the technical characteristics of these protection functions, please see par.12.4.



No parameterisation is allowed if the PR111 unit is in an alarm situation.

In the diagrams on the front plate (see ref. T Fig. 36), relative to the settings, the position of the dip-switch is indicated by the white part.



In the diagram at the side, the dip-switch is set in the top position

12.9.2.1 Example of setting

An example of setting the dip-switch of protection function S is given below, with:

- Trip threshold (I_2) $\Rightarrow 2 \times I_n$
- Curve (t_2) $\Rightarrow 0,05s$ (A) of type $t=k/I^2$

Threshold
 I_2



Curve
 t_2



Protection	Disabling	Threshold		Time		Tolerance threshold ⁽⁵⁾	Time Tolerance ⁽⁵⁾
		Range	Values Selectable	Range	Values Selectable		
L ($t=k/I^2$)	<input type="checkbox"/>	$0.4xI_n \leq I_1 \leq 1xI_n$	0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 0.95, 1	$3s \leq t_1 \leq 18s$ ^{(1) (2)}	3 (A), 6 (B), 12 (C), 18 (D)	Trip between 1.1 and 1.2xI ₁	$\pm 10\%$, $I_1 \leq 3xI_n$ $\pm 20\%$, $I_1 > 3xI_n$
S ($t=k$)	<input checked="" type="checkbox"/>	$1xI_n \leq I_2 \leq 10xI_n$	1, 2, 3, 4, 6, 8, 10 + Off	$0.05s \leq t_2 \leq 0.5s$ ⁽³⁾	0.05 (A), 0.1 (B), 0.25 (C), 0.5 (D)	$\pm 10\%$	the best of the two data $\pm 20\%$ or $\pm 50ms$
S ($t=k/f$)	<input checked="" type="checkbox"/>						
I ($t=k$)	<input checked="" type="checkbox"/>	$1.5xI_n \leq I_3 \leq 12xI_n$	1.5, 2, 4, 6, 8, 10, 12 + Off	Instantaneous	--	$\pm 20\%$	$\leq 35ms$ $I_r \leq 3xI_n$ $\leq 30ms$ $I_r > 3xI_n$
G ($t=k/f$)	<input checked="" type="checkbox"/>	$0.2xI_n \leq I_4 \leq 1xI_n$	0.2, 0.3, 0.4, 0.6, 0.8, 0.9, 1 + Off	$0.1s \leq t_4 \leq 0.8s$ ⁽⁴⁾	0.1 (A), 0.2 (B), 0.4 (C), 0.8 (D)	$\pm 10\%$	$\pm 20\%$
Inst	<input type="checkbox"/>	Only settable by ABB		Instantaneous	--	$\pm 5\%$	--

⁽¹⁾ The minimum value of this trip is 750ms regardless of the type of curve set (self-protection).

⁽²⁾ The trip time t_1 is defined for $I_f = 6I_1$

⁽³⁾ The trip time t_2 is defined for $I_f = 8I_n$ for $t=k/I^2$ and $I_f > I_2$ for $t=k$

⁽⁴⁾ The trip time t_4 is defined for $I_f = 4I_n$

⁽⁵⁾ These tolerances are valid with the following hypotheses:

- release self-supplied during service (without start-up)
- two-phase or three-phase power supply

For all cases not considered in the above hypotheses, the following tolerance values are valid:

	Trip threshold	Trip time
L	Trip between 1.1 and 1.25 x I ₁	$\pm 20\%$
S	$\pm 10\%$	$\pm 20\%$
I	$\pm 20\%$	$\leq 60ms$
G	$\pm 15\%$	$\pm 20\%$

12.9.3 Signals

12.9.3.1 Optical signals

Signal	Description
Led L (red)	• Presence of one or more overloaded phases with current values of $I > 1.0xI_1$ (protection "L" timing) (on the NE, it depends on the selection made. For example, at 50% the values are halved)*;
Led S (red)	• Timing in progress for protection function "S"

* The IEC 60947-2 Standard defines the timing threshold L for current: $1.05 < I < 1.3 \times I_1$

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12.10 Troubleshooting



The following table collects up a series of typical service situations, which are useful in order to understand and solve hypothetical faults or malfunctions.

N.B.:

1. Before consulting the following table, check any lighting up of the LEDs located on the front of the unit for some seconds.
2. FN indicates normal operation of the PR111.
3. In the case where the suggestions proposed do not lead to a solution of the problem, please contact the ABB SACE assistance service.

N°	Situation	Possible causes	Suggestions
1	It is not possible to carry out the trip test	<ol style="list-style-type: none"> 1. The busbar current is $\dot{e} > 0$. 2. The SA is not connected 3. TT1 device battery flat 	<ol style="list-style-type: none"> 1. FN 2. Check the SA cabling 3. Replace the battery inside the TT1
2	Trip times lower than those expected	<ol style="list-style-type: none"> 1. Threshold too low 2. Curve too low 3. Incorrect Neutral selection 	<ol style="list-style-type: none"> 1. Correct the threshold 2. Correct the curve 4. Correct the Neutral Selection
3	Trip times higher than those expected	<ol style="list-style-type: none"> 1. Threshold too high 2. Curve too high 3. Curve I^t inserted 4. Incorrect Neutral selection 	<ol style="list-style-type: none"> 1. Correct the threshold 2. Correct the curve 3. Exclude if not necessary 4. Correct the Neutral Selection
4	Rapid trip, with I ₃ =Off	Inst trip	FN with short-circuit with high I
5	Earth I high, but there is no trip	Function G prevented with I > 4 I _n	FN
6	It is not possible to modify any parameter	PR111 in alarm situation	FN

12.10.1 In the case of a fault

If it is suspected that the PR111 is faulty, shows malfunctions or has generated an unexpected trip, we recommend you strictly follow the indications below:

1. Note all the protection function settings.
2. Mark the type of circuit-breaker, number of poles, I_n and Serial Number (see Fig. 36)
3. Prepare a brief description of the opening (when did it happen? how many times? always under the same conditions? with what type of load? with what current? can the event be reproduced?)
4. Send/communicate all the information collected, together with the applicative circuit diagram of the circuit-breaker, to your nearest ABB Assistance service.

The completeness and the accuracy of the information supplied to ABB Assistance service will facilitate the technical analysis of the problem encountered, and will allow us to rapidly take all the useful measures to help the user.

12.11 Accessories

12.11.1 ABB SACE TT1 simple test unit

The SACE TT1 device is a test unit to be inserted in the special front TEST connector of the PR111 (see ref. G Figure 36). With this accessory, supplied as standard, it is possible carry out the opening test of the circuit-breaker ("Trip test") (see 12.8.3).

The unit is fitted with a 12V battery and does not therefore require any external power supply.

The item has two pushbuttons (one for PRESET and the other for TRIP) and an LED (READY) indication.

The accessory operates in the following way:

- Press the PRESET pushbutton and wait for the READY LED to light up
- Position the TT1 in the protection unit
- Within 30s from the PRESET operation press the TRIP pushbutton.
- Check the opening of the circuit-breaker.

When the READY LED does not light up it means that either the battery is flat or that the TT1 is faulty.

12.11.2 ABB SACE PR010/T complex test unit

By means of a cable connected to the front TEST connector of the PR111 (see ref. H Figure 36), the test with the SACE PR010/T unit allows correct operation of the inputs, outputs, thresholds and trip times of protection functions "L", "S", "I", "G" and "Inst" to be checked manually or automatically. It is also possible to obtain a test report which can be downloaded to a PC.

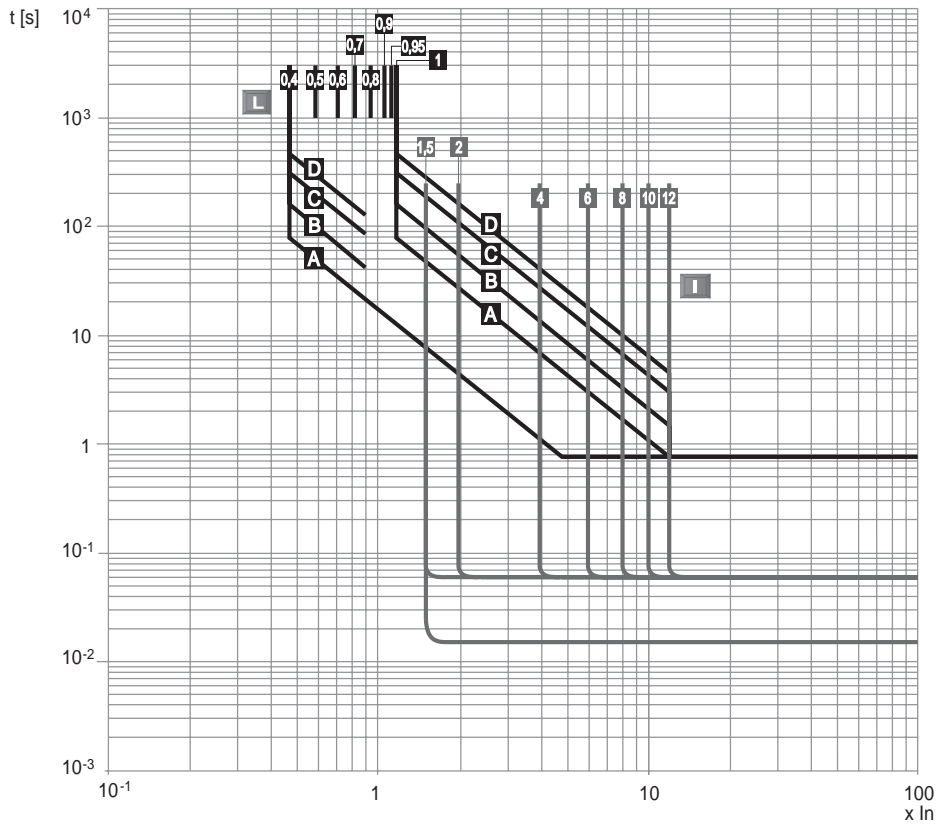
For operation of the PR010/T accessory, please consult the special instruction manual.

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12.12 Trip curves

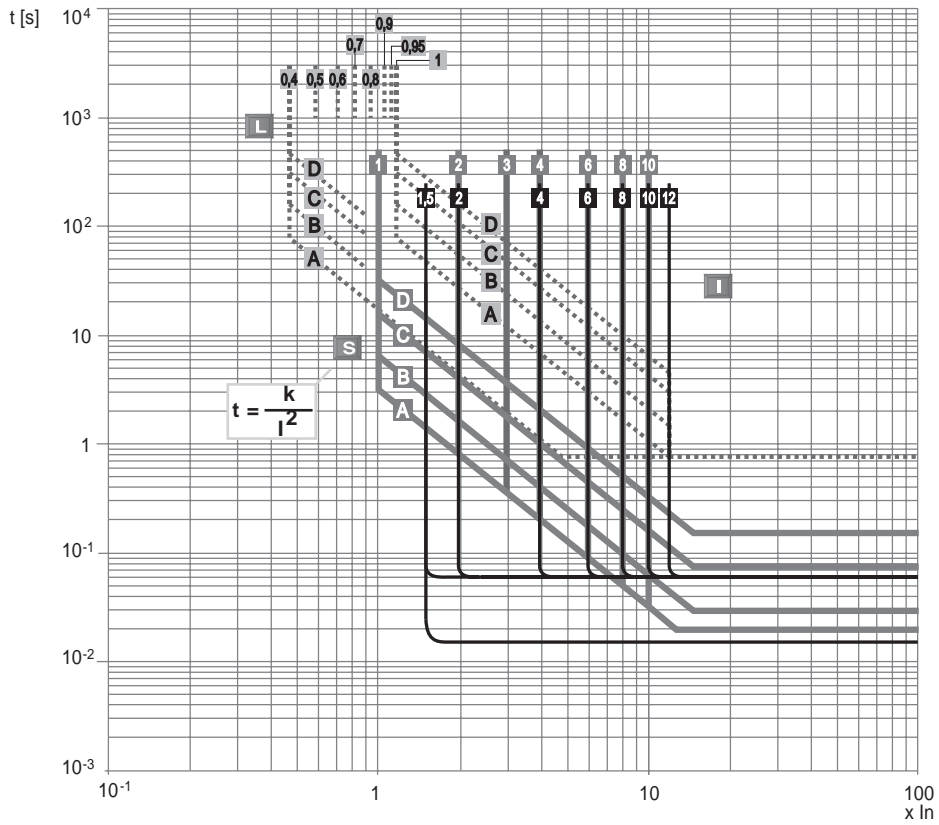
The trip curves given are indicative and only show a sub-group of the possible selections (see par. 12.9.2.1).

12.12.1 Trip curves of functions L-I



1SDC200101F0001

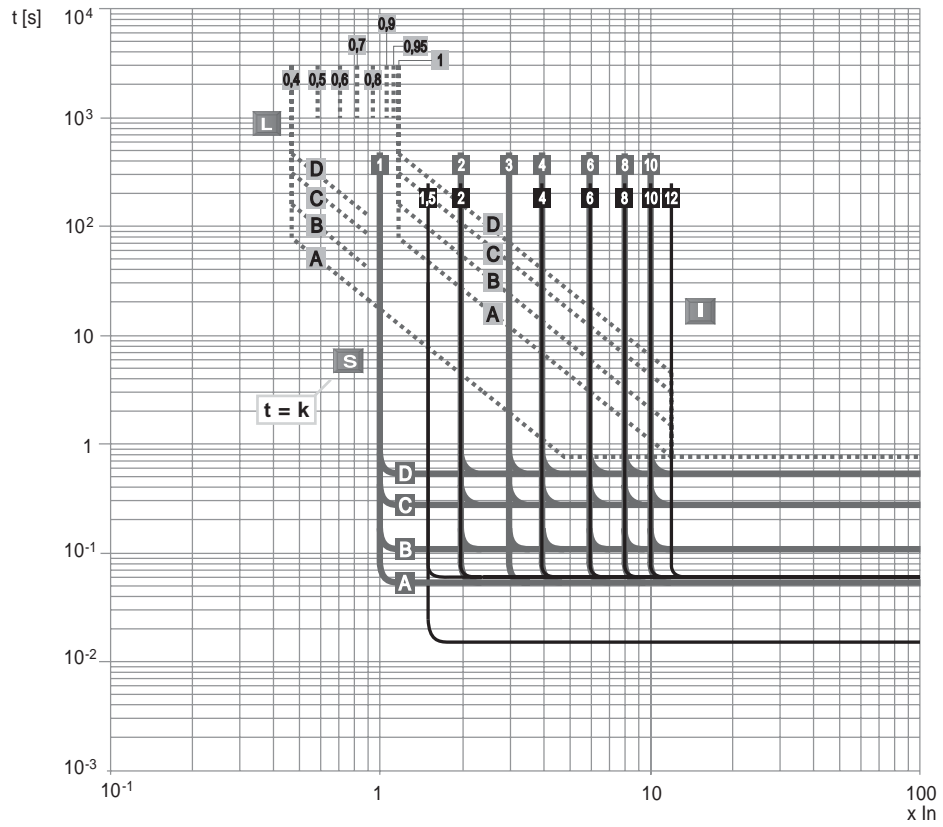
12.12.2 Trip curves of functions L-S-I



1SDC200101F0001

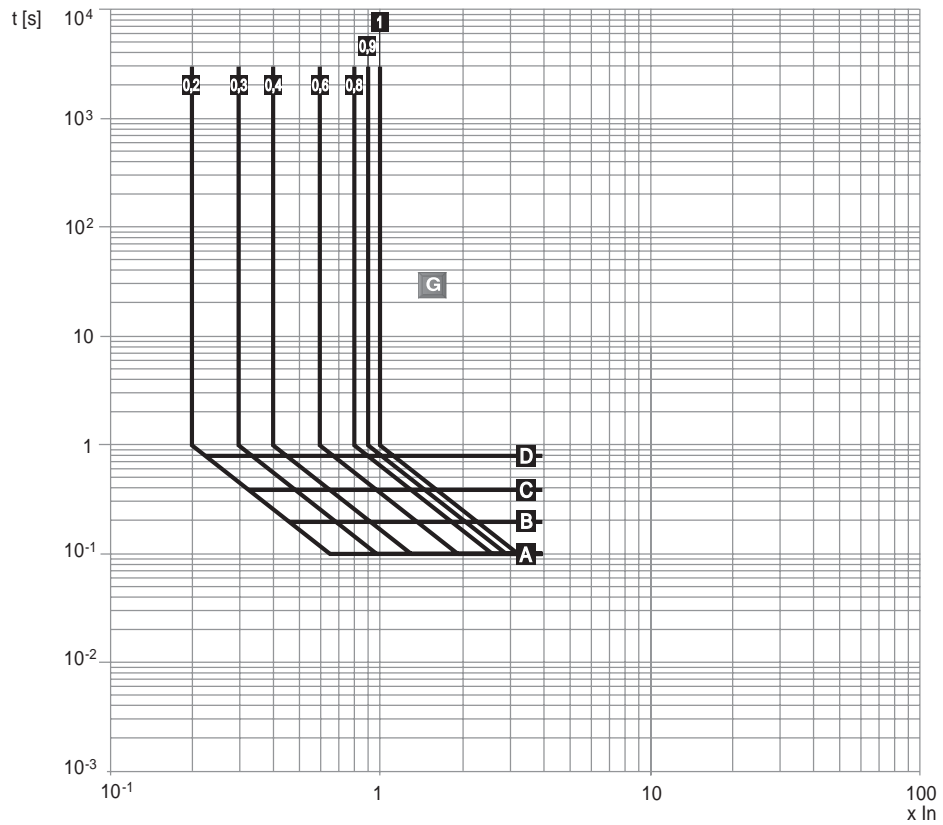
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12.12.3 Trip curves of functions L-S-I



15DC200102F0001

12.12.4 Trip curves of function G



15DC200103F0001

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13. SACE PR112/P release – Identification

The PR112 units available according to the IEC Standards are:

- PR112/P (LSI)
- PR112/P (LSIG)
- PR112/PD (LSI fitted with communication card).
- PR112/PD (LSIG fitted with communication card).

13.1 Standard

The PR112/P has been designed to work in accordance with the following international standard:
IEC 60947-2 Low voltage apparatus. Circuit-breakers.

13.2 Specifications

13.2.1 General

The PR112 unit carries out the **Protection, Measurement, Watchdog, Signalling, Test, Circuit-breaker Control, Communication and Storage functions** for low voltage 'EMAX' series three-pole and four-pole air circuit-breakers. The protections available are:

Protections available

Symbol	Protection against ...
L	overload with inverse long time-delay
S	short-circuit with adjustable delay
I	instantaneous short-circuit
G	earth fault with adjustable delay
U	phase unbalance (signalling only)
OT	temperature out of range
K	load control
linst	ultra rapid instantaneous short-circuit (for high currents)

The protections can be made in three-phase or three-phase with neutral mode according to of the type of circuit-breaker used (three-pole, three-pole with external neutral or four-pole). The unit is made using electronic digital technology and interfaces with the user with an alphanumerical display and membrane control keyboard. The protection parameters and in general the operating method of the unit are completely programmable by the user in 5 different languages. The unit carries out opening of the circuit-breaker in which it is integrated by means of the SA, which acts directly on the mechanical operating mechanism of the apparatus.

13.3 Electrical characteristics

Nominal operating frequency	50/60 Hz ±10%
Pass band	600 Hz max
Peak factor	2.1 max @ 4 In
MTBF	15 years @ 45°C

13.3.1 Self-supply

All the protection functions are operational without an external auxiliary power supply. In fact, self-supply is guaranteed by the CT installed in the circuit-breaker.

Minimum busbar current for turning the release on:

- 0.35xIn with single-phase current (0.50xIn for turning the display on as well)
- 0.20xIn with two-phase current (0.30xIn for turning the display on as well)
- 0.15xIn with three-phase current (0.20xIn for turning the display on as well)

The display lighting up time is about 3 s.

13.3.2 Auxiliary power supply

The unit operates regularly under self-supply, i.e. guaranteeing the configuration and protection of the circuit-breaker controlled.

When there is an auxiliary power supply, supplied by a galvanically separate converter, it is also possible to use the unit with the circuit-breaker open or with the circuit-breaker closed but with insufficient current to supply the device. Furthermore, the display is rear-lit, allowing data readout even in the dark. The PR112 time for reaching service operation, from the moment of connection of the Vaux is about 3 s.



Since an earth-insulated Vaux is required, it is necessary to use **“galvanically separate converters”** complying with the IEC 60950 (UL 1950) Standards or their equivalent [which guarantee a common mode current or leakage current (see IEC 478/1, CEI 22/3) not higher than 3.5mA], IEC 60364-41 and CEI 64-8.

Characteristics	PR112/P version
Power supply voltage	24V DC ±20%
Maximum ripple	5%
Inrush Current @ 24 V	~3A for 30ms
Start-up Current @ 24 V	~1.0A for 150ms
Rated current @ 24 V	~125mA
Nominal Power @ 24 V	~3W

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13.4 Environmental characteristics

Operating temperature	-25°C ... +70°C
Storage temperature	-40°C ... +90°C
Relative Humidity	0% ... 98% with condensation
Degree of protection (with PR112 inserted in the circuit-breaker)	IP 30

13.5 Inputs/outputs

13.5.1 Binary opto-insulated inputs

– **K51/S or G Zin:** Input SdZ S or G

13.5.2 Binary opto-insulated outputs

– **K51/S or G Zout:** SdZ S output or G

13.5.3 Output contacts

- **K51/p1:** relay output programmable by the user
- **K51/μP:** relay output for signalling microprocessor faulty
 - Monostable contacts, only active when there is Vaux;
 - Maximum changeover current: 3A – 250V AC (0.2A – 100V DC).
 - Contact-contact insulation voltage: 1000V AC
- **K51/Y01:** relay output for signalling “release tripped”
 - Bistable contact, also active in self-supply;
 - Maximum changeover current: 0.5A – 125V AC (0.3A – 110V DC)
 - Contact-contact insulation voltage: 750V AC

13.6 Communication bus

RS485 internal bus, 19,200 bps baud rate, ABB SACE protocol.

13.7 Protection functions

In the most complete configuration, the PR112 protection unit carries out six independent protection functions. In particular:

- Protection against overload with inverse time “**L**”
- Protection against short-circuit with adjustable delay “**S**”
- Protection against instantaneous short-circuit “**I**”
- Protection against earth fault with adjustable delay “**G**”
- Protection a fixed threshold against instantaneous short-circuit “**linst**”
- Protection against overtemperature “**OT**”
- “**K**” load control protection

Two functions (“**K**”) are also carried out for distinct control of loads: these are two predefined curves with threshold currents and trip times lower than those selectable with protection “**L**”, which can be used for two different applications:

1. disconnection of two distinct loads;
2. connection and disconnection of a load

These protections allow single loads to be disconnected before the protection for overload “**L**” intervenes to definitively open the circuit-breaker. This function is only available when there is an auxiliary power supply and when there is the external PR020/K signalling unit.

The protection allows current signal processing of the neutral pole in the following way:

1. at 50% of the phase value
2. at 100% of the phase value

The threshold values of protection functions “**L**”, “**S**”, “**I**” and “**G**” are indicated by I_1 , I_2 , I_3 and I_4 respectively, whereas the relative trip time is indicated by t_1 , t_2 , t_3 and t_4 .

There is an indication on the display of the unit which is activated during an overload. This is disabled when the overload is finished or a protection has tripped. Furthermore the circuit-breaker opens by means of the opening solenoid (SA), closes with the electrical protection tripped (K51/Y01) and the corresponding yellow magnetic flag.

For the protections with fixed time with adjustable delay, the relationship implemented is the following: $t = k$

For the protections with inverse time, the relationship between trip time and overcurrent is given by the formula: $t = k/I^2$

Rms and peak calculation

Protection functions “**L**”, “**S**” and “**G**” carry out the relative processing on the base of the true rms value of the secondary currents of the CT up to 6 In (protection **G** is disabled for currents higher than 4 In). For currents higher than 6 In, and for function “**I**”, the processing is carried out taking into account the peak value divided by $\sqrt{2}$, then the sinusoidal wave form is considered. This is because of incompatibility between the trip time and the calculation time of the rms value.

13.7.1 Protection “**L**”

Protection “**L**” is the only one which cannot be disabled since it carries out self-protection against overloads of the release itself. The trip time, inverse time, of the protection is given by the expression

$$\max \left[\frac{9 \cdot t_f}{(I_f / I_1)^2}, 0.75 \right] \text{ for } I_f \leq 12 I_n, 0.75 s \text{ for } I_f > 12 I_n \text{ where } I_f \text{ is the fault current and } I_1 \text{ is the protection threshold.}$$

NB: Time expressed in seconds.

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13.7.1.1 Thermal memory "L"

It is possible to enable the thermal memory function for cable protection. This is based on the "tL" parameter defined as the trip time of the curve (t1) at 1.25xI1.

The trip time of the release is certainly 100% of the one selected after which a time of tL has passed from the last overload or from the last trip. Otherwise the trip time will be reduced depending on the overload which has take place and on the time which has passed.

The PR112 is fitted with two instruments to make this thermal memory. The first only works when the release is supplied (it remembers overloads which did not last long enough to cause intervention of the release), whereas the second works even when the release is not supplied (it reduces any trip times when there is immediate reclosing).

It is the PR112 release which automatically decides which of the two to use according to the various different situations.

13.7.2 Protection "S"

The protection, which can be disabled, can be either with fixed time (t = k) or with inverse time. In the latter case, the trip time is given by the expression

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

NB: Time expressed in seconds.

13.7.2.1 Thermal memory "S"

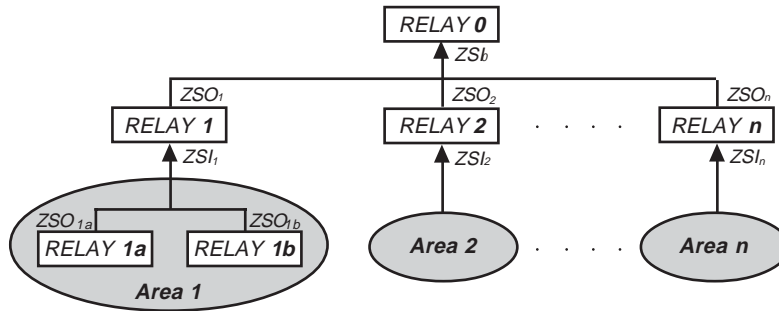
It is possible to enable the thermal memory function for cable protection when the inverse time curve is selected. This is based on the parameter "tS" defined as the trip time of the curve (t2) selected at 1.5xIn. The other characteristics are the same as those for thermal memory "L".

13.7.2.2 Zone selectivity "S"

By means of the keyboard, it is possible to enable or disable the zone selectivity function "S".

This is done by connecting together all the zone selectivity outputs (ZSO) of the releases belonging to the same zone and taking this signal to the zone selectivity input (ZSI) of the release immediately to the supply side.

If the cabling operation 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.



The zone selectivity function allows the fault area to be isolated, only isolating the installation at the level closet to the fault, keeping the rest of the installation operative.

This means that a fault on the load side of "Relay 1a" will be isolated by the latter without "Relay 1" and "Relay 0" intervening. A fault just to the load side of "Relay 1" will be isolated by the latter without "Relay 0" intervening, guaranteeing that Areas 2...n remain active.

Cabling of zone selectivity "S" is alternative to the one for "G" and operation is only guaranteed when there is an auxiliary voltage.

The ZSI signal can be connected up to 20 units in parallel (to the relative ZSO signal).

The ZSO unit can be connected to a maximum of 3 ZSI relays on the supply side in the selectivity chain.



The maximum length of the cabling 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).

13.7.3 Protection "I"

The protection, which can be disabled, is made with intentional delay nil.

13.7.4 Protection G



It is possible to disable the trip control of function G (Trip: Off). For the whole duration of the earth fault, circuit-breaker opening does not take place, but only the alarm conditions is signalled (Emergency LED lit and alarm message).

The PR112 unit is able to provide two different types of protection against earth fault.

13.7.4.1 Protection G with internal toroidal transformer

The first is carried out by means of passage of all the secondary currents (coming from the CTs) to the inside of a toroidal transformer (contained in the unit itself) which induces a current proportional to the fault current of the primary circuit on its secondary winding.

The fault current is defined by the following formula:

$$\bar{I}_g = \bar{I}_1 + \bar{I}_2 + \bar{I}_3 + \bar{I}_n \quad (\text{Vectorial sum of all the phase currents and neutral})$$

In the case when the circuit does not have any fault, the module of the sum of these currents is always 0, vice versa the value of the fault current will always take on a larger value depending on the size of the fault.

To work in this mode, it is necessary set Tor.selec.:Int.

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13.7.4.2 Protection G with external toroidal transformer “Source Ground Return”

The second, also called “Source Ground return”, can be carried out when there is the need to check operation of a machine (transformer or generator or motor etc.) which has star configuration of the windings. The protection is carried out by physically positioning an external toroidal transformer on the cable connected from the star centre of the machine to the earthing connection point. The induced current on the winding of the toroid is proportional to the fault current which in this case transits exclusively in the above-mentioned toroid. To work with this mode it is necessary to set Tor. selec.:Ext.



The external toroid must be connected to the PR112 by means of a corded shielded two-wire cable (see note A to par. 11.2.2) with a length not exceeding 15m . The shield must be earthed both on the circuit-breaker side and on the toroid side.

It is indispensable for the star centre to be connected openly to earth and that this is not also used as a neutral conductor (as in the TNC system), making a protection according to the TT system.

The nominal values of the current sensors available are given in the table on page 48.

In single-phase self-supply, protection G is only active if the primary current is higher than 0.4 x In. When the phase current value is above 4 x In , function “G” excludes itself since in this case there are the other protections which intervene as the fault is considered a phase fault.

13.7.4.3 Zone selectivity “G”

By means of the keyboard, it is possible to enable or disable the zone selectivity function “G”. Cabling of zone selectivity “G” is alternative to the one for “S” and operation is only guaranteed when there is an auxiliary voltage. The other characteristics are the same as those for zone selectivity “S”.

13.7.5 Signal of phase unbalance “U”

The signal, which can be excluded, generates a warning message in the case when unbalance between two or more phases higher than the set threshold I6 is determined.

The percentage of unbalance is calculated as follows $\% Sbil. = \frac{I_{max} - I_{min}}{I_{max}} \cdot 100$, where I_{max} is the maximum and I_{min} min the minimum phase current.

13.7.6 Protection against overtemperature inside the “OT” release

A sensor which monitors the temperature inside the unit is placed inside the PR112 unit. This allows signalling of the presence of abnormal temperatures, which could cause temporary or continuous malfunctions of the microprocessor.

This protection has two alarm levels:

- On exceeding the first fixed threshold at 70°C, there is a prealarm signal, when there is auxiliary voltage the rear illumination of the display is disabled.
- On exceeding the second fixed threshold at 85°C, there is an alarm signal and circuit-breaker opening if the “OverTemper Trip” function is enabled.

13.7.7 Load control “K”

This function is carried out in combination with the accessory PR020/K signalling unit and the PR112 release is operating with Auxiliary Power Supply.

There are two distinct protection curves with threshold currents and trip times lower than those selectable with protection L, which can be used for the following two applications:

1. disconnection of two distinct loads (2 curves with inverse time $t=k/I^2$);
2. connection and disconnection of a load (curve with adjustable delay $t=k$ for connection and with inverse time $t=k/I^2$ for disconnection)

These protections allow single loads to be connected/disconnected before the protection for overload L intervenes to definitively open the circuit-breaker.

13.7.7.1 Disconnection of two loads

Ic1 = load n°1 disconnection threshold
Ic2 = load n°2 disconnection threshold

t (Ic1) = load n°1 disconnection time (minimum trip time:190ms)
t (Ic2) = load n°2 disconnection time (minimum trip time: 375ms)

The protection is **excludable**, for both the loads individually, by selecting the [Off] value for the threshold.

Functionality:

The two protections use trip curves similar to those used by protection “L”, but with lower thresholds and shorter times. The trip curves to be used are those of protection “L”. No thermal memory is foreseen.

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The opening command to load n°1 is sent when $I > I_{c1}$ (for the time curve).
At this point the protection is disabled and a message appears for "load 1 open".

The opening command to load n°2 is sent when $I > I_{c2}$ (for the time curve).
At this point the protection is disabled and a message appears for "load 2 open".

To re-enable the protections on load n°1 (or n°2) to operate, it is necessary to press the "reset" key on the current page.

13.7.7.2 Connection - Disconnection of a load

I_{c1} = load n°1 connection threshold
 I_{c2} = load n°1 disconnection threshold

$t(I_{c1})$ = waiting time for reconnection of the load
 $t(I_{c2})$ = waiting time for disconnection of the load

The protection is **excludable**, for both the checks, by selecting the [Off] value for the threshold.

Functionality:

The disconnection protection uses trip curves similar to those used by protection "L", but with lower thresholds and shorter times.
The trip curves to be used are those of protection "L".
No thermal memory is foreseen. Operation with thermal memory "L" connected could cause abnormal behaviour.
For reclosing, adjustable t_{c1} fixed time timing is applied.

The closing control for load n°1 is sent when $I < I_{c1}$ (for the fixed time set with t_{c1}).

The opening control for load n°1 is sent when $I > I_{c2}$ (for the time curve). At this point the protection is disabled and a message appears for "load 2 open".

To re-enable operation of the protection on load n°1, it is necessary to press the "reset" key on the current page.

"Num.AR" indicates the number of load reclosing operations carried out.

"MaxAR" indicates the maximum number of reclosing operations which can be carried out (settable values: 1..9 reclosing operations, step 1 reclosing)
When "Num.AR = MaxAR", reclosing is disabled (a message appears for "auto-reclosing disabled").
To re-enable it, it is necessary to reset the "Num. AR" (entering "edit" mode on the protection setting page).

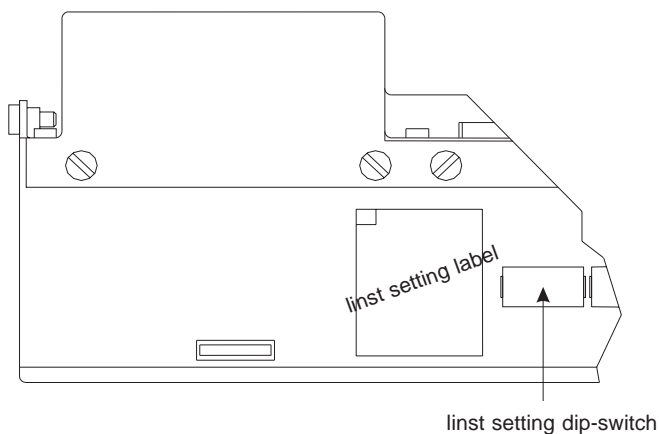
13.7.8 Protection against instantaneous short-circuit "linst"

This function has a single protection curve with fixed time.
When the protection trips, the circuit-breaker opens by means of the opening solenoid (SA).

13.7.8.1 Selection of the threshold value

To set the linst protection correctly, linked to the size of the circuit-breaker, work on the relative 10 dip-switches located on the part above the release (see figure), consulting the label placed at its side.

The protection, which can only be set by personnel ABB, cannot be excluded.



In the label diagrams relative to the settings, the position of the dip-switch is indicated by the white part.



In the diagram, the dip-switch is set in the top position (Off)

In the label diagrams relative to the settings, the position of the dip-switch is indicated by the white part.



13.8 Warning functions

13.8.1 Warning Threshold

When the maximum current (phase or neutral) exceeds the $0.9 \cdot I_1$ threshold (where I_1 is the set threshold of function L) the "warning" LED is lit and the warning message is displayed (see par. 13.17).

13.8.2 Harmonic distortion

The PR112 unit signals that a peak factor above 2.1 has been exceeded (see par.13.7.1) with a warning message (see par. 13.17) and the "warning" LED lighting up (remember that the IEC 60947-2 annex "F" foresees that the protection unit functions regularly with a peak factor of ≤ 2.1 , up to $2x I_n$).

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13.9 Measurement functions

13.9.1 Current measurements

The PR112 unit is always able to provide measurement of the currents in the three phases, in the neutral and for earth fault (ammeter function), both with self-supply and with auxiliary power supply.

The ".....A" indication corresponds to a current reading under the measurable minimum.

The "— A" indication corresponds to disabling of current measurement (greater than 4 In for earth fault).

The earth fault current takes on two different meanings according to whether the internal "Earth Fault" toroid or the external "Source Ground Return" one is selected.

The minimum value of current measurable is 0.1 In (10% of the nominal).

The maximum value of current measurable is 16 In.

Within the range	0.3...6.0In
Measurement precision	5%

13.10 Information functions

13.10.1 Software version

Whenever it is necessary to notify ABB SACE of any operating problems with the unit, it is advisable to indicate the **SW** version of the PR112 unit.

ABB SACE	Heading
PR112/P Sw : x.xx	Software version of the PR112 unit/P

13.10.2 Opening data storage

The function of opening data storage ("TRIP" = opening for protection) is only active when there is an Auxiliary power supply before, during and after (for at least 1 sec.) any opening of the circuit-breaker due to trip for protection by the release.

The function and also consultation of the page which shows the last data stored are therefore only available when **there is an auxiliary power supply**. In self-supply, the attempt to access the page makes a "function not available" message appear.

The percentage of contact wear is indicative of the electrical life of the EMAX circuit-breaker electrical contacts.

The functionality of the release is not in any way modified by the presence of the wear messages. The alarm message 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 on the absolute current interrupted during each of these.

13.10.2.1 Display of opening data

N°Open:xxxxx x PROT	Number of openings due to protections L, S, I and G and T for the PR112/P versions.
L1:xxxxxA L2:xxxxxA	Value of the currents interrupted during the last TRIP on L1 and L2
L3:xxxxxA Ne:xxxxxA	Value of the currents interrupted during the last TRIP on L3 and Ne
Wear:xxx% Gr:xxxxxA	Contact wear and earth fault current (only for versions LSIG)

In the case of trip for linst, the following page is displayed (without the values of the interrupted currents):

N°Open:xxxxx I PROT	number of openings carried out up to now by the circuit-breaker
Short circuit	Indication of trip against short-circuit
Current > I _{cw}	
Wear:xxx%	Contact wear

13.11 Other functions

13.11.1 Contact programming K51/p1

The PR112 is fitted with a release, whose contact is called K51/p1.

This can signal different situations, selectable by the user among those listed in the following table.

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Table 4. Values selectable for K51/p1 release

Event	Description
" L preal. "	Prealarm + timing protection "L"
" L timing "	Timing protection "L"
" S timing "	Timing protection "S"
" G timing "	Timing protection "G"
" G alarm "	Alarm protection "G"
" L trip "	Opening by protection "L"
" S trip "	Opening by protection "S"
" I trip "	Opening by protection "I"
" G trip "	Opening by protection "G"
" T trip "	Opening by protection "T"
" T >70°C "	Internal temperature higher than 70°C
" T >85°C "	Internal temperature higher than 85°C

13.11.2 Watchdog

The PR112 unit provides some Watchdog functions able to guarantee correct management of any release malfunctions.

In particular, the watchdog signal of the microprocessor is constantly monitored, generating an alarm signal when there is an operating anomaly (LED lighting up and μ P Fault contact closure).

13.11.3 Self Test

The PR112 unit is able to monitor correct operation of:

- Microprocessor and SA with the **Trip Test** function.

This is carried out by means of the TEST pushbutton on the front panel following enabling from the Test Menu: in the case of a positive result, the circuit-breaker is opened.

This function is always guaranteed when there is self-supply ($I > 0.35$ In single-phase) or auxiliary power supply.

- User interfacing devices with the **Self-test** function.

This is carried out by means of selection from the Test Menu: in the case of a positive result, correct operation of the following is verified:

- Display (all the pixel of the matrix light up)
- LEDs (4)
- Magnetic Flags (4 or 5 for LSIG version)
- Prealarm, Relay tripped and μ Pfault contacts

This function is guaranteed when there is an auxiliary power supply or in self-supply with at least 0.5 In single-phase: in the case of Warning or Emergency, the test is immediately abandoned, always guaranteeing all the protection function.

By pressing the "RESET" key the test is interrupted.

In all cases where there is no self-supply and/or auxiliary power supply, the energy can be supplied from the accessory PR120/B power supply unit (connected to the front test connector).

Following the instructions given under the "User interface" chapter, show on the display:

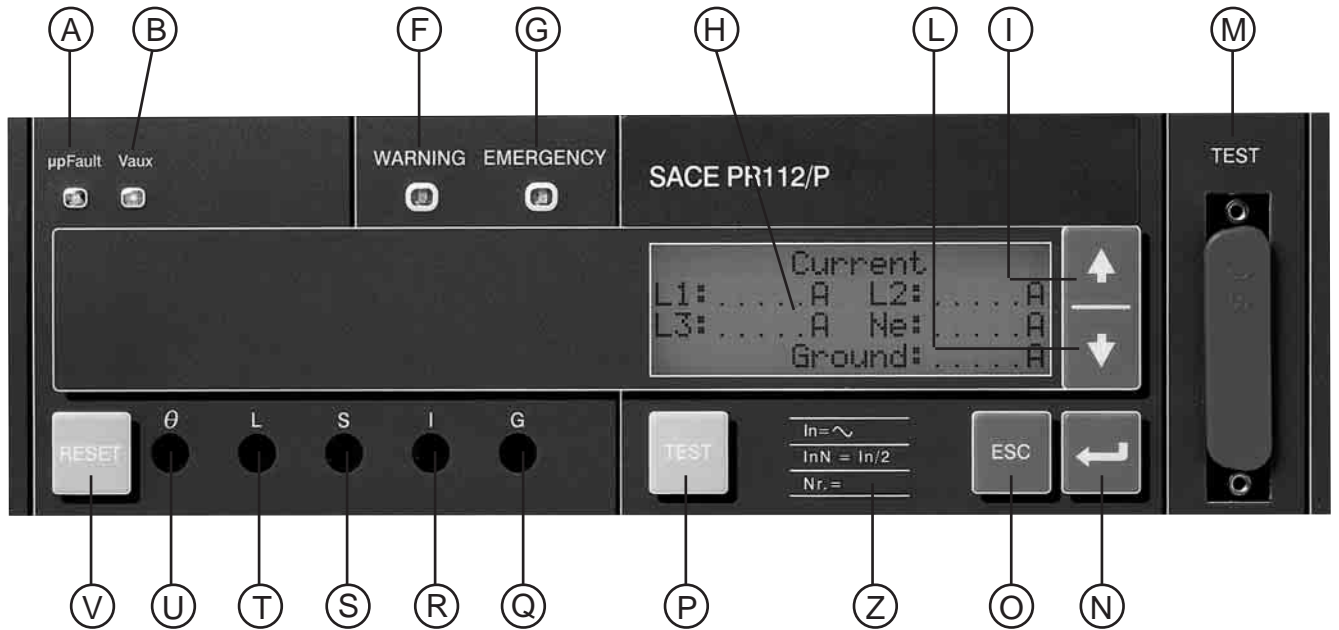
PR112 Tests	Heading
Trip Test : xxx	Select whether to enable the Trip Test function
Auto Test : xxx	Select whether to enable the Self-test function

13.11.4 Complex test of the release

Using the PR010/T test unit (see par. 13.18.1) connected to the release by means of the front multipin TEST connector, it is possible carry out a complete series of tests.

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13.12 User interface



Caption to the front of the PR112 unit :

Ref.	Description
A	"µP Fault" LED
B	"Vaux" LED
F	"WARNING" LED
G	"EMERGENCY" LED
H	Rear-lit alphanumerical display
I	Pushbutton for moving the cursor (UP)
L	Pushbutton for moving the cursor (DOWN)
M	TEST connector for application of the PR120/B or PR010/T accessory
N	Pushbutton to allow data entry or page change (ENTER)
O	Pushbutton for exiting the sub-menus or for cancelling (ESC)
P	Pushbutton to carry out release of the opening solenoid (TEST) + adjustment functions

Ref.	Description
Q	Magnetic signalling indicating earth fault "G" protection tripped
R	Magnetic signalling indicating instant. short-circuit "I" protection tripped
S	Magnetic signalling indicating select. short-circuit "S" protection tripped
T	Magnetic signalling indicating overload "L" protection tripped
U	Magnetic signalling indicating overtemperature "θ" protection tripped
V	Pushbutton to carry out reset of the magnetic and electrical signals (RESET) + end the Auto-Test + return to the currents page from the Trip page
Z	Serial Number of the unit

Alphanumerical display of the LCD type with 4 lines with 20 characters each, and which is rear-lit when auxiliary voltage is present. It is possible to adjust the contrast.

Each time the unit is activated, the display indicates the following page:

CURRENT	
L1:xxxxxA	L2:xxxxxA
L3:xxxxxA	Ne:xxxxxA
(*) Ground:xxxxxA	

(*) Indication only displayed in the case of PR112 unit/LSIG trip.

The ".....A" indication corresponds to a current reading under the measurable minimum (0.1In).

The "— A" indication corresponds to disabling of current measurement (earth fault).

Any "alarm" or "error" messages are displayed on the first line of this page. When there are more than one of these, they are displayed cyclically, one each second, on the first line. By pressing the ↵ key, it is possible to block message scrolling at the one currently displayed (the symbol "←" appears in the right-hand corner of the line). The various messages can therefore be scrolled through one at a time by using the "↓" key. To reset automatic updating, press the ↵ key again (the symbol "←" disappears).

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13.12.1 Use of pushbuttons

The variables described by the letters xxx, can be compiled using the ↑ or ↓ keys and confirming them with the ↵ key.

Basically, once you have entered the page you are interested in, moving from one size to the other can be done by using the ↑ or ↓ keys. On the other hand, to change a size, once the cursor is placed over the size itself, the ↵ key must be pressed and then it becomes possible to modify the parameters (the '→' symbol appears on the left of the parameter) by means of the ↑ or ↓ keys. Confirmation of the parameter is carried out by means of the ↵ key.

In the case where repeating programming of a parameter which has just been configured is necessary, it is sufficient to press the **ESC** key just once and the display cursor will go back to the same line of the page selected, otherwise to return to the main menu it is necessary to press the **ESC** key twice.

The **RESET** pushbutton must be used to reset the yellow magnetic flags and the contacts of the signalling release.

The **TEST** pushbutton must be used to carry out the Trip test (see par. 13.11.3).

13.12.2 Read and Edit modes

The map relative to the menus displays all the pages obtainable and the movements to be carried out with the keyboard, in the "READ" mode (just for data readout) or in the "EDIT" mode (for setting the protection parameters).

In the case when the page displayed is the one of the main menu or of other sub-menus, two different operating ways can be obtained, depending on the state of the unit:

1. "READ":

the page relative to the currents will be displayed automatically after about 120 seconds

2. "EDIT":

the page relative to the currents will be displayed automatically after about 240 seconds

The functions allowed according to the state are :

"READ":

- ✓ Consultation of the current measurements
- ✓ Consultation of the unit configuration parameters
- ✓ Consultation of the protection parameters
- ✓ Consultation of the protection unit information

"EDIT":

- ✓ Everything allowed in READ mode
- ✓ Configuration of the unit
- ✓ Programming the parameters relative to the protections
- ✓ "TEST" pushbutton enabling

13.13 Default settings

The ABB SACE PR112 is supplied with the following predefined parameters:

#	Protection	On/Off	Threshold	Time	Curve	T.M.	ZS
1	L	—	1 In	144 s	I _Δ	Off	—
2	S	Off	6 In	min	K	—	Off: 0.04s
3	I	On	4 In	—	—	—	—
4	G	Off	0.2 In	0.4 s	K	—	Off: 0.04s
5	U	Off					
6	OT	Off					
7	linst	On	E1 (*)	—			
8	Language	—	Eng				
9	Net Frequency	—	50 Hz				
10	PR020/K unit	Off					
11	Neutral sel.	—	50 %				
12	Toroid Selec.	—	Int.				
13	CB	—	E1B 800 (*)				
14	CS In	—	250 A (*)				
15	Password	—	0001				

- (*) Parameters set with these values only for PR112 sold as a loose piece.

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13.14 Putting into service

13.14.1 Connections



For the Connections to be provided by the user, strictly follow what is indicated in this document. This will mean that we can satisfy all the international reference Standards and guarantee perfect operation of the release even under severe environmental and electromagnetic conditions. Give special consideration to the types of cable, the earthing connections and the maximum recommended distances.

13.14.2 Test

Before putting into service, a test can be carried out using the specific "Self-test" function which can be activated on the PR112. A positive outcome is visible and is shown on the display.

Still with the specific function (Trip test), following this it is possible carry out the test of the whole SA chain. A positive result is given by the circuit-breaker opening.

13.14.3 Settaggi iniziali

If the PR112 is supplied directly installed in the circuit-breaker, it will be up to ABB SACE to set all the variables relative to the circuit-breaker or to the specific application correctly (e.g. Type of circuit-breaker, CT size, ...).



Vice versa, if the PR112 is supplied as a loose piece, it will be up to the user to set all the necessary parameters correctly. It should be noted that ABB SACE defines each possible setting in a sensible way (see default parameters in par. 13.13). Apart from this, it is absolutely indispensable for the user to modify the password and define each modifiable parameter carefully before putting the PR112 into service.

13.14.4 Password management

Password? [0***]

To enter "edit" mode it is necessary to enter a numerical password with four figures (the default password is "0001"). Select the value of the first figure (between '0' and '9') by means of the "up" and "down" keys and press "↵" to confirm the figure and pass on to enter the next. After entering the fourth figure, checking the password entered is carried out. If the password is correct, passing from the "read" mode to the "edit" mode takes place (the flashing cursor appears on the parameter which can be modified). In the case of a wrong password, the following message appears

Wrong password

It is possible to interrupt the operation by pressing the "ESC" key even during entry of the password.

which lasts until the "ESC" key is pressed (or after 2 minutes).

The password is valid for a maximum of two minutes from the last key being pressed. It is immediately reset in the case of a high priority alarm or in the case when the unit is reset.

Entering a page without modifiable parameters, the state of the protection is put on "read". If the password is still valid, to enter "edit" mode (in a page with modifiable parameters) simply press the "↵" key.

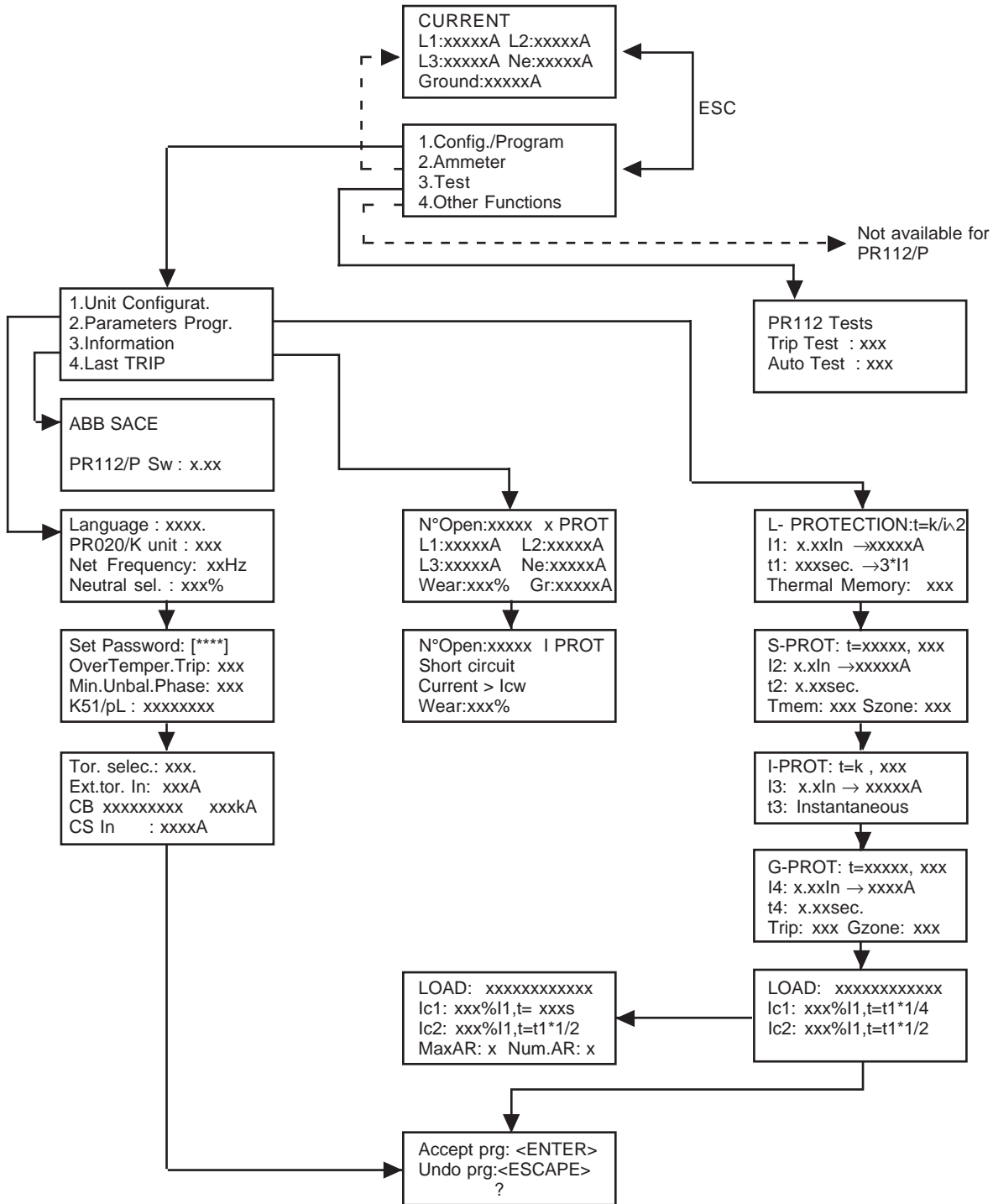
Disabling the Password

By setting the value of the password to "0000" (in the menu "Unit configuration") the password request is disabled. Passing from "read" to "edit" is therefore always possible.

To enter a new password, select the "Set Password" item from the "Unit Configuration" menu

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13.15.1 Menus



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13.15.2 Modification of parameters

In the case when the operator wants to carry out data readout or configuration operations, simply press the ESC key and the page relative to the main menu will automatically be displayed:

- | |
|---|
| 1. Config./Program
2. Ammeter
3. Test
4. Other functions |
|---|

Now, with the ↑ (up arrow) or ↓ (down arrow), ↵ and **ESC** keys it is possible to move around inside the main menu and reach all the pages relative to the configurations and parameterisations to display or modify the parameters set.

On completion of a programming operation, press the ↵ key to accept the new configuration (**Accept prg**) or press the ESC key to refuse it and therefore keep the old configuration (**Undo prg**).
The following will therefore appear:

Accept prg: <ENTER> Undo prg: <ESCAPE> ? Stored

Or

Accept prg: <ENTER> Undo prg: <ESCAPE> ? NOT stored

These pages indicate whether data storage has been successful or Not. In the latter case, the PR112 unit will use the last valid configuration set.

13.15.2.1 Modification of basic configuration



If the PR112 unit is in an alarm situation no parameterisation is allowed.

The basic configuration of the unit must be carried out in EDIT mode. Following what is given under the chapter. 13.12 show the following on the display:

Language : xxxx. PR020/K unit : xxx Net Frequency: xxHz Neutral sel. : xxx%
--

Select the language to be used to display the messages
 Indicate whether the accessory PR020/K unit is present
 Select the Nominal Frequency value for operation of the installation
 Select the setting value relative to protection of the neutral conductor (percentage expressed according to the phase current).

Set Password: [****] OverTemper.Trip: xxx Min.Unbal.Phase: xxx K51/pL : xxxxxxxx

Programming a new password in EDIT mode. The successive messages are :
New Password:→[**] and Confirm PSW :→[****]** for confirmation
 Select enabling or disabling of circuit-breaker opening in the case of the second temperature (85°C) threshold being exceeded. Select the minimum unbalance value of the currents between phases
 Select which information to combine with signalling by means of the K51/pL relay.
 The possible selections are given in the table of par. 13.11.1.

Tor. Selec.: xxx. Ext.Tor. In: xxxxA CB Exx-Axxxx xxxkA CS In : xxxxA
--

Select the type of protection against earth fault: select [Int] if you want to protect the installation with the help of the internal toroid, otherwise [Ext] if you want to protect it with the help of the external toroid by carrying out the "Source Ground Return" protection function. (This selection is only displayed in the LSiG version)
 Select the value of the rated current of the external toroidal transformer for the "Source Ground Return" function.
 Select the type of EMAX circuit-breaker (code and rated current) which the PR112 unit is mounted on The possible selections are available in the technical catalogue.
 Select the value of the rated current of the current sensors (CS) mounted on the circuit-breaker.

N.B.:

Incorrect configuration of "In" does not in any way jeopardize perfect functionality of the protections. The only problem will be incorrect display of the absolute value of the Currents.

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Properties / function	Values selectable
Language	Engl. (English), Ital. (Italian), Fran. (French), Deut. (German) Espa. (Spanish)
PR020/K unit	On , Off
Net Frequency	50Hz, 60Hz
Neutral sel.	50%, 100%
Set Password	0000...9999
OverTemper.trip	On, Off
Min.Unbal.Phase	Off, 10% ...90%
K51/p1	See par. 13.11.1
Tor. Selec.	Int (internal), Ext (external)
Ext.tor. In	100A, 250A, 400A, 800A
C.B. Type	Versions allowed in the catalogue
CS In	250A, 400A, 800A, 1000A, 1250A, 1600A, 2000A, 2500A, 3200A, 4000A, 5000A, 6300A

13.15.2.2 Modification of protection functions

The basic configuration of the unit must be made in EDIT mode.

This paragraph allows the user to program the protection functions implemented with the PR112 unit. Only the data programming methods and which values can be set are given. For all the other information relative to the technical characteristics of these protection functions, please refer to the "Protection functions" par..

Following the instructions given under chapter. 13.12, show the following on the display to set protection functions L, S, I and G:

L-PROTECTION:t=k/l λ 2	Heading. For protections S, I and G it is possible to select disablement of the function. For protections S and G it is also possible to select the type of curve.
I1: x.xxIn \rightarrow xxxxxA	Select which threshold value I1 to set. At the side of selection of threshold I1 , its value expressed in Amperes will also be displayed automatically.
t1: xxxsec. \rightarrow 3*I1	Select which trip curve t1 to set.
Thermal Memory: xxx	Select whether to enable or disable operation of protection L with thermal memory.
S-PROT: t=xxxxx, xxx l	Heading. For protections S, I and G it is possible to select disablement of the function. For protections S and G it is also possible select the type of curve.
I2: x.xIn \rightarrow xxxxxA	Select which threshold value to set. At the side of selection of the threshold, its value expressed in Amperes will also be displayed automatically.
t2: x.xxsec.	Select which trip curve to set (this is not possible for I).
Tmem: xxx Szone: xxx	For protection S it is possible to decide whether to enable or disable the thermal memory. For protections S and G it is possible to decide whether to enable or disable the zone selectivity. For protection G it is possible to decide whether to enable or disable the trip control at the end of timing.

Depending on the method used on the first line, the following pages will be displayed if PR020/K = on:

1°	LOAD: Open1-Open2 Ic1: xxx%I1,t=t1*1/4 Ic2: xxx%I1,t=t1*1/2	Method: "Disconnection of two loads" Selection of the threshold value of disconnection of the first load Selection of the threshold value of disconnection of the second load
2°	LOAD: Close1-Open1 Ic1: xxx%I1,t= xxxs Ic2: xxx%I1,t=t1*1/2 MaxAR: x Num.AR: x	Method: "Connection - disconnection of a load" Selection of the threshold of connection of the load and relative waiting time Selection of the threshold of disconnection of the load Maximum number of reclosing operations which can be carried out and number of reclosing operations carried out

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Protection	Disabling	Disabling only TRIP	Zone Selectivity	Thermal Memory	Threshold range	Time range	Threshold tolerance (3)	Time tolerance (3)
L ($t=k/l^2$)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	$0.4xI_n \leq I_1 \leq 1xI_n$ step $0.01xI_n$	$3s \leq t_1 \leq 144s$, step $3s$ ⁽¹⁾	Trip between 1.1 and $1.2 \times I_1$	$\pm 10\%$, $I_1 \leq 4xI_n$ $\pm 20\%$, $I_1 > 4xI_n$
S ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	$0.6xI_n \leq I_2 \leq 10xI_n$ step $0.1xI_n$	$\text{Min}^{(2)}$, $0.05s \leq t_2 \leq 0.75s$, step $0.01s$	$\pm 7\%$, $I_1 \leq 4xI_n$ $\pm 10\%$, $I_1 > 4xI_n$	The best of the two data $\pm 10\%$ o $\pm 50ms$, $I_1 \leq 4xI_n$ $\pm 15\%$ o $\pm 50ms$, $I_1 > 4xI_n$
S ($t=k/l^2$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	$0.6xI_n \leq I_2 \leq 10xI_n$ step $0.1xI_n$	$0.05s \leq t_2 \leq 0.75s$, step $0.01s$	$\pm 7\%$, $I_1 \leq 4xI_n$ $\pm 10\%$, $I_1 > 4xI_n$	$\pm 15\%$, $I_1 \leq 4xI_n$ $\pm 20\%$, $I_1 > 4xI_n$
I ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$1.5xI_n \leq I_3 \leq 15xI_n$ step $0.1xI_n$	Instantaneous	$\pm 10\%$, $I_1 \leq 4xI_n$ $\pm 15\%$, $I_1 > 4xI_n$	$\leq 25ms$
G ($t=k$)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	$0.2xI_n \leq I_4 \leq 1xI_n$ step $0.02xI_n$	$0.1s \leq t_4 \leq 1s$, step $0.05s$	$\pm 10\%$	The best of the two data $\pm 10\%$ o $\pm 50ms$, $I_1 \leq 4xI_n$
G ($t=k/l^2$)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$0.2xI_n \leq I_4 \leq 1xI_n$ step $0.02xI_n$	$0.1s \leq t_4 \leq 1s$, step $0.05s$	$\pm 10\%$	$\pm 20\%$
U ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$10\% \leq I_6 \leq 90\%$ step 10%	$0.5s \leq t_6 \leq 60s$, step $0.5s$	$\pm 10\%$	$\pm 20\%$
OT (temp=k)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Can only be set by ABB	Instantaneous	$\pm 1^\circ C$	---
K (Open1-Open2)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$0.5xI_1 \leq (I_{c1}, I_{c2}) \leq 1.0xI_1$ step $0.01xI_1$	$t_{c1} = t_1 / 4$ $t_{c2} = t_1 / 2$	$\pm 10\%$	$\pm 20\%$
K (Closed1-Open1)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$0.5xI_1 \leq (I_{c1}, I_{c2}) \leq 1.0xI_1$ step $0.01xI_1$	$10s \leq t_{c1} \leq 120s$ step $5s$ $t_{c2} \leq t_1 / 2$	$\pm 10\%$	$\pm 20\%$
linst	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Can only be set by ABB	Instantaneous	$\pm 5\%$	---

(1) The minimum value of this trip is 750ms regardless of the type of curve set (self-protection)

(2) In the case when the trip curve with fixed time ($t=k$) is selected, apart from those indicated, it is also possible to set the trip time $t_2=\text{min}$.

(3) These tolerances are valid with the following hypothesis:
- release self-supplied when running (without start-up)
- two-phase or three-phase power supply

For all cases not covered by the above hypothesis, the following tolerance values are valid:

Trip threshold	Trip time
L (Trip between 1.1 and $1.25 \times I_1$)	$\pm 20\%$
S $\pm 10\%$	$\pm 20\%$
I $\pm 15\%$	$\leq 60ms$
G $\pm 15\%$	$\pm 20\%$

13.15.3 Signals

13.15.3.1 Optic signals

Signalling	Description
Led Vaux (green)	Presence of Auxiliary power supply
Led μP Fault (red)	Microprocessor with temporary or permanent fault
Led Warning (yellow)	<ul style="list-style-type: none"> Presence of one or more phases with current values in the $0.9 \times I_1 < I < 1.05 \times I_1$ range (on the NE at 50% the values are halved); Presence, between two or three phases, of unbalance above the value programmed during configuration; First temperature threshold $T=70^\circ C$ exceeded; Contact wear higher than 80 %
Led Emergency (red)	<ul style="list-style-type: none"> Presence of one or more phases under overload with current values of $> 1.3 \times I_1$ (protection L timing) (on the NE at 50% the values are halved); Timing in progress for protection function S; Timing in progress for protection function G; Second temperature threshold $T=85^\circ C$ exceeded; Contact wear at 100 %.

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Signalling	Description
Yellow magnetic flag "0"	Trip of protection "T" for overtemperature (second threshold: T=85°);
Yellow magnetic flag "L"	Trip of protection "L";
Yellow magnetic flag "S"	Trip of protection "S";
Yellow magnetic flag "I"	Trip of protection "I" or "Iinst"
Yellow magnetic flag "G"	Trip of protection "G";

13.15.3.2 Electrical signals

Electrical signals (see par. on Inputs/Outputs)

Signalling	Description
Contact K51/p1	The signalling to which it is connected (see Table par.13.11.1) is active;
Contact K51/Y01	Any one of protections "L, S, I, G and 0" has tripped;
Contact K51/uP	Microprocessor with temporary or permanent fault. (closes with delay of 1...2 s). Only operational with Auxiliary power supply.

By pressing the "Reset" pushbutton, it is possible to reset the state of the magnetic flags and of the contacts.

This pushbutton is effective when there is self-supply or an auxiliary power supply.

Otherwise the energy accumulated by a special 'buffer' RESET capacitor is used, which is charged in 12s under self-supply running. This guarantees, in the case of no self-supply and auxiliary power supply, at least one RESET operation for 6 hours at 25°C.

In the case where the 'buffer' capacitor is also discharged, it can be used to RESET the PR120/B supplementary power supply unit.

In this situation, circuit-breaker closing is always possible, both by means of Closing coils (BC) and by means of a mechanical pushbutton. Operation of the release is ensured immediately after closing, whereas signal resetting can only be carried out after 12 seconds.

13.16 Troubleshooting

The following table gathers together a series of typical service situations, which are useful to understand and solve hypothetical faults or malfunctions.

N.B.:

1. Before consulting the following table, check any signalling of error messages on the first line of the display for a few seconds.
2. **FN** indicates normal operation of the PR112.
3. In the case when the suggestions proposed do not lead to a solution of the problem, please contact the ABB SACE Assistance service.

N°	Situation	Possible causes	Suggestions
1	It is not possible to reset the magnetic signals	The buffer capacitor is discharged	FN , connect the Vaux, the PR010/T or the PR120/B, to reset.,
2	It is not possible to carry out the trip test	1. The busbar current is > 0. 2. The SA is not connected	1. FN 2. Connect the SA
3	Trip times lower than those expected	1. Threshold too low 2. Curve too low 3. Thermal memory inserted 4. Incorrect Neutral Selection 5. The SdZ is inserted	1. Correct threshold 2. Correct curve 3. Exclude if not necessary 4. Correct Neutral Selection 5. Exclude if not necessary
4	Trip times higher than those expected	1. Threshold too high 2. Curve too high 3. Curve I ² t inserted 4. Incorrect Neutral Selection	1. Correct threshold 2. Correct curve 3. Exclude if not necessary 4. Correct Neutral Selection
5	Rapid trip, with I3=Off	Iinst trip	FN with short-circuit with high I
6	I of earth high, but there is no trip	1. Incorrect selection of the sensor 2. Function G prevented with I>4 In	1. Set int. or ext. sensor 2. FN
7	Display off	1. Vaux missing and the I of busbar is less than the minimum value. 2. Temperature out of range	1. FN, see 13.3.1 2. FN, see 13.7.6
8	The display is not rear-lit	Vaux missing	FN
9	Reading of I incorrect	Incorrect setting of In	Change parameters, see 13.15.2.1

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N°	Situation	Possible causes	Suggestions
10	"No Int Bus Comm" Message	There is no communication between PR112 and PR020/K	1. If not present, exclude PR020/K 2. Check bus connection 3. Check PR020/K
11	Display indicates "... " or "—" , instead of the data expected	Function excluded or data out of range	FN, see 13.9.1
12	The expected trip does not occur	Trip function excluded	FN enable trip if necessary
13	No activation of the Unbalance U protection	Values of I out of range	FN, see 13.7.5
14	Anomalous behaviour of Load control K protection	The MT of L is inserted.	FN, exclude the MT of L
15	No display of the of opening data	Vaux missing	FN, see 13.10.2
16	The password is not requested	The password has been disabled	FN, re-enter the password with a value other than 0000.
17	It is not possible to change any parameter	PR112 in alarm situation	FN

13.17 Warning and error 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.

INCORRECT CONFIGURATIONS

MESSAGE	DESCRIPTION
WRONG CS FOR THIS CB	A CS size which cannot be installed on the circuit-breaker has been selected (e.g. E1 with 6300A)
ERROR I2 <= I1	The trip threshold of function L is higher than threshold of function S
ERROR I3 <= I2	The trip threshold of function S is higher than threshold of function I
ERROR: S ZONE SEL.	Zone selectivity for function G has been activated but zone selectivity is already active for function S.
ERROR: G ZONE SEL.	Zone selectivity for function S has been activated but zone selectivity is already active for function G.
ERROR: V_AUX OFF	The auxiliary power supply is not present - function not available.
V_AUX OFF: Comm. OFF	The communication bus is not operating because the auxiliary voltage is missing.
NO Int. Bus Comm.	The presence of the PR020/K unit is set, but there is no communication on the internal bus.
NOT available	The function required is not available.
V_AUX Off: S Sel. Off	The unit is configured to operate with zone selectivity S but the auxiliary power supply has been removed.
V_AUX Off: G Sel. Off	The unit is configured to operate with zone selectivity G but the auxiliary power supply has been removed.

GENERAL ALARMS

MESSAGE	DESCRIPTION
CONTACTS WEAR >80%	The wear on the circuit-breaker electrical contacts has reached 80%
CONTACTS WEAR 100%	The wear on the circuit-breaker electrical contacts has reached 100%
HARMONIC DISTORSION	The current circulating in the circuit-breaker is distorted (peak factor >2.1).

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PROTECTION FUNCTIONS

MESSAGE	DESCRIPTION
PREALARM L	The current circulating on at least one phase is above the set prealarm threshold value for protection L - see par.13.8.1
L PROTECTION TIMING	The current circulating on at least one phase is above the set current threshold value for protection L and the unit is under timing.
S PROTECTION TIMING	The current circulating on at least one phase is above the set current threshold value for protection S and the unit is under timing.
G PROTECTION TIMING	The current circulating on at least one phase is above the set current threshold value for protection S and the unit is under timing.
G ALARM, TRIP OFF	Timing of function G is in progress, but the trip control which is given at the end of the timing has been disabled.

PR020/K

MESSAGE	DESCRIPTION
ERROR Ic2 < Ic1	The current threshold set for load n°1 is higher than that of load n°2 or the current threshold set for reclosing is higher than that of load opening.
K: LOAD 1 TIMING	The current circulating has exceeded the threshold of load n°1 connected to PR020/K and the unit is under timing for load opening.
K: LOAD 2 TIMING	The current circulating has exceeded the threshold of load n°2 connected to PR020/K and the unit is under timing for load opening.
K: LOAD 1 CLOSING	Load n°1 connected to PR020/K is about to be reconnected
K: LOAD 1 OPEN	Load n°1 connected to PR020/K has been isolated
K: LOAD 2 OPEN	Load n°2 connected to PR020/K has been isolated
K: AR DISABLED	The auto-reset of load n°1 connected to PR020/K has been disabled

PASSWORD MANAGEMENT

MESSAGE	DESCRIPTION
Password ? [****]	Enter the access password in EDIT mode
Wrong Password	The password entered is wrong
New Password : →[****]	Enter the new password
Confirm Password:→[****]	Confirm the new password entered

13.17.1 In the case of a fault



If it is suspected that the PR112 is faulty, has malfunctions or has generated an unexpected trip, we advise you to strictly following the indications below:

1. Do not reset the release.
2. Note down which small magnetic signal is activated (yellow area).
3. If there is Vaux, the release has memorized the trip data, so take these from the Last Trip page.
4. If there is no Vaux, use PR120/B and note down all the settings of the protection functions.
5. Note down the type of circuit-breaker, number of poles, any accessories connected, In, Serial Number (see par.13.12) and the SW version.
6. Prepare a brief description of opening (when did it take place? how many times? always under the same conditions? with what type of load? with what voltage? with what current? can the event be reproduced?)
7. Send/communicate all the information collected, together with the application circuit diagram of the circuit-breaker, to the ABB Assistance service closest to you.

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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13.18 Accessories

13.18.1 ABB SACE PR010/T complex test unit

The test with the SACE PR010/T unit allows correct operation of the inputs, outputs, thresholds and trip times of protection functions "L", "S", "I", "G" and "Inst" to be checked either manually or automatically.

Furthermore it is possible to obtain a test report and modify the settings.

For operation of the PR010/T accessory, please consult the special instruction manual.

13.18.2 ABB SACE PR020/K signalling unit

The PR020/K signalling unit, when connected to the internal bus of the PR112/P, allows the state of the protection functions and of the PR112/P trip itself to be signalled by means of clean power contacts.

The PR020/K must be supplied with 24Vdc $\pm 20\%$.

For operation/installation of the PR020/K accessory, please consult the special instruction manual.



The unit must be connected to the PR112 by means of an internal bus with a corded shielded cable with two conductors (see note A of par. 11.2.2) with a maximum length of 15m .

The shield must be earthed both on the circuit-breaker side and on the PR020/K side.

13.18.3 ABB SACE PR120/B power supply unit

The PR120/B is a supplementary power supply unit with front connection (by means of the test connector).

It is possible to read and configure the parameters of the PR112 unit whatever the status of the circuit-breaker (open, closed, in the test position or racked-in, and with/without auxiliary power supply) with this accessory, which is always supplied,

Inside it there is an electronic circuit which allows power supply to the unit for about 3h continuously, just to carry out the sole operations of reading, configurations and testing.

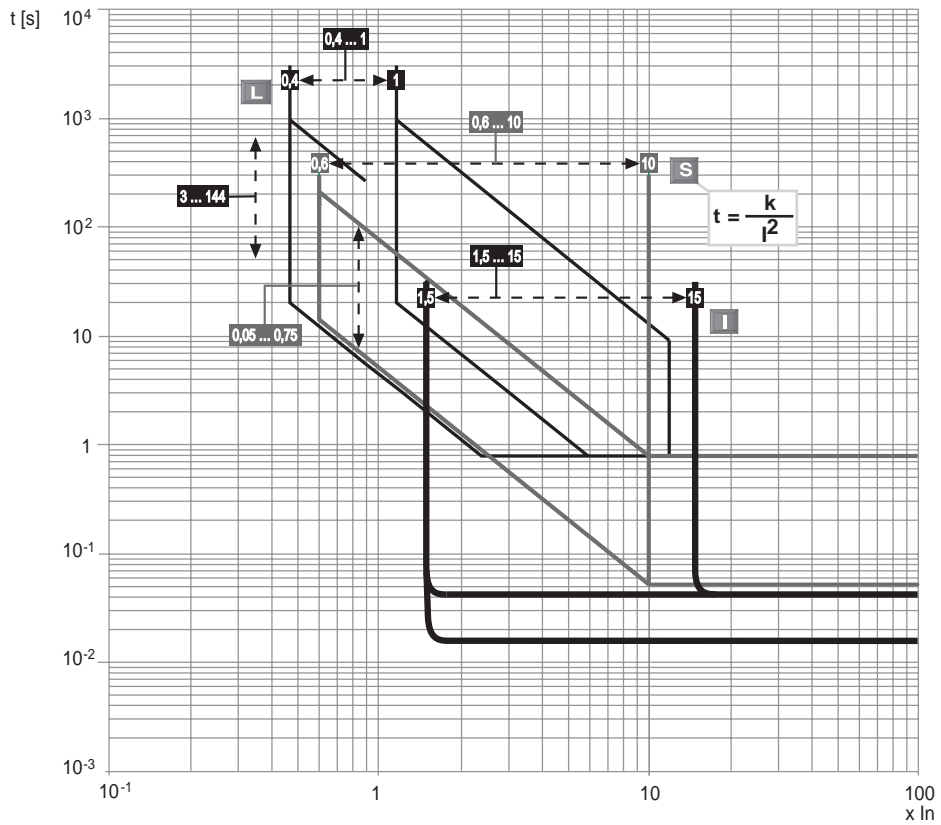
Its autonomy decreases, proportionally to its use, if the PR120/B accessory is also used to carry out the functions of the "Test" menu (Trip test, Self-test).

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13.19 Trip curves

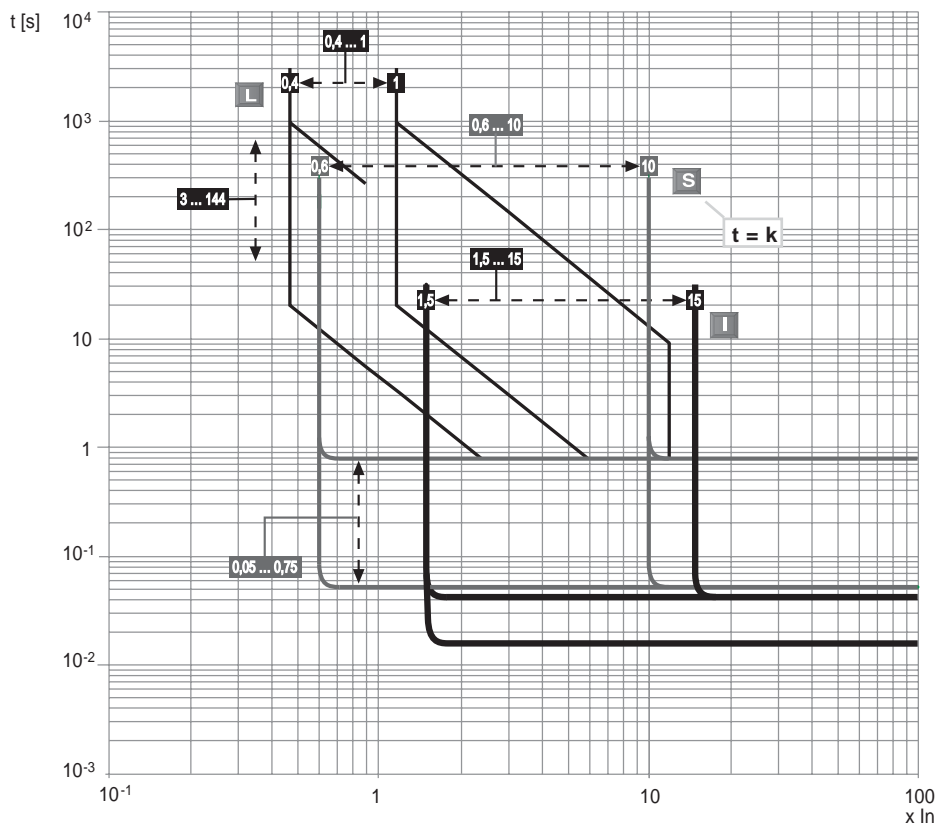
The trip curves given are indicative and only represent a sub-group of the possibilities selectable (par.13.15.2.2).

13.19.1 Trip curves of functions L-S-I



1SDC200111F0001

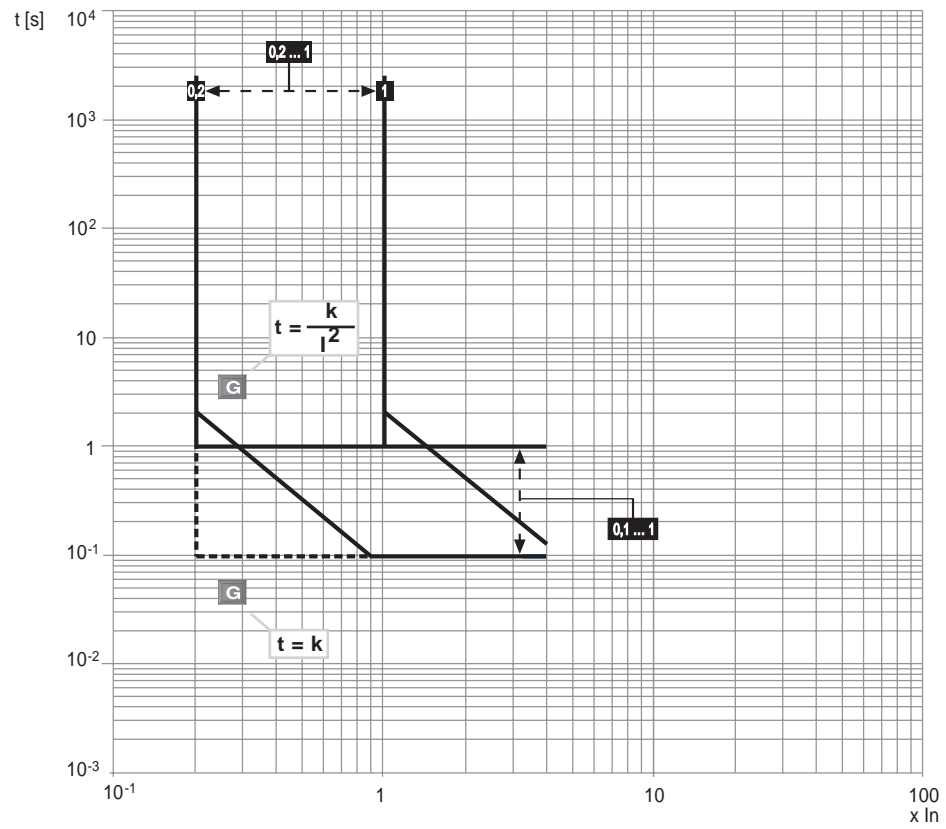
13.19.2 Trip curves of functions L-S-I



1SDC200111F0001

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13.19.3 Trip curves of function G



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14. SACE PR112/PD Release – Identification

The PR112 units available fitted with a dialogue unit are:

- PR112/PDM with Modbus™ protocol
- PR112/PDL with Lon™ protocol

14.1 Standard

The PR112 /PDM has been designed to work in accordance with the following international standard:

IEC 60947-2 Low voltage apparatus. Circuit-breakers.

14.2 Safety notes

For correct use and management of the PR112 protection unit fitted with a dialogue unit with Modbus™ protocol [PR112/PD], it is also necessary to consider what is given in the following documents:

- “PR112/P Instruction manuals “ (par.13)

For version with Modbus™ protocol

- “PR112/PD Modbus™ System Interface” - see par. 14.3 (doc. n° RH0295)
- “Modbus™ installation guideline” - see par. 14.3 (doc. n° RH0298)

For version with Lon™ protocol

- “PR112/PD Lon Works™ System Interface” - see par. 14.3 (doc. n° RH0251)
- “Lon™ installation guideline” - see par. 14.3 (doc. n° RH0297)

14.3 Various notes

- All the detailed information on the communication interface (necessary for development of the supervision and control system by the System integrator) is given in document RH0295.
- All the detailed information necessary to make the physical external connections to the release, as well as the maximum distances of the cabling, the type of conductor to be used, etc. are given in document RH0298.
- The following are trademarks of Modicon, Inc.:
 Modbus 984 P190 SM85
 ModConnect BM85 RR85 SQ85
 Modcom BP85 SA85
- All the detailed information on the communication interface (necessary for development of the supervision and control system by the System integrator) is given in document RH0251.
- All the detailed information necessary to make the physical external connections to the release, as well as the maximum distances of the cabling, the type of conductor to be used, etc. are given in document RH0297.
- Echelon, LON, LONWORKS, LonBuilder, NodeBuilder, LonManager, LonTalk, LonUsers, LonPoint, Neuron, 3120, 3150, the Echelon logo, and the LonUsers logos are trademarks of Echelon Corporation registered in the USA and in the other countries. LonLink, LonResponse, LonSupport, i.LON, LonWorld, Device Tone, ShortStack and LonMaker are trademarks of Echelon Corporation.

14.4 Specifications

14.4.1 General



When there is no auxiliary power supply, the communication functions are not active.

The PR112 units fitted with dialogue allow a supervision system to acquire information and send controls/parameters to the protection unit and to the circuit-breaker.

The information available is:

Data transmitted from the PR112/PD to the supervision system

1	Protection parameters set
2	Configuration parameters set
3	Phase, neutral and earth currents
4	Status of the circuit-breaker (open-closed)
5	Position of the circuit-breaker (connected-isolated)
6	State of the springs (charged-discharged)
7	Number of mechanical circuit-breaker operations, overall number of trips and for each protection
8	Last current interrupted
9	Contact wear
10	State of the protection functions (prealarm funct. L, timing funct. L, S, G...)
11	Overtemperature protection function
12	State of internal bus communication
13	Protection trip with time reference (only for PR112/PDL version)
14	**

** See par.14.3 note A (for PR112/PDM version) and note D (for PR112/PDL version)

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Data transmitted from the supervision system to the PR112/PD

1	Protection parameters (only for PR112/PD)
2	Opening and closing controls of the circuit-breaker (only for PR112/PD)
3	Reset for trip of some Protection functions
4	**

** See par. 14.3 note A (for PR112/PDM version) and note D (for PR112/PDL version)

14.4.1.1 Auxiliary power supply

When there is a PR112 equipped with a dialogue unit, the consumptions of the unit are different from those indicated just for the protection unit. The values to be considered are given in the following table

Characteristics	PR112/PD Version
Power supply voltage	24V DC ±20%
Maximum ripple	5%
Inrush Current @ 24 V	~5A for 30ms
Start-up Current @ 24 V	~1.0A for 150ms
Nominal Current @ 24 V	~250mA
Nominal Power @ 24 V	~6W

14.4.2 Inputs/outputs

14.4.2.1 Binary opto-insulated inputs

- **CB-Closed:** Status of circuit-breaker
- **CB-Open:** Status of circuit-breaker (for congruency control with CB-Closed)
- **CB-Springs:** State of springs
- **CB-Position:** Position of circuit-breaker

14.4.2.2 Output contacts

- **K51/YC:** relay output which can be activated by the user to close the circuit-breaker
- **K51/YO:** relay output which can be activated by the user to open the circuit-breaker
- Monostable contacts, only active when there is Vaux
- Maximum changeover current: 3A – 250V AC (0.2A – 100V DC)
- Insulation contact-contact voltage: 1000 V AC

14.4.3 Communication bus

For version with Modbus™ protocol:

- External bus Modbus™ protocol RS485 2-Wire Twisted Pair, 19.2kbit/s max., connection to differential bus (See par. 14.3 note B).

For version with Lon™ protocol:

- External bus LON™ protocol 2-Wire Twisted Pair, 78 kbit/s, connection to differential bus. (See par. 14.3 note E).

14.4.4 Information functions

To access the following pages, see par. 14.6.1.

14.4.4.1 Software version

ABB SACE
PR112/D-M Sw: x.xx

This page shows which Software version there is of the dialogue unit of the above PR112 /PD release.

Each time it is necessary to communicate any operating problems with the dialogue unit to ABB SACE, it is a good idea to indicate the Sw version of the unit ("x.xx").

14.4.4.2 Neuron ID

For version with Lon™ protocol:

Press <ENTER> to send the Service Pin message Neuld: xxxxxxxxxxxx
--

See par. 14.5.3
The Neuron ID (hexadecimal representation) is used during the node installation stage.

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14.4.4.3 Opening data storage

Manual Opens:xxxxx
Prot. Trips: xxxxx
Other Trips: xxxxx
Trip Fails: xxxxx

Sum of openings due to manual openings by means of pushbuttons on the front of the circuit-breaker, controls coming from opening coil (YO) and undervoltage (MT).
 Sum of openings due to protections (L, S, I, G,...).
 Sum of openings due to the trip test.
 Sum of any missed trips in relation to a fault.

L: xxxxx S: xxxxx
I: xxxxx G: xxxxx
T: xxxxx

Number of trips due to protections L, S, I, G and T (temperature) respectively.

14.4.4.4 Communication parameters

For version with Lon[®] protocol:

Dom 0: xx
S/N 0: xxx/xxx
Dom 1: xx
S/N 1: xxx/xxx

Indicative of logical domain 0
 Logical address of the device in the logical domain 0
 Indicative of logical domain 1
 Logical address of the device in the logical domain 1

14.4.4.5 State of circuit-breaker auxiliary inputs

CB Status: xxxxx
CB Springs: yyyyy
CB Pos.: zzzzz
Test YO/YC: kkk

Status of the circuit-breaker. The possible states are: Open - Closed – Error*
 State of spring charging. The possible states are: Charged – DischargedCharged – Discharged
 Position of the circuit-breaker. The possible states are: Conn. – Isol.
 See par. 14.4.5

* The display of **Error** indicates a condition of incongruence (both the CB-Open and CB-Closed inputs are in the same logical state)

14.4.5 Control functions

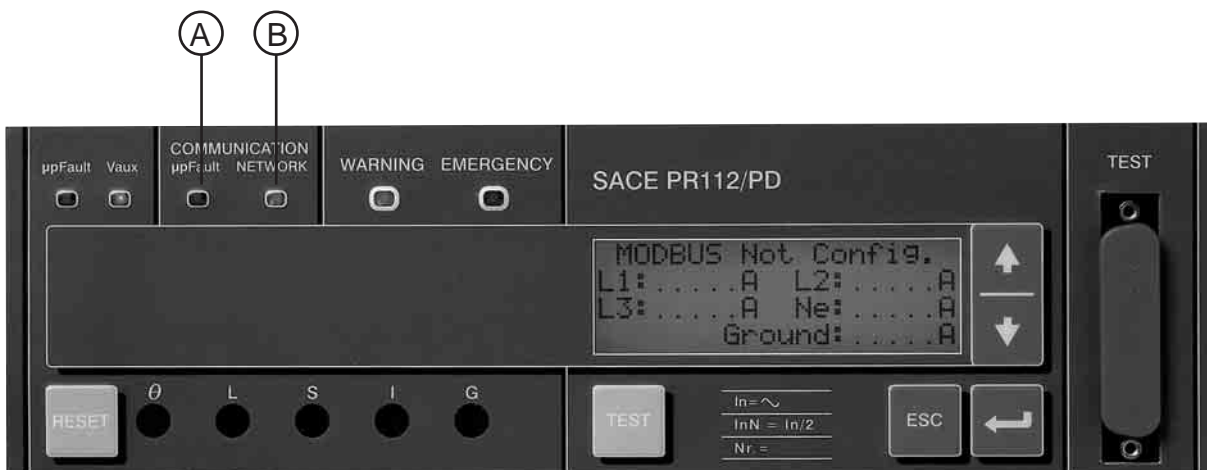
CB Status : xxxxx
CB Springs: yyyyy
CB Pos. : zzzzz
Test YO/YC: kkk

See par. 14.4.4.3
 See par. 14.4.4.3
 See par. 14.4.4.3
 Control function for opening and closing the circuit-breaker by means of coils YC and YO.

- To open the circuit-breaker, select YO and then press the TEST pushbutton on the front of the PR112/PD
- To close the circuit-breaker select YC and then press the TEST pushbutton on the front of the PR112/PD

14.4.6 User interface

Caption of the front of the PR112/PD unit (integration of the caption relative to the PR112/P version):



Ref.	Description
A	"µP fault" LED relative to operation of the µProcessor dialogue unit.
B	"NETWORK" LED linked to the state of communication activities (Tx) on external bus.

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14.4.6.1. Remote and Local modes

Il PR112/PD può operare in due modalità differenti, Locale o Remoto.

14.4.6.1.1 Local operating mode

In local mode :

- Remote parameterisation (i.e. from supervision and control system) not allowed (e.g. modification of protection function settings ...)
- Remote controls which cannot be carried out (e.g. circuit-breaker opening, closing ...)

The following actions are allowed:

- Reading current measurements
- Reading configuration parameters
- Reading protection parameters
- Reading parameters set for load control
- Reading the information relative to the protection unit

14.4.6.1.2 Remote operating mode

All the following actions are allowed in remote mode :

- Reading current measurements
- Reading configuration parameters
- Reading protection parameters
- Reading parameters set for load control
- Reading the information relative to the protection unit
- Modification of parameters linked to the protection and communication unit
- Circuit-breaker opening and closing controls

14.4.7 Default settings

For version with Modbus™ protocol:

– The PR112/PDM is supplied by ABB SACE with the following pre-defined communication parameters:

Slave Addr.	Baud rate	Parity	Addressing
255 (UNCONFIGURED)	19.200 bit/s	Even	Standard

Operating mode

Local

For version with Lon™ protocol:

– The PR112/PDL is supplied by ABB SACE with the following pre-defined communication parameters:

Domain [Dom]	Value	Subnet node[S/N]
0	none	0/0
1	none	0/0

Operating mode

Local

14.5 Putting into service

14.5.1 Connections



For the Connections to be made by the user, it is advisable to check what is indicated in par.14.3. This means that we shall be able to satisfy all the international reference Standards and guarantee perfect operation of the release even under severe environmental and electromagnetic conditions.

Pay particular attention to the types of cable, the connections to earth and the maximum distances recommended.

In case of replacement of a PR112/P with a PR112/PD it is necessary to complete the missing cabling on the terminal box (or sliding contacts of the circuit-breaker) with those required for the dialogue function as well as to replace the connectors which are coupled with the PR112 release from the terminal box.

14.5.2 Test

Before putting into service, it is advisable to carry out some opening, closing and resetting controls of the circuit-breaker, also checking correct indication of the status of the circuit-breaker on the display (open-closed).

It is also advisable to check the correct state of the springs (charged-discharged) as well as the position of the circuit-breaker (connected-isolated). For further details see par. 14.4.4.5.

14.5.3 Initial settings



ABB SACE defines each setting of the communication parameters (see default parameters par. 14.4.7). Apart from this, before putting the PR112 into service, it is absolutely indispensable for the user to carefully define each modifiable parameter (see par.14.6.2).

For installation of the Lon® node, it is possible to send the Service Pin Message by turning on the relative page and pressing the ENTER key on the front of the PR112/PD (see par. 14.4.4.2).

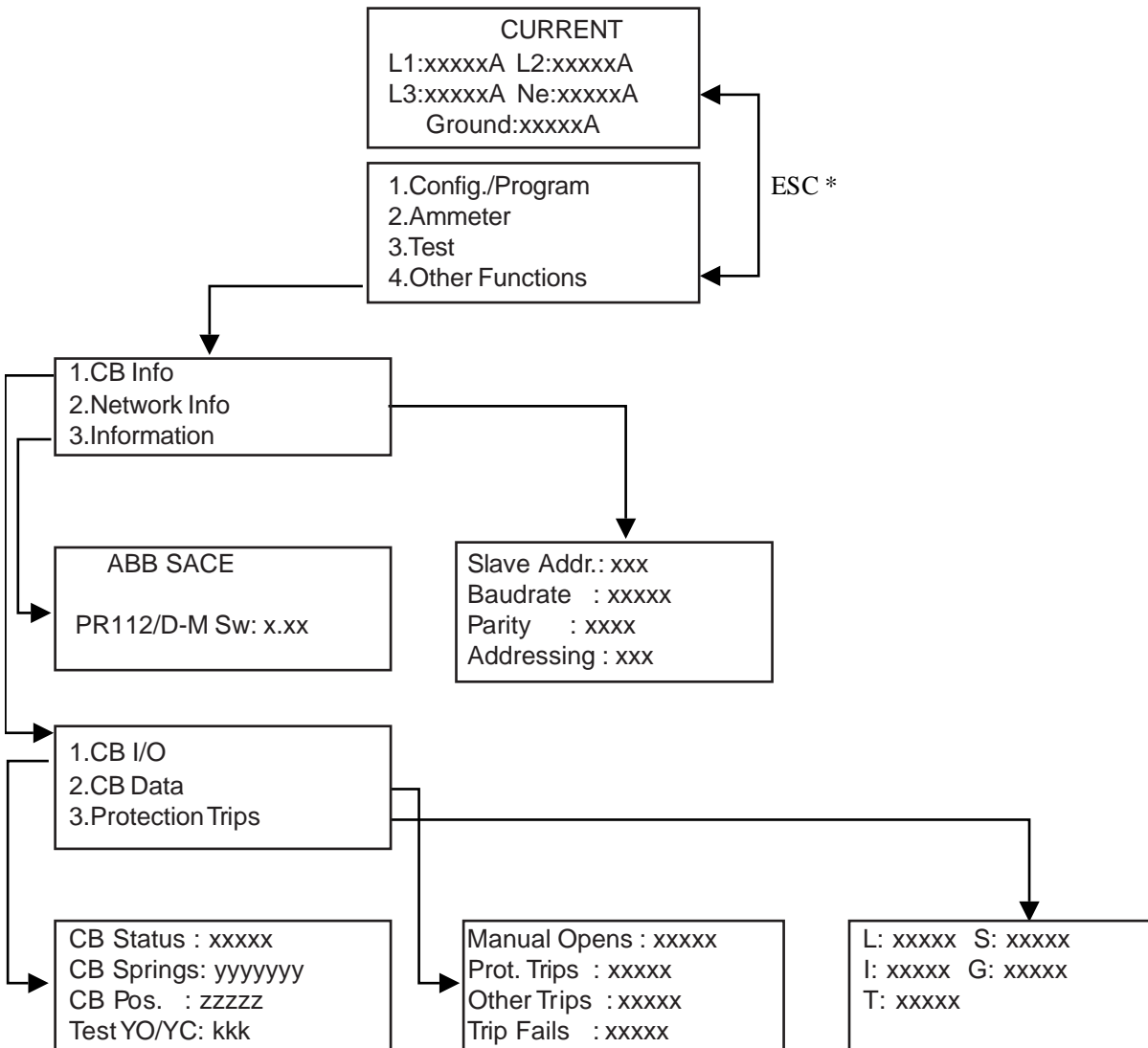
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14.6 Operative/operating instructions during service

14.6.1 Menus

For version with Modbus™ protocol:

As already seen previously, the PR112 uses the display to show messages, data and menus. These are organized in a logical and intuitive way. For user convenience, all the additional screens which can be seen with PR112/PD are given below.

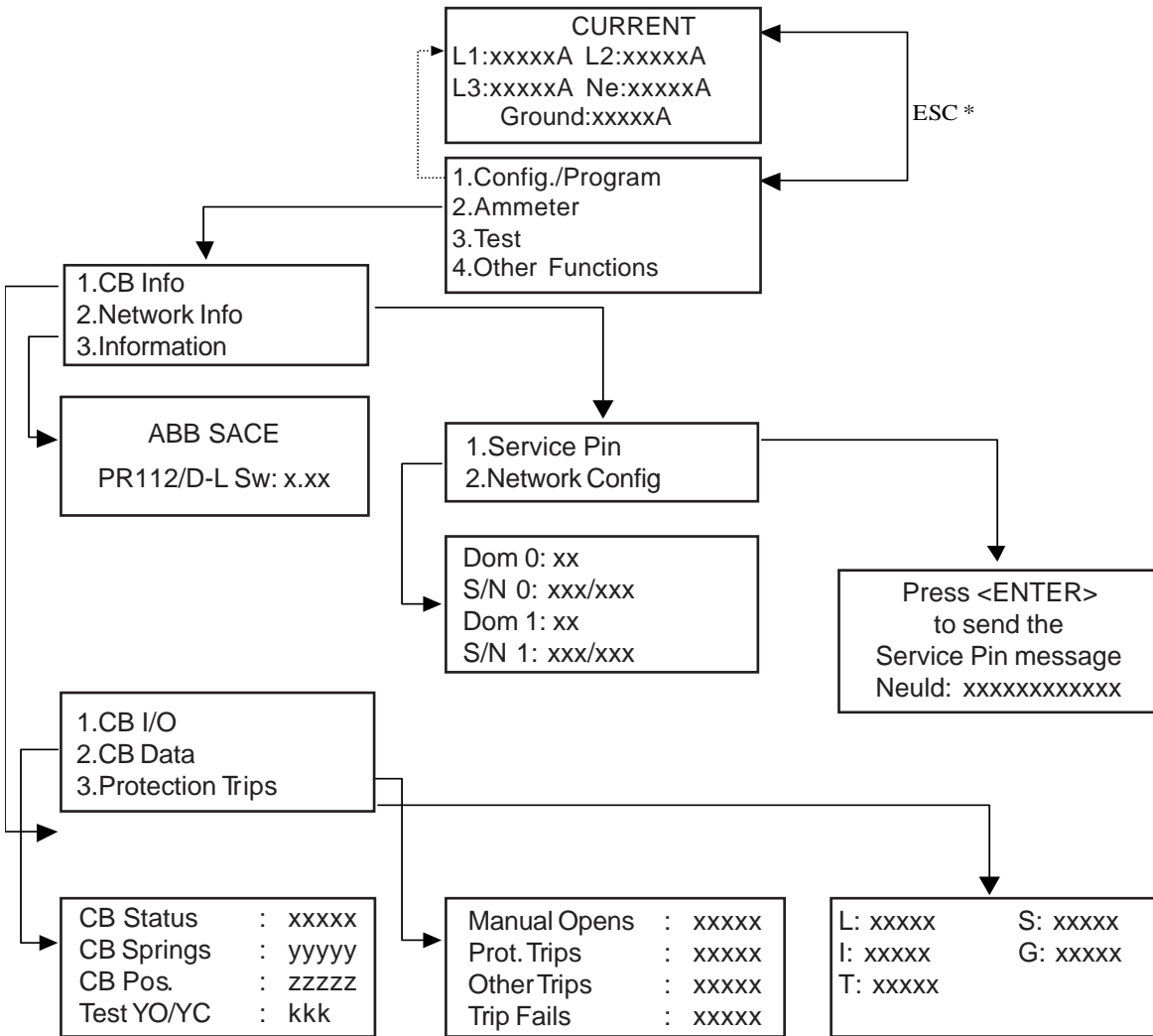


* Press ESC to return to the previous page

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For version with Lon® protocol:

As already seen previously, the PR112 uses the display to show messages, data and menus. These are organized in a logical and intuitive way. For user convenience, all the additional screens which can be seen with PR112/PD are given below.



* Press ESC to return to the previous page

14.6.2 Modification of parameters

The information for modification of the various parameters is given in the PR112/P part of the instruction manual.

14.6.2.1 Modification of basic configuration

With PR112/PD, a further page is displayed in the Config./Program menu

D configuration
 Operating Mode: xxx
 Wait Rem-> Loc: yyy

Properties / function	Selectable values	Description
Operating mode	Rem-Loc	See par. 14.4.6.1
Wait Rem -> Loc	On-Off	Wait by the protection unit inside the PR112 for consent from the communication unit (still inside the PR112) for passing from remote to local mode.

14.6.2.2 Modification of communication parameters

For version with Modbus™ protocol:

Slave Addr.: xxx
 Baudrate : xxxxx
 Parity : xxxx
 Addressing : xxx

Properties / function	Selectable values	Description
Slave Addr.	1...247and 255*	Logical address of the device.
Baudrate	9600-19200 bit/s	Data transmission speed.
Parity	Even-Odd	Control mode of data transmitted.
Addressing	Standard-ABB SACE	Type of addressing of the Modbus™ data.

* Slave Addr. = 255 means unit not configured.

14.6.3 Signals

14.6.3.1 Optical signals

Signalling	Description
Led µP Fault [COMMUNICATION] (red)	Microprocessor of the dialogue unit with temporary or permanent fault.
Led Network [COMMUNICATION] (yellow)	The communication (Tx) activity between the PR112 release and the remote supervision system is active (rapid flashing).

14.7 Troubleshooting

The following table collects up a series of typical service situations, which are useful in order to understand and solve hypothetical faults or malfunctions.

N.B.:

1. Before consulting the following table, check any signalling of error messages on the first line of the display for a few seconds.
2. **FN** indicates normal operation of the PR112.
3. In the case when the suggestions proposed do not lead to a solution of the problem, please contact the ABB SACE Assistance service.

N°	Situation	Possible causes	Suggestions
1	There is no serial communication activity with the remote supervision system	1. Incorrect cabling of the connections. 2. There is no auxiliary voltage 3. Incorrect communication parameters	1. Check the connections 2. Recover the auxiliary voltage 3. Set the correct parameters
2	Incorrect indication of the circuit-breaker status, circuit-breaker position and state of the springs	Incorrect cabling of the connections	Check the connections
3	Impossible to send circuit-breaker opening and/or closing controls	1. Incorrect cabling of the connections 2. No power supply to the opening and/or shunt closing releases	1. Check the connections 2. Recover the power supply voltage
4	Impossible to change the PR112 parameters and/or carry out opening/closing controls from the front keyboard	The unit is set to Remote	Set the unit to Local
5	Impossible to change the PR112 parameters and/or send remote opening/closing controls	The unit is set to Local	Set the unit to Remote
6	"No Int. Bus Comm" message on the display	No communication activity between protection unit and communication unit inside the PR112.	Contact ABB SACE
7	No updating of the opening data	Vaux not present during the trip	FN

14.8 Warning and error messages

For version with Modbus™ protocol:

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

Incorrect configurations	
MESSAGE	DESCRIPTION
MODBUS not config.	The dialogue unit does not have the address set (ABB default setting)
V_AUX OFF: Comm. OFF	The communication bus is not operating because there is no auxiliary voltage.
NO Int. Bus Comm.	No communication between the protection unit and the dialogue unit inside the PR112/PD.
NOT available	The function required is not available.
CB Status Unknown	See par.14.4.4.5
MODBUS Wink	The Wink mode has been activated. In this condition, rear illumination of the display is intermittent.

For version with Lon® protocol:

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

Incorrect configurations	
MESSAGE	DESCRIPTION
LON not config.	The dialogue unit does not have the communication parameters set (ABB default setting)
V_AUX OFF: Comm. OFF	The communication bus is not operating because there is no auxiliary voltage.
NO Int. Bus Comm.	No communication between the protection unit and the dialogue unit inside the PR112/PD.
NOT available	The function required is not available.
CB Status Unknown	See par. 14.4.4.5
LON Wink	The Wink mode has been activated. In this condition, rear illumination of the display is intermittent.

14.9 ACCESSORIES

See paragraph 13.18.

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15. SACE PR113/P Release – Identification

The PR113 units available according to the IEC Standards are:

- PR113/P (LSIG)
- PR113/PD (LSIG fitted with communication card).

15.1 Standard

The PR113 /P has been designed to work in accordance with the following international standard :

IEC 60947-2 Low voltage apparatus. Circuit-breakers.

15.2 Specifications

15.2.1 General

The PR113 unit is a self-supplied protection unit with high performance with Protection, Measurement, Watchdog, Signalling, Test, Control of the Circuit-breaker, Communication and Storage functions for ABB SACE 'EMAX' series of air three-pole and four-pole Low Voltage circuit-breakers

The protections available are:

Symbol	Protection against ...
L	overload with inverse long time-delay
S	short-circuit with adjustable delay
D	directional short-circuit with adjustable delay
I	instantaneous short-circuit
G	earth fault with adjustable delay
U	phase unbalance
OT	temperature out of range
K	load control
UV	undervoltage
OV	overvoltage
RV	residual voltage
RP	reverse active power
linst	ultra rapid instantaneous short-circuit (for high currents)

The PR113 can be installed both on three-pole, three-pole with external neutral or four-pole circuit-breakers.

It should be noted that the reference current, for the PR113, is the I_n (rated current of the CTs mounted in the circuit-breaker) and not the I_u (uninterrupted rated current of the circuit-breaker itself).

Example: the E1B800 circuit-breaker with 250 A CT, has an I_u of 800A and an I_n of 250 A.

The unit carries out opening of the circuit-breaker, in which it is integrated, by means of the SA, which acts directly on the mechanical lever mechanism of the apparatus.

The CTs supply the release with both the energy for self-supply, and the signal to calculate the current circulating in the busbars of the circuit-breaker.

Operation in self-supply is guaranteed for any protection function and for setting which can be defined by the user.

Some supplementary functions, for example the SdZ, require an external auxiliary power supply.

For further information regarding self-supply and the auxiliary power supply, see par. 15.2.2.

The VTs provide the signals used for the protection functions and for the measurements of voltage and power (see par. 15.3.2)



The maximum length of the VT - PR113 cabling must not exceed 15 meters.

Use corded shielded two-wire cable (see note A to par. 11.2.2).

The shield must be connected to earth on both sides.



Use VTs with a shield, connected to earth (see note A to par. 15.3.2.1).

The unit is made with electronic digital technology and interfaces with the user with a graphic display and a membrane control keyboard.

The protection parameters and in general the mode of operation of the unit are fully programmable by the user, in different languages.

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15.2.2 Electrical characteristics

Nominal operating frequency	50/60 Hz ±10%
Pass band	1200 Hz max
Peak factor	2.1 max @ 4 In
MTBF (MIL-HDBK-217E)	15 years @ 45°C

15.2.2.1 Self-supply

All the protection functions are operational without an external auxiliary power supply. In fact, self-supply is guaranteed by the CTs installed in the circuit-breaker.

Minimum busbar current for turning the release on:

- 0.35xIn with single-phase current
- 0.20xIn with two-phase current
- 0.15xIn with three-phase current

Minimum busbar current for turning the display on (not rear-lit):

- 0.50xIn with single-phase current
- 0.30xIn with two-phase current
- 0.20xIn with three-phase current

The display lighting up time is about 3 seconds.

15.2.2.2 Auxiliary power supply

The Auxiliary power supply guarantees operation of the PR113 in any condition, even with the circuit-breaker open or with circulating current lower than the values mentioned in the previous paragraph.

A sudden drop or loss of the Vaux does not have any effect on the protection functions, since, if involved in a fault current, this guarantees self-supply.

The Vaux is necessary for some special functions/performances (e.g. SdZ, communication, rear illumination of the display, etc.). The time for reaching normal running of the PR113, from the moment of connection of the Vaux, is about 5 s .



Since a Vaux insulated from earth is required, it is necessary to use “galvanically separate converters” conforming to the IEC 60950 (UL 1950) Standards or their equivalent [which guarantee a common mode current or leakage current (see IEC 478/1, CEI 22/3) not higher than 3.5mA], IEC 60364-41 and CEI 64-8

Characteristics	PR113/P Version
Power supply voltage	24V DC ±20%
Maximum ripple	5%
Inrush Current @ 24 V	~3A for 30ms
Start-up Current @ 24 V	~1.0A for 150ms
Rated current @ 24 V	~200mA
Nominal Power @ 24 V	~5W

15.2.3 Environmental characteristics

Operating temperature	-25°C ... +70°C
Storage temperature	-40°C ... +90°C
Relative Humidity	0% ... 98% with condensation
Degree of protection (with PR113 installed in the circuit-breaker)	IP 30

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15.2.4 Inputs/outputs

15.2.4.1 Binary opto-insulated inputs

- **CB-Closed:** circuit-breaker status
- **K51/SZin (K51/DFin):** SdZ S input (or FW in, for SdZ Directional function)
- **K51/Gzin (K51/DBin):** SdZ G input (or BW in, for SdZ Directional function)

15.2.4.2 Binary opto-insulated outputs

- **K51/SZout (K51/DFout):** SdZ S output (or FW out, for SdZ Directional function)
- **K51/GZout (K51/DBout):** SdZ G output (or BW out, for SdZ Directional function)

15.2.4.3 Output contacts

- **K51/p1:** relay output programmable by the user
- **K51/p2:** relay output programmable by the user
- **K51/μP:** relay output for signalling microprocessor faulty
- Monostable contacts, only active when there is Vaux;
- Maximum changeover current: 3A – 250V AC (0.6A – 100V DC).
- Contact-contact insulation voltage : 1000 V AC
- **K51/Y01:** relay output for signalling "release tripped"
- Bistable contact, also active in self-supply;
- Maximum changeover current: 0.5A – 125V AC (0.3A – 110V DC).
- Contact-contact insulation voltage : 750 V AC

15.2.5 Communication bus

Internal RS485 bus, 38,400 bps baud rate, ABB SACE protocol.

15.2.6 Protection functions

The PR113 protection unit carries out 13 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 directional short-circuit with adjustable delay "D";
4. Protection against instantaneous short-circuit "I";
5. Protection against earth fault with adjustable delay "G";
6. Protection against phase unbalance "U";
7. Protection against overtemperature "OT";
8. Load control protection "K" (#)
9. Protection against undervoltage "UV";
10. Protection against overvoltage "OV";
11. Protection against residual voltage "RV";
12. Protection against reverse active power "RP";
13. Protection with fixed threshold against instantaneous short-circuit "Inst";

(#) : The K protection, used for load control, is made up of two predefined curves with threshold currents and trip times lower than those selectable with protection "L", which can be used for two different applications:

1. disconnection of two distinct loads;
2. connection and disconnection of a load

This protection allows single loads to be disconnected before protection for overload "L" intervenes to definitively open the circuit-breaker. It is a function which is only available when there is an auxiliary power supply.

The PR113 unit allows current signal processing of the neutral pole with different relationships relative to the value of the phase.

N.B.: Over 15.5xIn of current on the Ne, the protection itself is considered as set to 100%.

An indication (message + "emergency" LED) is provided on the unit display which is activated during a protection alarm. This is de-activated when the alarm stops or with a protection tripped. On opening of the circuit-breaker by means of the SA (see note C to par. 11.2.2), the electrical contact of protection tripped (K51/Y01) is closed and the corresponding yellow magnetic flag turned. When there is an auxiliary power supply, the openings page with the data of the "trip" which has just occurred is also displayed (see par. 15.2.9.2) and the "Trip" LED is lit. The signals (K51/Y01, flag and Trip LED) are reset by pressing the RESET key (the Trip LED is also turned off by switching the unit off).

For the protections with fixed time with adjustable delay, the relationship implemented is the following: $t = k$.

For the protections with inverse time, the relationship between trip time and overcurrent is given by the formula: $t = k / I^2$.

Calculation of RMS and Peak

The "L, S, D, U, G and RP" protection functions carry out the relative processing on the basis of the true rms value of the secondary currents of the CTs up to 6 In (protection G is disabled for phase currents higher than 4xIn). For currents higher than 6xIn, and for function "I", the processing is carried out taking into account the peak value divided by $\sqrt{2}$ (the sinusoidal wave form is then considered). This is because of incompatibility between the trip time and the rms value calculation time.

If the waveform has a deformation above the declared limit (2.1@4 In), the calculation tolerance of the true rms value will increase. The UV, OV, RV voltage protections always work on the basis of the true rms value of the secondary voltages supplied by the VTs.

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15.2.6.1 Protection "L"

Protection "L" is the only one which cannot be disabled since it carries out self-protection against overloads of the release itself. The types of trip curves settable are divided into two groups according to the stand they refer to.

Standard trip curve according to IEC 60947-2

The type of curve settable ($t=k/I_2$) is a single one and defined by the IEC 60947-2 Standard. The protection trip time - inverse time - is given by the expression

$$\max \left[\frac{9 \cdot t_1}{(I_f / I_1)^2}, 0.75 \right] \text{ for } I_f \leq 12I_n, 0.75 \text{ s for } I_f > 12I_n \text{ where } I_f \text{ is the fault current and } I_1 \text{ the protection threshold.}$$

NB: Time expressed in seconds.

Standard trip curve according to IEC 60255-3

There are 3 types of curves settable and defined by the IEC60255-3 Standard as A, B and C. The protection trip time - inverse time - is given by the expression

$$t = \frac{k}{(I)^a - 1} \cdot b \text{ where } I = \frac{I_f}{I_1} \text{ NB: Time expressed in seconds.}$$

I_f is the fault current and I_1 the protection threshold, set by the user.

a and k are two parameters, suggested by the standard, which vary the type of slope selected (e.g. for type B slope $a = 1$ and $k = 13.5$); b is a parameter introduced by SACE to increase the number of curves with the same slope.

15.2.6.1.1 Thermal memory "L"

It is possible to enable the function of thermal memory for cable protection. This is based on the "tL" parameter defined as the trip time of curve (t1) selected at $1.25 \times I_1$.

The release trip time is certainly 100% of the one selected after which a time of τL has passed since the last overload or since the last trip. Otherwise the trip time will be reduced, depending on the overload which has occurred and on the time passed.

The PR113 is fitted with two instruments to make up this thermal memory. The first only works when the release is supplied (it remembers overloads which did not last long enough to make the release trip), whereas the second only works when the release is not supplied (it reduces any trip times in the case of immediate reclosing). The PR113 release automatically decides which of the two to use according to the various situations.

N.B.: The thermal memory function can only be set if the type of curve selected is the standard one ($t=k/I^2$) (see par. 15.2.6.1).

15.2.6.2 Protection "S"

This protection, which can be disabled, can be with fixed time ($t = k$) or inverse time. In the latter case, the trip time is given by the expression

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

15.2.6.2.1 Thermal memory "S"

It is possible to enable the thermal memory function 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 $1.5 \times I_2$. The other characteristics are the same as those for thermal memory "L" (see par.15.2.6.1.1).

15.2.6.2.2 Start-up threshold "S"

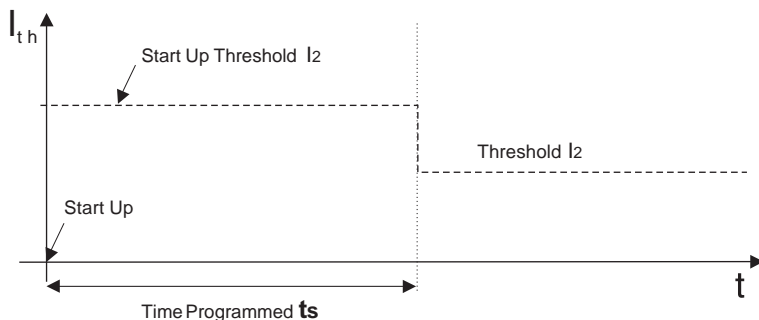
It is possible to select the start-up function in the case where the curve with fixed time is selected.

The function is disabled by selecting [----] at the "StartUp" parameter on the protection "S" page.

The time the start-up threshold is valid for depends on what is set for the "ts" parameter on the page for general enabling of the START-UP function (see par.15.4.2.2). If the function is placed on [Off] here, the start-up threshold is disabled for all the protections.

The start-up function allows modification of the protection threshold (S, D, I and G) during a time interval lasting "ts", starting from "start-up". The latter must be intended as follows:

- Turning on of the release, under self-supply;
- Passage of the peak value of the maximum current over $0.1 \times I_n$. A new start-up is possible after the current has gone down below $0.1 \times I_n$.



• Start-up time

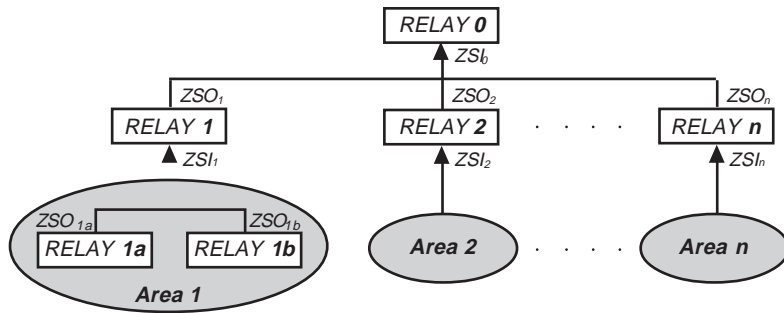
The start-up time is common to all the protections involved.

Range: 0.1 s ... 1.5 s, with steps of 0.05 s. Tolerance : $\pm 20\%$.

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15.2.6.2.3 Zone selectivity “S”

It is possible to enable the zone selectivity function in the case where the curve with fixed time is selected and there is an auxiliary power supply. This is carried out by connecting all the zone selectivity outputs to one another (ZSO=K51/SZout) of the releases belonging to the same zone and taking this signal to the zone selectivity input (ZSI=K51/SZin) of the release immediately on the supply side. If the cabling operation has been carried out 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.



The zone selectivity function allows the fault area to be isolated, only isolating the installation to the level nearest the fault and keeping the rest of the installation operational.

This means that a load side fault of “Relay 1a” will be isolated from the latter without “Relay 1” and “Relay 0” intervening. A fault just on the load side of “Relay 1” will be isolated from the latter without “Relay 0” intervening, guaranteeing that the Areas 2...n remain active.

The ZSI signal can be connected up to 20 units in parallel (to the relative ZSO signal).

The ZSO output can be connected to a maximum of 3 ZSI relays on the supply side in the selectivity chain.



**The maximum length of cabling 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 supply side relay (ZSI side).**

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

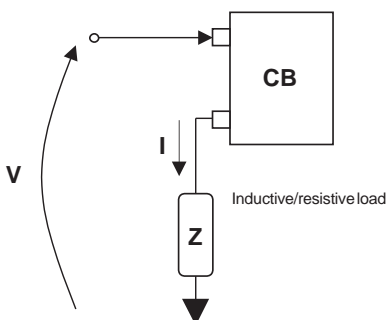
Zone selectivity	I _{max} > I ₂	ZSI signal	ZSO signal	Trip t ₂ T
Excluded	NO	0	0	No trip
Excluded	NO	1	0	No trip
Excluded	YES	0	0	t ₂ programmed
Excluded	YES	1	0	t ₂ programmed
Inserted	NO	0	0	No trip
Inserted	NO	1	1	No trip
Inserted	YES	0	1	t _{selectivity}
Inserted	YES	1	1	t ₂ programmed

As seen in par.15.4.2.2, it is possible to set the time t_{selectivity} (40 ... 200ms). The [tpgr] setting for the parameter makes t_{selectivity} = t₂ (useful for the relays at the base of the selectivity chain).

15.2.6.3 Directional Protection “D”

The PR113 unit carries out excludable directional protection against short-circuit with adjustable fixed time (t = k) active both with self-supply and with auxiliary supply.

The protection functionality is very similar to protection “S” with fixed time, with the capacity to recognize the current direction during the fault period as well. However, it is a phase and not neutral protection. The direction of the current allows determination of whether the fault is on the supply side or load side of the circuit-breaker. Especially in ring distribution systems, this allows the distribution stretch where the fault occurred to be identified and to isolate it without interfering with the rest of the installation (using zone selectivity).



The direction is only determined in the case where the maximum value of the phase reactive powers is higher than 2% of the nominal phase power ($P_Q \geq 2\% P_{nphase}$).

Once these conditions are fulfilled, the direction is defined in the following way:

- positive reactive power in → “forward” direction;
- negative reactive power in → “backward” direction.

In the drawing at the side, the direction of the current is “forward” ($P_Q > 0$).

With regard to the trip times, it is possible to set two different ones [Bw, Fw] according to whether the direction of the current trip selected is “backward” or “forward”.

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Operation, with zone selectivity disabled, is the following:

- If $I_{max} > I_7$ and current direction determined \neq direction set \rightarrow no alarm;
- If $I_{max} > I_7$ and current direction determined = direction set \rightarrow times and opens;
- If $I_{max} > I_7$ and current direction cannot be determined \rightarrow times and opens considering as the direction the one selected with the "Direction" parameter.

N.B.:

- Protection D always considers I neutral (Neutral sel.) = 100%.
- Protection D is not available with 250 and 400 A CT.
- See Warnings par. 15.3.2.

15.2.6.3.1 Start-up threshold "D"

The function is disabled by selecting [-----] at the "StartUp" parameter on the protection "D" page. The behaviour of the function is identical to the one described for protection "S" (see par. 15.2.6.2.2).

15.2.6.3.2 Zone selectivity "D"

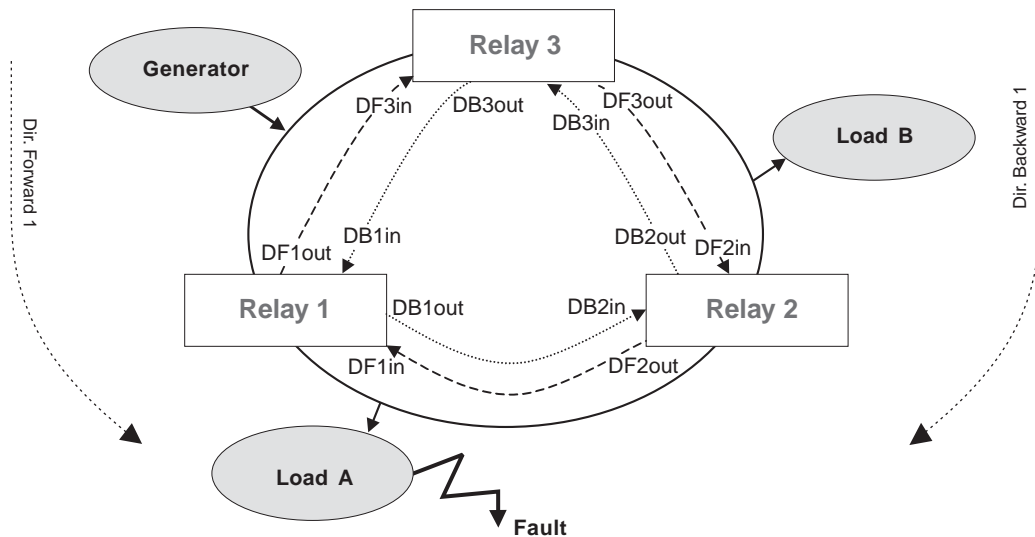
Zone selectivity "D" can only be set [On] in the case where zone selectivity "S" and "G" are set on [Off] and there is an auxiliary power supply. It uses 4 signals, two outputs and two inputs:

- DF_{in} (K51/DF_{in}), DF_{out} (K51/DF_{out}) for signalling in the case of "forward" direction of the fault current;
- DB_{in} (K51/DB_{in}), DB_{out} (K51/DB_{out}) for the signalling in the case of "backward" direction of the fault current.

With zone selectivity activated, if the direction is not determined, the protection trips considering the shorter time programmed of forward and backward and without activating any output (DF_{out} or DB_{out}).

Setting the "Direction" parameter for operation with zone selectivity has no influence.

The typical configuration of the circuit-breaker system for which the use of zone selectivity "D" is foreseen is the ring one, as shown as an example in the following figure.



In the case when a fault is determined on one of the sections of the system (Load A), the end circuit-breakers of the section itself (Relay1 and Relay2) communicate the presence of the fault to the circuit-breakers connected (Relay3) setting the DF_{out} or DB_{out} output signals on the basis of the direction of the current (DF_{out1}=On, DB_{2out}=On). In particular, the circuit-breakers which limit the section of the fault see the direction of the fault current in different ways (Relay1 "forward" and Relay2 "backward").

The circuit-breakers which limit the section involved by the fault intervene with selectivity time t_s (130 ... 500ms) whereas the circuit-breakers connected time with time t_7 (Relay3). In this way the system is isolated by excluding the fault area.

15.2.6.4 Protection "I"

The protection, which can be disabled, is made with intentional delay nil.

In the case where zone selectivity "S" (or "D") is active, during the trip of the relay for "I", the ZSO (or DFW and BFW) output signal is activated in any case to guarantee correct operation of the supply side (and load side) relay.

15.2.6.4.1 Start-up threshold "I"

The start-up function can be selected. The function is disabled by selecting '-----' at the "StartUp" parameter on the protection "I" page. The behaviour of the function is identical to the one described for protection "S" (see par. 15.2.6.2.2)

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15.2.6.5 Protection “G”

The protection, which can be disabled, can be with fixed time ($t = k$) or inverse time. In the latter case, the trip time is given by the expression

$$\max\left(\frac{2}{(I_f/I_4)^2}, t_4\right)$$

where I_f is the fault current and I_4 the protection threshold

NB: Time expressed in seconds.



It is possible to disable the trip control of the protection (“Trip: Off”). For the whole duration of the earth fault the circuit-breaker will not be opened, but only the alarm condition will be signalled (“emergency” LED lit and alarm message).

The PR113 unit is able to provide two different types of earth fault protection:

* **Internal protection G**

This is carried out inside the release by vectorially summing the phase and neutral currents. The fault current is defined by the following formula

$$\vec{I}_G = \vec{I}_1 + \vec{I}_2 + \vec{I}_3 + \vec{I}_{NE}$$

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.

It is necessary to set “Tor.selec.: Int.” to work in this mode.

* **Protection G with external toroidal transformer “Source Ground Return”**

Also called “Source Ground return”, this can be carried out when there is the need to check operation of a machine (transformer or generator or motor etc.) which has star configured windings. The protection is carried out by physically positioning an external toroidal transformer on the cable connected from the star centre of the machine to the earthing connection point. The induced current on to the winding of the toroid is proportional to the fault current which, in this case, only transits in the above-mentioned toroid.

It is necessary to set “Tor.selec.Ext.” to work in this mode.



**The external toroid must be connected to the PR113 by means of a corded shielded two-wire cable (see note A to par. 11.2.2) with a length not exceeding 15m.
The shield must be earthed both on the circuit-breaker side and on the toroid side.**

It is indispensable for the star centre to be connected openly to earth and for the same not to be used as a neutral conductor as well (as in the TNC system), making a protection according to the TT system. The nominal values of the current sensors available are given in par.15.4.2.1.

In single-phase self-supply, protection “G” is only active if the primary current is higher than 0.4xIn. When the value of the phase current is above 4xIn , function “G” excludes itself since, in this case, it is the other protections which intervene as the fault is considered a phase fault.

15.2.6.5.1 Start-up threshold “G”

It is possible to select the start-up function in the case where the curve with fixed time is selected. The function is disabled by selecting ‘——’ at the “Startup” parameter on the protection “G” page.

The behaviour of the function is identical to the one described for protection “S” (see par.15.2.6.2.2).

15.2.6.5.2 Zone selectivity “G”

It is possible to enable the function of zone selectivity in the case when the curve with fixed time is selected and there is an auxiliary power supply. The cabling and enabling of zone selectivity “G” is an alternative to the “D” one and operation is only guaranteed when there is auxiliary voltage.

Zone selectivity “G” can be active at the same time as zone selectivity “S” since the inputs and the outputs are independent (ZSI=K51/GZin and ZSO=K51/Gzout).

The behaviour and cabling of the function are identical to those indicated for zone selectivity “S” (see par.15.2.6.2.3).

15.2.6.6 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 t_6 set, an unbalance is determined between two or more phases higher than the set threshold **I6**.

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



It is possible to disable the trip control of the protection (“Protection Trip: Off”). In that case, for the whole duration of the unbalance the circuit-breaker will not be opened, but only the condition will be signalled by means of the “warning” LED lit up and a warning message.

When the value of the phase current is above a 6xIn , function “U” excludes itself since in this case it is the other protections which intervene since the fault is considered a phase fault.

The protection is not enabled for maximum phase current values lower than 0.3xIn.

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15.2.6.7 Protection against overtemperature inside the "OT" release

A sensor is placed inside the PR113 unit which monitors the temperature of the unit.

This allows the presence of abnormal temperatures which could cause temporary or continuous malfunctions of the electronic components of the unit to be signalled.

This protection has two states of operation:

* State of "WARNING TEMPERATURE" with $-25^{\circ}\text{C} < \text{temp.} < -20^{\circ}\text{C}$ or $70^{\circ}\text{C} < \text{temp.} < 85^{\circ}\text{C}$; the display is turned off and the led "TEMP" flashes.

* State of "ALARM TEMPERATURE" with $\text{temp.} < -25^{\circ}\text{C}$ or $\text{temp.} > 85^{\circ}\text{C}$; the display is turned off, the remains lit and the Trip is activated (if enabled, by means of the "Over Temper. Trip" = On parameter).

The precision of temperature measurement is $\pm 1^{\circ}\text{C}$ ("range" of measurement $-40^{\circ}\text{C} \dots +125^{\circ}\text{C}$).

N.B.:

- In case 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-supply.



Disabling the Trip control of the protection means that the PR113 unit could work, with the circuit-breaker closed, in a range of temperatures where correct operation of the electronics is not guaranteed.

15.2.6.8 "K" Load control function

There are two distinct protection curves with threshold currents and trip times lower than those selectable with protection L, which can be used for the following two applications:

1. disconnection of two distinct loads (2 curves with inverse time $t = k/I^2$);
2. connection and disconnection of one load (curve with adjustable delay $t = k$ for connection and with inverse time $t = k/I^2$ for disconnection)

These protections allow single loads to be connected/disconnected before protection L against overload intervenes to definitively open the circuit-breaker.

The disconnection protections use trip curves similar to those used by protection "L", but with lower thresholds and shorter times. The reference curves are those of protection "L".

Presence of a thermal memory is not foreseen. Operation with "L" thermal memory inserted could cause abnormal behaviour.

The "Load control" protection is carried out by means of the relay contacts on board the PR113 unit (K51/p1 and K51/p2 to be configured) or by means of the contacts supplied by the PR020/K accessory signalling unit (par. 15.7.2). The function is only active when there is an auxiliary power supply.

The protection can be totally disabled by selecting the value [Off] beside the indication of the type of control activated (see par.15.4.2.2). Each single protection is excludable by selecting "Off" for the threshold.

The trip thresholds are expressed in percentages of the "L" (I_L) threshold. The trip times for load disconnection are fractions of the time selected for protection "L" (t_L).

15.2.6.8.1 Disconnection of two loads

The opening control for load n°1 is sent when $I_{\text{max}} > I_{c1}$ (for the time curve = $t1/4$). At this point the protection is disabled and a message appears for "load 1 open".

The opening control for load n°2 is sent when $I_{\text{max}} > I_{c2}$ (for the time curve = $t1/2$). At this point the protection is disabled and a message appears for "load 2 open".

To re-enable operation of the protections on load n°1 (or n°2), it is necessary to press the "reset" key, on the current page, on the "default" page or on the one for configuration of protection "K".

15.2.6.8.2 Connection - Disconnection of a load

For reclosing timing with fixed adjustable time t_{c1} is applied. The closing control for load n°1 is sent when $I_{\text{max}} < I_{c1}$ (for the time set with t_{c1}). On start-up of the unit, if self-reclosing is not locked, reclosing is always carried out if $I_{\text{max}} < I_{c1}$.

The opening control for load n°1 is sent when $I_{\text{max}} > I_{c1}$ (for the time curve = $t1/2$). At this point the protection is disabled and a message appears for "load 1 open".

It is re-enabled by the automatic reclosing or by pressing the "reset" key on the currents page, on the "default" page or on the one for configuration of the protection (the opening protection is released voluntarily without a reclosing operation having taken place).

When the number of self-reclosing operations reaches the maximum number of self-reclosing operations which can be carried out ("Nr. AR = MaxAR"), reclosing is disabled (a message appears for "self-reclosing operation disabled"). To re-enable it, it is necessary to reset the "Nr. AR" (by entering the protection setting page in "edit" mode)

15.2.6.9 Voltage protections "UV", "OV", "RV"

The PR113 unit carries out 3 voltage protections, which are excludable, with fixed adjustable time ($t = k$), active both with self-supply and with auxiliary supply:

- Undervoltage "UV"
- Overvoltage "OV"
- Residual voltage "RV"

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The protections work on the phase voltages. The threshold voltages indicated refer to the phase voltage.

Apart from normal timing and "Trip" operation, the voltage protections can be in a state defined as "alarm" ("emergency" LED lit and display of alarm message), only with an auxiliary power supply. In fact, in the case where the circuit-breaker is open and no current is determined, 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 (VTs always connected) and the unit would therefore always be under "timing". When closing of the circuit-breaker or the passage of current is determined, you pass immediately from the state of "alarm" to "TRIP" without timing (for warning see par. 15.3.2).

15.2.6.9.1 Protection "UV"

When the minimum phase voltage drops below the set threshold V_8 , the protection times for the time set t_8 and then opens.

15.2.6.9.2 Protection "OV"

When the voltage phase maximum exceeds the set threshold V_9 , the protection times for the time set t_9 and then opens.

15.2.6.9.3 Protection "RV"

When the residual voltage exceeds the set threshold V_{10} , the protection times for the time set t_{10} and then opens.

The residual voltage V_0 is calculated by vectorially summing the phase voltages. It is therefore defined by the following formula

$$\vec{V}_0 = \vec{V}_1 + \vec{V}_2 + \vec{V}_3.$$

The protection allows determination of voltage unbalances in the case of star systems with neutral earthed.

15.2.6.10 Protection against Reverse active power "RP"

The PR113 unit carries out excludable, with fixed adjustable time ($t = k$) protection against reverse active power, active both with self-supply and with auxiliary supply.

When the total reverse active power (sum of the power of the 3 phases) exceeds the set threshold of reverse active power P_{11} , the protection times for the time set t_{11} and then opens.

The minus sign (-) in front of the threshold and the power indicates reverse power. The threshold is indicated in a percentage of "Pn", where "Pn" is the nominal power of the circuit-breaker ($3 V_n \cdot I_n$).

15.2.6.11 Protection against instantaneous short-circuit "Iinst"

This function has a single protection curve with fixed time.

When the protection trips, the circuit-breaker opens by means of the opening solenoid (SA).

15.2.6.11.1 Selection of the threshold value

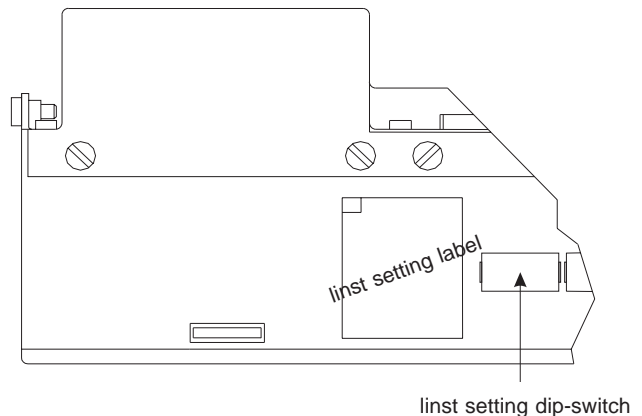
For correct setting of protection Iinst, linked to the size of the circuit-breaker, work on the relative 10 dip-switches placed on the part above the release (see figure), consulting the label at the side of them.

The protection, which can only be set by ABB personnel, cannot be excluded.

In the diagrams of the label, relative to the settings, the position of the dip-switch is indicated by the white part.



In the diagram at the side, the dip-switch is set in the top position (Off)



Modification of the threshold set can lead to permanent damage of the circuit-breaker and of the installation itself with consequent damage to the operator.

15.2.7 Warning functions

15.2.7.1 Warning Threshold

This function allows monitoring of a current threshold I_w which can be set inside the configuration menu (see par.15.4.2.1). The function can be disabled by selecting [---] (value on "Off").

When the maximum current (of phase or neutral) exceeds the set threshold, the "warning" LED is lit and the warning message is displayed. The signalling can be combined with one of the internal relays or with those of the PR020/K unit.

The precision of the threshold is $\pm 10\%$.

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15.2.7.2 Network frequency

The PR113 unit constantly measures the frequency of the network voltages it is connected to. When there are no voltages ($U_{max} < 0.1U_n$), determination is carried out on the currents (if $I_{max} > 0.1I_n$).

If the frequency goes out of the permitted range by $\pm 10\%$ in relation to the nominal frequency selected (50 or 60Hz), the “warning” LED is lit and the warning message is displayed (see par.15.6). Signalling can be combined with one of the internal relays or with those of the PR020/K unit.

Precision of frequency determination is $\pm 0.1\text{Hz}$.

15.2.7.3 Harmonic distortion

The PR113 unit signals that a peak factor above a 2.1 has been exceeded with a warning message and the “warning” LED lighting up (see par. 15.2.8.4.2) (remember that the IEC 60947-2 annex “F” Standard foresees that the protection unit must function regularly with a peak factor ≤ 2.1 , up to $2xI_n$).

Signalling can be combined with one of the internal relays or with those of the PR020/K unit.

15.2.7.4 Circuit-breaker status

When there is an auxiliary power supply, the PR113 unit determines the status of the circuit-breaker by means of special cabling on the circuit-breaker. In the case where the presence of current is determined with the circuit-breaker in the “OPEN” status, a status error is signalled by means of display of a warning message (see par.15.6) and the “warning” LED lighting up.

Signalling can be combined with one of the internal relays or with those of the PR020/K unit.

15.2.8 Measurement functions

The measurements are always available when there is an auxiliary power supply. In the case of self-supply, the sum of the entering currents must exceed a certain value (see par. 15.2.2.1) for the display to be activated. Both with Vaux and self-supply, the display is lit after a few seconds (see par. 15.2.2) from when the PR113 itself is turned on.

The indication “.....” corresponds to a value under the minimum measurable.
 The indication “> xxxx” corresponds to a value over the maximum measurable.
 The indication “-----” corresponds to disabling of the calculation of the value.

15.2.8.1 Current measurements

.....Message.....	
C u r r e n t s	
L 1 :	A L 2 :
L 3 :	A N e :
G r o u n d :	

The PR113 unit is able to provide current measurement of the three phases, of the neutral and of the earth fault, both with self-supply and with an auxiliary power supply. The earth fault current takes on two different meanings according to whether the internal “Earth Fault” toroid is selected or the external “Source Ground Return” one.

You access the page from the default one by using the ↓ (↑ to go back).

The minimum value of current measurable is $0.1xI_n$ (10% of the nominal).
 The maximum value of current measurable is $16xI_n$.

The measurement of current for the earth fault is disabled when the current of one of the phases exceeds a defined value (see par. 15.2.6.5).

Range	0.4...2xIn
Measurement precision	2 %

15.2.8.2 Voltage measurements

.....Message.....	
V o l t a g e s	
V 1 :	V 1 2 :
V 2 :	V 2 3 :
V 3 :	V 3 1 :
V 0 :	

The PR113 unit is able to provide voltage measurement of the three phases, of the relative line-to-line voltages and of the residual voltage both with self-supply and with an auxiliary power supply.

You access the page from the current measurement one using the ↓ (↑ to go back).

The minimum value of voltage measurable is $0.05xU_n$ (5% of the rated one).
 The maximum value of current measurable is $1.2xU_n$.

Measurement precision	1 %
-----------------------	-----

Values obtained with class 0.5 voltage sensors (see note A to par.15.3.2.1)

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15.2.8.3 Power measurements

```

.....Message.....
  Active Power
PA1:..... kW
PA2:..... kW
PA3:..... kW
-----
PAT:..... kW
    
```

```

.....Message.....
  Reactive Power
PQ1:..... kvar
PQ2:..... kvar
PQ3:..... kvar
-----
PQT:..... kvar
    
```

```

.....Message.....
  Apparent Power
P_1:..... kVA
P_2:..... kVA
P_3:..... kVA
-----
P_T:..... kVA
    
```

The PR113 unit is able to provide measurement of the active, reactive and apparent powers of the three phases and of the relative total powers (of the system), both with self-supply and with an auxiliary power supply.

You access the "Active power" page from the one of voltage measurements using the ↓ (↑ to go back). Still with ↓ in succession, you access the other two "Reactive power" and "Apparent Power" pages. From the latter, by pressing ↑ again, you return to the default page.

The minimum value of power measurable is $0.02 \times P_{n, \text{phase}}$ (2% of the nominal of phase $U_n \times I_n$).
 The maximum value of power measurable is $19.2 \times P_{n, \text{phase}}$.

Range	0.4 ... $2 \times P_{n, \text{phase}}$
Measurement precision	3 % *

*: With $\cos F > 0.5$.

15.2.8.4 Other Measurements

```

.....Message.....
1. Power Factor
2. Frequency / Peak Factor
3. Energy Counters
4. WaveForm / Harmonics
5. Watt Volt Amps Graphs
6. Last TRIPs
    
```

From the "Measurements/Trips" menu it is possible to access a whole series of other measurements. Only the "Power factor" and "Frequency/peak factor" pages are also available with self-supply. Position the cursor arrow over the required position and press the ↵ key to access the measurement desired.

15.2.8.4.1 Power factor Measurements

```

.....Message.....
  Power Factor
Cos φ 1: ..... Cos φ 2: .....
Cos φ 3: ..... Cos φ T: .....
    
```

The PR113 unit provides measurement of the power factor of each phase and of the system (calculated as a weighted average of the phase factors). For phase power under 2% ($0.02 \times P_{n, \text{phase}}$), the value is not displayed and is replaced by '.....'.

La precisione della misura è classe 2 nell'intervallo [0.5...1].

15.2.8.4.2 Frequency and Peak factor Measurements

This page allows display of the network frequency. This is calculated on the voltages (if $U_{\text{max}} > 0.1 U_n$) and, if these are lacking, on the currents (if $I_{\text{max}} > 0.1 I_n$). The calculation of the frequency allows a precision of $\pm 0.1 \text{ Hz}$ (after a maximum of 5s from the variation of the frequency).

```

.....Message.....
  Frequency: ..... Hz
-----
  Peak Factor -----
L1: ---- L2: ----
L3: ---- Ne: ----
    
```

Measurement of the peak factor - relationship between $I_{\text{peak}} / I_{\text{rms}}$ - for each of the phases is also present. The measurement is not displayed for phase current less than $0.3 \times I_n$ and is not available for phase current above $6 \times I_n$. The accuracy of the calculation follows what is indicated for measurement of the currents (see par. 15.2.8.1).

15.2.8.4.3 Energy Measurements

```

.....Message.....
  Energy
--Active : ..... MWh
--Reactive : ..... Mvarh
--Apparent : ..... MVAh
    
```

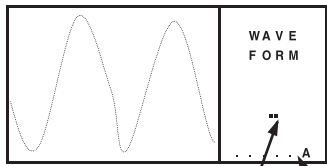
The unit carries out counter measurements of active, reactive, and total apparent energy of the system. The minimum value which can be displayed is 0.001MWh or 0.001Mvarh or 0.001MVAh. The counter resets itself when the apparent energy accumulated reaches a value equivalent to 200 days at the nominal three-phase power of the circuit-breaker (continuous).

By pressing the "RESET" key inside the page the counter is reset.

The accuracy of the calculation follows what is indicated for measurement of the powers (see par. 15.2.8.3).

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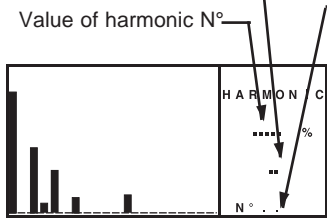
15.2.8.4.4 Display of Wave form and harmonic calculation



By entering the page, 120 samples of the wave form of phase L1 are acquired and then displayed. By pressing the \downarrow key, a new acquisition and re-display of the waveform is carried out. By means of the \rightarrow or \leftarrow keys, it is possible to display the waveforms on the other measurement channels (L2, L3, Ne, V1, V2, V3, Gt).

Channel displayed

RMS of the signal displayed



Value of harmonic N°

N° of harmonic currently selected

Using either the \uparrow or \downarrow keys, it is possible to carry out a harmonic analysis of the samples acquired and displayed on the "Wave Form" page.

This means the page indicated here at the side is displayed, containing the module of the harmonics from the 2^a to the 20^a (up to the 19^a for network frequency set to 60Hz) referred as a percentage of the fundamental (harmonic n°1) and therefore always indicated at 100%.

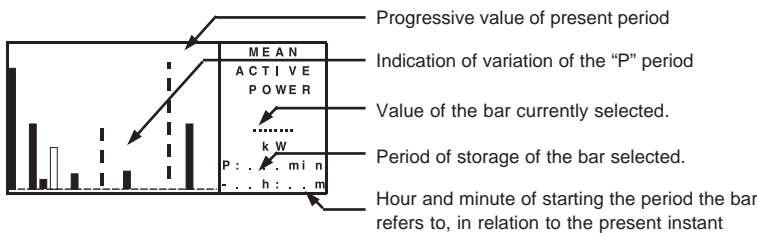
Using the \rightarrow and \leftarrow keys, it is possible to position yourself over the desired bar (at the "N°" of harmonic desired, the bar starts to flash) and read the corresponding percentage value.

Measurement precision	5%
-----------------------	----

15.2.8.4.5 Historic Measurements

The PR113 unit is able to provide the trend of the measurements of some values over a settable period of time "P" (see par. 15.4.2.1 for setting the periods).

Memory (not volatile) is kept of the last 24 "P" periods which are displayed in a histogram (see figure) with the least recent period positioned on the right side of the page whereas on the left side there is another bar (the 25^a) representing the progressive value of the period in progress of storage.



Progressive value of present period

Indication of variation of the "P" period

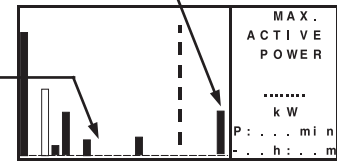
Value of the bar currently selected.

Period of storage of the bar selected.

Hour and minute of starting the period the bar refers to, in relation to the present instant

Indication of Vaux being turned on

The "empty" bars indicate a negative value.

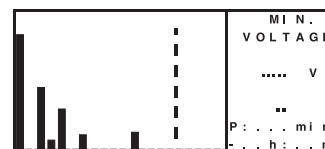
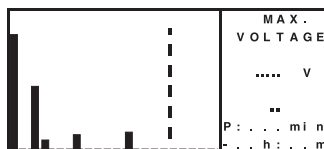
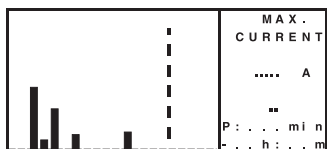


Using the \rightarrow and \leftarrow keys, it is possible to position yourself over the bar desired (which starts to flash) and read the corresponding value of the that period (for example, the maximum power determined in the "P" interval) as well as the time that period of measurement was started with reference to the present instant.

The measurements can only be acquired with Vaux present for the whole period of storage, otherwise the data is not recorded. The "turning on auxiliary" symbol indicates that there has been a period (without Vaux) of no storage during which the data were lost and the time counter was blocked.

The full-scale of the histograms is fixed by the graduated scale present on the diagram (on the left side). In any case, the higher values are correctly displayed in the "Value of the present bar" field.

Apart from "Average active power" and "Maximum Active power", the "Maximum Current", "Maximum Voltage" and "Minimum Voltage" historical values are also available.



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15.2.9 Information functions

15.2.9.1 Software version

```

.....Message.....

      ABB SACE

PR113 / P      Sw:  x . x x
    
```

This page shows what the software version of the relative PR113 release is.

Each time it is necessary to communicate any unit operating problems to ABB SACE, it is advisable to indicate the **Sw** version of the unit ("x.xx")

15.2.9.2 Opening data storage

The storage function of the opening data ("TRIP" = opening for protection) is only active if there is an Auxiliary power supply before, during and after (for at least 1sec.) any circuit-breaker opening due to a trip for protection by the release.

The function and also consultation of the page which shows the last data stored are therefore only available when there is an auxiliary power supply. In self-supply, the attempt to access the page makes a "function not available" message appear.

```

.....Message.....

N° OPEN: . . . . . PROT
L1: . . . . . A      L2: . . . . . A
L3: . . . . . A      Ne: . . . . . A
Wear: . . . . . %     Gr: . . . . . A
Vx: . . . . . V      V: . . . . . V
V0: . . . . . V PAT: . . . . . kW
    
```

Number of openings due to the protections and to the TRIP tests

Indication for protection tripped

Value of the currents interrupted on phases (L1, L2, L3), neutral (Ne) and Earth (Gr) not available in the case of a trip with phase current > 4xIn or I or S with "minimum" time).

Contact wear accumulated

Value of total interrupted Active power (not available in the case of S, I, D and G trip)

Value of phase voltages (V1, V2 and V3; not available in the case of I trip) and residual voltage (V0; not available in the case of I or S with "minimum" time trip) at the moment of interruption

```

.....Message.....

N° OPEN: . . . . . Is PROT
Short circuit
Current > Icw
Wear: . . . . . %
    
```

In the case of trip for "Inst", the page at the side is displayed.

Entering the page from the "Measurements/Trips" menu by selecting "Last Trip", the last opening carried out is always presented. Using the ↑ and ↓ keys it is possible to scroll through the last 10 Trips stored by the unit.

The percentage of contact wear is indicative of the electrical life of the electrical contacts of the EMAX circuit-breaker.

In any case, functionality of the release 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, "emergency" LED lighting up) indicates that it is necessary to check the state of contact wear. The signals are only active with Vaux. The percentage of wear depends on the number of openings carried out by the circuit-breaker and by the absolute interrupted current during each of them.

Protection	Symbol	Protection	Symbol	Protection	Symbol
Prot. L	L	Prot. I	I	Overvoltage	OV
Prot. S	S	Earth fault	G	Undervoltage	UV
Directional (direction not determined)	D	Phase unbalance	U	Residual voltage	RV
Directional (forward direction)	Df	Temperature	OT	Reverse active power	RP
Directional (backward direction)	Db			Prot. Inst	Is

15.2.10 Other functions

15.2.10.1 Programming contacts K51/p1 and K51/p2

The PR113 is fitted with two relays, whose contacts are called K51/p1 and K51/p2.

These can signal different situations, selectable by the user among those listed in the following table.

N°	Value	Description	Notes
1.	" L preal. "	Prealarm of "L"	Active with I > Prealarm Threshold, see par.15.4.3.1
2.	" L timing "	Timing protection "L"	
3.	" S timing "	Timing protection "S"	
4.	" D timing "	Timing protection "D"	

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N°	Value	Description	Notes
5.	" G timing "	Protection "G" timing	
6.	" G alarm "	Protection "G" Alarm	<i>Active in the case when "G" trip is disabled</i>
7.	" UV tim. "	"Undervoltage" protection Timing	
8.	" UV alarm. "	"Undervoltage" protection Alarm	<i>Active in the case of circuit-breaker open state</i>
9.	" V<TH.UV. "	"Undervoltage" protection at threshold	<i>Equivalent to the logical OR of "UV tim." and "UV alarm."</i>
10.	" OV tim. "	"Overvoltage" protection Timing	
11.	" OV alarm. "	"Overvoltage" protection Alarm	<i>Active in the case of circuit-breaker open state</i>
12.	" V>TH.OV. "	"Overvoltage" protection at threshold	<i>Equivalent to the logical OR of "OV tim." and "OV alarm"</i>
13.	" RV tim. "	"Residual Voltage" protection Timing	
14.	" RV alarm. "	"Residual Voltage" protection Alarm	<i>Active in the case of circuit-breaker open state</i>
15.	" V0>TH.RV "	"Residual Voltage" protection at threshold	<i>Equivalent to the logical OR of "RV tim." and "RV alarm"</i>
16.	" RP tim. "	"Reverse Power" protection Timing	
17.	"U tim. "	"Unbalanced Phases" protection Timing	
18.	"U alarm. "	"Unbalanced Phases" protection Alarm	<i>Active in the case "U" trip is disabled</i>
19.	" L trip "	Opening by protection "L"	<i>Reset signalling by means of "RESET" key</i>
20.	" S trip "	Opening by protection "S"	<i>Reset signalling by means of "RESET" key</i>
21.	" D trip "	Opening by protection "D"	<i>Reset signalling by means of "RESET" key</i>
22.	" I trip "	Opening by protection "I"	<i>Reset signalling by means of "RESET" key</i>
23.	" G trip "	Opening by protection "G"	<i>Reset signalling by means of "RESET" key</i>
24.	" T trip "	Opening by protection "T"	<i>Reset signalling by means of "RESET" key</i>
25.	"UV trip "	Opening by protection "UV"	<i>Reset signalling by means of "RESET" key</i>
26.	"OV trip "	Opening by protection "OV"	<i>Reset signalling by means of "RESET" key</i>
27.	"RV trip "	Opening by protection "RV"	<i>Reset signalling by means of "RESET" key</i>
28.	"RP trip "	Opening by protection "RP"	<i>Reset signalling by means of "RESET" key</i>
29.	"U trip "	Opening by protection "U"	<i>Reset signalling by means of "RESET" key</i>
30.	"Any trip "	Opening of one of the protections listed	<i>Reset signalling by means of "RESET" key</i>
31.	"Warn. T "	Thresholds exceeded : temp. <-20°C and temp. > +70°C	
32.	"Alarm T "	Thresholds exceeded : temp. <-25°C and temp. > +85°C	
33.	"Sz: IN "	Zone selectivity S (or DFW) on input ON	
34.	"Sz: OUT"	Zone selectivity S (or DFW) on output ON	
35.	"Gz: IN"	Zone selectivity G (or DBW) on input ON	
36.	"Gz: OUT"	Zone selectivity G (DBW) on output ON	
37.	"LC1 set"	Load control n°1 contact	Relative to threshold Ic1
38.	"LC2 set"	Load control n°2 contact	Relative to threshold Ic2
39.	"Harmonic"	Peak factor > 2.1	Harmonic distortion
40.	"Out fre."	Frequency out of 50Hz 10% or 60Hz 10% range	
41.	"Iw thre."	Current above the set threshold Iw	
42.	"RCC Al."	Signalling CT disconnection	At least one
43.	"CCC Al."	Signalling SA disconnection	
44.	"CCC,RCC"	Logical OR between "RCC Al." and "CCC Al."	
45.	"Trip ba."	Backup protection tripped (TRIP fail)	See "note C" to par.11.2.2
46.	"YO back."	Backup protection control for YO	See "note C" to par.11.2.2
47.	"CB close"	Signalling circuit-breaker closed status	
48.	"CB error"	Presence of current with circuit-breaker open	See paragraph 15.2.7.4
49.	"No I. bus"	No communication on the internal bus	With PR020/K active

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15.2.10.2 Programming contacts K51/1 K51/8 of the PR020/K

Using a PR020/K, connected to the PR113, the user has the possibility of combining up to 7 different situations, selectable from the previous table (par. 15.2.10.1), with the relays available in the PR020/K itself.

It is also possible to connect two or three PR020/Ks with the PR113.

The only points to note are that the Vaux must be common to all the PR020/Ks, and that one must be configured as master, whereas another as slave.

In this way it is possible to activate up to $(7 + 8 + 3 =)$ 18 contacts without potential (relay), plus 6 replicated, (see par. 15.7.2).

15.2.10.3 Watchdog

The PR113 unit provides some watchdog functions able to guarantee correct management of the release malfunctions. These functions are as follows:

Watchdog of correct operation of the microprocessor (by means of a Watchdog signal generated by the microprocessor). In the case of a fault, signalling takes place by means of the front "mP Fault" LED lighting up (also operational in self-supply) and closing of the monostable contact k51/mP (only with Vaux).

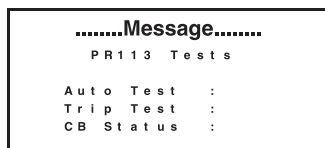
Watchdog for presence of Auxiliary power supply.

Signalling by means of front 'Vaux' LED.

Watchdog for correct connection of the current sensors (CT). In the case of a fault, signalling takes place by means of a special alarm message and the "emergency" LED lighting up.

Watchdog for correct connection of the opening solenoid (SA). In the case of a fault, signalling takes place by means of a special alarm message and the "emergency" LED lighting up.

15.2.10.4 Self-Test



The page shown at the side will be displayed by selecting the sub-menu "4. Test" from the main menu screen.

At this point it is possible to check correct operation of:

Actuation chain (microprocessor, cabling and SA) with the "Trip Test" function. Select [On] and press the TEST pushbutton. In the case of a positive result the circuit-breaker is opened. The function is only available with busbar current nil (use Vaux, PR120/B or PR010/T).

User interface devices with the "Self-test" function. Select [On] and press ↵ to check correct operation of:

- Display (all the pixel of the matrix light up)
- Contrast (this is decreased, increased and then reset)
- LED (n°6)
- Magnetic Flags (n°5)
- Relay tripped contact (k51/Y01)
- μPfault, k51/p1 and k51/p2 contacts (only with Vaux)

In the case of Warning or Emergency, the test is immediately abandoned, still guaranteeing all the protection functions. The test is interrupted by pressing the "RESET" key.

The functions are guaranteed when there is Vaux or in self-supply with at least single-phase 0.5xIn.

In the absence of both, the energy can be supplied by the PR120/B accessory power supply unit.

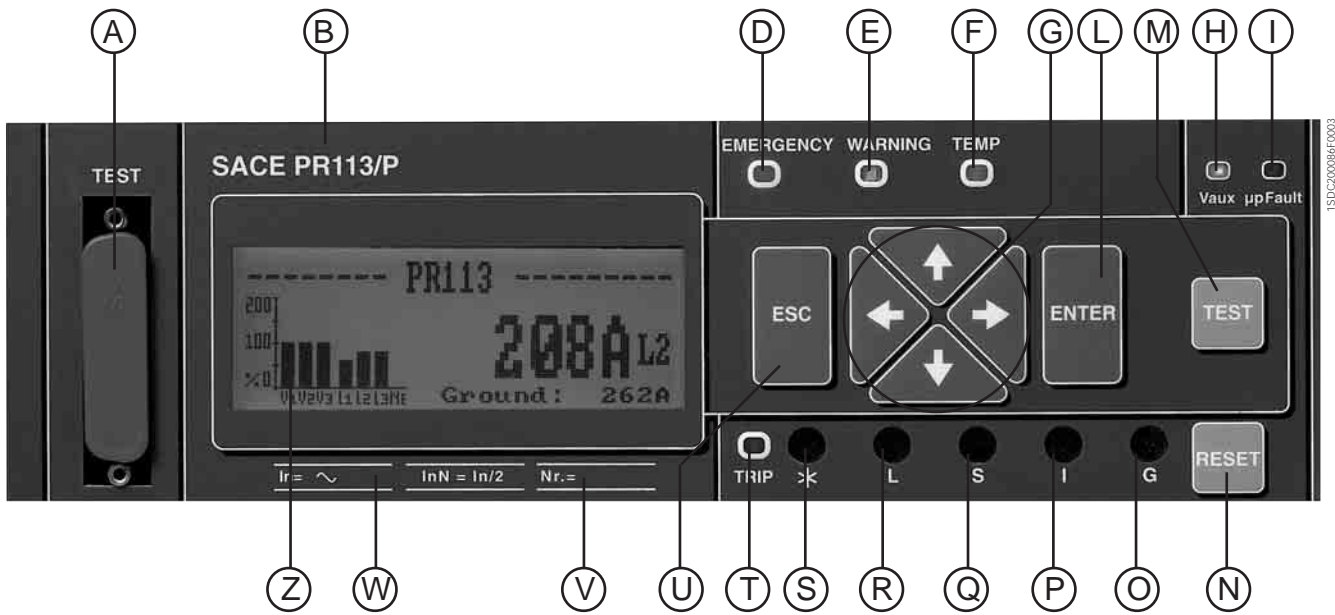
On this page - only with Vaux - it is also possible to see the status of the circuit-breaker ("CB STATUS"), thereby checking correct cabling of the input.

15.2.10.5 Complex test of the release

It is possible to carry out a complete series of tests, with a report which can be downloaded to a PC by using the PR010/T test unit (see par. 15.7.1) connected to the release by means of the front TEST connector.

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15.2.11 User interface



Ref.	Description
A	TEST connector for application of the PR120/B or PR010/T accessories.
B	SACE Logo identifying the product.
D	"EMERGENCY" LED.
E	"WARNING" LED.
F	"TEMP" LED.
G	Pushbuttons for moving the cursor and setting the parameters: UP, DOWN, LEFT, RIGHT.
H	Vaux" LED.
I	"μP Fault" LED.
L	Consent pushbutton for entering data or for confirmation (ENTER).
M	Pushbutton to make the opening solenoid trip (TEST) + adjustment functions.
N	Pushbutton for resetting the magnetic and electrical signals (RESET), to end the Self-Test or to return to the current page from the Trip page.
O	Magnetic signalling indicating earth fault "G" protection tripped.
P	Magnetic signalling indicating instantaneous short-circuit "I" protection tripped.
Q	Magnetic signalling indicating trip of protection functions "S" or "D".
R	Magnetic signalling indicating overload "L" protection tripped.
S	Magnetic signalling indicating trip of one of the following protections: undervoltage, overvoltage, residual voltage, and reversal of active power, phase unbalance or overtemperature.
T	"TRIP" LED.
U	Pushbutton for exiting the sub-menus or for cancellation (ESC).
V	Serial number of the unit
Z	Rear-lit graphic display
W	In (Rated current of the CTs installed)

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The Graphic Display is of the LCD type with 192x64 pixel and is rear-lit when there is an auxiliary voltage. The display is always lit, when there is V_{aux} , or, in self-supply with a minimum busbar current, as defined in par. 15.2.2.1 It is possible to adjust the contrast by pressing over the **TEST** key on the current page (the one which shows the four busbar and the earth currents), using the \uparrow and \downarrow keys to increase and decrease it, and \downarrow for the ABB SACE default value. N.B: In the case of "TEMP" LED lit or flashing, the display turns off (see par.15.2.6.7).



Fig. 7 - Some screens of the unit.

15.2.11.1 Use of pushbuttons

The modifiable fields can be filled in using the \rightarrow or \leftarrow keys and confirming with the \downarrow , and \uparrow or \downarrow keys. Once entered on the relative page, movement from one value to another can be carried out by using the \uparrow and \downarrow keys. To change a value, on the other hand, once the cursor is positioned over the value itself (the modifiable field will be put in reverse, i.e. white on a black background), use the \rightarrow or \leftarrow keys.

To confirm the programming operation of the parameters just configured, press the **ESC** key once only. A check will be carried out for parameters entered and then the page for programming confirmation will be displayed. To return to the main menu, it is necessary to press the **ESC** key twice.

The **RESET** pushbutton must be used to reset the yellow magnetic flags, the contacts of the signalling relay unit and to interrupt the self-test.

The **TEST** pushbutton must be used to carry out the Trip test and to activate adjustment of the contrast on the display.

15.2.11.2 Read and Edit mode

The map relative to the menus (see par. 15.4.1) displays all the pages which can be obtained and the movements to be carried out with the keyboard, in the "READ" mode (just for data readout) or in the "EDIT" mode (for the setting the parameters).

Starting from any page displayed, two different operations can be obtained according to the state of the unit:

1. "READ":
the default page will be displayed automatically after about 120 seconds.
2. "EDIT":
the default page will be displayed automatically after about 240 seconds.

The functions allowed according to the state are :

"READ":

- ✓ Consultation of the measurements and of the historical data
- ✓ Consultation of the unit configuration parameters
- ✓ Consultation of the protection parameters

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“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 \downarrow key on of a page with fields which can be edited. A password will therefore be required to enable passing into the editing mode.

15.2.12 Default settings

The PR113/P is supplied by ABB SACE with the following predefined parameters:

#	Protection	On/Off	Threshold	Time	Curves	T.M.	ZS	Trip
1	L	--	1 In	144 s	I ² t	Off	--	--
2	S	Off	6 In	min	K	--	Off: 0.04s	--
3	D	Off	6 In	0.2s-0.2s			Off: 0.13s	
4	I	On	4 In	--	--	--	--	--
5	G	Off	0.2 In	0.4 s	K	--	Off: 0.04s	On
6	U	Off	50 %	5 s				Off
7	OT	--	See par.15.2.6.7					Off
8	K	Off						
9	UV	Off	0.9 Un	5 s				Off
10	OV	Off	1.05 Un	5 s				
11	RV	Off	0.15 Un	15 s				
12	RP	Off	- 0.1 Pn	10 s				
13	linst	On	E1 (*)	--				
14	Language	--	Engl					
15	Net Frequency	--	50 Hz					
16	PR020/K	Off						
17	PR020/K relays	--- (Off)						
18	Neutral sel.	--	50 %					
19	Toroid Selec.	--	Int.					
20	CB	--	E1B800 (*)					
21	CS In	--	250 A (*)					
22	Ext. tor. In	---- (Off)	100 A					
23	Vs Un	--	380/ $\sqrt{3}$ V					
24	Startup Thresholds	Off	--	0.10 s				
25	S startup (threshold)	---- (Off)	---- In					
26	D startup (threshold)	---- (Off)	---- In					
27	I startup (threshold)	---- (Off)	---- In					
28	G startup (threshold)	---- (Off)	---- In					
29	Password	--	0001					
30	Store Meas. T.	--	60 min.					
31	Warning Current Thre.	-- (Off)	--					
32	PR113 Relay 1		PL					
33	PR113 Relay 2	Off						

(*) Parameters set with these values only for PR113 sold as a loose piece.

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15.3 Putting into service

15.3.1 Connections

For the connections to be provided by the user, it is recommended to strictly follow what is indicated in this document. This means that we shall be able to satisfy all the international reference Standards and guarantee perfect operation of the release even under severe environmental and electromagnetic conditions. Pay particular attention to the types of cable, the connections to earth and the maximum distances recommended.

15.3.2 VT Connections



Dielectric strength tests are not allowed on the inputs and outputs of the releases.

15.3.2.1 Summarized Table for VT connections

Types of transformers:

VT ABB SACE: ABB SACE model TV055 transformers (with nominal secondary voltage = $100\sqrt{3}$ V).

VT Custom (A): single custom-made "ad hoc" transformers with the same electrical characteristics as the ABB SACE VT (ABB SACE RE0382 drawing)

VT Standard (A): single standard transformers "compatible" with ABB SACE VT (the same electrical characteristics except for the output voltage: $U_s=100V_{rms}$).

(A): The VTs must have a performance of between 1VA and 5VA max., 4 KV insulation between primary and secondary and towards the shield, primary impedance of 600 ohm; class 0.5. They must be of the insulation type (fitted with metal shield between the two windings) with the shield earthed.

Installation System	ABB SACE VT type transformer (Star/Star)		"VT Custom" type transformer (Star/Star)		"VT Standard" type transformer (Delta/Delta)	
	Application diagram	Functionality	Application diagram	Functionality	Application diagram	Functionality
TN-C	A	Total	D	Total	C	Note 5
TN-S	A/B	Total	D	Total	C	Note 5
IT with neutral	A	Total	D	Total	C	Note 5
IT	B	Note 1 and 4	n.c	—	C	Note 5
TT with neutral	A	Total	D	Total	C	Note 5
TT without neutral	B	Note 1 and 4	n.c	—	C	Note 5

Caption:

UV: Undervoltage protection; **OV:** Overvoltage protection; **D:** directional protection; **n.c.:** not allowed.

Nota 1: - In application diagram B, the RV (residual voltage) protection is not correctly operative

Nota 2: - for TN-C systems the connection must be carried out on PEN

- for TN-S systems the connection must be carried out on N for configurations with neutral or on PE for configurations without neutral

as shown in application diagram A; in the case where the PE is used, the current on this could be around a dozen mA. If the customer considers this value too high or has a residual current protection which risks intervening, application diagram B must be used (see notes 1 and 3)

- for IT and TT systems with neutral, the connection must be carried out on N

Nota 3: - For the TV055 transformer, the U_p (primary voltage) and U_s (secondary voltage) voltages are starred voltages (phase-neutral).

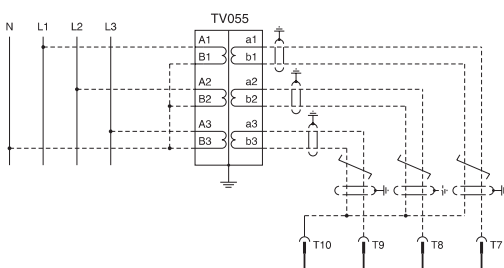
- For the VT_ADAPTER adapter, the line voltage is intended as line-to-line (phase-phase).

Nota 4: - For voltages lower than 230V or higher than 690V, the protection functions which make reference to the voltage measurements cannot be used.

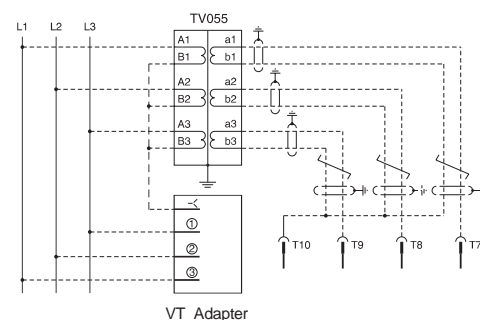
Nota 5: - Exclude functions UV, OV, RV and D. The voltage and power measurements are calculated using a reconstructed star centre.

15.3.2.2 Connection application diagrams

Application diagram A (see Note 3)



Application diagram B (see Note 1 and Note 3)

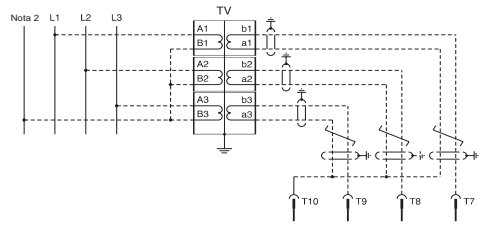
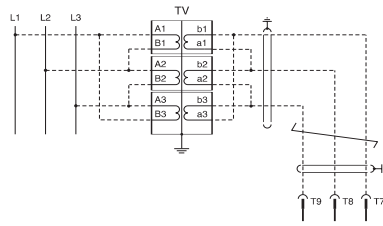


VT_Adapter

Input connections

U_p	①	②	③
$U_p < 230$ V		See Note 4	
230...277 V	A1	A2	A3
347...480 V	B1	B2	B3
500...690 V	C1	C2	C3
$U_p > 690$ V		See Note 4	

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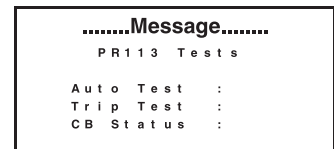


15.3.3 CT and SA connection check

! If installation of the PR113 was carried out by the user, at the time the release is turned on for the first time, it is advisable to check the first line of the display. No messages of CTs and/or SA disconnected must appear, otherwise immediately open the circuit-breaker and make the correct connections.

15.3.4 Test

Before putting into service, it is possible carry out a test by means of the specific “Self-test” function which can be activated on the PR113. A positive result is visible and shown on the display. Following this, it is possible carry out, still using the specific function (Trip test), testing of the whole SA chain. A positive result is given by the circuit-breaker opening. Check, on the same “PR113 Tests” screen, the open or closed status of the circuit-breaker, checking “CB Status”.



15.3.5 Initial settings

If the PR113 is supplied directly installed in the circuit-breaker it is up to ABB SACE to set all the variables referring to the circuit-breaker or to the specific application correctly (e.g. Type of circuit-breaker, CT size, network frequency ...). Vice versa, if the PR113 is supplied as a loose piece, it will be up to the user to set all the necessary parameters correctly. It should be noted that ABB SACE defines each possible setting in a sensible way (see default parameters).

! Apart from this, it is absolutely indispensable for the user to modify the password and carefully define each modifiable parameter, before putting the PR113 into service.

15.3.6 Password management

Password? [0***]

To enter “edit” mode it is necessary to enter a four-figure numerical password. Select the value of the first figure (between ‘0’...‘9’) by means of the ↑ and ↓ keys and press ↵ to confirm the figure and pass on to entering the next one. After entering the fourth figure, check the password entered. If the password is correct, you pass from the “READ” mode to the “EDIT” mode (at this point the first field which can be edited on the page is displayed in reverse).

In the case of a wrong password, the message following message appears
Wrong password

which remains until the **ESC** key is pressed (or after 2 minutes).

It is also possible to interrupt the operation during entry of the password by pressing the **ESC** key.

The password is valid for a maximum of two minutes from the last time a key was pressed. It is immediately reset in the case of a high priority alarm or when the unit is reset.

On entering a page without modifiable parameters, the state of the protection is put on “READ”. If the password is still valid, to enter “edit” mode (on a page with modifiable parameters) simply press the key ↵.

Disabling the Password.

By setting the value of the password to [0000] (in the “Unit configuration” menu) the request for password is disabled. Passing from “READ” to “EDIT” is therefore always possible.

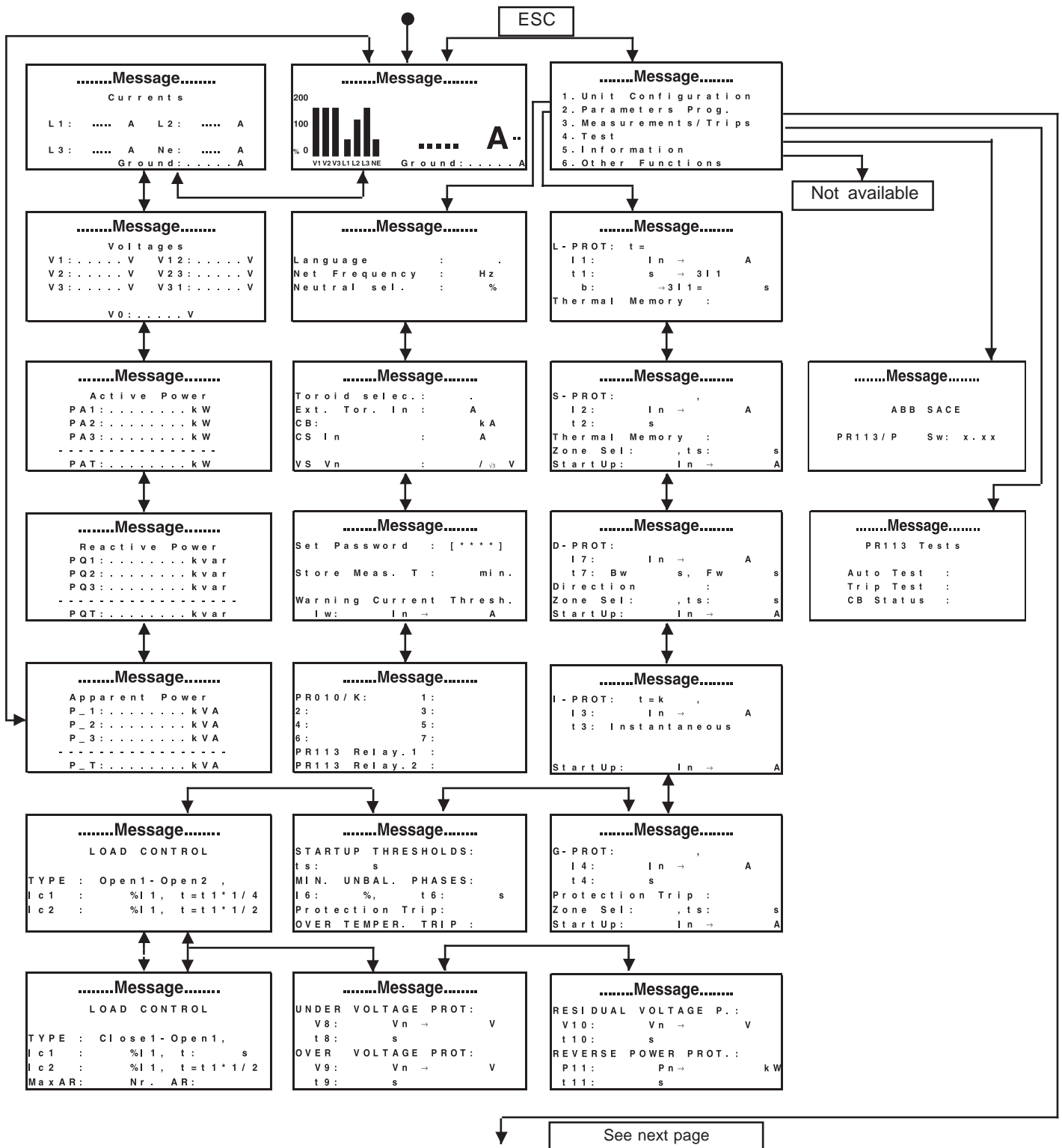
To enter a new password, select “Set Password” from the “Unit Configuration” menu.

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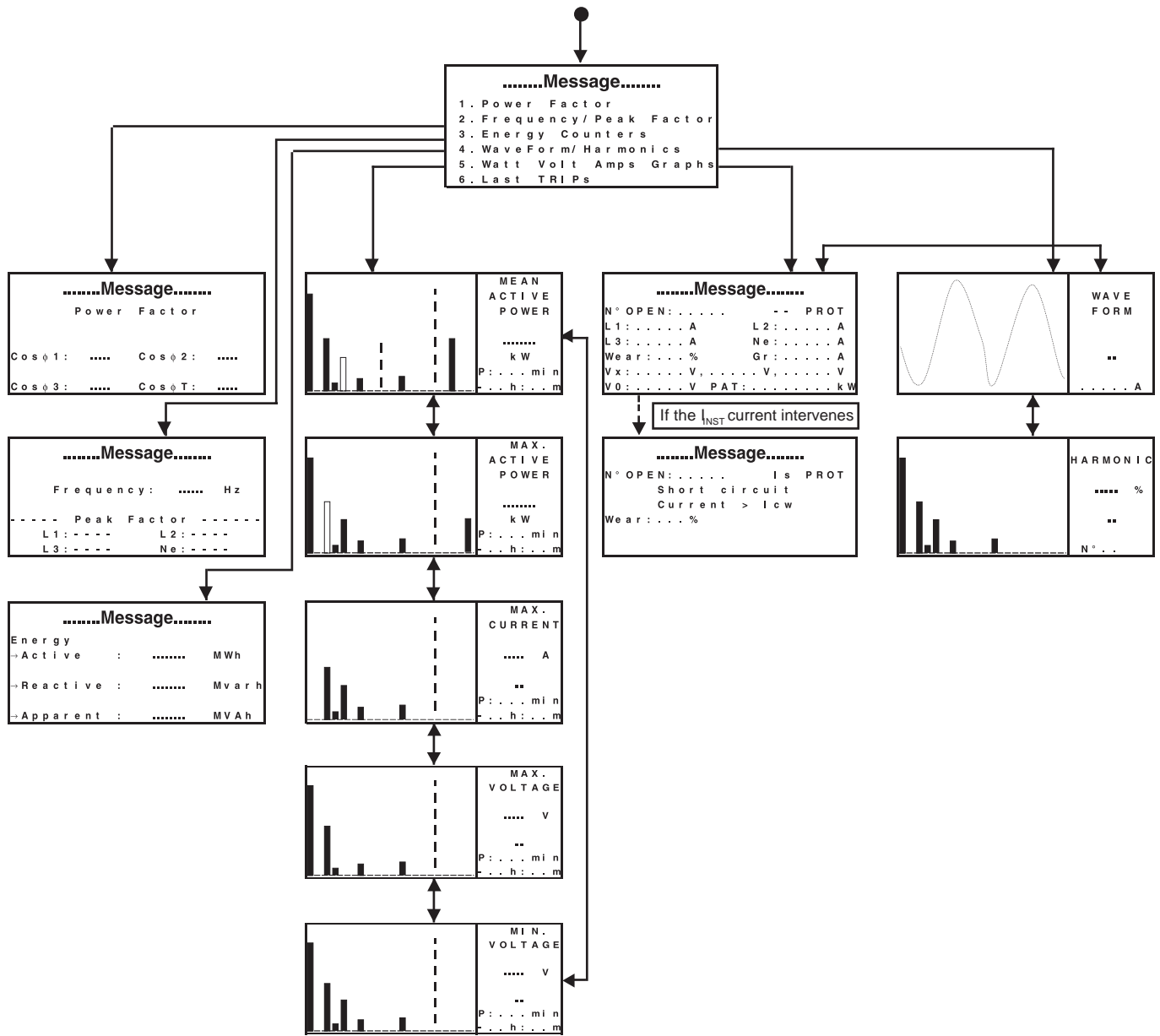
15.4 Operative/operating instructions during service

15.4.1 Menus

As already seen previously, the PR113 uses the display to show messages, diagrams and menus. These are organized in a logical and intuitive way. For user convenience, all the screens visible are given below.



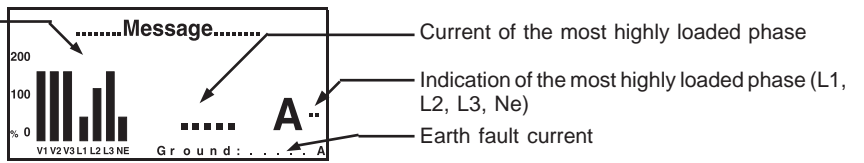
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Each time the unit is activated, or after more than 2 minutes of inactivity on the keyboard, the display indicates the following page (default):

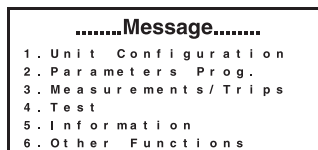
Percentage of the present currents and voltages in relation to the rated values (100%)



On most pages, in the space indicated by "...Message...", any "warning" or "error" messages are displayed (see par.15.6). In the case where there is more than one, they are displayed cyclically, one each second. By pressing the ↵ key, it is possible to block scrolling of the messages on the one currently displayed (the "←" symbol appears in the right-hand corner of the line). This means the various messages can be scrolled one at a time using the ↵ key. To reset automatic updating, simply press the ↵ key again. (the "←" symbol disappears). In the case when there are no messages, the name of the unit is displayed.

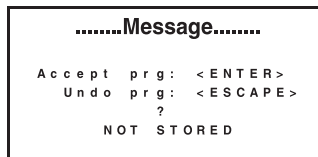
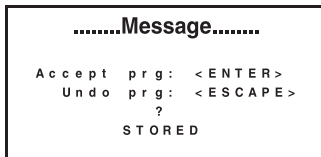
15.4.2 Modification of parameters

In the case where the operator wants carry out reading or data configuration operations, it is sufficient to press the **ESC** (escape) key and the page relative to the main menu will automatically be displayed:



Now, with the ↑ (up arrow), ↓ (down arrow), ↵ (enter) and **ESC** (escape) keys, it is possible to move around inside the main menu and reach all the pages relative to the configurations and parameterisations to display or modify the parameters set.

On completion of a programming operation, to accept the new configuration (**Accept prg**) press the ↵ key or press the ESC key to refuse it and therefore keep the old configuration (**Undo prg**). The following will therefore appear:

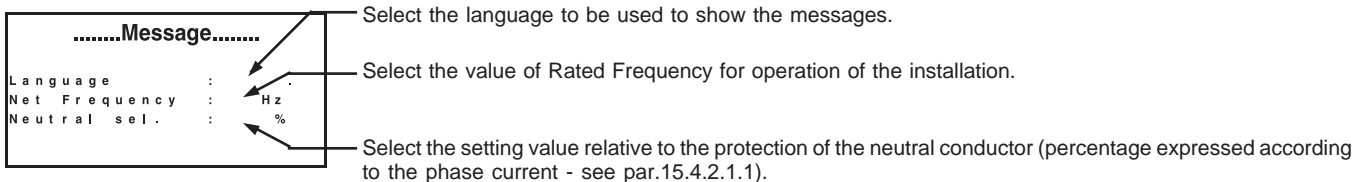


These pages indicate whether data storage has been successful or not. In the latter case, the PR113 unit will use the last valid configuration set.

15.4.2.1 Modification of basic configuration

If the PR113 unit is in an alarm situation no parameterisation is allowed.

The configuration of the unit must be carried out in EDIT mode. Following what is indicated in par.15.2.11, show the following on the display:



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.....Message.....

```
Toroid selec. : .
Ext. Tor. In : A
CB: k A
CS In : A
VS Vn : / 33 V
```

Select the type of protection against earth fault: select [Int] if you want to protect the installation with the help of the internal toroid, otherwise [Ext] if you want to protect with the help of the external toroid by making the "Source Ground Return" protection function.

Select the value of the rated current of the external toroidal transformer for the "Source Ground Return" function.

Select the type of EMAX circuit-breaker (code and rated current) on which the PR113 unit is mounted. The selections possible are available in the technical catalogue.

Select the value of the rated current of the current sensors (CS) mounted on the circuit-breaker.

Select the rated voltage of the voltage sensors (VT) installed for the circuit-breaker.

.....Message.....

```
Set Password : [****]
Store Meas. T : min.
Warning Current Thresh.
Iw: In A
```

Programming new password in EDIT mode. The successive messages are:
New Password: [****] e Confirm PSW: [****] **for confirmation.**

Select the time interval for data acquisition in the Historical Measurements.

Select the Warning current threshold value (Iw) (the absolute value of the threshold is also displayed).

.....Message.....

```
PR010/K: 1: }
2: 3: }
4: 5: }
6: 7: }
PR113 Relay. 1 : }
PR113 Relay. 2 : }
```

Indicate whether there is an PR020/K accessory unit (can only be set with Vaux).

Select what information to combine with the 7 clean contacts present on the PR020/K. Selection is only possible if the accessory unit is configured as present on the PR113. The selections possible are given in par 15.2.10.1. The PR020/K must be set to operate in "Configurable from PR113" mode by means of special dip-switches (only with Vaux).

Select what information to combine with the 2 clean contacts (K51/p1 and K51/p2) present on the PR113/P.

N.B.:

Incorrect configuration of In and Un does not jeopardize perfect functionality of the protections in any way, (except, possibly, selection of threshold G).

The only problem will be display of an incorrect absolute value of Currents, Voltages and Powers.

Properties/function	Values selectable
Language	Engl. (English), Ital. (Italian), Fran. (French), Deut. (German) Espa. (Spanish)
Net Frequency	50Hz, 60Hz
Neutral sel.	50%, 100%, 150%, 200%
Toroid Selec.	Int (internal), Ext (external)
Ext. tor. In	100A, 250A, 400A, 800A
C.B.	Versions allowed in the catalogue
CS In	250A, 400A, 800A, 1000A, 1250A, 1600A, 2000A, 2500A, 3200A, 4000A, 5000A, 6300A
VS Un	[100, 115, 120, 190, 208, 220, 230, 240, 277, 347, 380, 400, 415, 440, 480, 500, 550, 600, 660, 690, 910, 950, 1000] / $\sqrt{3}$ V
Password	0000...9999
Store Meas. T.	[5, 15, 30, 60, 120] minutes
Warning current Th.	'—' (off), 0.3 3.0 x In step 0.05 x In
PR020/K	On , Off
PR020/K relays, PR113 releases 1 and 2	See par. 15.2.10.1

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15.4.2.1.1 Adjustment of the neutral

The neutral protection is normally set to a current value at 50% of the adjustment carried out on the phases.
 In some installations, where particularly high harmonics occur, the current circulating on the neutral can be higher than that of the phases.
 In the SACE PR113 release, it is possible to set this protection for the following values : $I1N = 50\% - 100\% - 150\% - 200\% \cdot I1$.
 In the table below the settable values for adjustment of the neutral are indicated, for the various possible combinations between types of circuit-breakers and adjustment of threshold I1.

Adjustments which can be set for the Neutral protection

Adjustments of the threshold I1 (protection against overload)

Circuit-breaker size	0,4 = I1 = 0,5	0,5 < I1 = 0,66	0,66 < I1 = 1 ⁽¹⁾
E1B	50-100-150-200%	50-100-150%	50-100%
E1N	50-100-150-200%	50-100-150%	50-100%
E2B	50-100-150-200%	50-100-150%	50-100%
E2N	50-100-150-200%	50-100-150%	50-100%
E2L	50-100-150-200%	50-100-150%	50-100%
E3N	50-100-150-200%	50-100-150%	50-100%
E3S	50-100-150-200%	50-100-150%	50-100%
E3H	50-100-150-200%	50-100-150%	50-100%
E3L	50-100-150-200%	50-100-150%	50-100%
E4S	50-100%	50%	50%
E4H	50-100%	50%	50%
E4S/f	50-100-150-200%	50-100-150%	50-100%
E6H	50-100%	50%	50%
E6V	50-100%	50%	50%
E6H/f	50-100-150-200%	50-100-150%	50-100%

Note 1: The I1=1 setting must be intended as the maximum adjustment of the protection against overload. The actual maximum permitted adjustment must take into account any derating according to the temperature, terminals used and altitude (please refer to the "Installation in Switchgear" chapter).



Not respecting the limits at settings of "I1" and "Neutral sel." can damage the circuit-breaker with consequent risks for the operator as well.

15.4.2.2 Modification of protection functions

The basic configuration of the unit must be carried out in EDIT mode.

This paragraph allows the user to program the PR113 unit protection functions implemented. Here only the methods for data programming and which values can be set are given. For all the other information relative to the technical characteristics of these protection functions, see par.15.2.6. Following the instructions given in par. 15.2.11.2 and par 15.4.1, show the pages for setting the protection functions on the display:

.....Message.....

L-PROT: t =

I1: In → A

t1: s → 3 I1

b: → 3 I1 =

Thermal Memory :

Heading: all the protections, excluding L, T and Iinst, are disabled. For protections S and G, it is also possible to select the type of curve (t=k or t=k/ti²).

Select which threshold value to set. The value of this, expressed in Amperes, will also be displayed automatically at the side of the threshold selection.

Select which trip curve t1 (trip time at 3 x I1) to set.

Selezionare il valore della curva desiderato, secondo IEC60255-3. (tempo a 3 x I1)
 NB: in alternativa alla curva t=k/I².

Select whether to enable or disable operation of protection L with thermal memory.

.....Message.....

S-PROT: t =

I2: In → A

t2: s

Thermal Memory :

Zone Sel: , ts:

Start Up: In → A

Set the type of curve (t=k or t=k/I²) and the state of the protection (On, Off).

Select which threshold value to set (with I2>I1). The value of this, expressed in Amperes, will also be displayed automatically at the side of the threshold selection.

Select which trip curve to set.

Select whether to enable or disable operation of protection S with thermal memory (only with curve type t = k/I²).

For protections S, D and G, it is possible to enable or disable operation of the protection with zone selectivity (only with curve type t = k). At the side, it is also possible to set the selectivity trip time for the protection.

For protections S, D, I and G, it is possible to select which threshold value of start-up to set (only with curve type t=k and locally at the protection considered). The value of this, expressed in Amperes, will also be displayed automatically at the side of the threshold selection.

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```

.....Message.....
D-PROT:
I7: Bw In → A s
t7: Bw s, Fw s
Direction :
Zone Sel: , ts: s
StartUp: In → A

```

Set the trip direction.
 Set a time for each direction.
 Set I7>I1.

```

.....Message.....
I-PROT: t=k ,
I3: In → A
t3: Instantaneous
StartUp: In → A

```

Set I3>(I2, I7).

```

.....Message.....
G-PROT:
I4: In → A
t4: s
Protection Trip:
Zone Sel: , ts: s
StartUp: In → A

```

For the protection, the TRIP can be disabled (only alarm signalling).

```

.....Message.....
STARTUP THRESHOLDS:
ts: s
MIN. UNBAL. PHASES:
I6: %, t6: s
Protection Trip:
OVER TEMPER. TRIP:

```

Activate or disable START-UP function in a global way
 Set the period of validity of the START-UP function
 Phase Unbalance Function. Enabling, threshold (in percentage), trip time (t=k) and TRIP enabling.
 Activate or disable the TRIP of the protection for "Temperature out of range"

```

.....Message.....
LOAD CONTROL
TYPE: Open1-Open2 ,
Ic1: %I1, t=t1*1/4
Ic2: %I1, t=t1*1/2

```

Load n°1 disconnection threshold (% of I1).
 Load n°2 disconnection threshold (% of I1).

Depending on the TYPE selection, one of the following pages will be displayed:
 "Disconnection of two loads" Mode
 "Connection-disconnection of one load" Mode

```

.....Message.....
LOAD CONTROL
TYPE: Close1-Open1,
Ic1: %I1, t: s
Ic2: %I1, t=t1*1/2
MaxAR: Nr. AR:

```

Load connection threshold (% of I1) and relative waiting time.
 Load disconnection threshold (% of I1).
 Maximum number of self-reclosing operations which can be carried out and number of reclosing operations carried out.

Voltage Protections:

```

.....Message.....
UNDER VOLTAGE PROT:
V8: Vn → V
t8: s
OVER VOLTAGE PROT:
V9: Vn → V
t9: s

```

Activation of protection (t=k), trip threshold setting (Un) and trip time. The phase voltage corresponding to the set threshold is displayed.

```

.....Message.....
RESIDUAL VOLTAGE P.:
V10: Vn → V
t10: s
REVERSE POWER PROT.:
P11: Pn → kW
t11: s

```

Activation of Reverse Active Power protection (t=k), trip threshold setting (Pn) and trip time. The power (of the system) corresponding to the set threshold is displayed.

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Protection	Disabling	Disabling of TRIP only	Zone selectivity	Start-up threshold	Thermal memory	Threshold Range	Time Range	Tolerance threshold (3)	Time Tolerance (3)
L ($t=k/I^2$)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	$0.4xI_n \leq I_1 \leq 1xI_n$ step $0.01xI_n$	$3s \leq t_1 \leq 144s$, step $3s$ ⁽¹⁾	Trip between 1.1 and $1.2 \times I_1$	$\pm 10\%$, $I_1 \leq 4xI_n$ $\pm 20\%$, $I_1 > 4xI_n$
L (in accordance with IEC 60255-3 Standard)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$0.4xI_n \leq I_1 \leq 1xI_n$ step $0.01xI_n$	$B = 0.2 \dots 10$, step $0.1s$	Trip between 1.1 and $1.25 \times I_1$	$\pm 20\%$, $I_1 > 5xI_1$ $\pm 30\%$, norma $2xI_1 < I_1 < 5xI_1$
S ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	$0.6xI_n \leq I_2 \leq 10xI_n$ step $0.1xI_n$	Min ⁽²⁾ , $0.05s \leq t_2 \leq 0.75s$, step $0.01s$	$\pm 7\%$, $I_1 \leq 4xI_n$ $\pm 10\%$, $I_1 > 4xI_n$	the best of the two data $\pm 10\% \circ \pm 50ms$, $I_1 \leq 4xI_n$ $\pm 15\% \circ \pm 50ms$, $I_1 > 4xI_n$
S ($t=k/I^2$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	$0.6xI_n \leq I_2 \leq 10xI_n$ step $0.1xI_n$	$0.05s \leq t_2 \leq 0.40s$, step $0.01 \ln$	$\pm 7\%$, $I_1 \leq 4xI_n$ $\pm 10\%$, $I_1 > 4xI_n$	$\pm 15\%$, $I_1 \leq 4xI_n$ $\pm 20\%$, $I_1 > 4xI_n$
I ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	$1.5xI_n \leq I_3 \leq 15xI_n$ step $0.1xI_n$	Instantaneous	$\pm 10\%$, $I_1 \leq 4xI_n$ $\pm 15\%$, $I_1 > 4xI_n$	$\leq 25ms$
G ($t=k$)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	$0.2xI_n \leq I_4 \leq 1xI_n$ step $0.02xI_n$	$0.1s \leq t_4 \leq 1s$, step $0.05s$	$\pm 7\%$, $I_1 \leq 4xI_n$	the best of the two data $\pm 10\% \circ \pm 50ms$, $I_1 \leq 4xI_n$
G ($t=k/I^2$)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$0.2xI_n \leq I_4 \leq 1xI_n$ step $0.02xI_n$	$0.1s \leq t_4 \leq 1s$, step $0.05s$	$\pm 7\%$, $I_1 \leq 4xI_n$	$\pm 15\%$
D ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	$0.6xI_n \leq I_7 \leq 10xI_n$ step $0.1xI_n$	$0.20s \leq t_7 \leq 0.75s$, step $0.01s$	$\pm 10\%$	$\pm 20\%$
U ($t=k$)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$10\% \leq I_6 \leq 90\%$ step 10%	$0.5s \leq t_6 \leq 60s$, step $0.5s$	$\pm 10\%$	$\pm 20\%$
OT (temp=k)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Only settable by ABB	Instantaneous	$\pm 1^\circ C$	---
K (Open1-Open2)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$0.5xI_1 \leq (I_{c1}, I_{c2}) \leq 1.0xI_1$ step $0.01xI_1$	$t_{c1} \leq t_1 / 4$ $t_{c2} = t_1 / 2$	$\pm 10\%$	$\pm 20\%$
K (Closed1-Open1)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$0.5xI_1 \leq (I_{c1}, I_{c2}) \leq 1.0xI_1$ step $0.01xI_1$	$10s \leq t_{c1} \leq 120s$ step $5s$, $t_{c2} \leq t_1 / 2$	$\pm 10\%$	$\pm 20\%$
UV ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$0.6xU_n \leq V_8 \leq 0.95xU_n$ step $0.01xU_n$	$0.1s \leq t_8 \leq 5s$, step $0.1s$	$\pm 5\%$	$\pm 20\%$
OV ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$1.05xU_n \leq V_9 \leq 1.2xU_n$ step $0.01xU_n$	$0.1s \leq t_9 \leq 5s$, step $0.1s$	$\pm 5\%$	$\pm 20\%$
RV ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$0.1xU_n \leq V_{10} \leq 0.4xU_n$ step $0.05 U_n$	$0.5s \leq t_{10} \leq 30s$, step $0.5s$	$\pm 5\%$	$\pm 20\%$
RP ($t=k$)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	$-0.3xP_n \leq P_{11} \leq -0.1xP_n$ step $0.02 P_n$	$0.5s \leq t_{11} \leq 25s$, step $0.1s$	$\pm 10\%$	$\pm 20\%$
linst	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Only settable by ABB	Instantaneous	$\pm 5\%$	---

⁽¹⁾ The minimum value of this trip is 750ms regardless of the type of curve set (self-protection).

⁽²⁾ "Minimum time": minimum time which can be taken by the protection

⁽³⁾ These tolerances are valid in the following hypotheses:
- release self-supplied during running (without start-up)
- two-phase or three-phase power supply

For all cases not considered in the above hypotheses, the following tolerance values are valid:

Trip threshold	Trip time
L Trip between 1.1 and $1.25 \times I_1$	$\pm 20\%$
S $\pm 10\%$	$\pm 20\%$
I $\pm 15\%$	$\leq 60ms$
G $\pm 10\%$	$\pm 20\%$

15.4.3 Signals

15.4.3.1 Optical signals

Signalling	Description
Led Vaux (green)	Presence of Auxiliary power supply
Led μP Fault (red)	Microprocessor with temporary or permanent fault
Led Temp (orange)	<ul style="list-style-type: none"> • <i>Flashing with values</i> of "Warning temperature", see par. 15.2.6.7 • <i>Lit permanently with values</i> of "Alarm temperature", see par. 15.2.6.7
Led Trip (red)	Lights up (only with Vaux) following an opening due to a protection.
Led Warning (yellow)	<ul style="list-style-type: none"> • The prealarm threshold has been exceeded; one or more phases with current values in the $0.83 \times I_1 < I < 1.0 \times I_1$ range. (the selection carried out depends on the Ne. For example, at 50% the values are halved) • Presence, between two or three phases, of unbalance above the value programmed for the "Unbalanced Phases" protection, with protection trip disabled. Presence of Distorted Wave form with Shape Factor > 2.1; • Contact wear higher than 80% (and less than 100%; only with Vaux); • WARNING THRESHOLD exceeded, see par.15.2.7.1; • Circuit-breaker status error (only with Vaux); • Frequency out of range.
Led Emergency (red)	<ul style="list-style-type: none"> • Presence of one or more phases under overload with current values $I > 1.0 \times I_1$ (protection "L timing") (the selection carried out depends on the Ne. For example, at 200% the values are doubled)*; • Timing in progress for protection function S; • Timing in progress for protection function I; • Timing in progress for protection function G; • Timing in progress for protection function D; • Timing in progress for the voltage protection functions (UV, OV, RV); • Timing in progress for the reverse active power protection function (RP); • Timing in the case of unbalance between the phases above the value set in the configuration with protection trip set to on; • Wear at 100 %; • CTs disconnected; • Opening solenoid (SA) disconnected. <p><i>NB. Flashes</i> in the case of trip of the backup protection.</p>

* The IEC 60947-2 Standard defines the timing threshold L for current: $1.05 < I < 1.3 I_1$

Signalling	Description
Yellow magnetic flag	"*" Trip of one of the following protections: undervoltage, overvoltage, residual voltage, reverse active power, phase unbalance, overtemperature;
Yellow magnetic flag	"L" Trip of protection "L";
Yellow magnetic flag	"S" Trip of protection "S" or "D";
Yellow magnetic flag	"I" Trip of protection "I" or "Inst"
Yellow magnetic flag	"G" Trip of protection "G".

15.4.3.2 Electrical signals

Signalling	Description
Contact K51/p1	The signalling to which it is connected (see par. 15.2.10.1) is active (only with Vaux);
Contact K51/p2	The signalling to which it is connected (see par. 15.2.10.1) is active (only with Vaux);
Contact k51/YO1	Trip of one of the following protections: L, S, D, I, G, U, OT, UV, OV, RV, RP, linst;
Contact K51/μP	Microprocessor with temporary or permanent fault. (closes with a delay of 1...2 s, only with Vaux).

By pressing the "Reset" pushbutton, it is possible to reset the normal state of both the magnetic flags (black) and of the contacts (normally open).

This pushbutton is also active without an auxiliary power supply.

With the relay not supplied, the energy accumulated by a special 'buffer' Reset capacitor is used, which is charged when turned on (in ~12s). This means that, @ 25°C, at least one Reset operation is guaranteed in the case of no of self-supply or auxiliary power supply, within 2 hours from circuit-breaker opening, for the flags, and 12 hours for the SRE contact.

Should the capacitor 'buffer' also be discharged, the PR113 can be supplied momentarily by means of the PR120/B or PR010/T (see par. 15.7). Regardless of the state of the signals and of the relay power supply, it is always possible to close the circuit-breaker, both by means of Closing Coils (BC) and by means of a mechanical pushbutton.

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15.5 Troubleshooting

The following table collects up a series of typical service situations, which are useful in order to understand and solve hypothetical faults or malfunctions.

N.B.:

1. Before consulting the following table, check any lighting up of the LEDs located on the front of the unit for some seconds.
2. **FN** indicates normal operation of the PR113.
3. In the case where the suggestions proposed do not lead to a solution of the problem, please contact the ABB SACE assistance service.

N°	Situation	Possible causes	Suggestions
1	It is not possible to reset signals	The buffer capacitor is discharged	FN , connect the Vaux, the PR010/T or the PR120/B, to reset.
2	It is not possible to carry out the trip test	1. The busbar current is > 0. 2. The SA is not connected	1. FN 2. Check the messages on the display
3	Trip times lower than those expected	1. Threshold too low 2. Curve too low 3. Thermal memory inserted 4. Incorrect Neutral Selection 5. The SdZ is inserted	1. Correct threshold 2. Correct curve 3. Exclude if not necessary 4. Correct Neutral Selection 5. Exclude if not necessary
4	Trip times higher than those expected	1. Threshold too high 2. Curve too high 3. Curve I ² t inserted 4. Incorrect Neutral Selection	1. Correct threshold 2. Correct curve 3. Exclude if not necessary 4. Correct Neutral Selection
5	Rapid trip, with I3=Off	Inst trip	FN with short-circuit with high I
6	I of earth high, but there is no trip	1. Incorrect selection of the sensor 2. Function G prevented with I>4 In	1. Set int. or ext. sensor 2. FN
7	Display off	1. Vaux missing and the busbar I is less than the minimum value. 2. Temperature out of range	1. FN, see 15.2.2.12. 2. FN, see 15.2.6.7
8	Il display non è retroilluminato	Vaux missing	FN
9	Reading of I and/or V incorrect	Incorrect setting of In and Un	Change parameters, see 15.4.2.1
10	Reading of V, W and power factor incorrect	Incorrect connection of the VT	Check VT-PR113 connections
11	"No Int Bus Comm" Message	There is no communication between PR113 and PR020/K	1. If not present, exclude PR020/K, see 15.4.2.1 2. Check bus connection 3. Check PR020/K
12	Display indicates "... " or ">xxxx " , instead of the data expected	Function excluded or data out of range	FN, see 15.2.8
13	The expected trip does not occur	Trip function excluded	FN enable trip if necessary
14	No activation of the Unbalance U protection	Values of I out of range	FN, see 15.2.6.6
15	Anomalous behaviour of Load control K protection	The MT of L is inserted.	FN, exclude the MT of L
16	No display of the opening data	Vaux missing	FN, see 15.2.9.2
17	The password is not requested	The password has been disabled	FN, re-enter the password with a value other than 0000.
18	It is not possible to change any parameter	PR113 in alarm situation	FN
19	The display shows "ABB SACE psw ? [****]"	You are trying to access an ABB reserved area	FN, press "Esc" to exit.

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15.6 Warning and error 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.

INCORRECT CONFIGURATIONS	
MESSAGE	DESCRIPTION
WRONG CS FOR THIS CB	A CS size which cannot be installed on the circuit-breaker has been selected (e.g. E1 with 5000A)
ERROR I2 <= I1	The trip threshold of function L is higher than threshold of function S
ERROR I5 <= I1	The trip threshold of function L is higher than threshold of function D
ERROR I3 <= I2	The trip threshold of function S is higher than threshold of function I
ERROR I3 <= I5	The trip threshold of function D is higher than threshold of function I
ERROR: S ZONE SEL.	Zone selectivity for function D has been activated but zone selectivity is already active for function S
ERROR: D ZONE SEL.	Zone selectivity for function G has been activated but zone selectivity is already active for function D
ERROR: V_AUX OFF	The auxiliary power supply is not present - function not available
V_AUX OFF: Comm. OFF	The communication bus is not operating because there is no auxiliary voltage
NO Int. Bus Comm.	The presence of the PR020/K unit is set, but there is no communication on the internal bus
WRONG NE% SELECTION	A Neutral protection incompatible with the present CT and circuit-breaker has been selected, or a CT incompatible with the current Neutral protection and circuit-breaker has been selected. The condition $CT * \%Ne (0.5, 1, 1.5 \text{ or } 2) \leq \text{"Circuit-breaker rated current"}$ must be valid
NOT available	The function required is not available
CB STATUS ERROR	Current is determined with circuit-breaker status "OPEN". The status input of the circuit-breaker has not been cabled correctly (check only carried out with Vaux)
V_AUX Off: S Sel. Off	The unit is configured to operate with zone selectivity S but the auxiliary power supply has been removed
V_AUX Off: G Sel. Off	The unit is configured to operate with zone selectivity G but the auxiliary power supply has been removed
V_AUX Off: D Sel. Off	The unit is configured to operate with zone selectivity D but the auxiliary power supply has been removed

GENERAL ALARMS	
MESSAGE	DESCRIPTION
CONTACTS WEAR >80%	The wear on the circuit-breaker electrical contacts has reached 80%
CONTACTS WEAR 100%	The wear on the circuit-breaker electrical contacts has reached 100%
HARMONIC DISTORSION	The current circulating in the circuit-breaker is distorted (peak factor >2.1)
CS-L1 DISCONNECTED	Current sensor relative to phase L1 not connected
CS-L2 DISCONNECTED	Current sensor relative to phase L2 not connected
CS-L3 DISCONNECTED	Current sensor relative to phase L3 not connected
CS-NE DISCONNECTED	Current sensor relative to neutral NE not connected
SA DISCONNECTED	Shunt opening release not connected
FREQUENCY OUT OF RANGE	Frequency of the measured current/voltage out of limits
CURRENT > Iw THRESHOLD	Presence of current higher than the free threshold set by user (Iw)

PROTECTION FUNCTIONS	
MESSAGE	DESCRIPTION
PREALARM L	The current circulating on at least one phase is above the set prealarm threshold value for protection L see par. 15.4.3.1
L PROTECTION TIMING	The current circulating on at least one phase is above the set current threshold value for protection L and the unit is under timing
S PROTECTION TIMING	The current circulating on at least one phase is above the set current threshold value for protection S and the unit is under timing
G PROTECTION TIMING	The current circulating on at least one phase is above the set current threshold value for protection S and the unit is under timing

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PROTECTION FUNCTIONS	
MESSAGE	DESCRIPTION
G ALARM, TRIP OFF	Timing of function G is in progress, but the trip control which is given at the end of the timing has been disabled.
OVERVOLTAGE TIMING	The voltage on at least one phase is above the voltage value of the OV protection threshold and the unit is under timing
OVERVOLTAGE ALARM	The voltage on at least one phase is above the voltage value of the OV protection threshold, timing is completed and the protection is in the "ALARM" state
UNDERVOLTAGE TIMING	The voltage on at least one phase is less than the voltage value of the UV protection threshold and the unit is under timing
UNDERVOLTAGE ALARM	The voltage on at least one phase is less than the voltage value of the UV protection threshold, is completed and the protection is in the "ALARM" state
RESIDUAL VOLTAGE TIMING	The residual voltage calculated is above the voltage value of the threshold of protection RV protection threshold and the unit is under timing.
RESIDUAL VOLTAGE ALARM	The residual voltage calculated is above the voltage value of the threshold of protection RV protection threshold, is completed and the protection is in the "ALARM" state.
REVERSE A.POWER TIMING	The active power total is less than value of reverse power of the threshold of protection RP protection threshold and the unit is under timing
UNBALANC. PHASES TIMING	Presence of an unbalance between at least two phases above the value set and the unit is under timing.
UNBALANC. PHASES ALARM	Presence of an unbalance between at least two phases above the value set, but the trip control which is given at the end of the timing has been disabled

PR020/K	
MESSAGE	DESCRIPTION
ERROR Ic2 < Ic1	The current threshold set for load n°1 is higher than that of load n°2 or the current threshold set for reclosing is higher than that of load opening
K: LOAD 1 TIMING	The current circulating has exceeded the threshold of load n°1 connected to PR020/K and the unit is under timing for load opening
K: LOAD 2 TIMING	The current circulating has exceeded the threshold of load n°2 connected to PR020/K and the unit is under timing for load opening
K: LOAD 1 CLOSING	Load n°1 connected to PR020/K is about to be reconnected
K: LOAD 1 OPEN	Load n°1 connected to PR020/K has been isolated
K: LOAD 2 OPEN	Load n°2 connected to PR020/K has been isolated
K: AR DISABLED	The auto-reset of load n°1 connected to PR020/K has been disabled

PASSWORD MANAGEMENT	
MESSAGE	DESCRIPTION
Password ? [****]	The password entered is wrong
Wrong Password	La password inserita è errata
New Password:→[****]	Enter the new password
Confirm Password:→[****]	Confirm the new password entered

15.6.1 In the case of a fault



If it is suspected that the PR113 is faulty, has malfunctions or has generated an unexpected trip, we advise you to strictly following the indications below:

1. Do not reset the release.
2. Note down which small magnetic signal is activated (yellow area).
3. If there is Vaux, the release has memorized the trip data, so take these from the Last Trip page.
4. If there is no Vaux, use PR120/B and note down all the settings of the protection functions.
5. Note down the type of circuit-breaker, number of poles, any accessories connected, In, Serial Number (see par. 15.2.11) and the SW version.
6. Prepare a brief description of opening (when did it take place? how many times? always under the same conditions? with what type of load? with what voltage? with what current? can the event be reproduced?)
7. Send/communicate all the information collected, together with the application circuit diagram of the circuit-breaker, to the ABB Assistance service closest to you.

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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15.7 Accessories

15.7.1 ABB SACE PR010/T complex test unit

The test with the SACE PR010/T unit allows correct operation of the inputs, outputs, thresholds and trip times of protection functions "L", "S", "I", "G", "U", "Inst", "UV", "OV" and "RV" to be checked either manually or automatically. Furthermore it is possible to obtain a test report and modify the settings of the PR113 unit.

For operation of the PR010/T accessory, please consult the special instruction manual.

15.7.2 ABB SACE PR020/K signalling unit

The PR020/K signalling unit, when connected to the internal bus of the PR113/P, allows the state of the protection functions and of the PR113/P trip itself to be signalled by means of clean power contacts (250 Vac, 5A).

The user has the possibility of individually "combining" one of the signals defined to par. 15.2.10. with each of the 7 K51 power relays, inside the PR020/K.

In this way, the user can obtain indication of the signals considered most important by means of clean power contacts.

If the signalling requirements are the classic ones (Alarm L, S, I ... Trip), these are pre-configured in the PR020/K, making putting into service immediate.

The PR020/K must be supplied with 24Vdc $\pm 20\%$ Vaux.

For installation and operation of the PR020/K accessory, please consult the special instruction manual.



The unit must be connected to the PR113 by means of an internal bus with a corded shielded cable with two conductors (see note A of par. 11.2.2) with a maximum length of 15m .

The shield must be earthed both on the circuit-breaker side and on the PR020/K side.

15.7.3 ABB SACE PR120/B power supply unit

The PR120/B is a momentary power supply unit to be inserted in the front test connector of the PR113.

With this accessory, supplied as standard, it is possible carry out the test, read and configure the parameters of the PR113 unit whatever the status of the circuit-breaker (open, closed, in the test position or racked-in, and with/without auxiliary power supply).

Testing the PR113 with the power supply supplied by the PR120/B, it is normal for the display to turn off for a few seconds after a trip test.

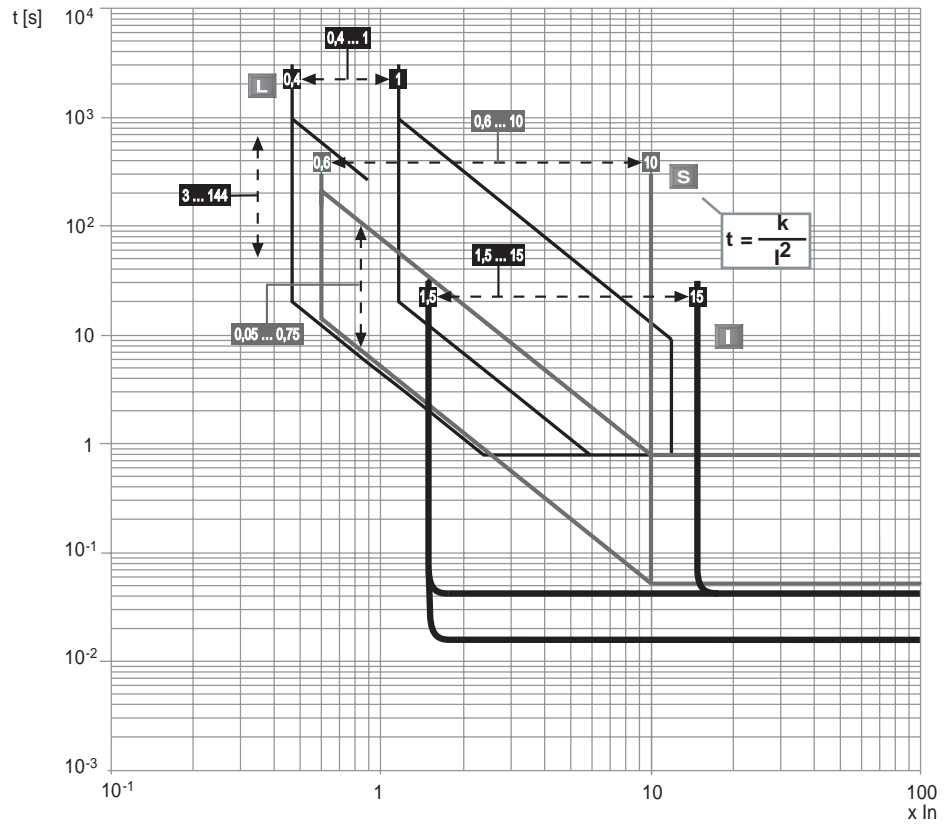
The battery inside the PR120/B guarantees power supply to the unit for about 3h continuously (depending on the operations carried out on the PR113)

Mod.	L0849			Apparatus	Emax	Scale
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15.8 Trip curves

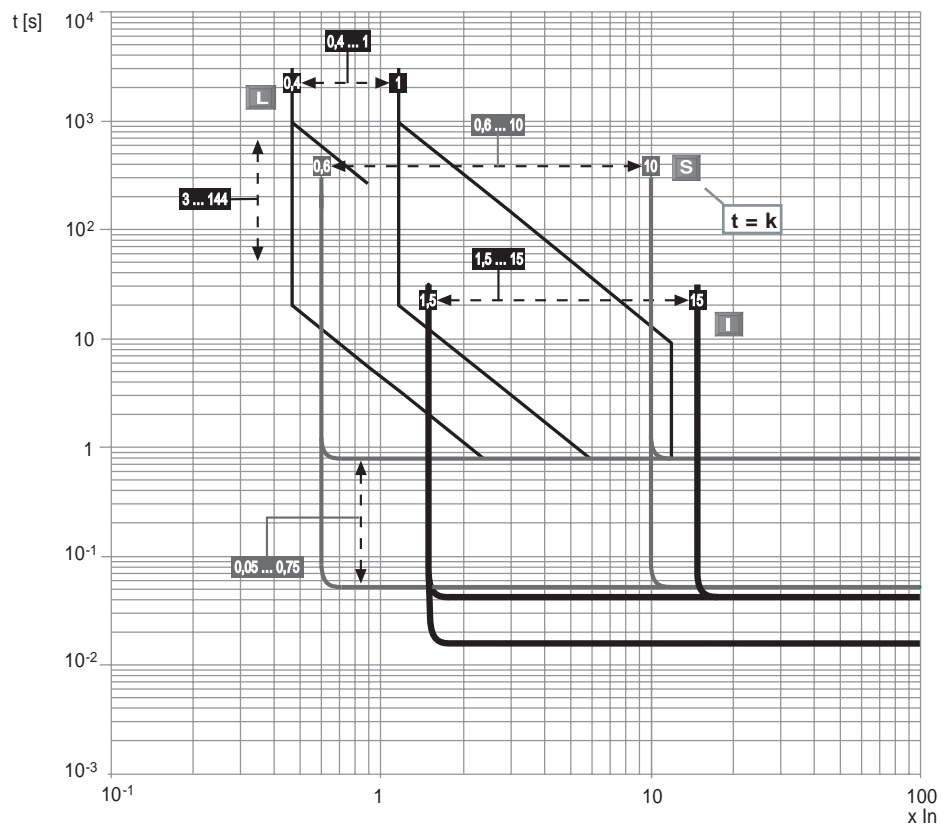
The trip curves given are indicative and only show a sub-group of the possible selections (see par. 15.4.2.2).

15.8.1 Trip curves of functions L-S-I



15DC200110F0001

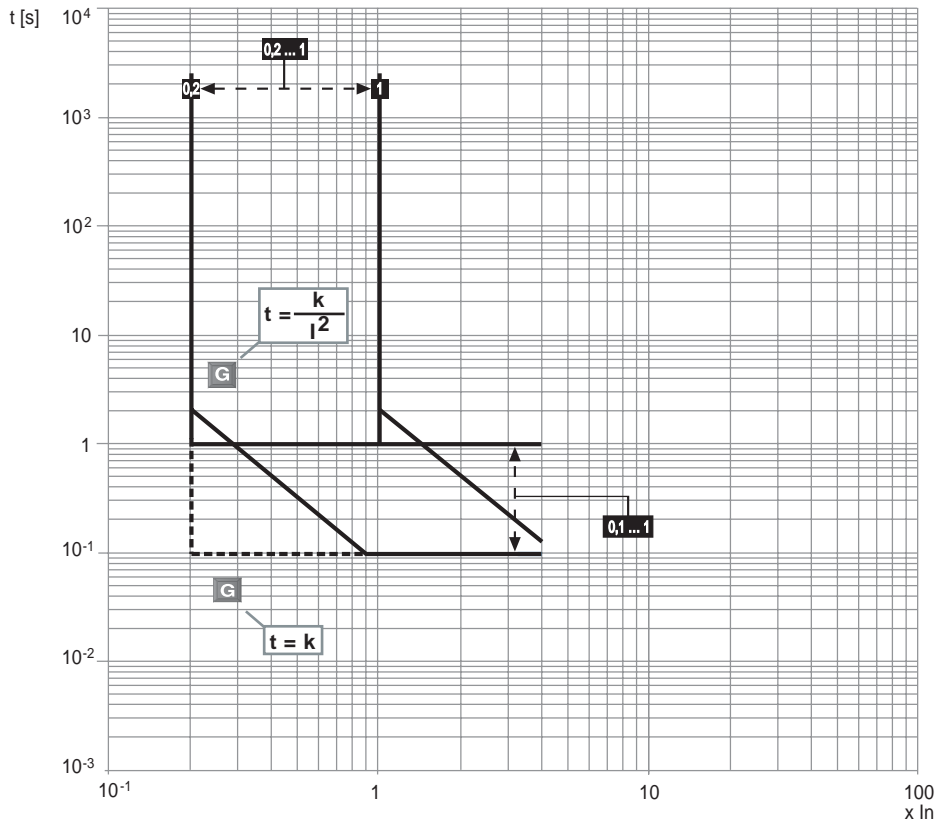
15.8.2 Trip curves of functions L-S-I



15DC200111F0001

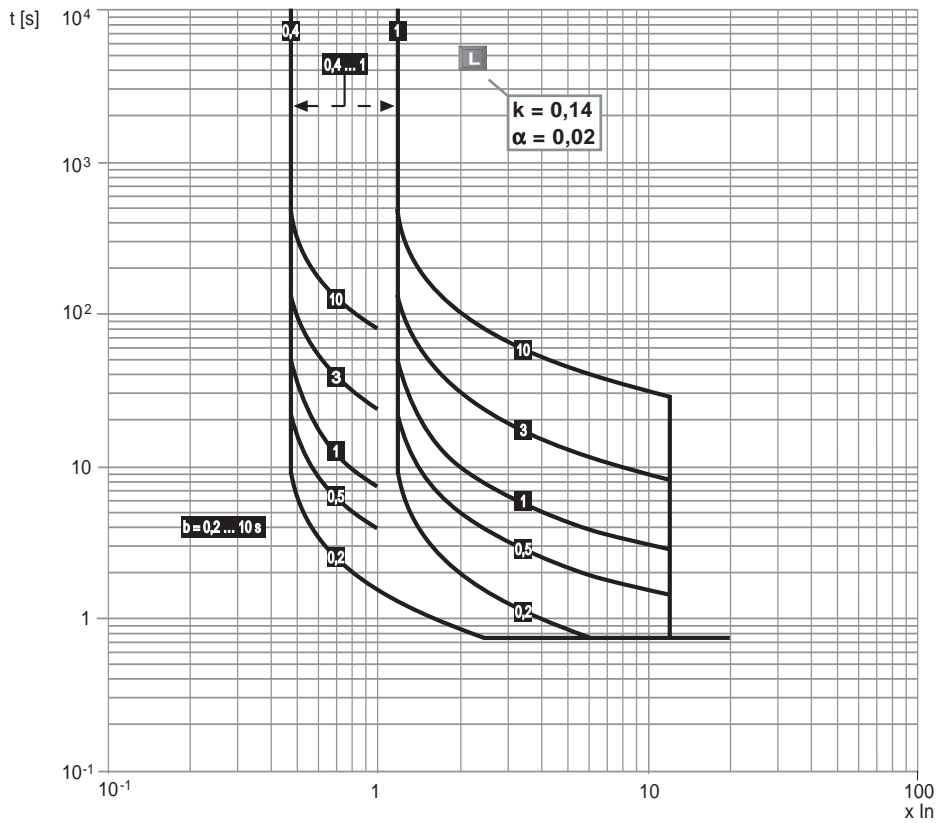
Mod.	L0849		Apparatus	Emax	Scale
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15.8.3 Trip curves of function G



15DC200112F0001

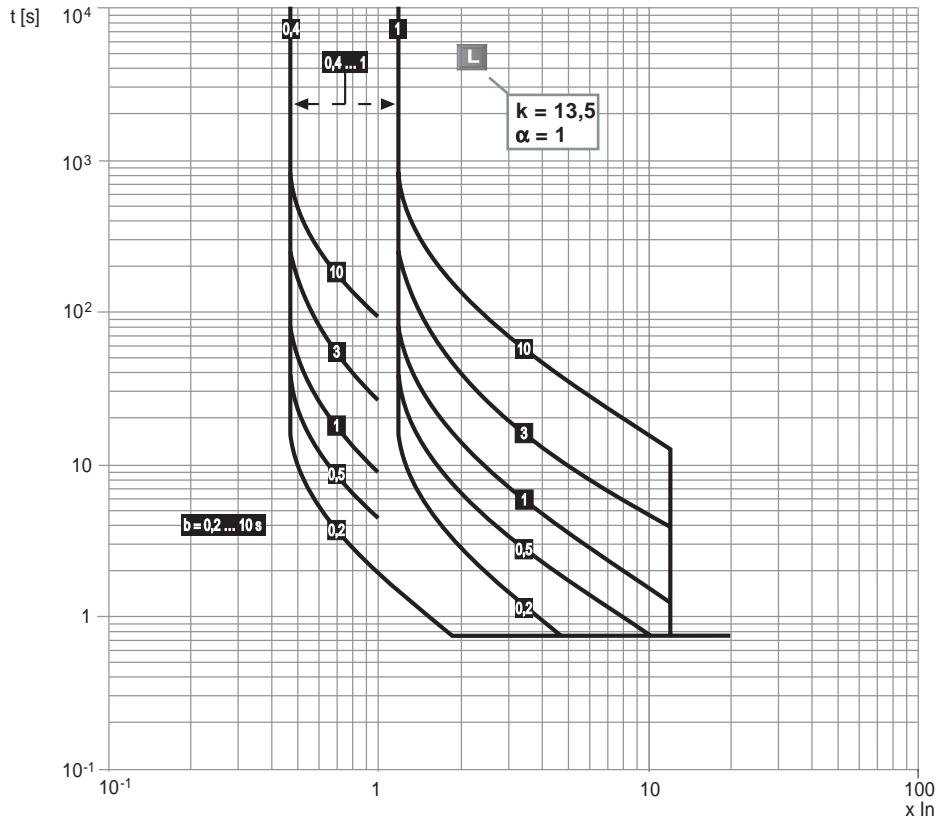
15.8.4 Trip curves of function L according to IEC 60255-3 (type A)



15DC200118F0001

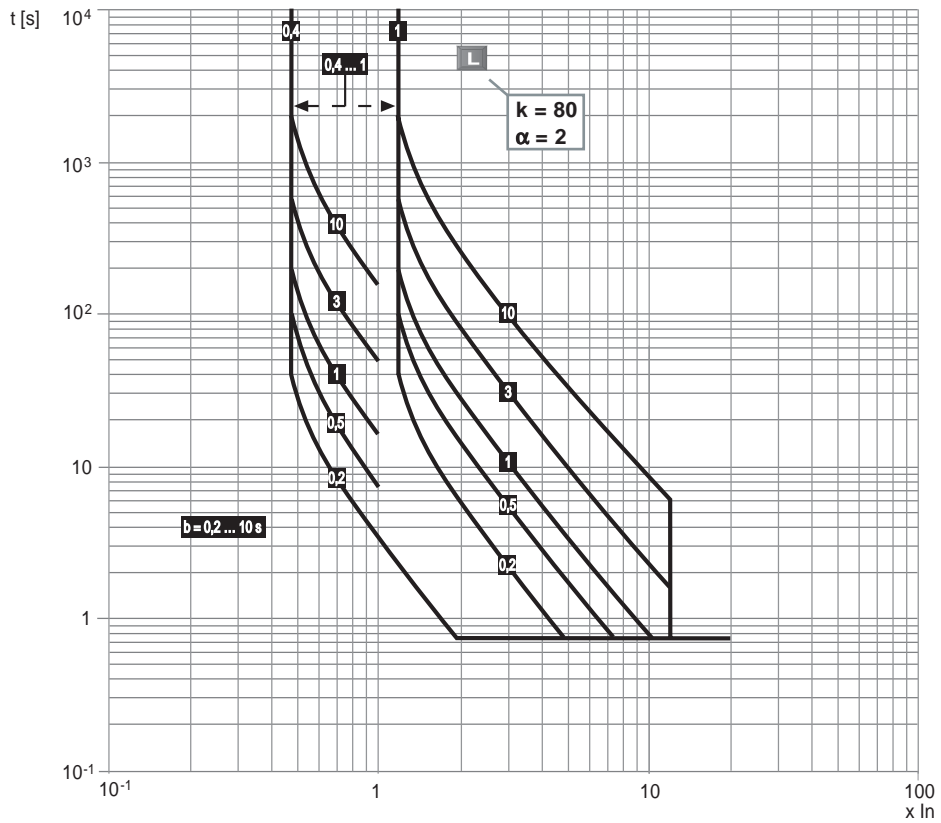
Mod.	L0849		Apparatus	Emax	Scale
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15.8.5 Trip curves of function L according to IEC 60255-3 (type B)



15DC200119F0001

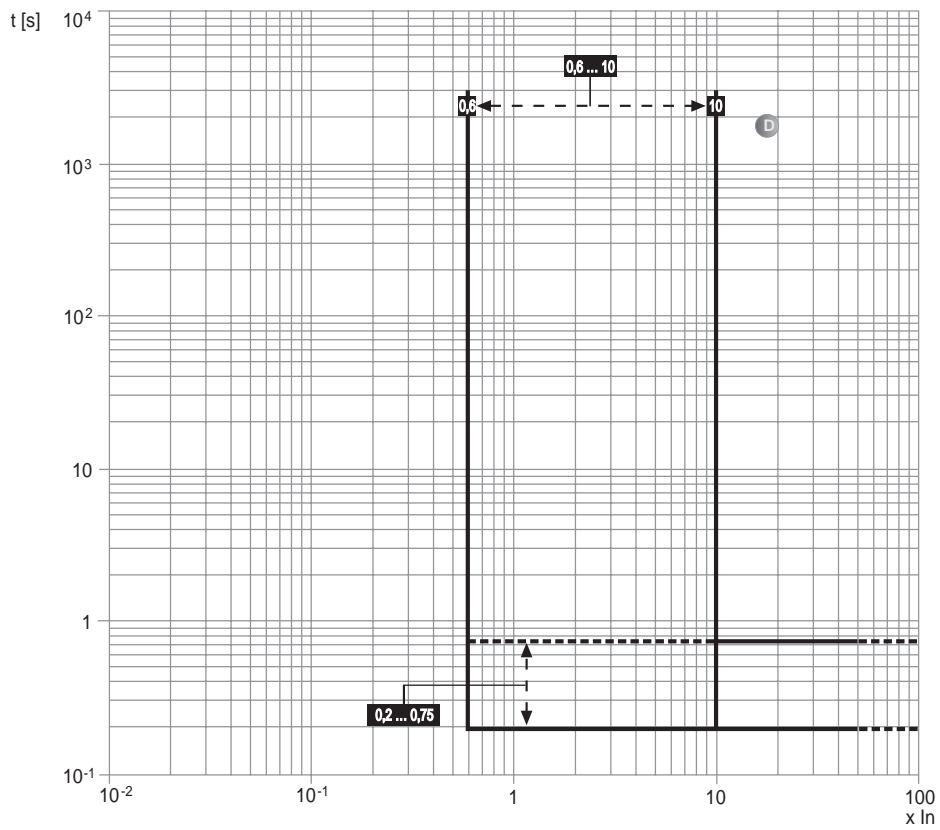
15.8.6 Trip curves of function L according to IEC 60255-3 (type C)



15DC200120F0001

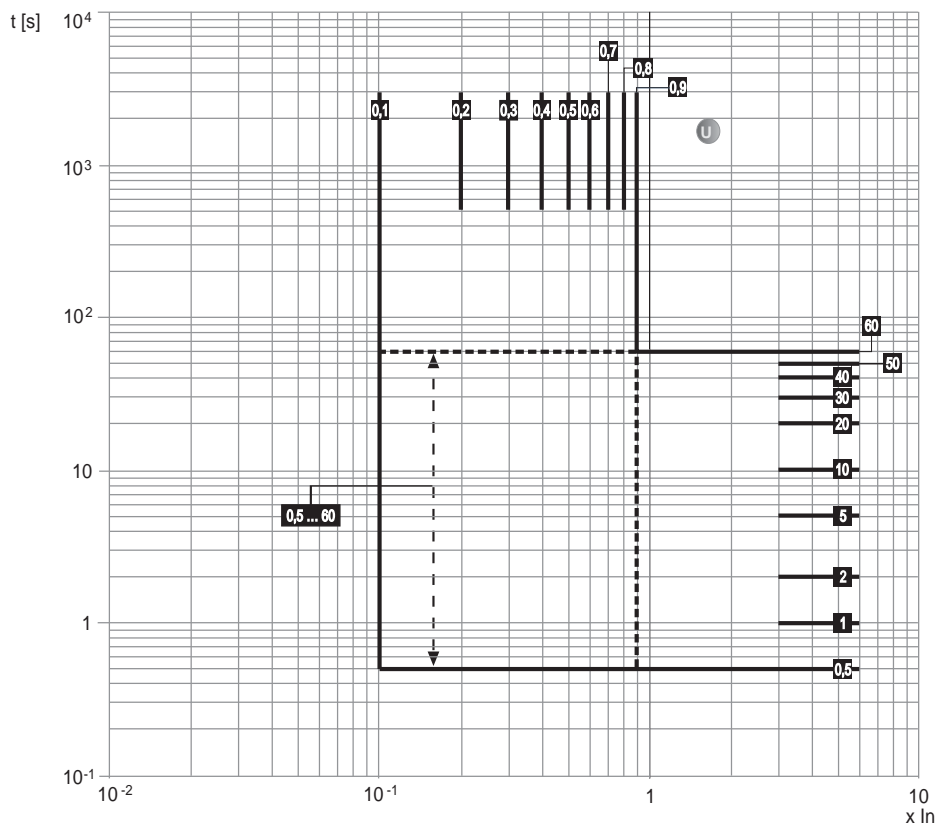
Mod.	L0849		Apparatus	Emax	Scale
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15.8.7 Trip curves of function D



15DOC20012/F0001

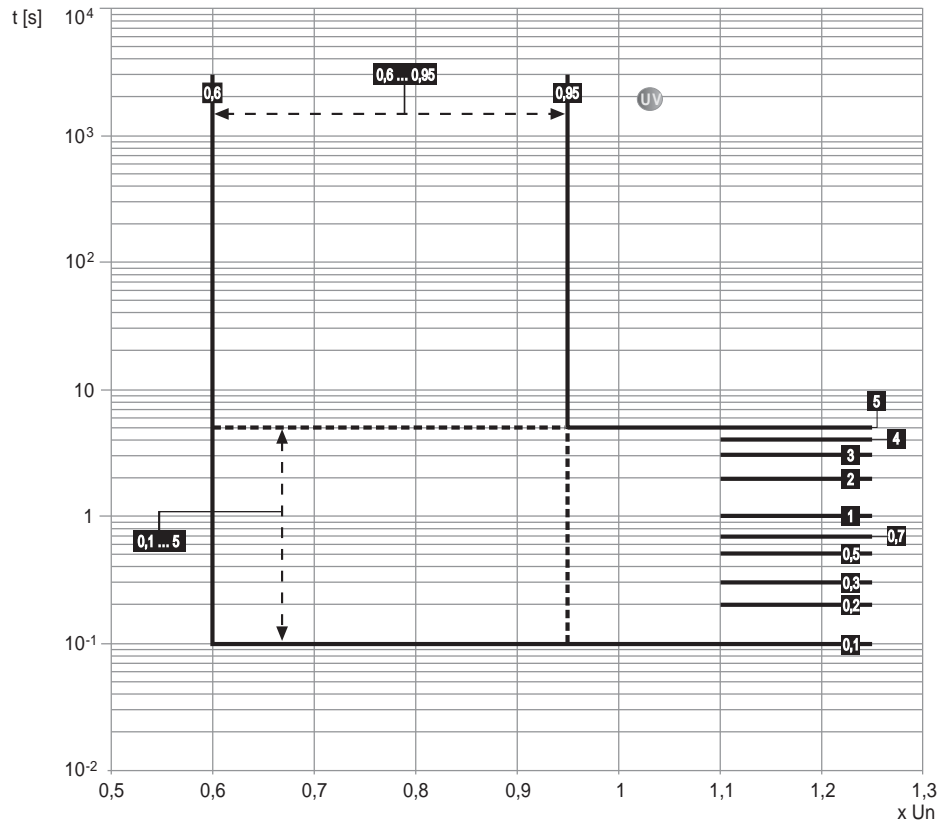
15.8.8 Trip curves of function U



15DOC20012/F0001

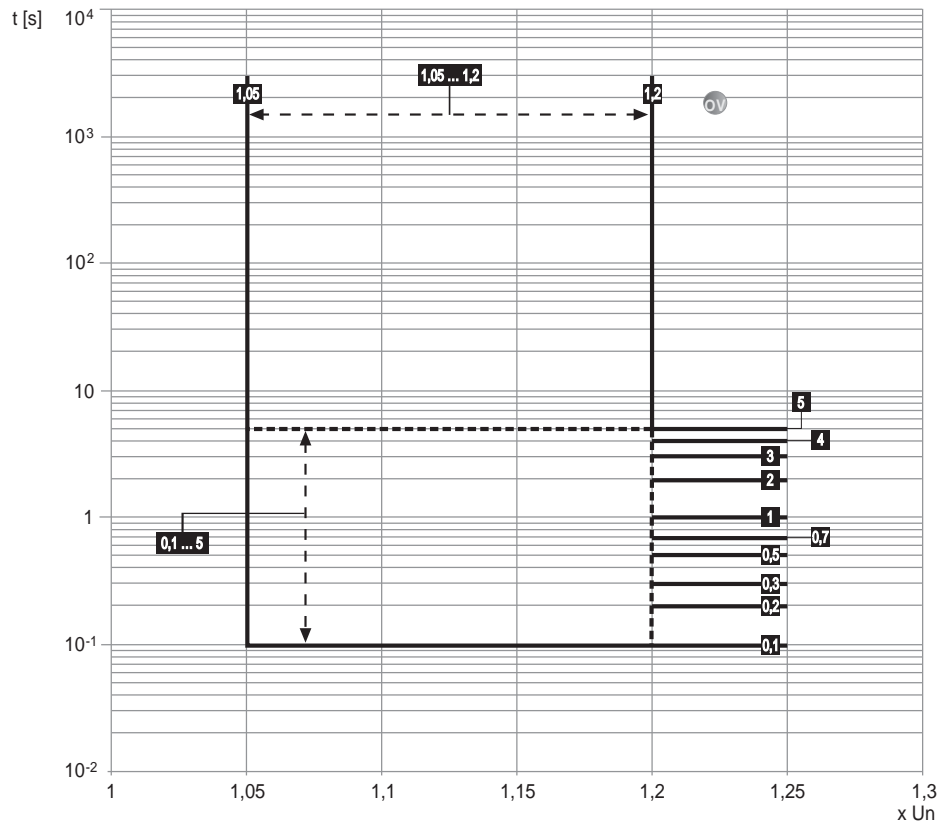
Mod.	L0849		Apparatus	Emax	Scale
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15.8.9 Trip curves of function UV



15D/C200123F0001

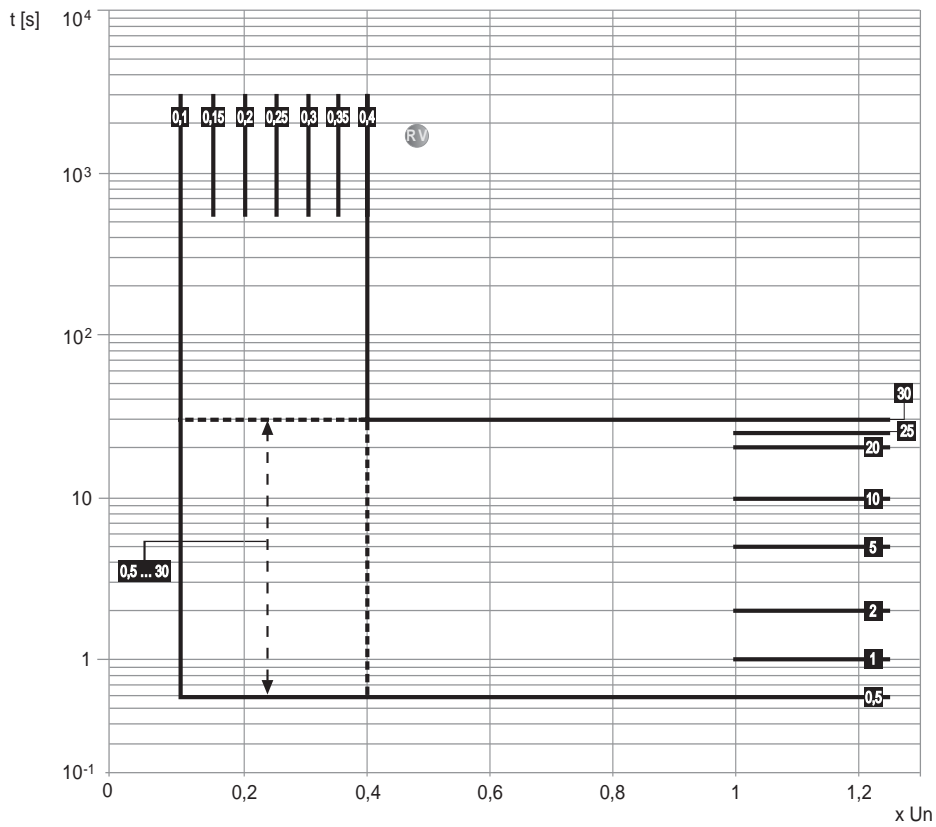
15.8.10 Trip curves of function OV



15D/C200124F0001

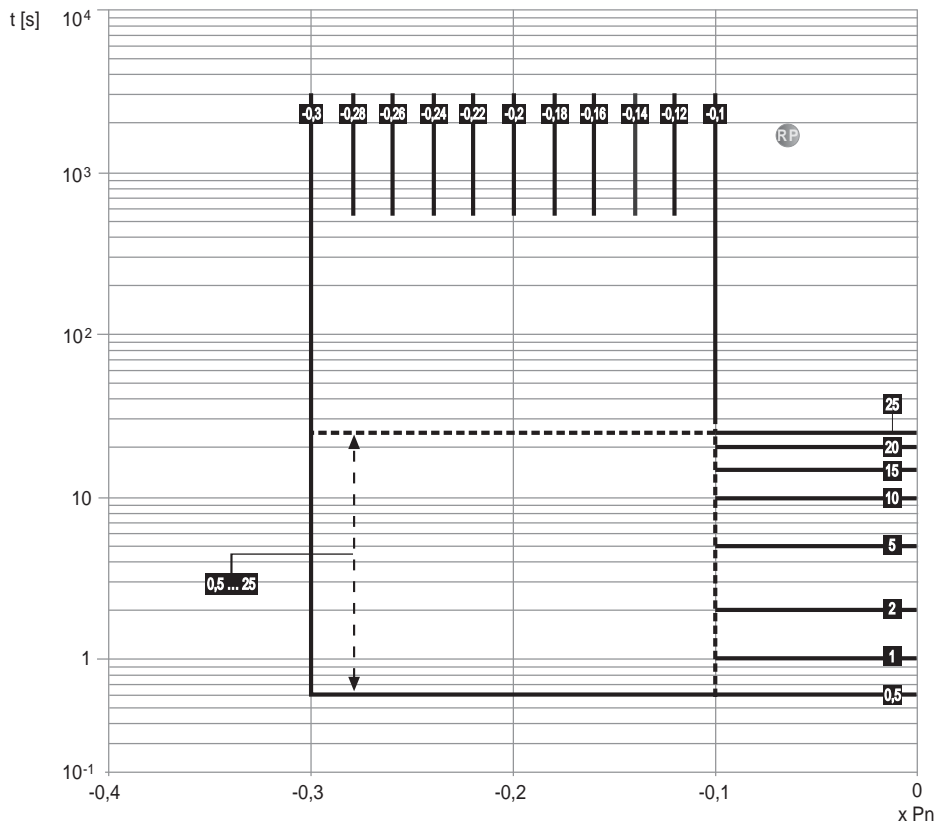
Mod.	L0849		Apparatus	Emax	Scale
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15.8.11 Trip curves of function RV



15DC200126F0001

15.8.12 Trip curves of function RP



15DC200126F0001

Mod.	L0849		Apparatus	Emax	Scale
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16 SACE PR113/PD Release – Identification

The PR113 units available fitted with a dialogue unit, with Modbus™ protocol , are:

- PR113/PD (in accordance with IEC Standards)

16.1 Standard

The PR113 /PD has been designed to work in accordance with the following international standard:
IEC 60947-2 Low voltage apparatus. Circuit-breakers.

16.2 Safety notes



This symbol identifies information on the procedures, actions or circumstances which can lead to wounds or injury of personnel, damage to the unit or economic losses.

Read this manual carefully and all the way through.

This appendix is intended as an integration of the PR113/P instruction manual.

For correct use and management of the PR112 protection unit fitted with a dialogue unit with Modbus™ protocol [PR112/PD], it is also necessary to consider what is given in the following documents:

- Instruction manuals “ (par.15)
- “PR113/PD Modbus™ System Interface” - see par.3 (doc. n° RH0296)
- “Modbus™ installation guide line” - see par.3 (doc. n° RH0298)

16.3 Various notes

A. All the detailed information on the communication interface (necessary for development of the supervision and control system by the System integrator) is given in document RH0296.

B. All the detailed information necessary to make the physical external connections to the release, as well as the maximum distances of the cabling, the type of conductor to be used, etc. are given in document RH0298.

C. The following are trademarks of Modicon, Inc.:

Modbus	984	P190	SM85
ModConnect	BM85	RR85	SQ85
Modcom	BP85	SA85	

16.4 Specifications

16.4.1 General



When there is no auxiliary power supply, the communication functions are not active.

The PR113 unit fitted with dialogue allows a supervision system to acquire information and send controls/parameters to the protection unit and to the circuit-breaker. The information available is:

Data transmitted from the PR113/PD to the supervision system

1	Protection parameters set
2	Configuration parameters set
3	Phase, neutral and earth currents
4	Line-to-line and starred voltages
5	Power factor for each phase and total
6	Active, reactive and apparent power
7	Line frequency
8	Status of the circuit-breaker (open-closed)
9	Position of the circuit-breaker (connected-isolated)
10	State of the springs (charged-discharged)
11	Number of mechanical circuit-breaker operations, overall number of trips and for each protection
12	Last current , voltage and power interrupted
13	Historical variations in current, voltage and energy
14	Contact wear
15	State of the protection functions (prealarm funct. L, timing funct. L, S, G, UV, OV, RV,...)
16	Overtemperature protection function
17	State of internal bus communication
18	State of SA and current sensor connection
19	**

** See par.16.3 note A

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Data transmitted from the supervision system to the PR113/PD

1	Protection parameters
2	Circuit-breaker opening and closing controls
3	Reset for trip of some protection functions
4	**

** See par.16.3 note A

16.4.1.1 Auxiliary power supply

When there is a PR113 equipped with a dialogue unit, the consumptions of the unit are different from those indicated just for the protection unit. The values to be considered are given in the following table.

Characteristics	PR113/PD Version
Power supply voltage	24V DC \pm 20%
Maximum ripple	5%
Inrush Current @ 24 V	~5A for 30ms
Start-up Current @ 24 V	~1.0A for 150ms
Nominal Current @ 24 V	~310mA
Nominal Power @ 24 V	~8W

16.4.2 Inputs/outputs

16.4.2.1 Binary opto-insulated inputs

- **CB-Closed:** Status of circuit-breaker
- **CB-Open:** Status of circuit-breaker (for congruency control with CB-Closed)
- **CB-Springs:** State of springs
- **CB-Position:** Position of circuit-breaker

16.4.2.2 Output contacts

- **K51/YC:** relay output which can be activated by the user to close the circuit-breaker
- **K51/YO:** relay output which can be activated by the user to open the circuit-breaker

- Monostable contacts, only active when there is Vaux
- Maximum changeover current: 3A – 250V AC (0.2A – 100V DC)
- Insulation contact-contact voltage: 1000 V AC

16.4.3 Communication bus

- External bus Modbus™ protocol RS485 2-Wire Twisted Pair, 19.2kbit/s max., connection to differential bus (See par.16.3 note B).

16.4.4 Information functions

To access the following pages, see par.16.6.1.

16.4.4.1 Software version

ABB SACE PR13/D-M Sw: x.xx	This page shows which Software version there is of the dialogue unit of the above PR113/PD unit. Each time it is necessary to communicate any operating problems with the dialogue unit to ABB SACE, it is a good idea to indicate the Sw version of the unit ("x.xx").
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16.4.4.2 Opening data storage

Manual Opens:xxxxx Prot. Trips: xxxxx Other Trips: xxxxx Trip Fails: xxxxx	Sum of openings due to manual openings by means of pushbuttons on the front of the circuit-breaker, controls coming from opening coil (YO) and undervoltage (MT) Sum of openings due to protections (L, S, I, G, T temperature, D, UN, UV, OV, RV,...). Sum of openings due to the trip test. Sum of any missed trips in relation to a fault.
L: xxxxx UN: xxxxx S: xxxxx UV: xxxxx I: xxxxx OV: xxxxx G: xxxxx RV: xxxxx T: xxxxx RP: xxxxx D: xxxxx	Number of trips due to protections L, S, I, G and T (temperature), D, UN, UV, OV, RV, RP.

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16.4.4.3 State of circuit-breaker auxiliary inputs

CB Status: xxxxx	Status of the circuit-breaker. The possible states are: Open - Closed – Error*
CB Springs: yyyyy	State of spring charging. The possible states are: Charged – Discharged
CB Pos.: zzzzz	Position of the circuit-breaker. The possible states are: Conn. – Isol.
Test YO/YC: kkk	See par. 16.4.5

*The display of **Error** indicates a condition of incongruence (both the CB-Open and CB-Closed inputs are in the same logical state)

16.4.5 Control functions

CB Status :	xxxxx	See par. 16.4.4.3
CB Springs:	yyyyy	See par. 16.4.4.3
CB Pos. :	zzzzz	See par. 16.4.4.3
Test YO/YC:	kkk	Control function for opening and closing the circuit-breaker by means of coils YC and YO.

- To open the circuit-breaker, select YO and then press the TEST pushbutton on the front of the PR113/PD
- To close the circuit-breaker, select YC and then press the TEST pushbutton on the front of the PR113/PD

16.4.6 User interface

Caption of the front of the PR113/PD unit (integration of the caption relative to the PR113/P version):



Ref.	Description
A	"NETWORK" LED linked to the state of communication activities (Tx) on external bus.
B	"μP fault" LED relative to operation of the μProcessor dialogue unit.

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16.4.6.1 Remote and Local modes

The PR113/PD can operate in two different modes, local or remote.

16.4.6.1.1 Local operating mode

In local mode :

- Remote parameterisation (i.e. from supervision and control system) not allowed (e.g. modification of protection function settings ...)
- Remote controls which cannot be carried out (e.g. circuit-breaker opening, closing ...)

The following actions are allowed:

- Reading current measurements
- Reading configuration parameters
- Reading protection parameters
- Reading parameters set for load control
- Reading the information relative to the protection unit

16.4.6.1.2 Remote operating mode

All the following actions are allowed in remote mode :

- Reading current measurements
- Reading configuration parameters
- Reading protection parameters
- Reading parameters set for load control
- Reading the information relative to the protection unit
- Modification of parameters linked to the protection and communication unit
- Circuit-breaker opening and closing controls

16.4.7 Default settings

The PR113/PD is supplied by ABB SACE with the following pre-defined communication parameters:

Slave Addr.	Baudrate	Parity	Addressing
255 (UNCONFIGURED)	19.200 bit/s	Even	Standard

Operating mode

Local

16.5 Putting into service

16.5.1 Connections



For the Connections to be made by the user, it is advisable to check what is indicated in par.16.3 note B.

This means that we shall be able to satisfy all the international reference Standards and guarantee perfect operation of the release even under severe environmental and electromagnetic conditions.

Pay particular attention to the types of cable, the connections to earth and the maximum distances recommended.

In case of replacement of a PR113/P with a PR113/PD it is necessary to complete the missing cabling on the terminal box (or sliding contacts of the circuit-breaker) with those required for the dialogue function, as well as to replace the connectors which are coupled with the PR113 release from the terminal box.

16.5.2 Test

Before putting into service, it is advisable to carry out some opening, closing and resetting controls of the circuit-breaker, also checking correct indication of the status of the circuit-breaker on the display (open-closed).

It is also advisable to check the correct state of the springs (charged-discharged) as well as the position of the circuit-breaker (connected-isolated). For further details see par. 16.4.4.3.

16.5.3 Initial settings



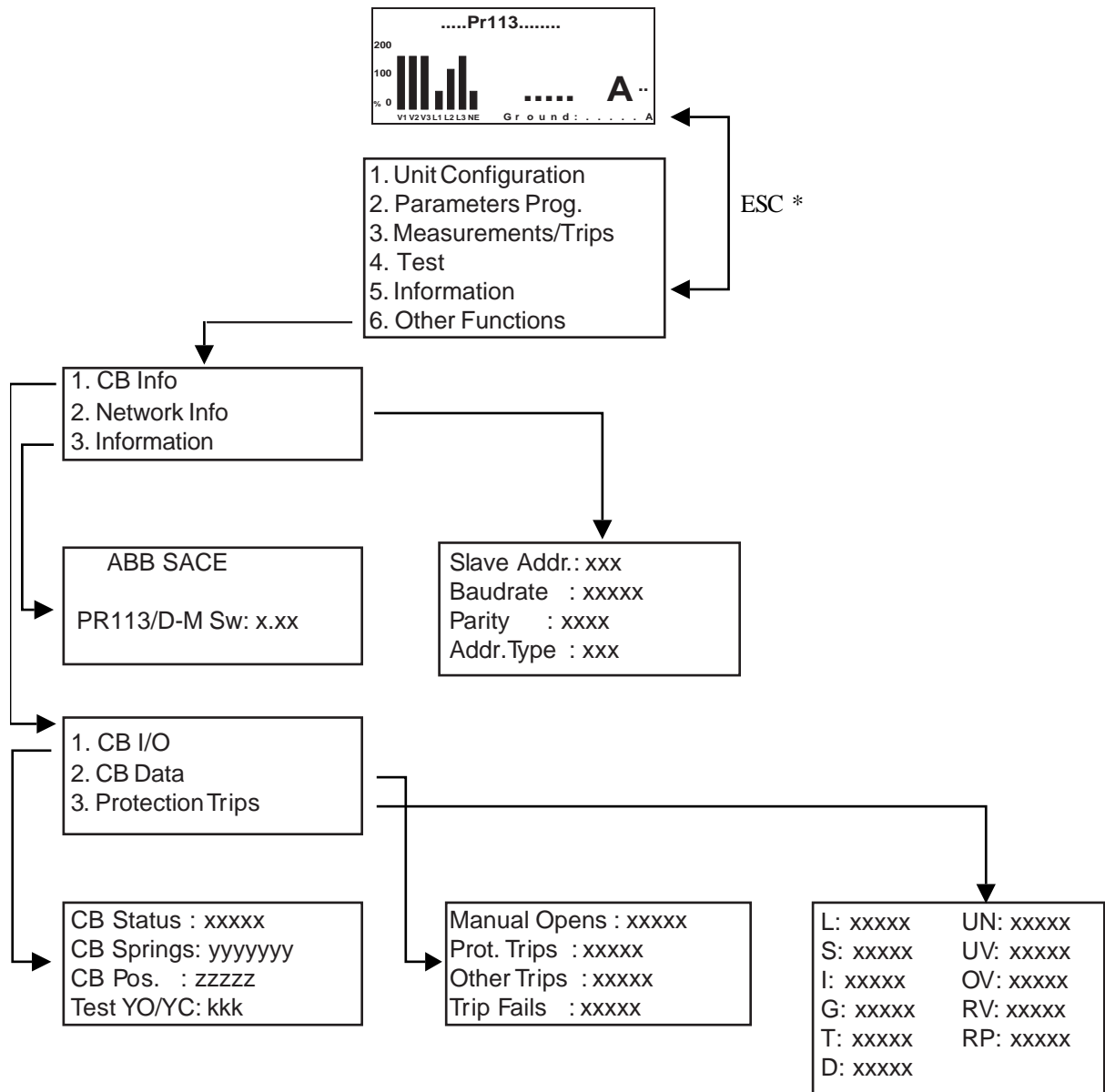
ABB SACE defines each setting of the communication parameters (see default parameters). Apart from this, before putting the PR113 into service, it is absolutely indispensable for the user to carefully define each modifiable parameter (see par.16.6.2).

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16.6 Operative/operating instructions during service

16.6.1 Menus

As already seen previously, the PR113 uses the display to show messages, data and menus. These are organized in a logical and intuitive way. For user convenience, all the additional screens which can be seen with PR113/PD are given below.



* Press ESC to return to the previous page

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16.6.2 Modification of parameters

The information for modification of the various parameters is given in the PR113/P part of the instruction manual.

16.6.2.1 Modification of basic configuration

With PR113/PD, a further page is displayed in the Config/Program menu.

Operating Mode	:xxx
Language	:yyy
Net frequency	:kkk
Neutral sel.	:zzz

Properties / function	Selectable values	Description
Operating Mode	Rem-Loc	See par. 16.4.6.1

16.6.2.2 Modification of communication parameters

Slave Addr.	: xxx
Baudrate	: xxxxx
Parity	: xxxx
Addr. Type	: xxx

Properties / function	Selectable values	Description
Slave Addr.	1...247 e 255*	Logical address of the device.
Baudrate	9600-19200 bit/s	Data transmission speed.
Parity	Even-Odd	Control mode of data transmitted.
Addr. Type	Standard-ABB SACE	Type of addressing of the Modbus™ data.

* Slave Addr. = 255 means unit not configured.

16.6.3 Signals

16.6.3.1 Optical signals

Signalling	Description
Led µP Fault [COMMUNICATION] (red)	Microprocessor of the dialogue unit with temporary or permanent fault.
Led Network [COMMUNICATION] (yellow)	The communication (Tx) activity between the PR113 trip unit and the remote supervision system is active (rapid flashing).

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16.7 Troubleshooting

The following table collects up a series of typical service situations, which are useful in order to understand and solve hypothetical faults or malfunctions.

N.B.:

1. Before consulting the following table, check any lighting up of the LEDs located on the front of the unit for a few seconds.
2. **FN** indicates normal operation of the PR113.

In the case where the suggestions proposed do not lead to a solution of the problem, please contact the ABB SACE assistance service.

N°	Situation	Possible causes	Suggestions
1	There is no serial communication activity with the remote supervision system	1. Incorrect cabling of the connections. 2. There is no auxiliary voltage 3. Incorrect communication parameters	1. Check the connections 2. Recover the auxiliary voltage 3. Set the correct parameters
2	Incorrect indication of the circuit-breaker status, circuit-breaker position and state of the springs	Incorrect cabling of the connections	Check the connections
3	Impossible to send circuit-breaker opening and/or closing controls	1. Incorrect cabling of the connections 2. No power supply to the opening and/or closing coils	1. Check the connections 2. Recover the power supply voltage
4	Impossible to change the PR113 parameters and/or carry out opening/closing controls from the front keyboard	The unit is set to Remote	Set the unit to Local
5	Impossible to change the PR113 parameters and/or send remote opening/closing controls	1. The unit is set to Local 2. The device is a PR113/PD	1. Set the unit to Remote 2. FN
6	"No Int. Bus Comm" message on the display	No communication activity between protection unit and communication unit inside the PR113	Contact ABB SACE
7	No updating of the opening data	Vaux not present during the trip	FN

16.8 Warning and error messages

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

Incorrect configurations	
MESSAGE	DESCRIPTION
MODBUS not config.	The dialogue unit does not have the address set (ABB default setting)
V_AUX OFF: Comm. OFF	The communication bus is not operating because there is no auxiliary voltage.
NO Int. Bus Comm.	No communication between the protection unit and the dialogue unit inside the PR112/PD.
NOT available	The function required is not available.
CB Status Unknown	See par.16.4.4.3
MODBUS Wink	The Wink mode has been activated. In this condition, rear illumination of the display is intermittent.

16.9 ACCESSORIES

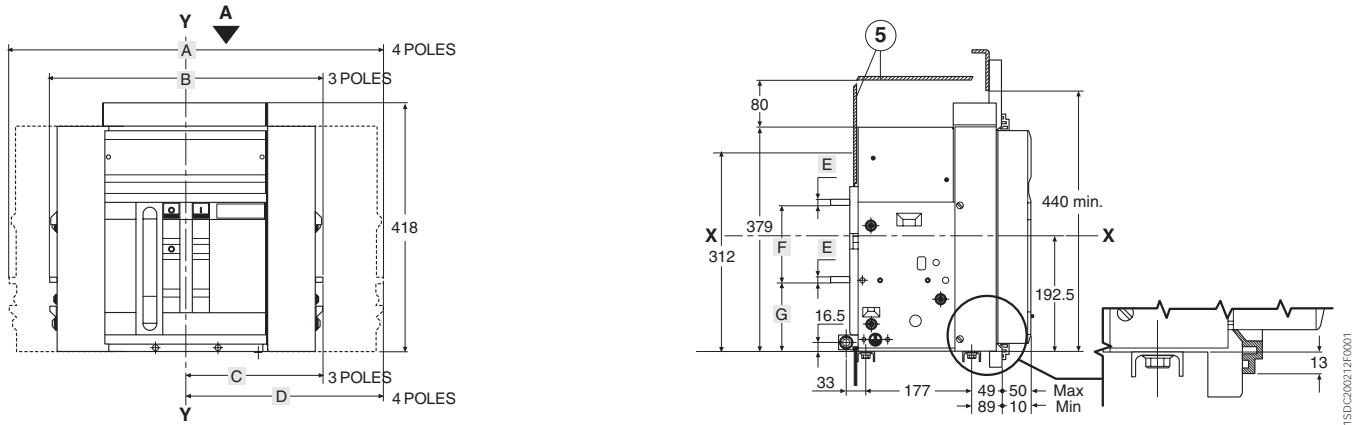
See paragraph 15.7.

Mod.	L0849		Apparatus	Emax	Scale
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17. Overall dimensions

Fixed circuit-breaker

Basic version with horizontal rear terminals

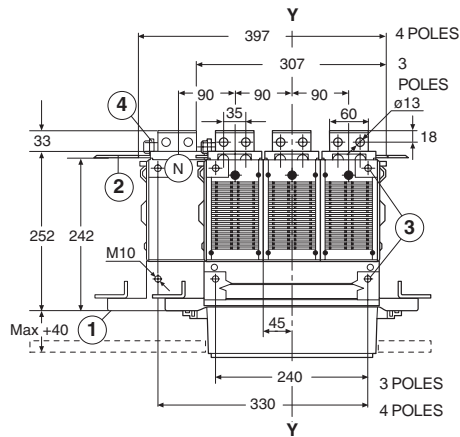


Caption

- ① Inside edge of compartment door
- ② Segregation (where foreseen)
- ③ Circuit-breaker M10 fixing drilling (use M10 screws)
- ④ No. 1 M12 screw (E1, E2, E3) or no. 2 M12 screws (E4, E6) for earthing (included in the supply)
- ⑤ Insulating or metal-insulated wall

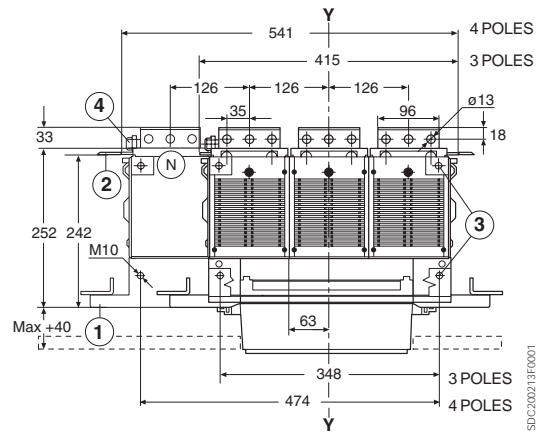
E1/E2

View A



E3

View A



	A	B	C	D	E	F	G
E1	386	296	148	148	10	130	117,5
E2	386	296	148	148	26	114	117,5
E3	530	404	202	202	26	114	117,5
E4	656	566	238	328	26	166	91,5
E4/f	746	-	-	328	26	166	91,5
E6	908	782	328	454	26	166	91,5
E6/f	1034	-	-	454	26	166	91,5

Fig. 35

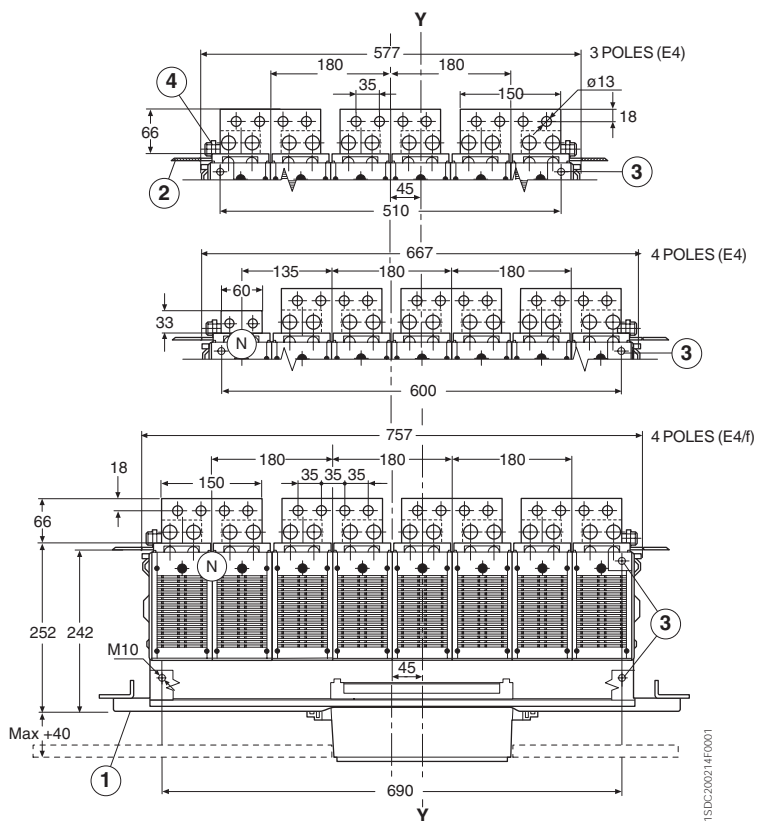
Mod.	L0849			Apparatus	Emax	Scale
				Doc. N°	RH0288002	Page N° 108/132

Fixed circuit-breaker

Basic version with horizontal rear terminals

E4

View A



E6

View A

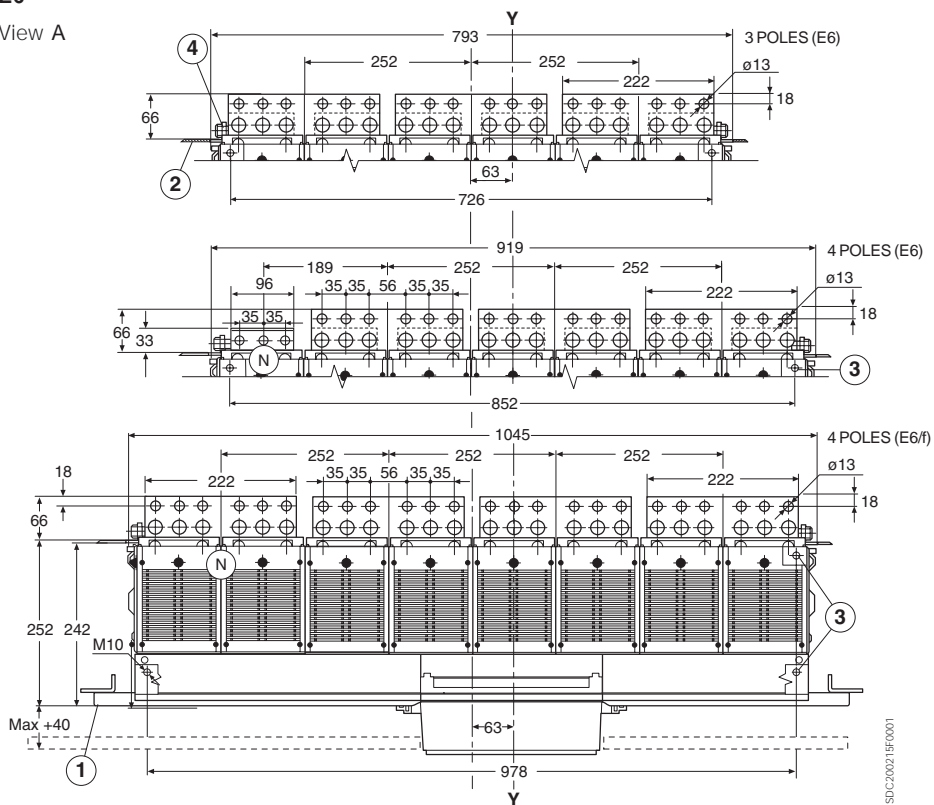
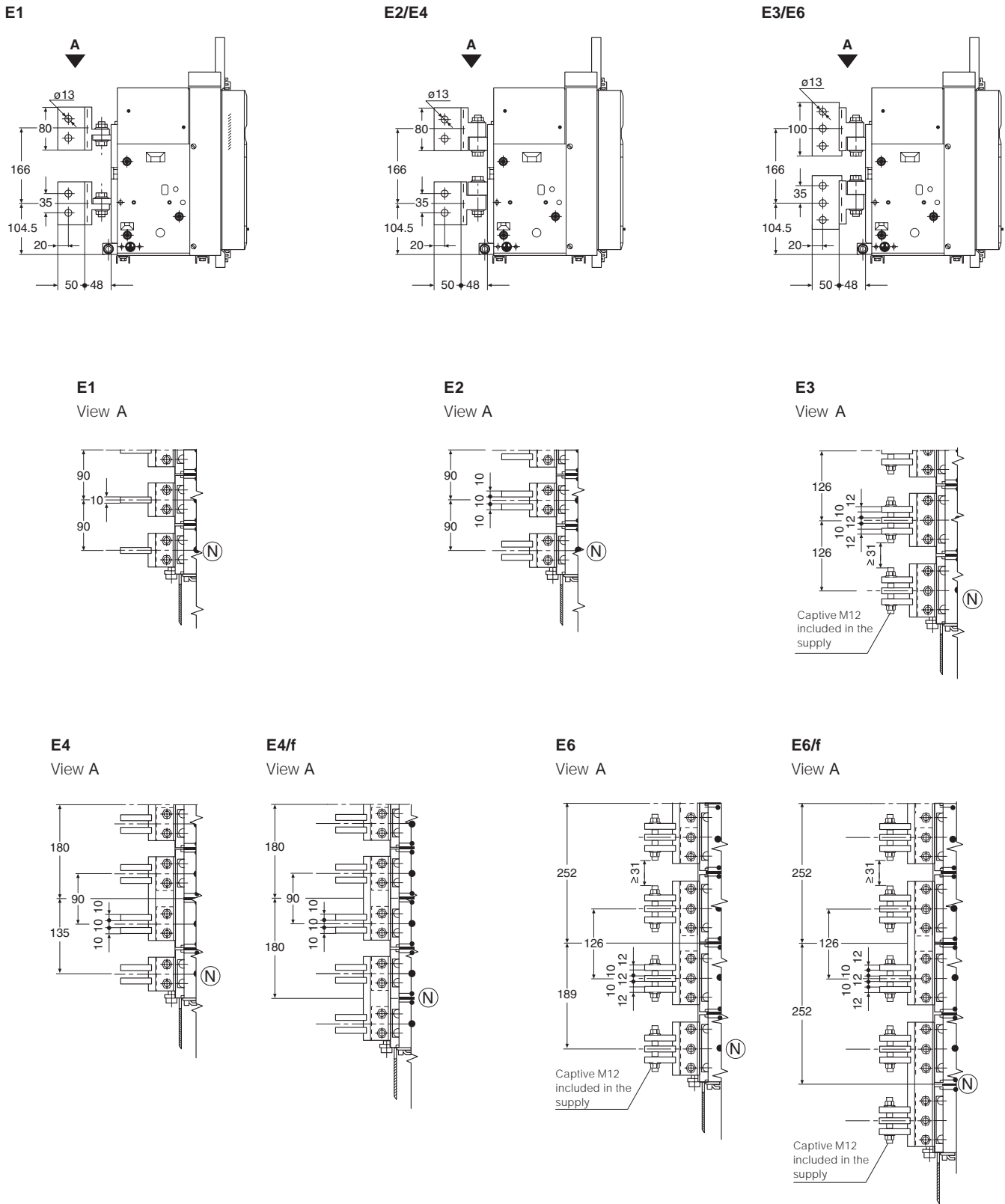


Fig. 36

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 109/132

Fixed circuit-breaker

Basic version with vertical rear terminals



15DC200216f0001

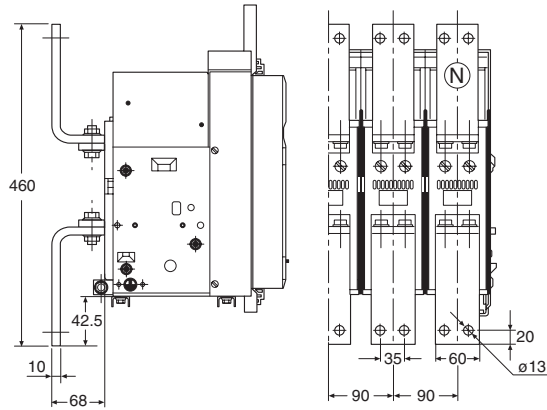
Fig. 36a

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 110/132

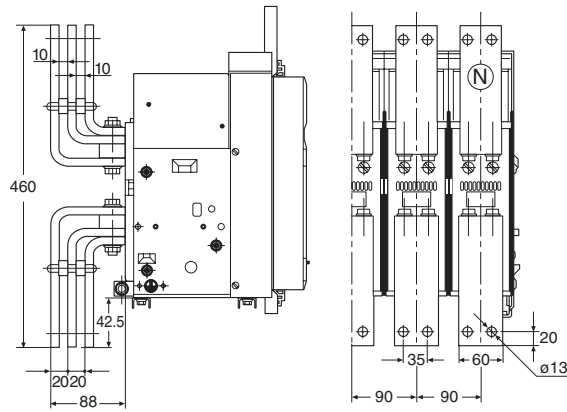
Fixed circuit-breaker

Version with front terminals

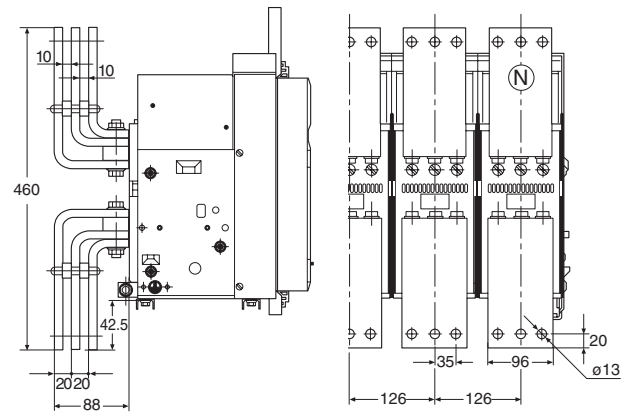
E1



E2



E3



15DC00217F0001

Fig. 37

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 111/132

Fixed circuit-breaker

Version with front terminals

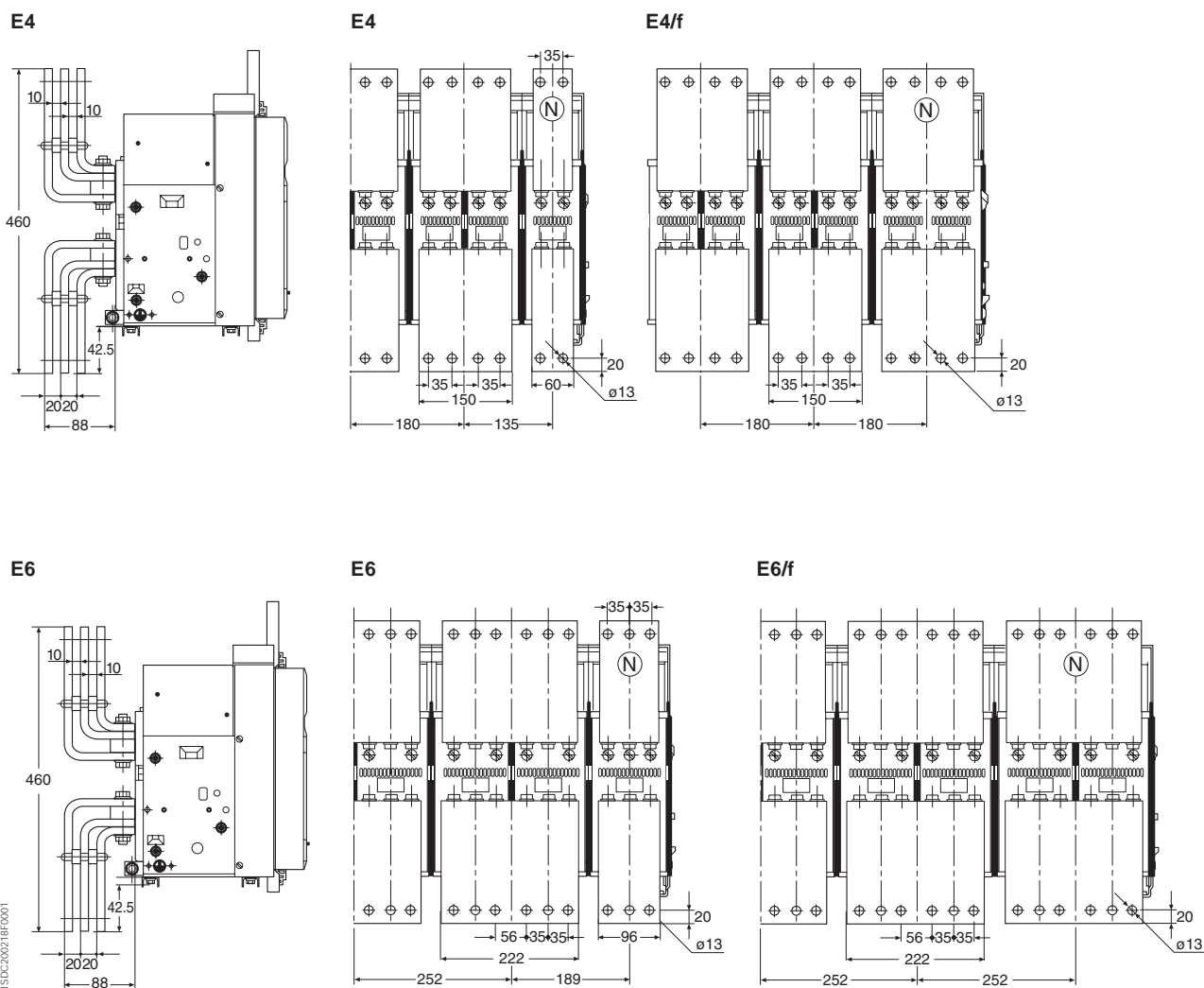
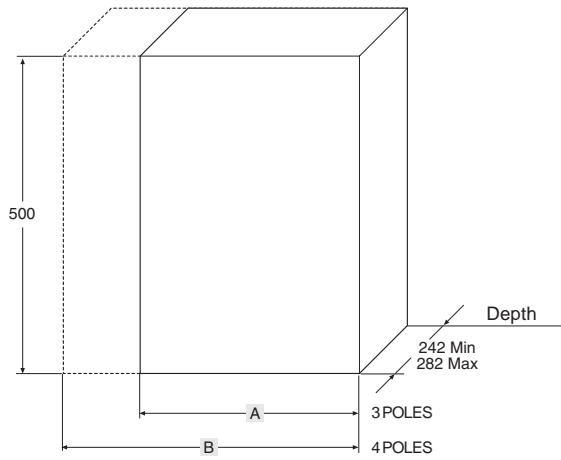


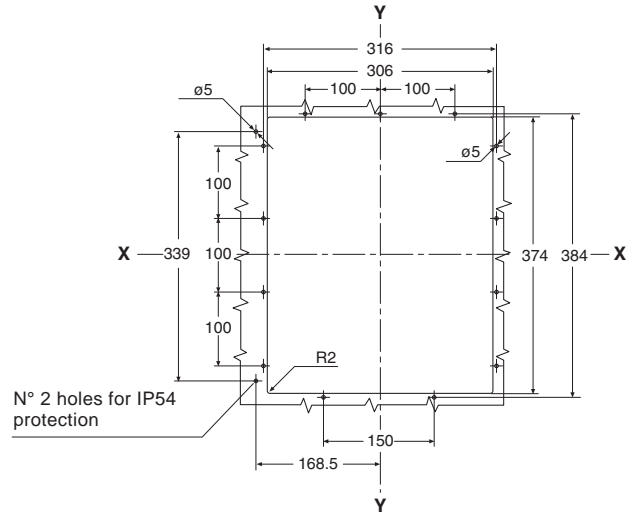
Fig. 38

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 112/132

Compartment dimensions



Compartment door drilling



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

	A	B
E1	400	490
E2	400	490
E3	500	630
E4	700	790
E4/f	-	880
E6	1000	1130
E6/f	-	1260

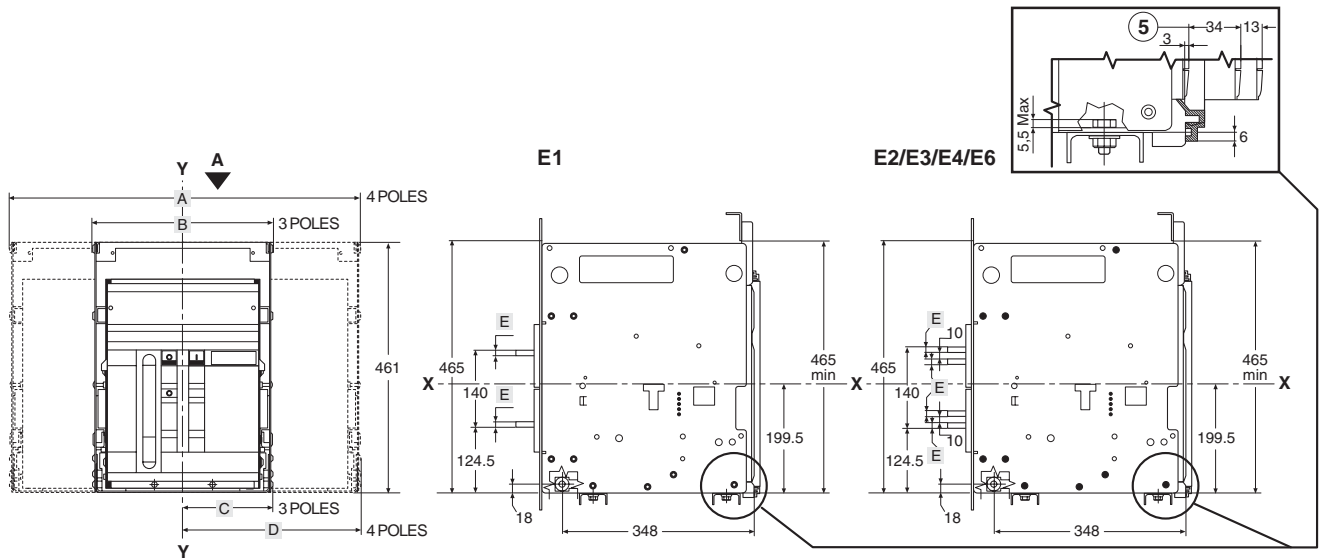
		High resistance M12 screw Quantity per terminal	
		PHASE	NEUTRAL
	E1-E2	2	2
	E3	3	3
	E4-E4/f	4	2-4
	E6-E6/f	6	3-6

Fig. 39

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 113/132

Withdrawable circuit-breaker

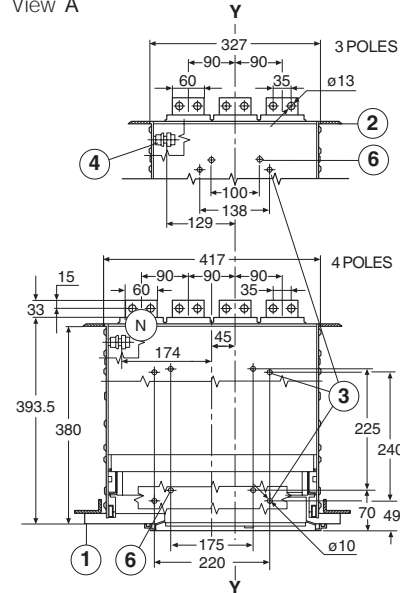
Basic version with horizontal rear terminals



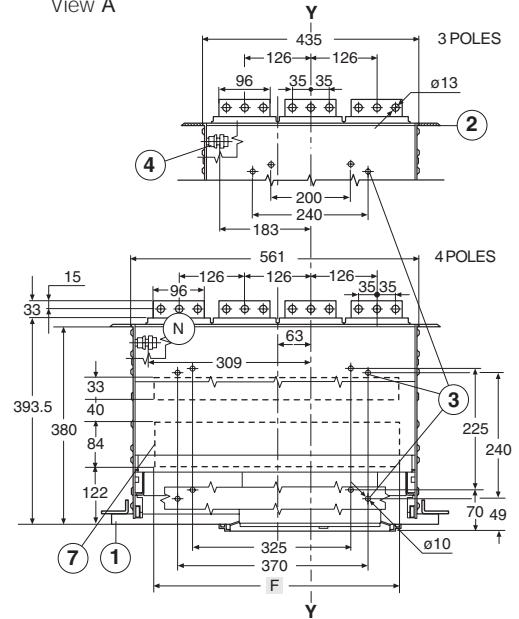
Caption

- ① Inside edge of compartment door
- ② Segregation (where foreseen)
- ③ Fixing fixed part $\varnothing 10$ drilling (use M8 screws)
- ④ No. 1 M12 screw (E1, E2, E3) or no. 2 M12 screws (E4, E6) for earthing (included in the supply)
- ⑤ Run from connected for a TEST to isolated
- ⑥ Alternative drilling with 25 mm pitch for fixing fixed part
- ⑦ Ventilation drilling on the switchgear

E1/E2
View A



E3
View A



	A	B	C	D	E	F	
						3poles	4 poles
E1	414	324	162	162	10	-	-
E2	414	324	162	162	8	-	-
E3	558	432	216	216	8	370	490
E4	684	594	252	342	8	530	610
E4/f	774	-	-	342	8	-	700
E6	936	810	342	468	8	750	870
E6/f	1062	-	-	468	8	-	1000

Fig. 40

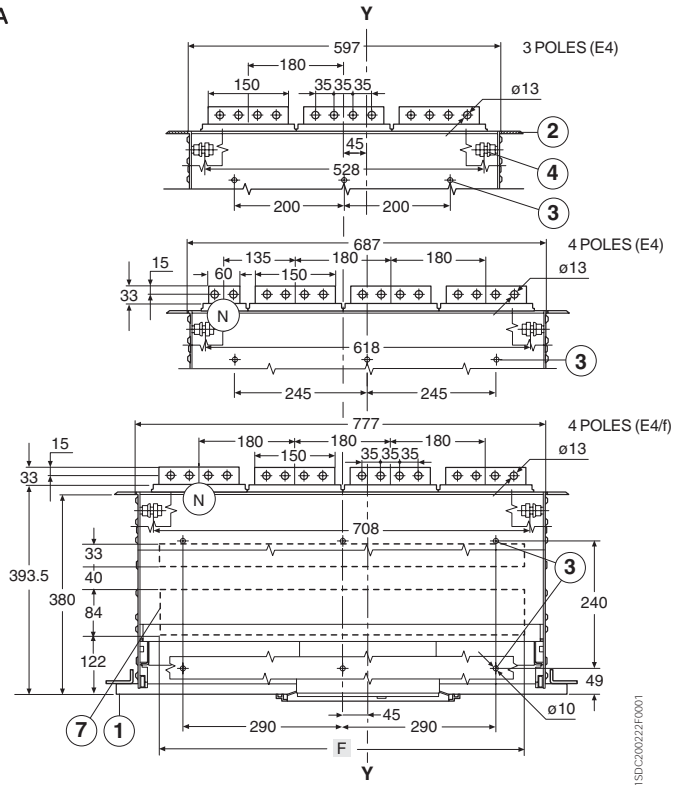
Mod.	L0849			Apparatus	Emax	Scale
				Doc. N°	RH0288002	Page N° 114/132

Withdrawable circuit-breaker

Basic version with horizontal rear terminals

E4

View A



E6

View A

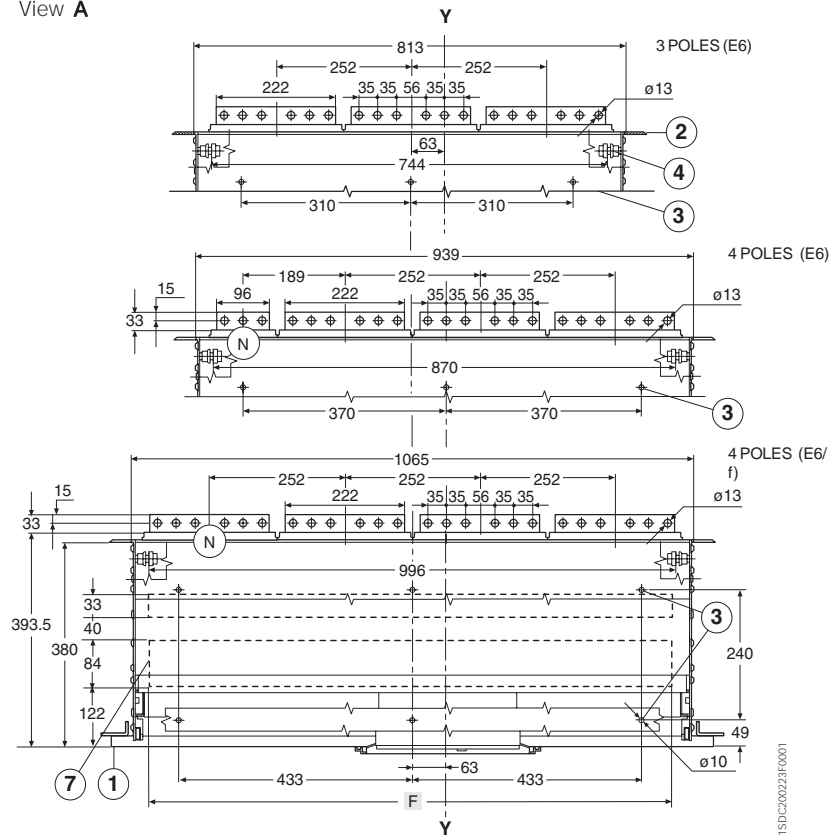
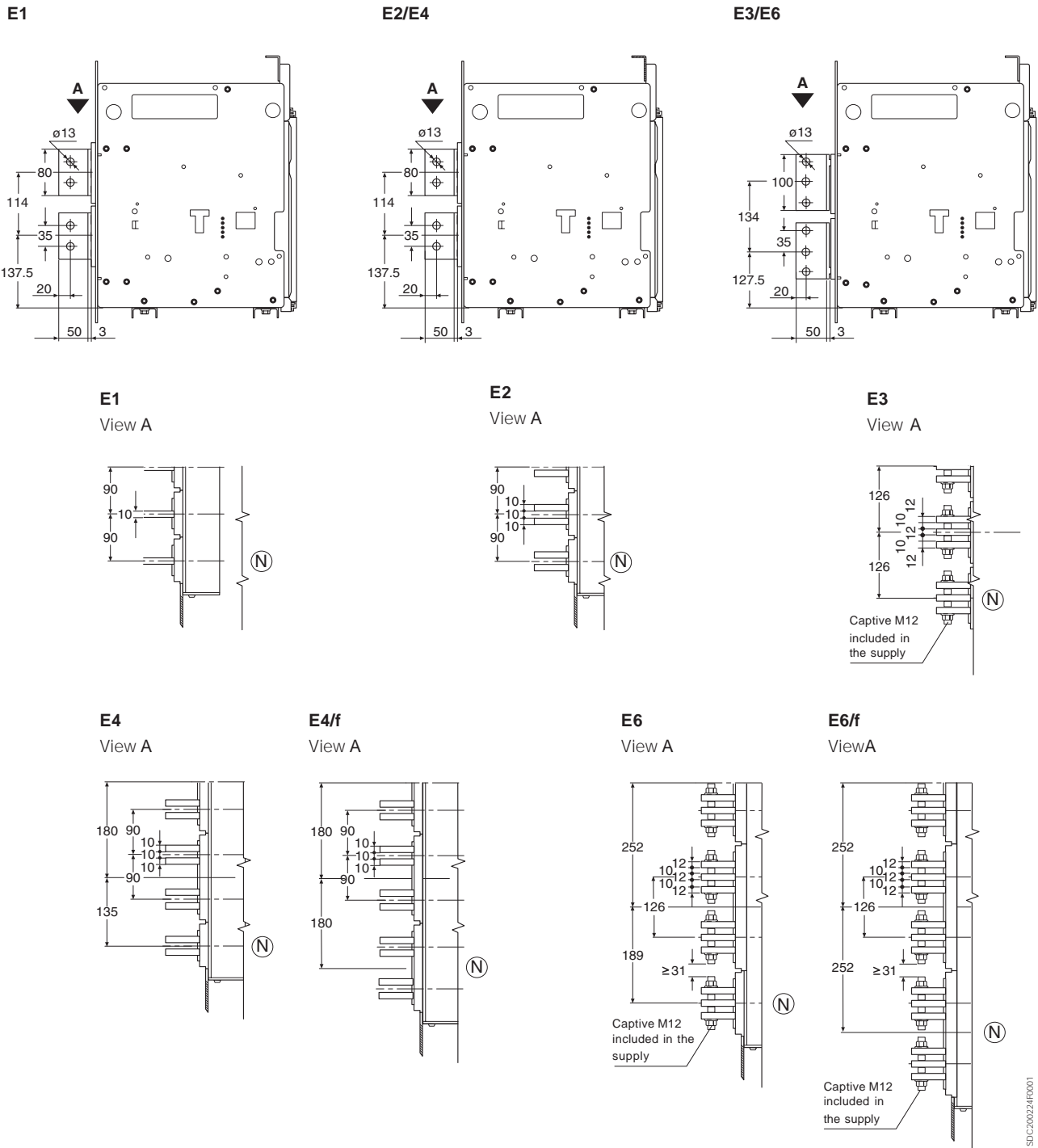


Fig. 41

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 115/132

Withdrawable circuit-breaker

Basic version with vertical rear terminals



15DC200224F0001

Fig. 42

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 116/132

Withdrawable circuit-breaker

Version with front terminals

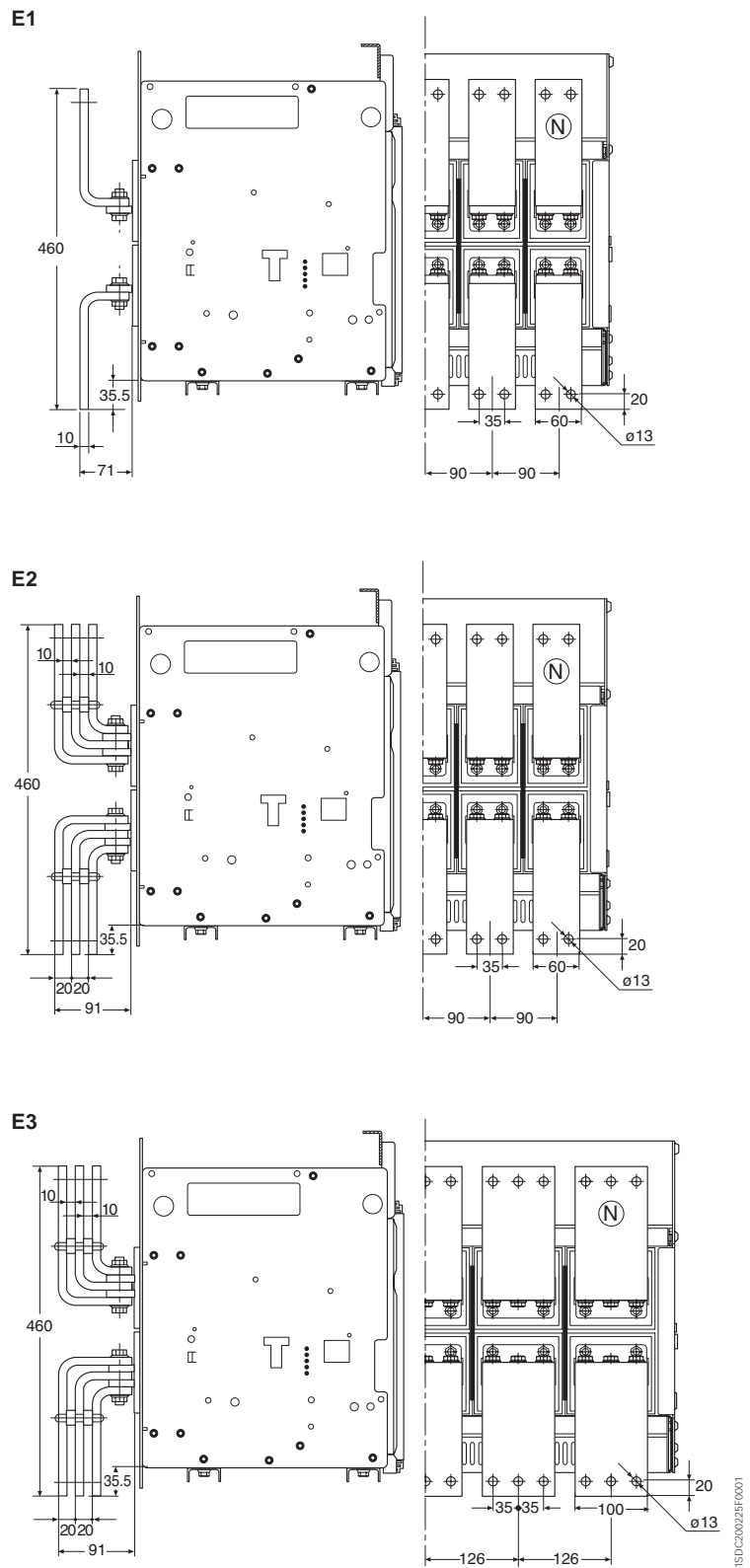
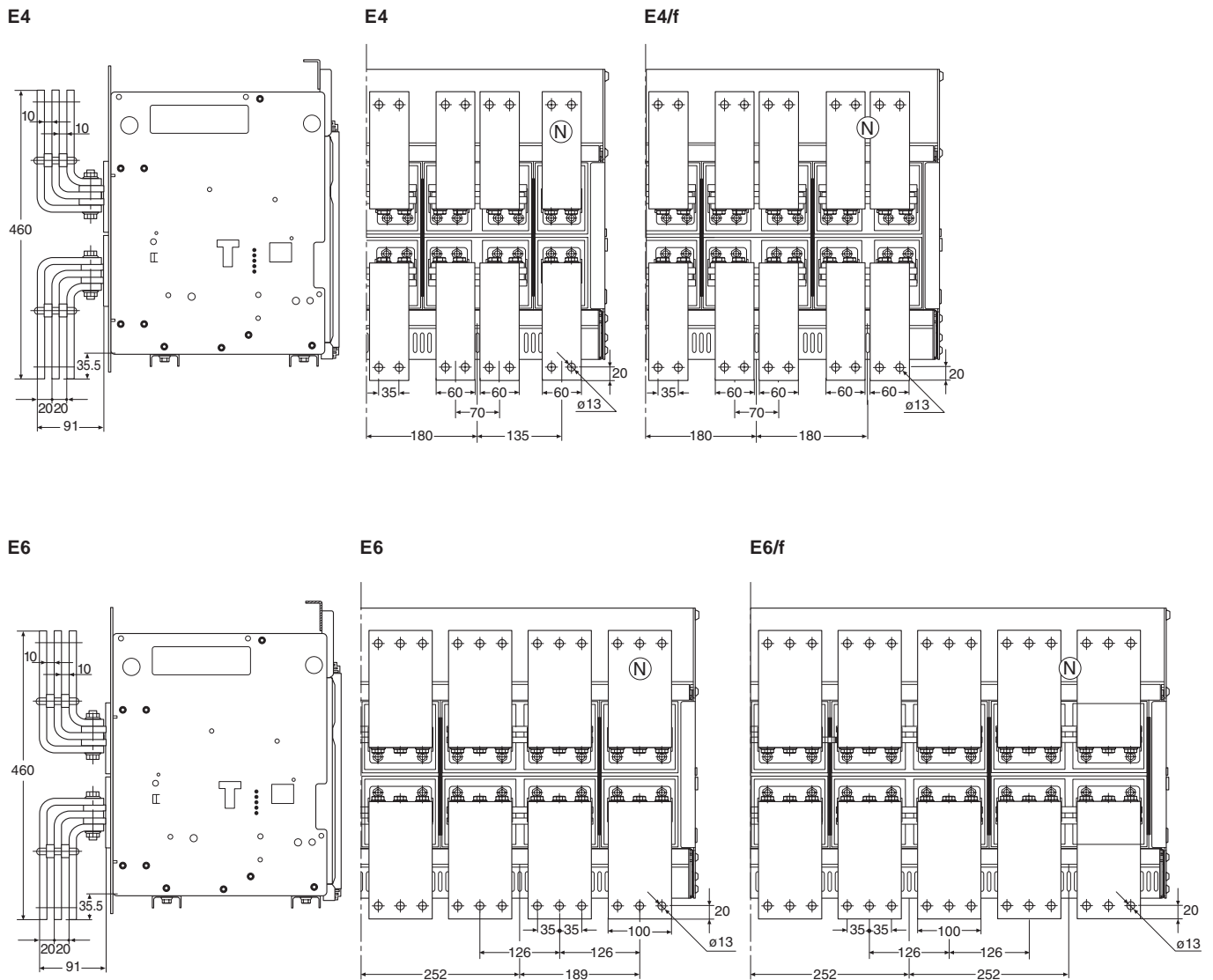


Fig. 43

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 117/132

Withdrawable circuit-breaker

Version with flat terminals



1SDC200226F0001

Fig. 44

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 118/132

Withdrawable circuit-breaker

Version with flat terminals

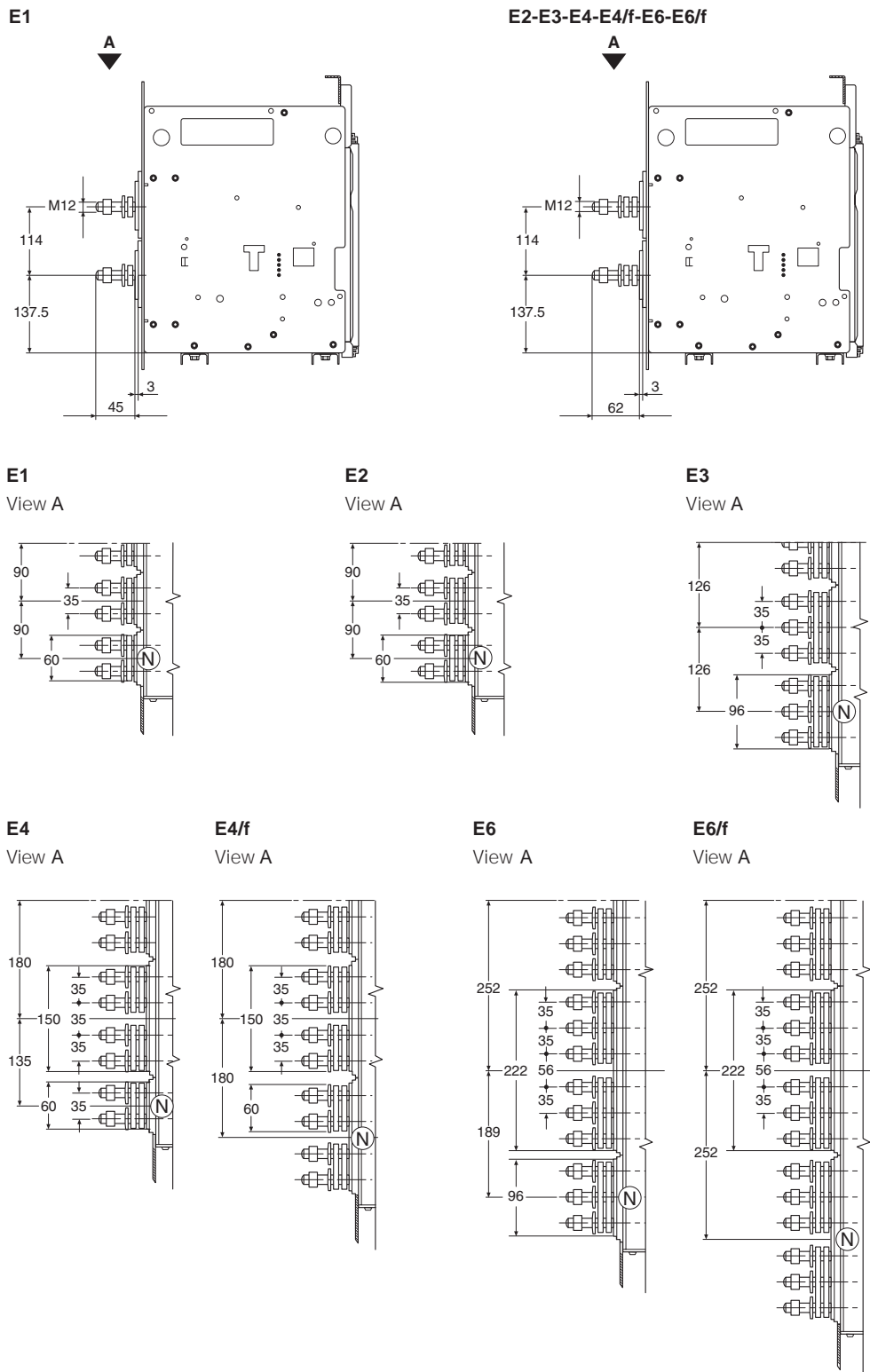
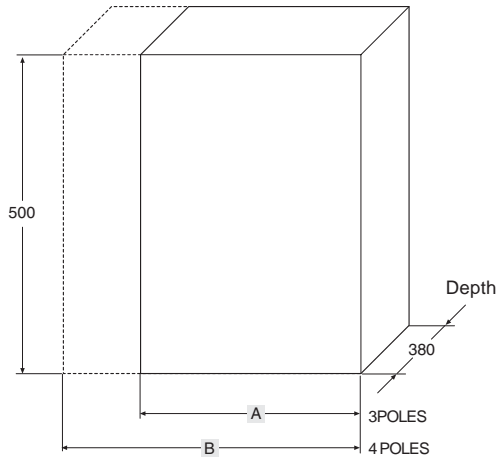


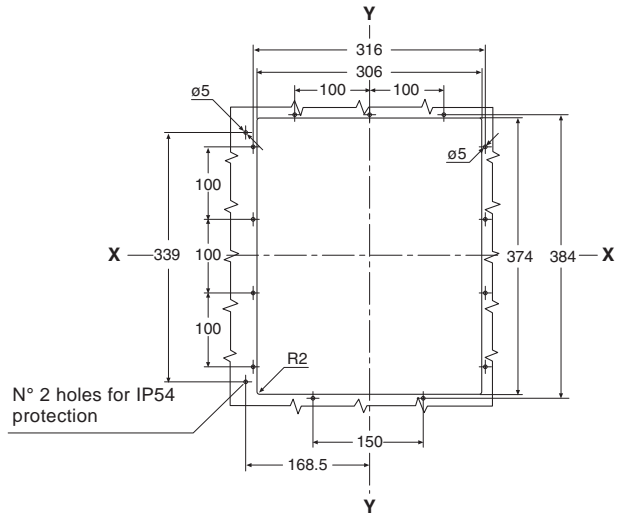
Fig. 45

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 119/132

Compartment dimensions



Compartment door drilling



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

	A	B
E1	400	490
E2	400	490
E3	500	630
E4	700	790
E4/f	-	880
E6	1000	1130
E6/f	-	1260

	High resistance M12 screw Quantity per terminal	
	PHASE	NEUTRAL
E1-E2	2	2
E3	3	3
E4-E4/f	4	2-4
E6-E6/f	6	3-6

Fig. 46

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 120/132

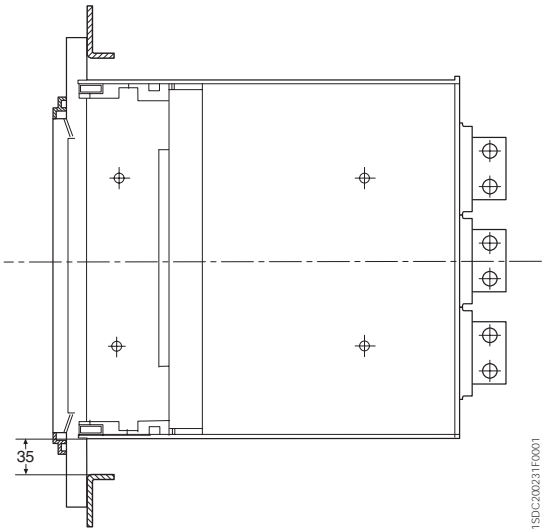
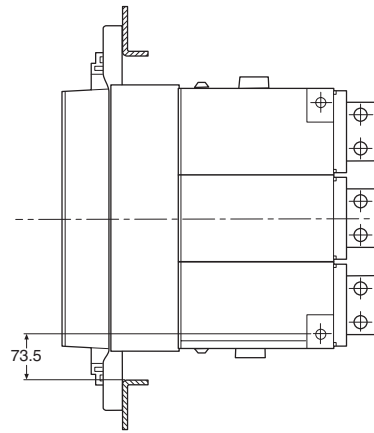
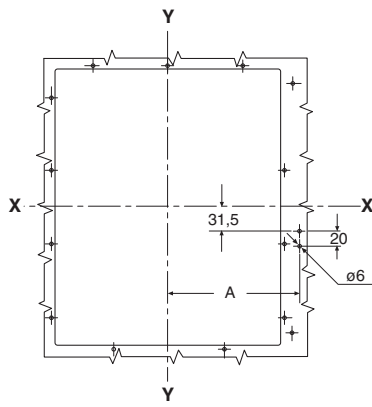
Compartment door mechanical lock

Door drilling

Minimum distance between the circuit-breaker and the switchgear wall

Fixed version

Withdrawable version



15DC/20231F0001

	A	
	3 POLES	4 POLES
E1	180	180
E2	180	180
E3	234	234
E4	270	360
E4/f	-	360
E6	360	486
E6/f	-	486

Fig. 47

Mod.	L0849		Apparatus	Emax	Scale
			Doc. N°	RH0288002	Page N° 121/132

18. Electrical circuit diagrams

State of operation shown

The diagram is shown in the following conditions:

- withdrawable version circuit-breaker, open and racked-in
- circuits de-energized
- releases not tripped
- motor operator with springs discharged.

Versions

The diagram shows a withdrawable version circuit-breaker, but is also valid for fixed version circuit-breakers.

Fixed version

The control circuits are included between the XV terminals (the X connector is not supplied).
The applications indicated in figures 31, 32 and 51 cannot be supplied with this version.

Withdrawable version

The control circuits are included between the poles of the X connector (the XV terminal box is not supplied).
The application indicated in figure 52 cannot be supplied with this version.

Version without overcurrent release

The applications indicated in figures 3, 5, 13, 41, 42, 43, 44, 51, 52, 53 and 62 cannot be supplied with this version.

Version with PR111 with electronic release

The PR111 overcurrent release is only fitted with the protection unit.
The applications indicated in the figures 3, 5, 41, 42, 43, 44, 53 and 62 cannot be supplied with this version.

Version with electronic PR112/P release

The PR112/P overcurrent release is only fitted with the protection unit.
The applications indicated in the figures 3, 5, 22, 42, 43, 44 and 53 cannot be supplied with this version.

Version with electronic PR112/PD release

The PR112/PD overcurrent release is fitted with the protection and dialogue unit.
The applications indicated in the figures 22, 41, 43, 44 and 53 cannot be supplied with this version.

Version with electronic PR113/P release

The PR113/P overcurrent release is only fitted with the protection unit.
The applications indicated in the figures 3, 5, 22, 41, 42 and 44 cannot be supplied with this version.

Version with electronic PR113/PD release

The PR113/PD overcurrent release is fitted with the protection and dialogue unit.
The applications indicated in the figures 22, 41, 42 and 43 cannot be supplied with this version.

Caption

- = Number of figure of the diagram
* = See the note indicated by the letter
- A1 = Applications of the circuit-breaker
A13 = PR020/K signalling unit (only provided with PR112/P, PR112/PD, PR113/P or PR113/PD release)
A3 = Applications located on the fixed part of the circuit-breaker (only provided with withdrawable version circuit-breakers)
A4 = Indicative apparatus and connections for control and signalling, outside the circuit-breaker
AY = SACE SOR TEST UNIT: control/monitoring unit (see note R)
D = Electronic time-delay device of the undervoltage release, outside the circuit-breaker
F1 = Fuse with delayed intervention
K51 = PR111, PR112/P, PR112/PD, PR113/P or PR113/PD type electronic overcurrent release with the following protection functions (see note G):
- L against overload with inverse long delay trip - adjustment I1
- S against short-circuit with inverse or definite short delay trip - adjustment I2
- I against short-circuit with instantaneous trip - adjustment I3
- G against earth fault with inverse short delay trip - adjustment I4
K51/μP = Electrical alarm signalling for operating anomalies of the microprocessor (only provided with Uaux. and PR112/P, PR112/PD, PR113/P or PR113/PD release)
K51/1...8 = PR020/K signalling unit contacts
K51/GZin = Zone selectivity: input for protection G or input in "backward" direction for protection D (DBin) (only provided with Uaux. and PR113/P or PR113/PD release)
K51/GZout = Zone selectivity: output for protection G or output in "backward" direction for protection D (DBout) (only provided with Uaux. and R113/P or PR113/PD release)
K51/P1 = Programmable electrical signalling (only provided with Uaux. and PR112/P, PR112/PD, PR113/P or PR113/PD release)
K51/P2 = Programmable electrical signalling (only provided with Uaux. and PR113/P release)
K51/SZin = Zone selectivity: input for protection S or input in "forward" direction for protection D (DFin) (only provided with Uaux. and PR113/P or PR113/PD release)
K51/SZout = Zone selectivity: output for protection S or output in "forward" direction for protection D (DFout) (only provided with Uaux. and PR113/P or PR113/PD release)
K51/YC = Closing control from PR112/PD or PR113/PD electronic release
K51/Y0 = Opening control from PR112/PD or PR113/PD electronic release
K51/Y01 = Electrical signalling of release trip for shunt opening release Y01 TRIPPED (only provided with PR112/P, PR112/PD, PR113/P or R113/PD release)
K51/Zin = Zone selectivity: input (only provided with Uaux. and PR112/P or PR112/PD release)
K51/Zout = Zone selectivity: output (only provided with Uaux. and PR112/P or PR112/PD release)
M = Motor for closing spring charging
Q = Circuit-breaker
Q/1...25 = Circuit-breaker auxiliary contacts

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S33M/1	= Limit contact of spring charging motor
S33M/2	= Contact for electrical signalling of springs charged
S43	= Changeover switch for setting remote/local control
S51	= Contact for electrical signalling of circuit-breaker open due to trip of the overcurrent release. Circuit-breaker closing can only take place after having pressed the reset pushbutton
S75E/14	= Contacts for electrical signalling of circuit-breaker in racked-out position (only provided with withdrawable version circuit-breakers)
S75I/14	= Contacts for electrical signalling of circuit-breaker in racked-in position (only provided with withdrawable version circuit-breakers)
S75T/14	= Contacts for the electrical signalling of circuit-breaker in test position (only provided with withdrawable version circuit-breakers)
SC	= Pushbutton or contact for circuit-breaker closing
SO	= Pushbutton or contact for circuit-breaker opening
SO1	= Pushbutton or contact for circuit-breaker opening with delayed trip
SO2	= Pushbutton or contact for circuit-breaker opening with instantaneous trip
TI/L1	= Current transformer located on phase L1
TI/L2	= Current transformer located on phase L2
TI/L3	= Current transformer located on phase L3
TI/N	= Current transformer located on the neutral
TI/O	= Homopolar current transformer located on the conductor which connects the MV/LV transformer star centre to earth (see note G)
TU	= Insulation transformer
Uaux.	= Auxiliary power supply voltage (see note F)
UI/L1	= Current sensor (Rogowski coil) located on phase L1
UI/L2	= Current sensor (Rogowski coil) located on phase L2
UI/L3	= Current sensor (Rogowski coil) located on phase L3
UI/N	= Current sensor (Rogowski coil) located on the neutral
W1	= Serial interface with the control system (external bus): EIA RS485 interface (see note E)
W2	= Serial interface with the accessories of the PR112/P, PR112/PD, PR113/P and PR113/PD (internal bus) releases
X	= Delivery connector for withdrawable version circuit-breaker auxiliary circuits
X1...X7	= Connectors for the circuit-breaker applications
XF	= Delivery terminal box for the withdrawable version circuit-breaker position contacts (located on the fixed part of the circuit-breaker)
XK1	= Connector for the power circuits of the PR111, PR112/P, PR112/PD, PR113/P and PR113/PD releases
XK2 - XK3	= Connectors for the auxiliary circuits of the PR112/P, PR112/PD, PR113/P and PR113/PD releases
XO	= Connector for the YO1 release
XV	= Delivery terminal box for fixed version circuit-breaker auxiliary circuits
YC	= Shunt closing release
YO	= Shunt opening release
YO1	= Shunt opening release for overcurrent
YO2	= Second shunt opening release (see note Q)
YU	= Undervoltage release (see notes B and Q)

Description of figures

Fig. 1	= Closing spring charging motor circuit
Fig. 2	= Shunt closing release circuit
Fig. 3	= Shunt closing release circuit with control from the dialogue unit of the PR112/PD or PR113/PD release
Fig. 4	= Shunt opening release
Fig. 5	= Shunt opening release circuit with control from the dialogue unit of the PR112/PD or PR113/PD 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 charged.
Fig.12	= Contact for electrical signalling of undervoltage release energized (see notes B, L and S)
Fig.13	= Contact for electrical signalling of circuit-breaker open due to trip of the overcurrent release. Circuit-breaker closing can only take place after the reset pushbutton has been pressed.
Fig.21	= First pack of circuit-breaker auxiliary contacts
Fig.22	= Second pack of circuit-breaker auxiliary contacts (not available with the PR112/P, PR112/PD, PR113/P and PR113/PD releases).
Fig.23	= Third pack of additional circuit-breaker auxiliary contacts outside the circuit-breaker
Fig.31	= First pack of contacts for electrical signalling of circuit-breaker in racked-in, test or racked-out position
Fig.32	= Second pack of contacts for electrical signalling of circuit-breaker in racked-in, test or racked-out position
Fig.41	= Auxiliary circuits of the PR112/P release (see note F)
Fig.42	= Auxiliary circuits of the PR112/PD release (see note D, F and M)
Fig.43	= Auxiliary circuits of the PR113/P release (see note F)
Fig.44	= Auxiliary circuits of the PR113/PD release (see notes F and M)
Fig.51	= Circuit of the current transformer on the neutral conductor outside the circuit-breaker, for withdrawable version circuit-breaker
Fig.52	= Circuit of the current transformer on the neutral conductor outside the circuit-breaker, for fixed version circuit-breaker (see note C)
Fig.53	= Circuit valid in the case of three-pole circuit-breaker with PR113/P or PR113/PD release without current transformer on the neutral conductor outside the circuit-breaker (see note H)
Fig.61	= SACE SOR TEST UNIT: control/monitoring unit (see note R)
Fig.62	= PR020/K signalling unit (only provided with PR112/P, PR112/PD, PR113/P or PR113/PD release)

Incompatibility

The circuits shown in the following figures cannot be provided on the same circuit-breaker at the same time:

2 - 3
4 - 5
6 - 7 - 8
22 - 41 - 42 - 43 - 44
31 - 51
51 - 52 - 53

Mod.	L0849			Apparatus	Emax	Scale
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Notes

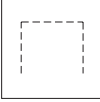
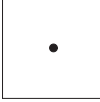
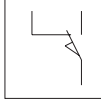
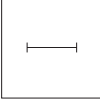
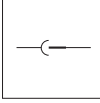
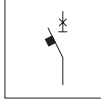

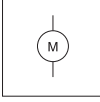
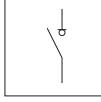

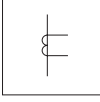
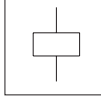
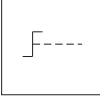
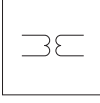
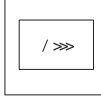
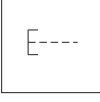
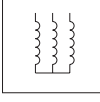
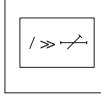
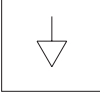
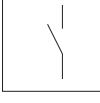
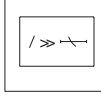
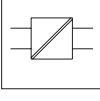
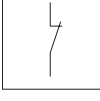
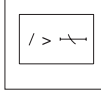
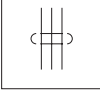
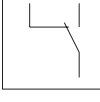
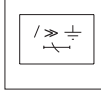
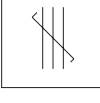
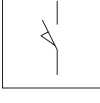
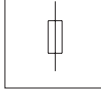


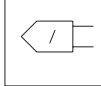
- A) The circuit-breaker is only fitted with the applications specified in the ABB order confirmation. To make out the order, please consult the apparatus catalogue.
- B) The undervoltage release is provided for power supply branched on the supply side of the circuit-breaker or from an independent source: circuit-breaker closing is only allowed with the trip energized (the lock on closing is made mechanically).
In the case where there is the same power supply for the shunt closing releases and undervoltage releases and automatic circuit-breaker closing is required, on return of the auxiliary voltage, it is necessary to introduce a delay of 30 milliseconds between the instant of consent of the undervoltage release and energisation of the shunt closing release. This can be carried out by means of a circuit outside the circuit-breaker including a permanent closing contact, the contact indicated in figure 12 and a time-delay relay.
- C) In the case of a fixed version circuit-breaker with current transformer on the neutral conductor outside the circuit-breaker, when the circuit-breaker is to be removed, it is necessary to short-circuit the terminals of the TI/N transformer.
- D) Connect the S33M/2 contact indicated in fig. 11, one of the closing contacts and one of the opening contacts of the circuit-breaker indicated in fig. 21 in the way shown in fig. 42.
- E) For connection of the EIA RS485 serial line, see the following documentation:
- RH0297 for LON communication
- RH0298 for MODBUS communication
- F) The auxiliary voltage U_{aux} allows actuation of all operations of the PR112/P, PR112/PD, PR113/P and PR113/PD releases. In this regard, refer to the corresponding user manuals. 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.
- G) Protection against earth fault is available with the PR112/P, PR112/PD, PR113/P and PR113/PD releases by means of a current transformer located on the conductor which connects the MV/LV transformer star centre to earth. The connection between terminals 1 and 2 of the TI/O current transformer and the T5 and T6 poles of the X (or XV) connector, must be made using a shielded and corded two-pole cable (see instruction manual) not longer than 15 m. The shield must be earthed on the circuit-breaker side and on the current transformer side.
- H) In the case of PR113/P or PR113/PD releases mounted on a three-pole circuit-breaker without connection to the neutral outside, the T3 and T4 poles of the X (or XV) connector must be short-circuited (by the customer).
- I) The contact cannot be used if the PR112/PD and PR113/PD unit is present.
- L) The contact cannot be used if the PR113/P or PR113/PD unit is present.
- M) Connect one of the S75I contacts indicated in fig. 31 or 51 in the way shown in figs. 42-44.
In the case of fixed version circuit-breakers, connect the XV-K14 terminal directly to the XV-K16 terminal (contact S75I does not exist).
- N) With PR112/P, PR112/PD, PR113/P and PR113/PD releases, the connections to the zone selectivity inputs and outputs must be made using a shielded and corded two-pole not longer than 300m. The shield must be earthed on the selectivity input side.
- O) With PR113/P and PR113/PD releases, the connection between the voltage sensors (TV) and the circuit-breaker must be made using a shielded and corded two-pole cable not longer than 15 m.
The shield must be earthed on both sides (sensor and circuit-breaker).
- P) With PR112/PD and PR113/PD releases, the power supply of the YO and YC coils must not be branched from the main one.
The coils can be controlled directly from the K51/YO and K51/YC contacts with maximum voltage values of 60VDC and 240-250VAC for PR112/PD, 240-250VDC and 240-250VAC for PR113/PD.
- Q) The second shunt opening release must be installed as an alternative to the undervoltage trip.
- R) The operation of the SACE SOR TEST UNIT system + shunt opening release (YO) is guaranteed starting from 75% of the U_{aux} of the shunt opening release.
During closing of the power supply contact to YO (short-circuit of terminals 4 and 5), the SACE SOR TEST UNIT is not able to determine the state of the opening coil.
For this reason:
- In the case of an opening coil supplied continuously, the TEST FAILED and ALARM signals will be activated.
- If the control of the opening coil is carried out impulsively, the TEST FAILED signal may be activated at the same moment. In this case, the TEST FAILED signal should only be considered an actual alarm signal if it remains for longer than 20s.
- S) Also available in the normally closed contact version.
- T) Configuration valid for four-pole or three-pole circuit-breaker with external neutral. For other installation configurations, please see par. 15.3.2.

Instructions to follow for replacement of the PR111, PR112/P, PR112/PD, PR113/P or PR113/PD releases:

- Take special notice of the notes indicated on the electrical circuit diagrams provided
- The contact for electrical signalling of undervoltage release energized (Fig. 12 of the enclosed diagrams) must be removed from the terminal box.

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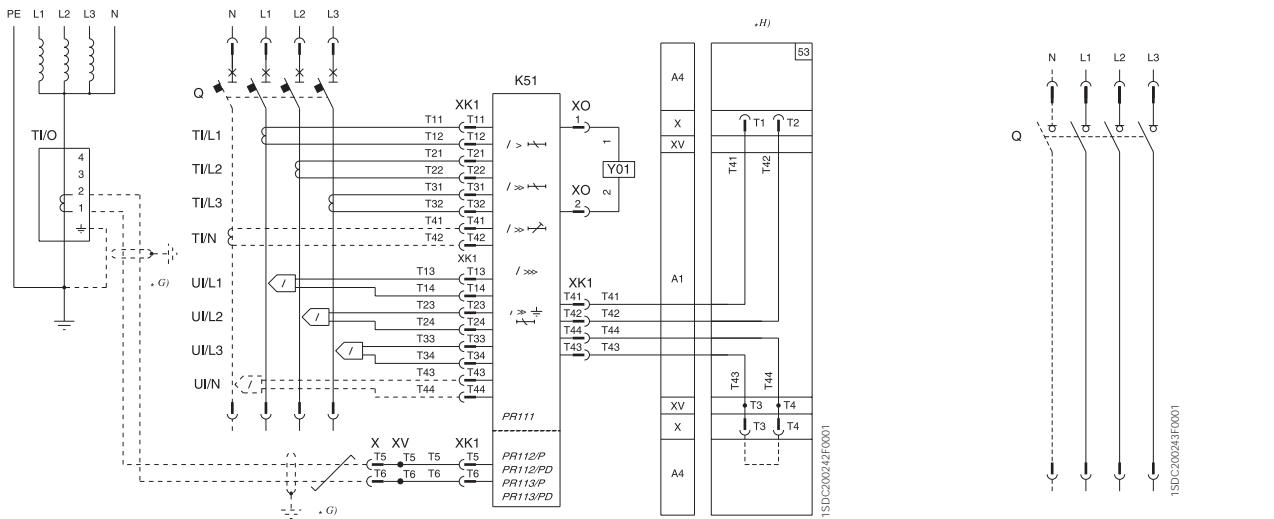
Graphic symbols for electrical circuit diagrams (IEC 60617 and CEI 3-14...3-26 Standards)

	Shield (can be drawn in any shape)		Connection of conductors		Opening position contact (limit switch)
	Timing		Thermal effect		Electromagnetic effect
	Mechanical connection		Terminal or clamp		Control coil (general symbol)
	Manual mechanical operating mechanism (general case)		Socket and plug (female and male)		Instantaneous overcurrent release
	Rotary handle operating mechanism		Motor (general symbol)		Overcurrent release with short adjustable time-delay characteristic
	Pushbutton operating mechanism		Make contact		Overcurrent release with inverse short time-delay characteristic
	Equipotentiality		Break contact with automatic trip		Overcurrent release with inverse long time-delay characteristic
	Converter separated galvanically		Changeover contact		Overcurrent release for earth fault with inverse short time-delay characteristic
	Conductors in shielded cable (e.g. three conductors)		Closing position contact (limit switch)		Fuse (general symbol)
	Conductors or corded cables (e.g. 3 conductors)		Power switch-disconnector with automatic opening		Current sensor
	Current transformer		Power switch-disconnector with automatic opening		Sensore di corrente

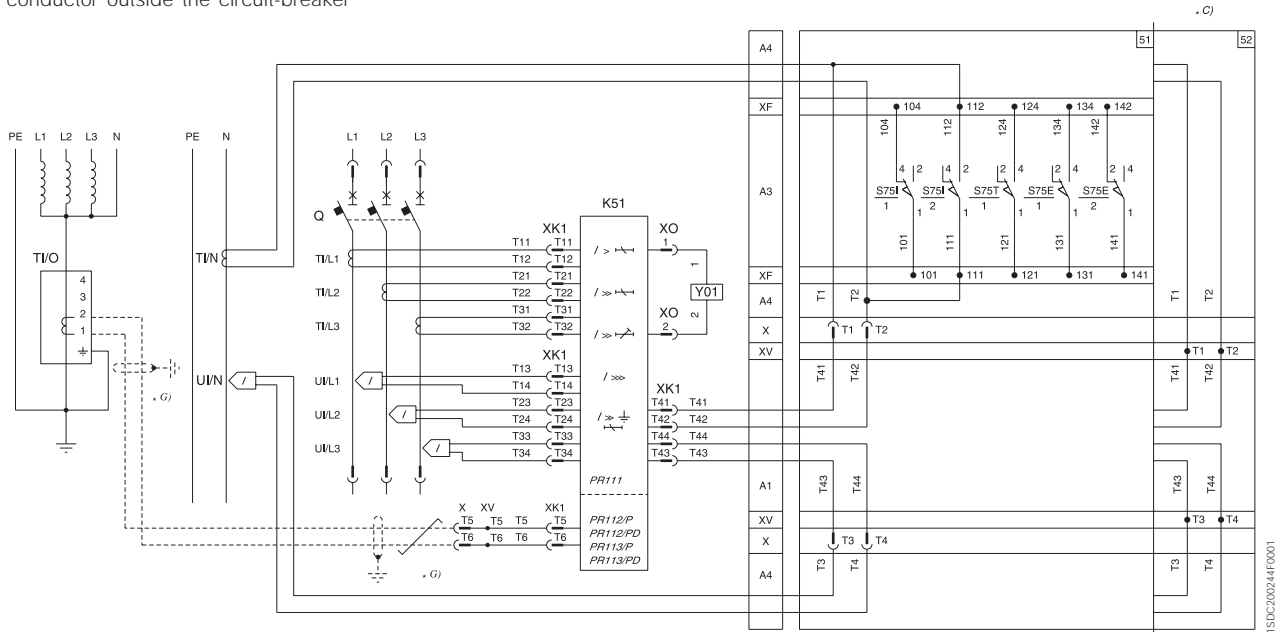
Electrical circuit diagram - State of operation

Three-pole or four-pole circuit-breaker with PR111, PR112/P, PR112/PD, PR113P and PR113/PD electronic release

Three-pole or four-pole switch-disconnector

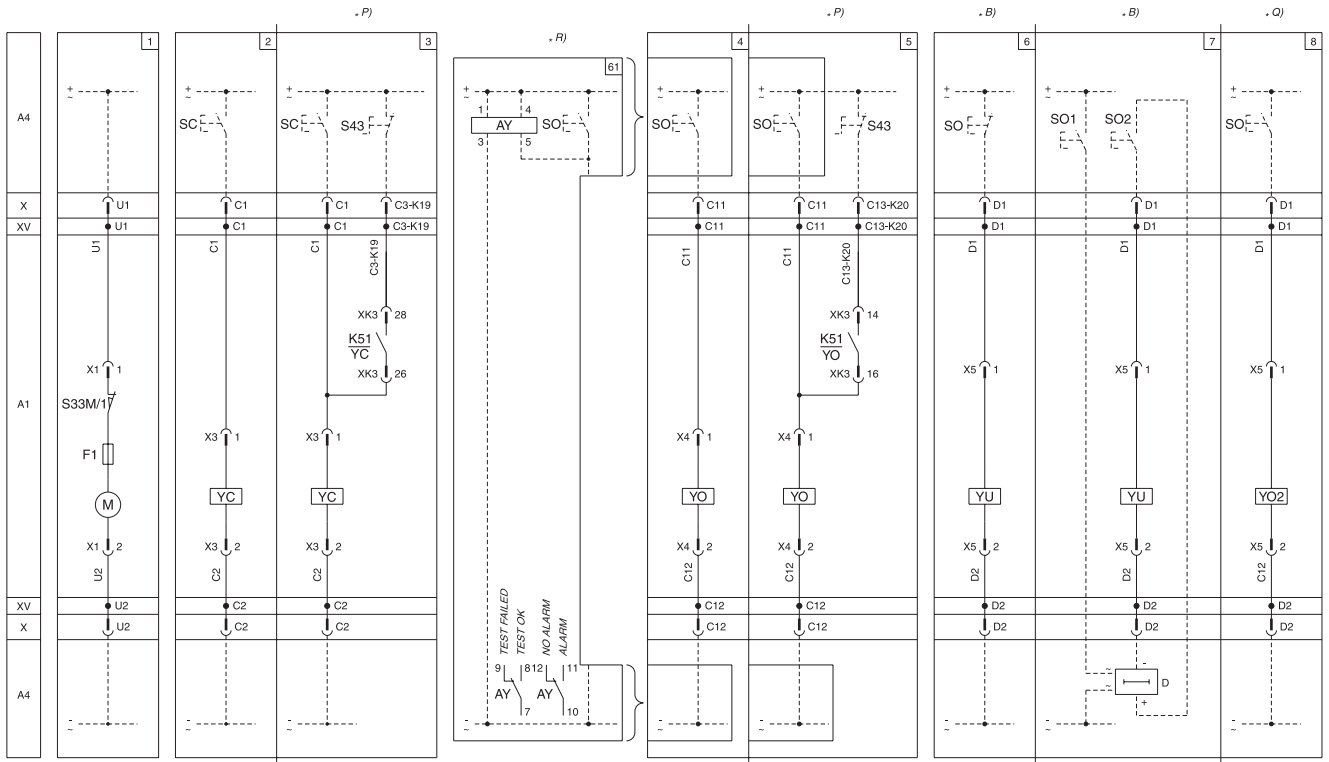


Three-pole circuit-breaker with electronic PR111, PR112/P, PR112/PD, PR113P and PR113/PD releases and current transformer on neutral conductor outside the circuit-breaker

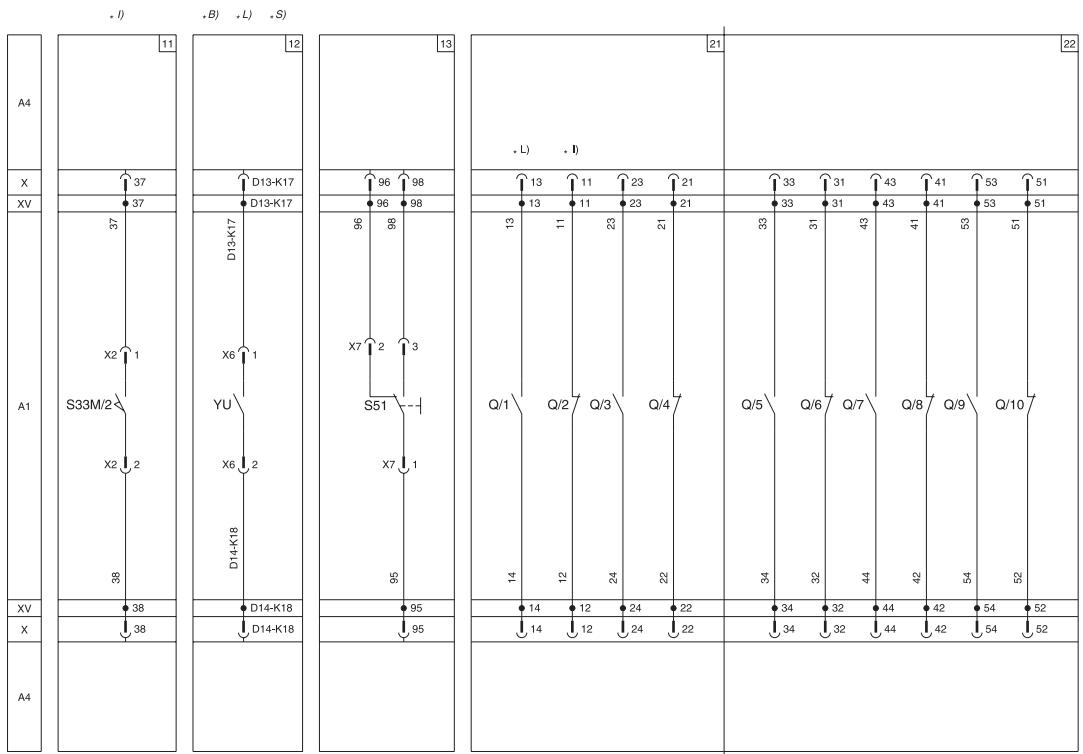


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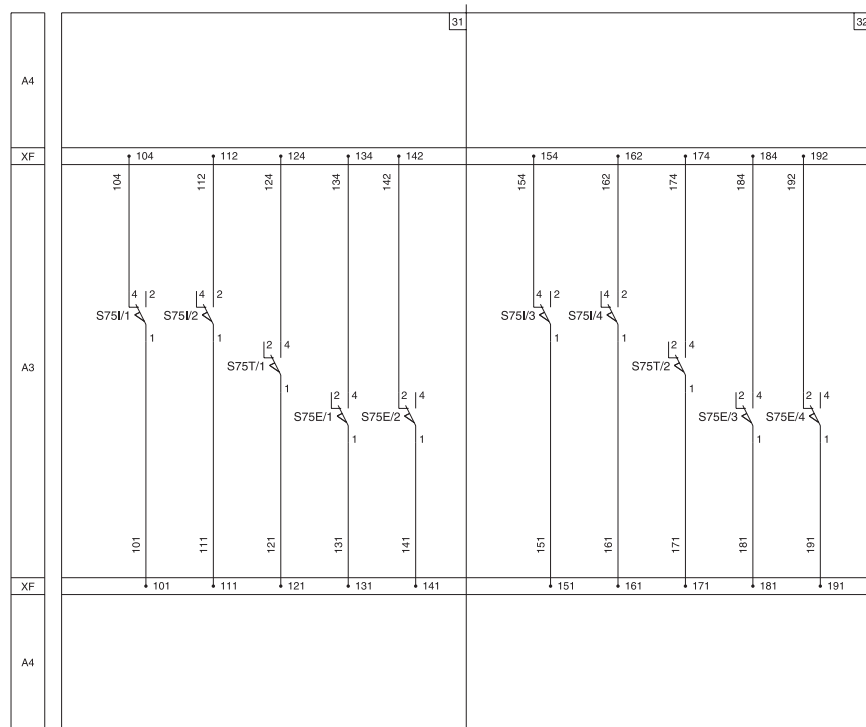
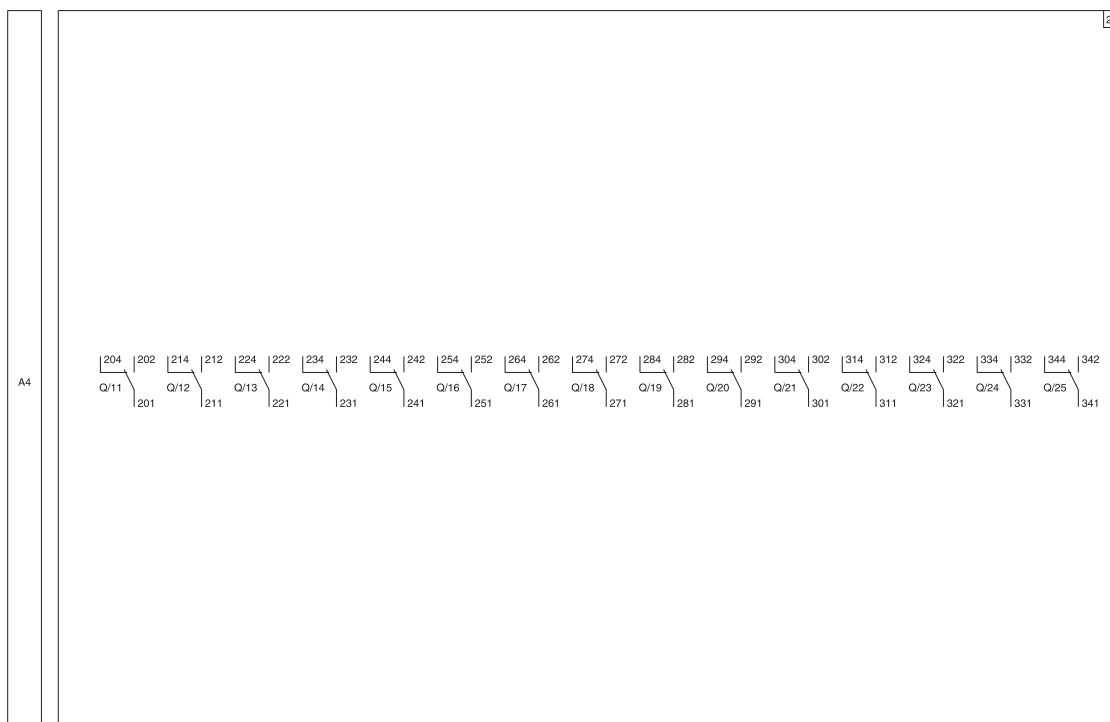
Motor operator, shunt opening releases, shunt closing releases and undervoltage releases



Signalling contacts

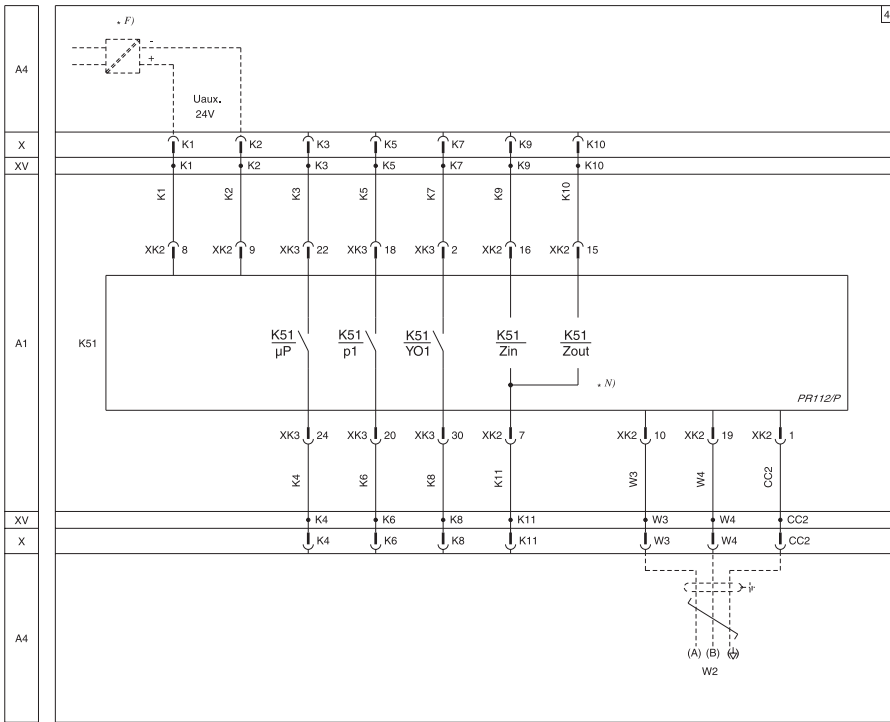


Signalling contacts

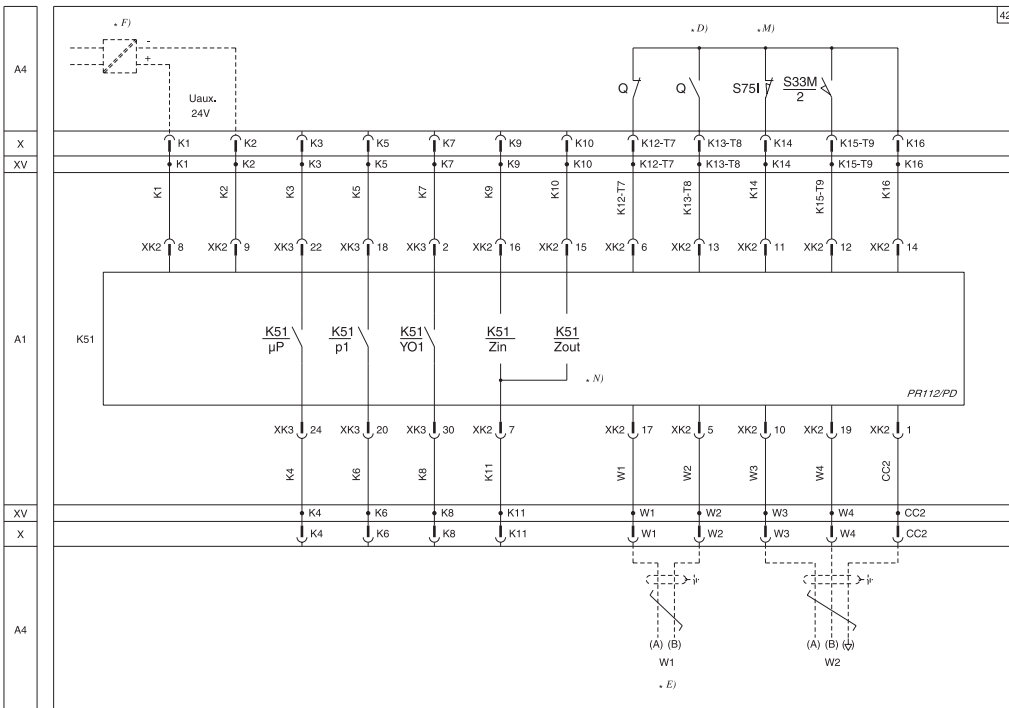


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Auxiliary circuits of the PR112/P release

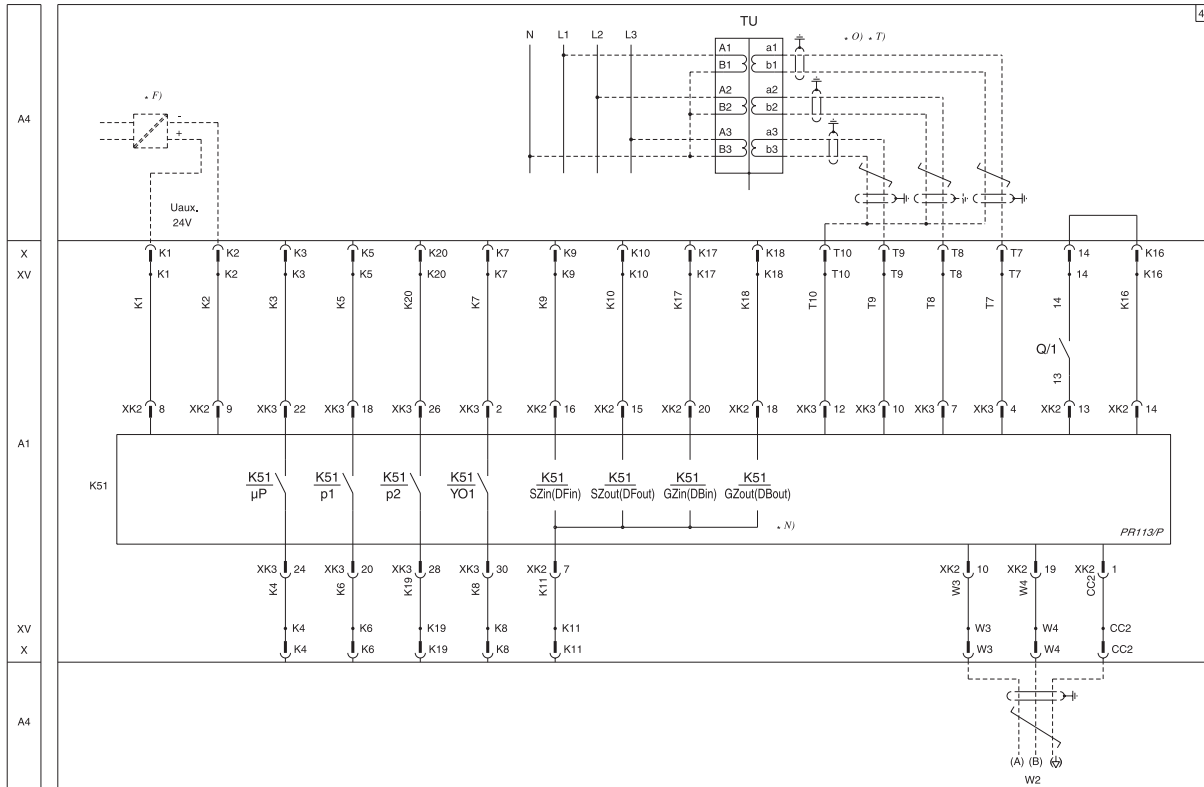


Auxiliary circuits of the PR112/P release

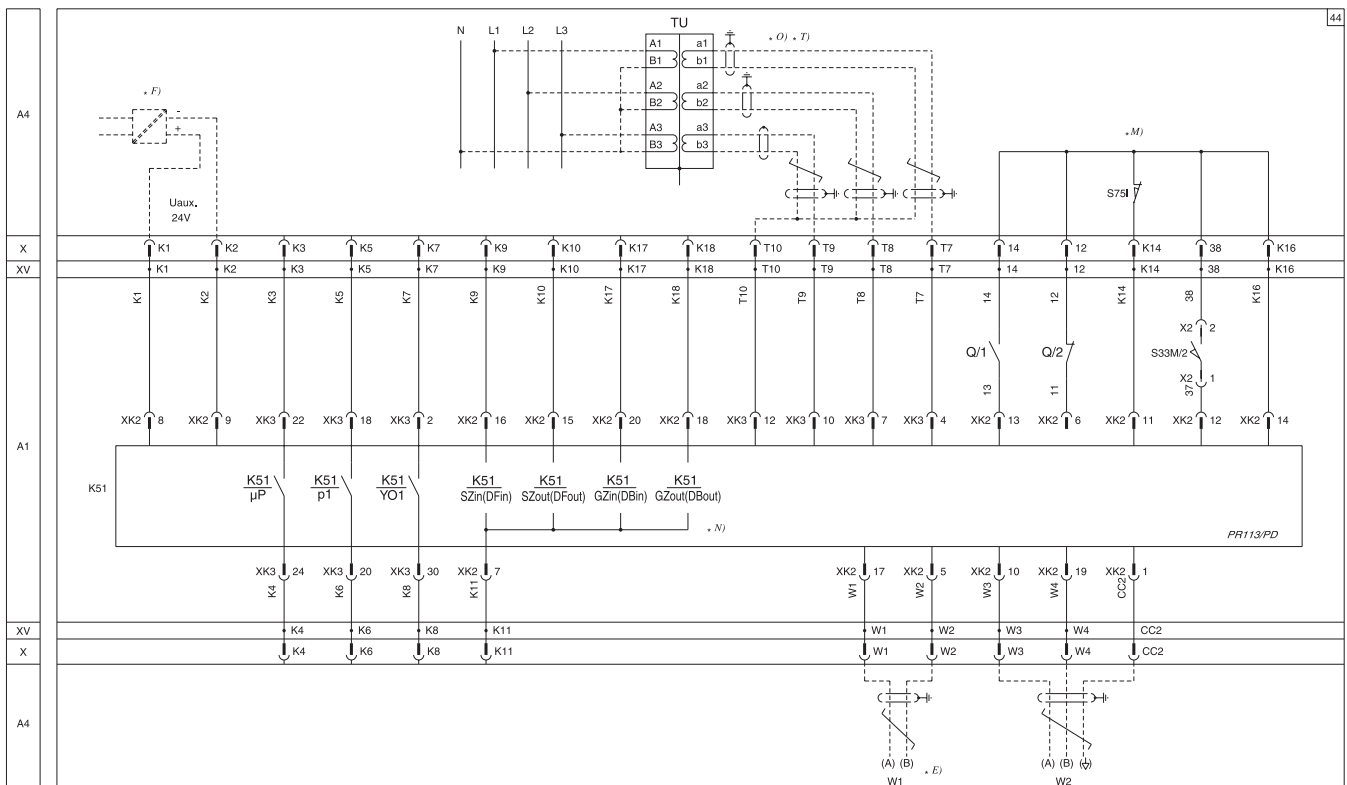


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Auxiliary circuits of the PR113/P release

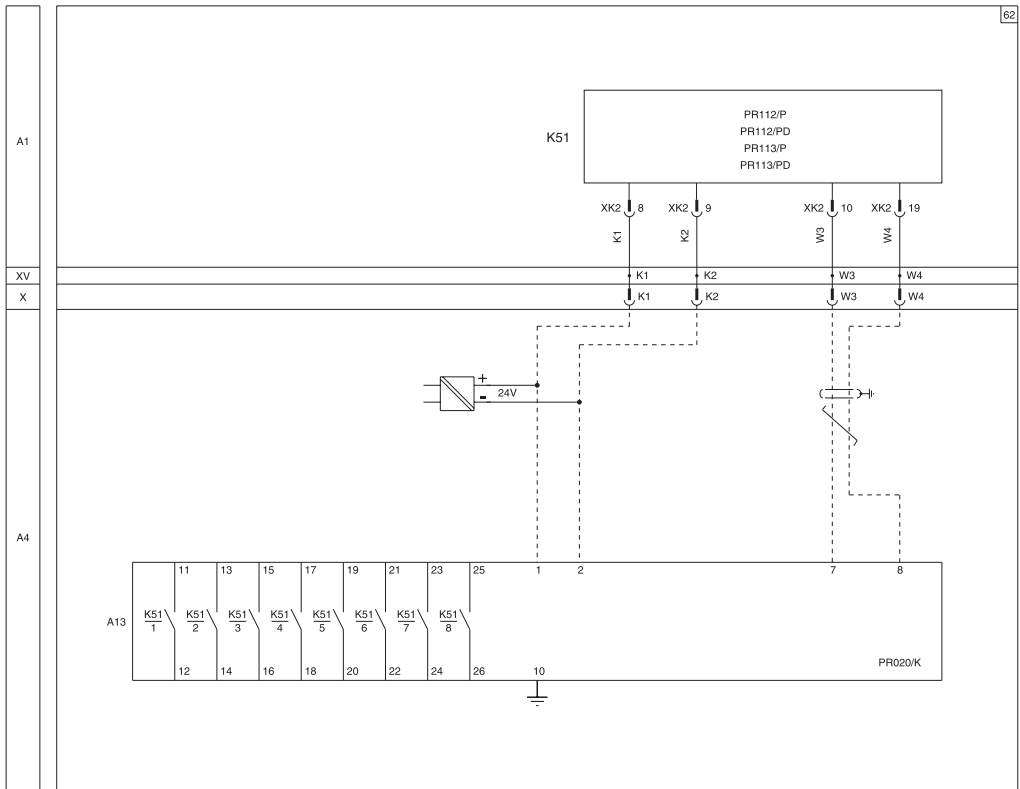


Auxiliary circuits of the PR113/PD release



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PR020/K signalling unit



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Due to possible developments of standards as well as of materials, the characteristics and dimensions specified in the present catalogue may only be considered binding after confirmation by ABB SACE.