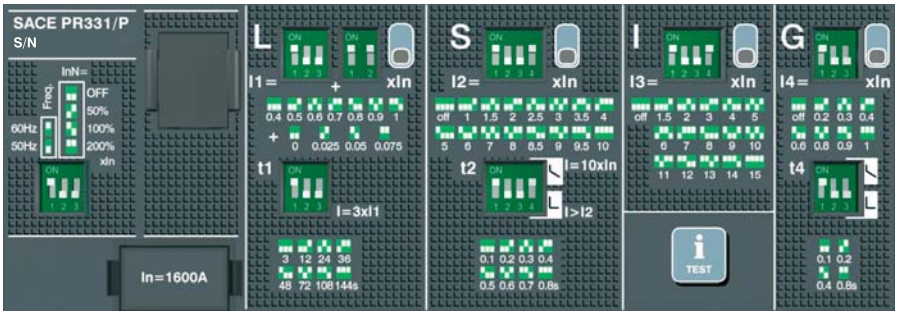
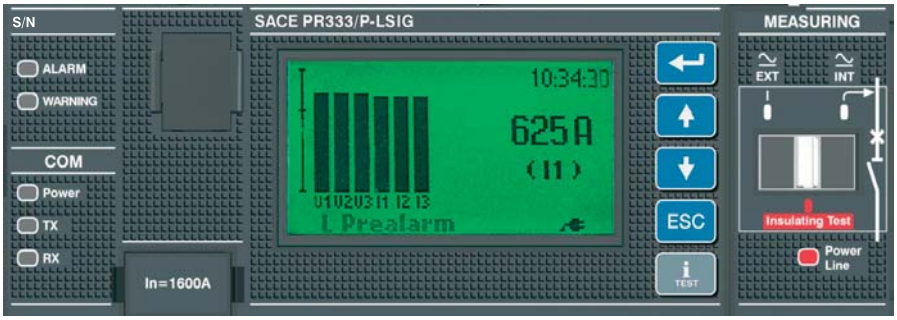
# Operating istructions for T7-T8-X1 low voltage air circuit breakers protection releases

1SDH000587R0002 L3821

# Emax-Tmax







| | | | | | |
|---|---|---|---|---|---|
| Dwg. | | Resp. Off. | | Title **Operating istructions for low voltage air circuit breakers protection releases** | Language **en** |
| App. | | Take over Off. | | | |
| Model | L2798 | L3821 | | Apparatus **Emax-Tmax** | Scale |
| | L2957 | | | | |
| ABB | | | | Doc. no. **1SDH000587R0002** | |

# Contents


1. Protection releases - General notes ..... *page* 3
1.1 Safety notes ..... « 3
1.1.1 Notes for dielectric stiffness tests ..... « 4
1.2 Abbreviations and notes ..... « 4
1.2.1 Abbreviations ..... « 4
1.2.2 Notes ..... « 4
1.2.3 Compatibility between CB and relay ..... « 4

2. SACE PR331/P Release - Identification ..... « 5
2.1 Standard ..... « 5
2.2 Specifications ..... « 5
2.2.1 General ..... « 5
2.2.2 Electrical characteristics ..... « 5
2.2.2.1 Self-powering ..... « 5
2.2.2.2 Auxiliary power supply ..... « 5
2.2.3 Environmental characteristics ..... « 6
2.2.4 Communication bus ..... « 6
2.2.5 Protection functions ..... « 6
2.2.5.1 RMS calculation ..... « 6
2.2.5.2 Measuring function ..... « 6
2.2.5.3 Watchdog ..... « 6
2.2.6 Description of protection functions ..... « 7
2.2.6.1 Protection “L” ..... « 7
2.2.6.1.1 Thermal memory “L” ..... « 7
2.2.6.2 Protection “S” ..... « 7
2.2.6.2.1 Thermal memory “S” ..... « 7
2.2.6.3 Protection “I” ..... « 7
2.2.6.4 Protection against closing upon short-circuit “MCR” « 7
2.2.6.5 Protection “G” ..... « 7
2.2.6.6 Protection against instantaneous short-circuit “Iinst” « 7
2.2.7 Summary table of protections ..... « 8
2.2.8 Measurements ..... « 8
2.3 Other functions ..... « 9
2.3.1 Indication of trip cause and trip test button ..... « 9
2.3.2 Programmable signal contact S51/P1 ..... « 9
2.4 Commissioning ..... « 9
2.4.1 Connections ..... « 9
2.4.2 CS and TC connection check ..... « 9
2.4.3 Current sensor connection for external neutral conductor ..... « 9
2.5 User interface ..... « 9
2.5.1 Trip Test ..... « 10
2.5.2 Initial settings ..... « 10
2.5.3 Changing protection functions ..... « 10
2.5.3.1 Example of setting ..... « 10
2.5.4 Default setting of PR331/P unit ..... « 11
2.6 Operating instructions/Operation in service ..... « 11
2.6.1 Adjusting the neutral ..... « 11
2.6.2 Guidance for Neutral adjustment ..... « 11
2.6.3 Replacing an electronic release ..... « 11
2.7 Definition of alarms and signals for the PR331/P unit ..... « 12
2.7.1 Optical signals ..... « 12
2.7.2 Troubleshooting ..... « 13
2.7.3 In case of a fault ..... « 13
2.8 Accessories ..... « 13
2.8.1 ABB SACE PR010/T test and configuration unit ..... « 13
2.8.2 BT030 communication unit ..... « 13
2.8.3 PR021/K and HMI030 units ..... « 13
2.8.4 PR030/B power supply unit ..... « 13
2.8.5 Flex Interface ..... « 13

3. SACE PR332/P-PR333/P releases - Identification ..... *page* 14
3.1 Standard ..... « 14
3.2 Specifications ..... « 14
3.2.1 General ..... « 14
3.2.2 Electrical characteristics ..... « 15
3.2.2.1 Self-powering ..... « 15
3.2.2.2 Auxiliary power supply ..... « 15
3.2.2.3 Powered by the PR330/V module ..... « 15
3.2.3 Environmental characteristics ..... « 15
3.2.4 Description of inputs/outputs ..... « 15
3.2.4.1 Binary inputs ..... « 15
3.2.4.2 Binary outputs ..... « 15
3.2.5 Communication bus ..... « 15
3.2.6 Protection functions ..... « 15
3.2.6.1 RMS calculation ..... « 16
3.2.6.2 Mains frequency ..... « 16
3.2.6.3 Harmonic distortion ..... « 16
3.2.6.4 Circuit-breaker state ..... « 16
3.2.7 Measurement functions ..... « 16
3.2.8 Watchdog ..... « 16
3.2.9 Description of protection functions ..... « 17
3.2.9.1 Protection “L” ..... « 17
3.2.9.1.1 Thermal memory “L” ..... « 17
3.2.9.2 Protection “S” ..... « 17
3.2.9.2.1 Thermal memory “S” ..... « 17
3.2.9.2.2 Start-up threshold “S” ..... « 17
3.2.9.2.3 Zone selectivity “S” ..... « 18
3.2.9.3 Double S ..... « 18
3.2.9.4 Directional Protection “D” ..... « 18
3.2.9.4.1 Start-up threshold “D” ..... « 19
3.2.9.4.2 “D” (directional) zone selectivity ..... « 19
3.2.9.5 Protection “I” ..... « 20
3.2.9.5.1 Start-up threshold “I” ..... « 20
3.2.9.6 Protection against closing upon short-circuit“MCR” « 20
3.2.9.7 Protection “G” ..... « 21
3.2.9.7.1 Start-up threshold “G” ..... « 21
3.2.9.7.2 Zone selectivity “G” ..... « 21
3.2.9.8 Protection against phase unbalance “U” ..... « 21
3.2.9.9 Protection against overtemperature inside the relay “OT” ..... « 22
3.2.9.10 Load control function ..... « 22
3.2.9.11 Voltage protections “UV”, “OV”, “RV” ..... « 22
3.2.9.11.1 Protection “UV” ..... « 22
3.2.9.11.2 Protection “OV” ..... « 22
3.2.9.11.3 Protection “RV” ..... « 22
3.2.9.11.4 Protection “U” ..... « 22
3.2.9.12 Protection against Reverse active power “RP” ..... « 23
3.2.9.13 Frequency protections “UF”, “OF” ..... « 23
3.2.9.14 Double protections setting ..... « 23
3.2.9.15 Summary table of the protection function settings for the PR333/P ..... « 24
3.2.9.16 Table of measurements ..... « 25
3.3 Commissioning ..... « 26
3.3.1 Connections ..... « 26
3.3.1.1 Current sensor connection for external neutral conductor ..... « 26
3.3.2 VT connections ..... « 26
3.3.3 CS and TC connection check ..... « 26
3.3.4 Test ..... « 26
3.3.5 Initial settings ..... « 27

3.3.6 Password management ... *page* 27
3.3.7 Replacing an electronic release ... « 27
3.3.7.1 Installation ... « 27
3.3.7.2 Uninstalling ... « 27
3.4 User interface ... « 28
3.4.1 Use of pushbuttons ... « 28
3.4.2 Read and Edit modes ... « 29
3.4.3 Changing parameters ... « 29
3.4.3.1 Modification of basic configuration ... « 31
3.4.4 Default settings ... « 32
3.5 Operating instructions/Operation in service ... « 33
3.5.1 Menu ... « 33
3.5.2 Protections menu ... « 34
3.5.2.1 Protections menu table ... « 34
3.5.3 Measurements Menu ... « 37
3.5.3.1 Measurements Menu table ... « 37
3.5.4 Settings Menu ... « 37
3.5.4.1 Settings Menu table ... « 37
3.5.4.2 Adjusting the neutral ... « 38
3.5.4.3 Mains frequency settings ... « 38
3.5.4.4 Modules ... « 39
3.5.4.4.1 PR330/V - MEASURING module ... « 39
3.5.4.4.2 PR330/D-M - COM module ... « 39
3.5.4.4.3 Programmable contact S51/P1 - SIGNALLING ... « 39
3.5.4.4.4 Settings for the Local Bus unit ... « 39
3.5.5 Test Menu ... « 39
3.5.5.1 Test Menu table ... « 40
3.5.6 Information Menu ... « 40
3.5.6.1 Information on trip and opening data ... « 40
3.6 Definition of alarms and signals for the PR332/P-PR333/P units ... « 41
3.6.1 Optical signals ... « 41
3.6.2 Electrical signals ... « 41
3.6.3 Table of error and warning messages ... « 41
3.6.4 Error messages displayed in pop-up window ... « 42
3.7 Troubleshooting PR332/P-PR333/P units ... « 43
3.7.1 In case of a fault ... « 44
3.8 Accessories ... « 44
3.8.1 ABB SACE PR010/T test and configuration unit ... « 44
3.8.2 BT030 communication unit ... « 44
3.8.3 PR021/K and HMI030 units ... « 44
3.8.4 PR030/B power supply unit ... « 44
3.8.5 Flex interface ... « 44

4 Modules ... *page* 45
4.1 PR330/V - MEASURING Module ... « 45
4.1.1 General characteristics ... « 45
4.1.2 Front view ... « 45
4.1.3 Releases complete with module ... « 45
4.1.4 Powering the PR332/P and PR333/P units via the PR330/V Module ... « 45
4.1.5 Operating instructions/Operation in service ... « 46
4.1.5.1 Using the Measurement submenus with the PR330/V module ... « 46
4.1.5.2 Table of submenus for the PR330/V Module ... « 48
4.1.5.3 Measurements Menu table ... « 48
4.1.5.4 Measurements Menu ... « 49
4.1.5.4.1 Historicals ... « 49
4.1.5.4.2 Trips ... « 49
4.1.5.4.3 Events ... *page* 49
4.1.5.4.4 Measurements ... « 49
4.1.5.4.5 Power factor ... « 49
4.1.5.4.6 Energy ... « 50
4.1.5.4.7 Peak factor ... « 50
4.1.5.4.8 Mains frequency ... « 50
4.1.5.4.9 Contact wear ... « 50
4.1.5.4.10 Wave forms ... « 50
4.1.6 Data Logger ... « 50
4.1.7 Electrical characteristics of the transformers ... « 51
4.2 PR330/D-M - COM communication module ... « 51
4.2.1 General characteristics ... « 51
4.2.2 Front view ... « 51
4.2.3 Releases complete with module ... « 51
4.2.4 Power supply ... « 51
4.2.5 Communication functions available ... « 51
4.2.6 Command functions ... « 52
4.2.7 PR330/D-M - COM Module Menu ... « 52
4.3 Programmable contact S51/P1 ... « 52
4.3.1 General characteristics ... « 52
4.3.2 Releases complete with module ... « 52
4.3.3 Characteristics of the signalling contacts ... « 52
4.3.4 Power supply ... « 52
4.3.5 S51/P1 Contact Menu ... « 52
4.3.6 S51/P1 contact surfing diagram ... « 53

5 Appendices ... *page* 54
5.1 Data Logger (recorder) ... « 54
5.1.1 General characteristics ... « 54
5.1.2 Description of the Data Logger menu ... « 54
5.1.2.1 Data Logger enabling ... « 54
5.1.2.2 Setting the sampling frequency ... « 54
5.1.2.3 Setting the standard triggers ... « 54
5.1.2.4 Events and display of custom triggers ... « 55
5.1.2.5 Setting the stopping delay ... « 55
5.1.2.6 Restart/Stop Data Logger ... « 55
5.1.3 Recording time windows ... « 55
5.1.4 Description of the information given by the Data Logger system ... « 56
5.1.4.1 Combination of devices for reading/setting data from the Data Logger system ... « 56
5.1.4.2 Access to saved data from the system ... « 56
5.1.4.3 Information from the system on configuration and status of Data Logger ... « 57
5.1.5 Data Logger commands from system ... « 57
5.2 Event list table ... « 57
5.2.1 “Standard” events for S51/P1 and PR021/K that can be selected from the relay ... « 57
5.2.2 “Standard” events for the Data Logger function, selectable from the relay ... « 57
5.2.3 Examples of “custom” events for Data Logger function, S51/P1 and PR021/K ... « 58
5.2.4 Combining the devices needed to customize settings ... « 58
5.3 Residual current protection function (for IEC type CB only) ... « 58
5.3.1 General Description ... « 58
5.3.2 Commissioning ... « 59
5.3.3 Rc test Menu ... « 59
5.4 Other informations ... « 59

# 1. Protection releases - General notes

The new series of ABB circuit breakers - Emax X1 and Tmax T7-T8 - are equipped with a new range of electronic relays.

These new relays are called PR331, PR332 and PR333.
The new protection releases integrate all the functions of their forerunners, adding new and interesting technical features that are useful for satisfying every current and future system installation requirements.
Every operational requirement is now met thanks to the different performance levels of the new relays and of the additional modules that can be fitted inside them (PR330/V, PR330/D-M).
A table can best illustrate the technical features and matching features of the three relays.

| Function/Unit | PR331 | PR332 | PR333 |
|---|---|---|---|
| **Current protections** (L, S, I, G) | **S** | **S** | **S** |
| **Additional protections** (U, OT) | **-** | **S** | **S** |
| **Voltage protections** (UV, OV, RV, RP, UF, OF) | **-** | **S** (3) | **S** |
| **Further protections** (D, S2, Double G) | - | - | **S** |
| **Protection MCR** | **S**(4) | **S**(4) | **S** |
| **Harmonics analysis** | **-** | **-** | **S** |
| **Temperature protection** | **-** | **S** | **S** |
| **Thermal memory** | **S** | **S** | **S** |
| **Local bus for separate auxiliary units** | **S** | **S** | **S** |
| **Cable communication** (RS485) | **-** | **S** (2) | **S** (2) |
| **Radio communication** (wireless Bluetooth) | **S** (1) | **S** (1) | **S** (1) |
| **Data Logger** | **-** | **S** | **S** |
| **Compatibility with SD.Pocket** | **S** | **S** | **S** |
| **Compatibility with SD.Testbus** | **S** | **S** | **S** |
| **Compatibility with PR010/T** | **S** | **S** | **S** |
| **Dual setting** | **-** | **-** | **S** |
| **PR330/V Measuring** (internal voltages module) | **-** | **O** | **S** |
| **PR330/D-M Com** (internal communication module) | **-** | **O** | **O** |
| **PR330/R** | **-** | **O** | **O** |
| **Protection from residual current** | **-** | **O** | **O** |
| **PR021/K** (separate signalling unit) | **O** | **O** | **O** |
| **Flex Interface** | **O** | **O** | **O** |
| **HMI030** (separate graphic interface) | **O** | **O** | **O** |
| **PR030/B** (separate power supply unit) | **O** | **S** | **S** |
| **BT030** (separate Bluetooth communication unit) | **O** | **O** | **O** |

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

**Notes:**
1. : with separate BT030 unit (for temporary connection),
2. : with PR330/D-M module,
3. : with PR330/V module.
4. : for C.B. type X1 only.

The main features and improvements of the new relay PR33x are (depending on relay + modules combination):

1. High current reading accuracy (1.5%) and other numerous functions.
2. The PR330/V module for measuring line voltages up to 690 V, is integrated in the relay, making a separate voltage transformer unnecessary.
3. One power output fully-configurable by the customer in terms of status, delay and type (S51/P1).
4. Wireless Bluetooth connection to PDA and/or PC (BT030).
5. Freely available software for relay testing and maintenance.
6. High-performance data logger with 8 analogue signals and 64 digital signals, which can be synchronized with hundreds of events/situations as selected by user.
7. Relay powered even with circuit-breaker open, using busbar voltages (with PR330/V).
8. New residual-current function (Rc). (Available with IEC type CB only).
9. Double protection G function, with simultaneous reading from two sensors (PR333 Restricted Earthfault).
10. Continuous control of current sensor and trip coil connection (all relays).
11. Analysis up to the 40$^{th}$ harmonic.
12. Cause of trip is memorized even in self-powered mode (all relays).
13. PR331 with serial link for separate PR021/K, HMI030 and Flex Interface modules.
14. Extended neutral selection.
15. Double protection S (PR333).
16. Date and time in "real time" (all relays).

## 1.1 Safety notes

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

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

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

**Safe usage is assumed as impossible when:**
1. the unit shows visible signs of damage.
2. the unit does not function (for example with autotest or with trip test unit).
3. the unit has been damaged in transit.

**Prior to operate and/or carry out replacements on the circuit breaker, this must be open. Further, all connected power supplies must be disabled.**

### 1.1.1 Notes for dielectric stiffness tests

**Dielectric stiffness tests on releases' inputs and outputs are not permitted.**

## 1.2 Abbreviations and notes

### 1.2.1 Abbreviations

| Abbreviations | Meaning |
|---|---|
| BA | Opening coil |
| BC | Closing coil |
| BT030 | Power supply and wireless communication unit ABB SACE |
| CB | Circuit Breaker (for example Emax) |
| CS | Current Sensor (current transformer) |
| PDA | Pocket Pc with Bluetooth |
| Emax | Series of ABB SACE air circuit-breakers |
| HMI 030 | Human Machine Interface |
| HW | Hardware |
| In | Rated current of the Rating Plug installed in the circuit breaker |
| MT | Thermal memory |
| Pn | Circuit-breaker rated power |
| $Pn_{phase}$ | Phase rated power |
| PR330/V | Measuring module |
| PR021/K | Signalling unit |
| PR330/D-M | Communication module |
| PR330/R | Actuator module |
| PR010/T | ABB SACE test unit |
| PR331/P | Protection relay for CB Emax X1 and Tmax T7-T8 |
| PR332/P | Protection relay for CB Emax X1 and Tmax T7-T8 |
| PR333/P | Protection relay for CB Emax X1 |
| PR030/B | ABB SACE power supply unit |
| Relay | also called "protection unit" or "protection release" |
| RMS | Root mean square value |
| TC | Trip Coil (opening solenoid) |
| SdZ | Zone selectivity |
| SGR | External toroid |
| SW | Software |
| i-Test | "Info/test" button on the front of the relay |
| Trip | CB opening, generated by the release |
| VT | Voltage transformer (see also VS) |
| Un | Rated voltage of the voltage transformers installed (phase voltage) |
| Vaux | Auxiliary power supply |
| VS | Voltage Sensor (see also VT) |

### 1.2.2 Notes

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

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

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

### 1.2.3 Compatibility between CB and relay

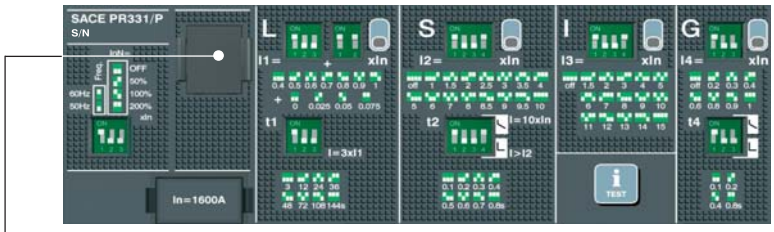
This table summarizes all possible fitting of the relays to Emax X1 and Tmax T7-T8 circuit breakers.

| CB\Relay | PR331 | PR332 | PR333 |
|---|---|---|---|
| T7 | x(1) | x | |
| T8 | x(1) | x | |
| X1 | x | x | x |

(1) LSIG version only

# 2. SACE PR331/P Release - Identification

The PR331/P units available, in accordance with IEC and UL standards, with protections and optional modules, are shown in the following figure.




| | PR331/P | PR331/P | PR331/P |
|---|---|---|---|
| Protections | L I | L S I | L S I G |
| Optional modules available | | | |
| **BT030** | | | |
| **PR030/B** | | | |

## 2.1 Standard

The PR331/P has been designed to work in accordance with the following international standards:
- ***IEC 60947-2 Low voltage apparatus. Circuit-breakers*** *(for T7-T8 and X1).*
- ***UL 489 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures*** *(for T7-T8).*
- ***UL 1066 Low Voltage Power Circuit Breaker*** *(X1).*

## 2.2 Specifications

### 2.2.1 General

The PR331/P unit is a high-performance self-powered protection unit with **Protection** functions for the ABB SACE 'Tmax T7-T8' and 'Emax X1' range of 3-pole and 4-pole low voltage circuit-breakers. The unit's user interface also enables parameter setup and full pre-alarm and alarm management with LED warning/alarm indicators for protection and watchdog functions.

Depending on the version, the protections available are as follows:

| 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 |

The PR331/P can be installed on 3-pole CBs with and without an external neutral, or on 4-pole CBs.

It should be noted that the reference current for PR331/P is In (rated current defined by Rating Plug) and not Iu (uninterrupted rated current of the CB itself).
Example: CB X1B 800 with a 400 A Rating Plug has an Iu of 800 A and an In of 400 A.

The unit opens the circuit breaker in which it is installed by means of the TC, which operates directly on the device's mechanical linkage.

The unit is made using a digital microprocessor technology and interfaces with user by means of DIP switches. The unit's protection parameters and general operating mode can be set by user.

### 2.2.2 Electrical characteristics

| | |
|---|---|
| Rated operating frequency | 50/60 Hz ±10% |
| Pass band | 3000 Hz max |
| Peak factor | 6.3 max @ 2 In |
| MTBF (MIL-HDBK-217E) | 15 years @ 45 °C |

#### 2.2.2.1 Self-powering

The unit requires no outside power source for protection and alarm signal functions. It is self-powered by current sensors installed on circuit breaker. Operation simply depends on current defined below running through at least one phase. An outside power source can be connected to enable other functions and particularly for connection to separate devices: HMI030 and PR021/K.
The characteristics of the busbar current are given in the table below.

| Characteristics | Enabling the relay |
|---|---|
| Minimum three-phase busbar current to enable the relay (Led alive enable and full relay operation) | >80 A |

#### 2.2.2.2 Auxiliary power supply

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

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

Presence of the auxiliary power supply enables the relay unit to be used even with circuit breaker open.
The characteristics of the power pack are given in the table below.

| Characteristics | PR331/P Version |
|---|---|
| Auxiliary voltage (galvanically separated) | 24 V DC ±20% |
| Maximum ripple | 5% |
| Inrush current @ 24 V | ~2 A for 5 ms |
| Rated power @ 24 V | ~2 W |

### 2.2.3 Environmental characteristics

| | |
|---|---|
| Operating temperature | -25 °C ... +70 °C |
| Storage temperature | -40 °C ... +90 °C |
| Relative humidity | 0% ... 98% with condensation |
| Degree of protection (with PR331/P installed in the CB) | IP 30 |

### 2.2.4 Communication bus

Local bus on rear connector; RS485 physical interface, Modbus protocol RTU.
Test Bus on front test connector.

### 2.2.5 Protection functions

The PR331/P protection unit carries out 6 independent protection functions, i.e.:
1. Protection against overload with inverse time "**L**";
2. Protection against short-circuit with adjustable delay "**S**";
3. Protection against instantaneous short-circuit "**I**";
4. Protection against closing upon short-circuit "**MCR**" (for X1 CB only);
5. Protection against earth fault with adjustable delay "**G**";
6. Protection against instantaneous short circuit at high currents "**Iinst**".

The PR331/P unit allows processing of current signal of neutral pole with different relationships relative to the value of the phases.
**N.B.: Beyond 15.5xIn of current on the Ne, the protection is considered as being set to 100%.**

A timing indication ("alarm" LED) is provided on front side of unit, which is enabled during an alarm for each protection. It is disabled when the alarm condition ceases or when the protection has been tripped.
The unit has a "backup-protection" function. If the circuit breaker does not open immediately the first time the Trip Coil is hit (partial TC failure), TRIP commands are sent repeatedly until the circuit breaker opens.
For inverse-time protections, the relationship between trip time and overcurrent is given by the formula: $t = k/I^2$.
For fixed-time protections with an adjustable delay, the relationship adopted is as follows: $t = k$.

#### 2.2.5.1 RMS calculation

All protection functions perform their respective processing cycles on the basis of real rms value of currents (protection G is disabled for current values greater than 8In (where $I_4 \geq 0.8In$), greater than 6In (where $0.5In \leq I_4 < 0.8In$) and greater than 4In (where $I_4 < 0.5In$)).
If the waveform is distorted beyond the established limit (6.3@2 In), the tolerance for the calculation of the true rms value will increase.

#### 2.2.5.2 Measuring function

The current measuring (ammeter) function is available on all versions of the SACE PR331/P unit.
This function may be accessed through PR010/T test unit only via the test bus, through HMI030 via local bus and with Flex Interface modules.
Under auxiliary voltage, the protection records maximum historical current value ever read.

#### 2.2.5.3 Watchdog

The PR331/P unit provides some watchdog functions which can guarantee proper management of relay malfunctions. These functions are as follows:

- ❑ Rating Plug validity
- ❑ Watchdog for proper connection of current sensors (CS). Any faults are indicated by a glowing LED, as explained in par. 2.7.1.
- ❑ Watchdog for proper opening solenoid connection (TC). Any faults are indicated by a glowing LED, as explained in par. 2.7.1.
- ❑ Watchdog for protection of Trip Hw. If the sensors are disconnected or there is a Rating Plug error, if enabled, a CB opening command is delivered through TC activation. This function can be enabled by PR010/T test unit.

### 2.2.6 Description of protection functions

#### 2.2.6.1 Protection "L"

"L" is the only protection that cannot be disabled because it is for self-protection against overloading of the relay.
The type of curve that can be set is $t=k/I^2$.
Protection trip time - inverse time - is given by the expression:

$$\max\left[\ \frac{9\cdot t_1}{(I_f / I_1)^2},\ 1\ \right]$$ where $I_f \le 12In$, 1s where $I_f > 12In$

$I_f$ is the fault current and $I_1$ the protection threshold set by user.
NB: Time expressed in seconds.

##### 2.2.6.1.1 Thermal memory "L"

The thermal memory function can be enabled for cable protection. It is based on the "tL" parameter defined as trip time of the curve (t1) selected at 1.25xI1. This function can be enabled through PR010/T, SD-Testbus2 or SD-Pocket.
Release trip time certainly is 100% of the one selected, after a time interval tL has passed since last overload or since last trip. Otherwise, trip time will be reduced, depending on overload occurred and time elapsed.

PR331/P is fitted with two instruments to make up this thermal memory. The first instrument operates when the release is powered (it also records overloads that have not lasted long enough to trip the release), while the second works even when the release is not powered, reducing any trip times in case of an immediate re-closing, and is enabled as soon as the CB is tripped.
It is the PR331/P release that automatically decides which of the two to use, according to the various situations.

#### 2.2.6.2 Protection "S"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/I^2$) type. In the latter case, trip time is given by the expression

$$\max\left[\ \frac{100\cdot t_2}{(I_f / I_n)^2},\ t_2\ \right]$$ where $I_f > I_2$

$I_f$ is the fault current and $I_2$ the protection threshold set by user.
NB: Time expressed in seconds.

##### 2.2.6.2.1 Thermal memory "S"

The thermal memory function can be enabled for cable protection in the event that the curve with inverse time is selected. This is based on the "tS" parameter defined as trip time of the curve (t2) selected at 1.5xI2. The other characteristics are the same as those for thermal memory "L" (see par. 2.2.6.1.1).

#### 2.2.6.3 Protection "I"

This fixed time (t=k) protection can be disabled and is designed for a nil intentional delay.

#### 2.2.6.4 Protection against closing upon short-circuit "MCR" (for X1 CB only)

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

#### 2.2.6.5 Protection "G"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/i^2$) type. In the latter case, trip time is given by the expression

$$\max\left[\ \frac{2}{I^2},\ t_4\ \right]$$ where $I = I_f / I_4$

$I_f$ is the fault current and $I_4$ the protection threshold set by user.
NB: Time expressed in seconds.

The PR331/P unit can provide earth fault protection, achieved inside the relay by vectorially adding together phase and neutral currents. Fault current is defined by the following formula:

$$\overrightarrow{I_G} = \overrightarrow{I_1} + \vec{I}_2 + \vec{I}_3 + \vec{I}_N$$

If the circuit shows no faults, the module of the sum of these currents is always nil; vice versa, the value of the fault current takes on a larger and larger value depending on size of fault.

#### 2.2.6.6 Protection against instantaneous short-circuit "Iinst"

This function has a single fixed-time protection curve.
When the protection is tripped, the circuit breacker is opened by the opening solenoid (TC).

### 2.2.7 Summary table of protections

| Protection | Disabling | Trip threshold | Trip time | Trip threshold tolerance(2) | Trip time tolerance(2) |
|---|---|---|---|---|---|
| **L** ($t=k/I^2$) | ☐ | **I1 =** 0.4 - 0.425 - 0.45 - 0.475 - 0.5 - 0.525 - 0.55 - 0.575 - 0.6 - 0.625 - 0.65 - 0.675 - 0.7 - 0.725 - 0.75 - 0.775 - 0.8 - 0.825 - 0.85 - 0.875 - 0.9 - 0.925 - 0.975 - 1 x In | t1 = 3 - 12 - 24 - 36 - 48 - 72 108 - 144 s (1) @ 3 I1 | Release between 1.05 and 1.2 x I1 | ± 10% $I_g \leq$ 6 x In<br>± 20% $I_g >$ 6 x In |
| **S** (t=k) | ☒ | **I2 =** 0,6 - 0,8 - 1,2 - 1,8 - 2,4 - 3 - 3,6 - 4,2 5 - 5,8 - 6,6 - 7,4 - 8,2 - 9 - 10 x In | with I > I2<br>t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 0.7 - 0.8 s | ± 7% $I_g \leq$ 6 x In<br>± 10% $I_g >$6 x In | The best of the two data:<br>± 10% or ± 40 ms |
| **S** ($t=k/I^2$) | ☒ | **I2 =** 0,6 - 0,8 - 1,2 - 1,8 - 2,4 - 3 - 3,6 - 4,2 5 - 5,8 - 6,6 - 7,4 - 8,2 - 9 - 10 x In | t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 0.7 - 0.8 s @ 10 In | ± 7% $I_g \leq$ 6 x In<br>± 10% $I_g >$6 x In | ± 15% $I_g \leq$ 6 x In<br>± 20% $I_g >$6 x In |
| **I** (t=k) | ☒ | **I3 =** 1,5 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 x In | ≤ 30 ms | ± 10% | |
| **MCR** (t=k) | ☒ | **I5 =** 6.0 - 6.1 - 6.2 - 6.3 - 6.4 ... 14.5 - 14.6 -14.7 - 14.8 - 14.9 - 15 x In | ≤ 30 ms(3) | ± 10% | |
| **G** (t=k) | ☒ | **I4 =** 0.2 - 0.3 - 0.4 - 0.6 - 0.8 - 0.9 - 1 x In | with I > I4<br>t4 = 0.1 - 0.2 - 0.4 - 0.8 s | ± 7% | The best of the two data:<br>± 10% or ± 40 ms |
| **G** ($t=k/I^2$) | ☒ | **I4 =** 0.2 - 0.3 - 0.4 - 0.6 - 0.8 - 0.9 - 1 x In | t4 = 0.1@ 4.47 I4<br>t4 = 0.2@ 3.16 I4<br>t4 = 0.4@ 2.24 I4<br>t4 = 0.8@ 1.58 I4 | ± 7% | ± 15% |
| **I inst** | ☐ | Automatic, defined by SACE | Instantaneous | | |

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

(2) These tolerances apply under the following conditions:
- self-powered relay at full power (without start-up)
- presence of auxiliary power supply
- two-phase or three-phase power supply
- preset trip time ≥100ms

(3) The value of this trip is ensured inside the time window ranging from 40 to 500 ms from CB closing; this setting must be done by customer.

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

| Protections | Trip threshold | Trip time |
|---|---|---|
| L | Release between 1.05 and 1.25 x I1 | ± 20% |
| S | ± 10% | ± 20% |
| I | ± 15% | ≤ 60 ms |
| G | ± 10% | ± 20% |
| Others | ± 20% | |

### 2.2.8 Measurements

The PR331/P protection unit can perform different types of measurements shown in the following table with relevant tolerances.

| Type of measurement | Tolerance Range | % |
|---|---|---|
| Phase and neutral current | 0.3 ... 6 In | 1.5 |
| Earth fault current | 0.3 ... 4 In | 1.5 |

## 2.3 Other functions

### 2.3.1 Indication of trip cause and trip test button

Using the “i Test” button, any information stored in the past 48 hours can be retrieved. In addition, a trip test can be obtained by keeping the button pressed for 7 seconds, and autotest by keeping button pressed for 3 seconds, with PR030/B battery unit on and with no running current.

### 2.3.2 Programmable signal contact S51/P1

The device houses the programmable S51/P1 contact that can be combined with multiple events (see par. 5.2). This contact is default-set on Alarm L event, and can be programmed through PR010/T, SD-Testbus 2 or SD-Pocket.

## 2.4 Commissioning

### 2.4.1 Connections

**For the connections provided by user, the recommendations contained in this document must be strictly complied with.**
**This will enable us to meet all international reference standards and ensure perfect relay operation even under severe environmental and electromagnetic conditions. Take particular care with earthing connections.**

### 2.4.2 CS and TC connection check

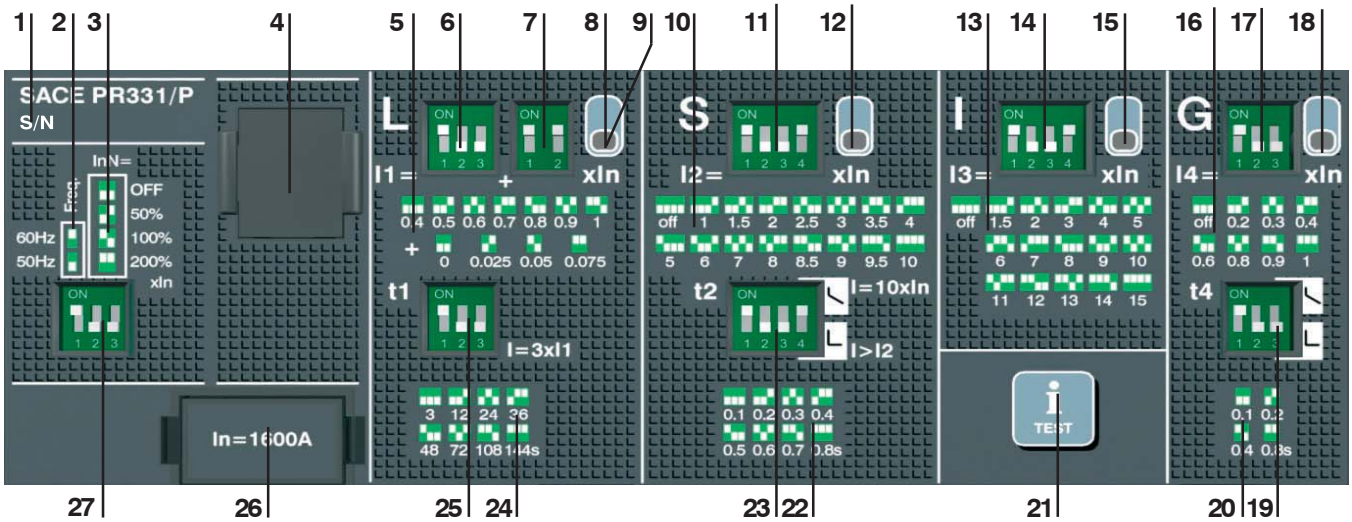
If PR331/P has been installed by user, proper connection of TC and CS cables should be checked (with CB open and Vaux or PR030/B) before commissioning the circuit breaker; if not so, make the right connections. If any of the red LEDs is lit, this means an error in CS and/or TC connections. See par. 2.7.1.

### 2.4.3 Current sensor connection for external neutral conductor

When the current sensor for the external neutral conductor has to be connected to a three-pole circuit breaker, remember to set $I_nN$ accordingly (see par. 2.5, ref. 3).
During this procedure, the circuit breaker must be open and preferably isolated.

## 2.5 User interface

Wording on PR331/P unit front side:




| Ref. | Description |
|---|---|
| 1 | Serial number of PR331/P protection release |
| 2 | Position indicator for mains frequency DIP switch |
| 3 | Position indicator of DIP switch for setting neutral conductor’s protection |
| 4 | Test connector to connect or test release using an external device (PR030/B battery unit, BT030 wireless communication unit and SACE PR010/T unit) |
| 5 | Position indicator of DIP switches for setting threshold I1 |
| 6 | DIP switches for main setting of current threshold I1 |
| 7 | DIP switches for fine-setting of current threshold I1 |
| 8 | Alarm indicator LED for protection function L |
| 9 | Pre-Alarm indicator LED for protection function L |
| 10 | Position indicator of DIP switches for setting threshold I2 |
| 11 | DIP switches for setting current threshold I2 |
| 12 | Alarm indicator LED for protection function S |

| Ref. | Description |
|---|---|
| 13 | Position indicator of DIP switches for setting threshold I3 |
| 14 | DIP switches for setting current threshold I3 |
| 15 | Alarm indicator LED for protection function I |
| 16 | Position indicator of DIP switches for setting threshold I4 |
| 17 | DIP switches for setting current threshold I4 |
| 18 | Alarm indicator LED for protection function G |
| 19 | DIP switch for setting trip time t4 and type of curve |
| 20 | Position indicator of DIP switches for setting time t4 |
| 21 | Test and “i Test” info button |
| 22 | Position indicator of DIP switches for setting time t2 |
| 23 | DIP switch for setting trip time t2 and type of curve |
| 24 | Position indicator of DIP switches for setting time t1 |
| 25 | DIP switch for setting trip time t1 |
| 26 | Rating plug |
| 27 | DIP switch for setting mains frequency and adjusting neutral protection |

#### 2.5.1 Trip Test

Before commissioning, run a test (“Trip Test”) on the whole TC chain by pressing and holding button “iTest” pressed for at least 7 sec. A positive outcome is shown by circuit-breaker opening (see Watchdog). To run the test, PR030/B battery unit must be connected.

#### 2.5.2 Initial settings

ABB SACE will have the adhesive labels affixed onto the PR331/P for all variables relating to circuit breaker (e.g. Type of circuit breaker, Rating Plug size, etc.)
Consider that ABB SACE provides a sensible definition for each possible setting (see par. 2.5.4).

**Apart from this, before the PR331/P unit is commissioned, user must accurately define every alterable parameter.**

#### 2.5.3 Changing protection functions

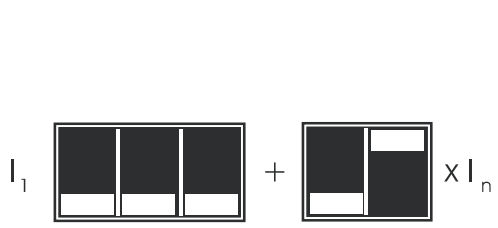
This paragraph describes setting of protection functions implemented in the PR331/P unit. Only setting methods and values that can be selected are explained here. For all other information on the technical characteristics of the protection functions, see par. 2.2.5.

**No parameters can be set when the PR331/P unit is in alarm conditions.**

##### 2.5.3.1 Example of setting

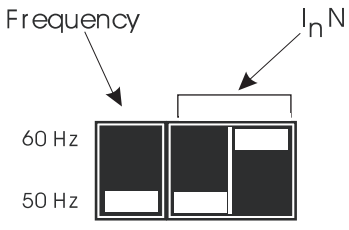
In the diagrams on front plate (see par. 2.5) relating to settings, the position of the DIP switch is shown in white color.

An example of how to set the DIP switch for protection function L is given below, where $I_n$ = 2000 A:




I1 = 0,4 + 0.025 x In
I1 = 850A


t1 = 3s@2.550A (3*$I_1$)




Frequency = 50 Hz
$I_n$N = 50%

Incorrect configuration of DIP switches causes a “inconsistent settings” indicated by LEDs (see par. 2.7.1).
The rule to be complied with is: I1<I2<I3.

E.g.: if I1=1In and I2=1In, the relay will indicate an “inconsistent setting” error. Same indication if I2=5In and I3=4In

### 2.5.4 Default setting of PR331/P unit

The PR331/P is supplied by ABB SACE with the following predefined parameters:

| # | Protection | Thresholds | Time |
|---|---|---|---|
| 1 | **L** | 1 In | 144 s |
| 2 | **S** | Off | 0.1 s |
| 3 | **I** | 4 In | — |
| 4 | **G** | Off | 0.1 s |
| 5 | **Mains frequency** | (1) | |
| 6 | **Neutral Sel.** | (2) | |
| 7 | **S51/P1** | On - Alarm L | |

Note:
(1) = 50 Hz for IEC type CB
60 Hz for UL type CB
(2) = Off for three-pole versions
50% for 4-pole versions

## 2.6 Operating instructions/Operation in service

### 2.6.1 Adjusting the neutral

Neutral protection is normally set to a current value 50% of the adjustment made on the phases.
In some installations, where particularly high harmonics occur, the current running on neutral may be higher than that of phases.
In the SACE PR331/P release, this protection can be set for the following values: $I_nN$ =0 - 50% - 100% - 200% * $I_n$.

**With three-pole circuit breakers, without external neutral, Neutral is adjusted to OFF**

### 2.6.2 Guidance for Neutral adjustment

Adjustment of neutral value ($I_nN$) must comply with the following formula: $I_1 \times I_nN \leq Iu$
When a 4-pole CB is available, this setting is controlled by the relay which signals the fault through a LED (see par. 2.7.1), and automatically adjusts the parameter within the accepted limits.
When a 3-pole CB with external neutral is available, the relay does not perform any control and settings are to be adjusted by user.

E.g.: With CBX1B 800 with Rating Plug at 400 A, Iu=800 A and I1=1In, adjustment of $I_nN$ may be 50-100-200%
With CB X1B 800 and 800 A Rating Plug, Iu=800 A and I1=1In, adjustment of $I_nN$ may be 50-100%

**Note 1:** $I_1=1I_n$ setting is intended as the maximum adjustment of the protection against overloads. Actual maximum allowable adjustment must take into account any temperature derating, terminals used and altitude, or In (rating plug)≤ 50% of circuit breaker size.

**Failure to comply with the setting limits for "$I_1$ " and "$I_nN$" can cause damage to circuit breaker with consequent risks even for operator.**

### 2.6.3 Replacing an electronic release

To complete the procedure for installing PR331/P, take the following steps:

1. With the circuit breaker open and preferably isolated, install the protection unit on the circuit breaker.
2. Power the unit ONLY from the PR030/B.
3. If there are no errors other than configuration error (see par. 2.7.1), press and hold "i Test" button for a few seconds until all red LEDs start flashing confirming that installation is completed.
4. Remove the PR030/B.
5. Power the relay from any supply (Vaux, PR030/B, PR010/T).
6. Make sure there are no configuration errors ("Alive" LED glows).
7. Circuit breaker and release can now be commissioned.

## 2.7 Definition of alarms and signals for the PR331/P unit

### 2.7.1 Optical signals

The following table shows how the LEDs are managed in accordance with IEC 60073 standard (clause 4.2.3.2 in particular).
The LED alerts about status of the function set on its zone; e.g. in the figure in par. 2.5 the LED referenced as 8 identifies status of function L. Also see the following table

| Type of information | Flashing slowly (0.5 Hz) | | Flashing fast (2Hz) | | | LED flashing with two 0.5 sec pulses every 2 sec | | LED flashing with one pulse every 3 sec | LED permanently ON | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | All LEDs | Single LED | All LEDs | Single LED | | All LEDs | Single LED | Single LED | All LEDs | Single LED | |
| | RED | ORANGE | RED | RED | ORANGE | RED | ORANGE | ORANGE | RED | RED | ORANGE |
| TC error or TC disconnected | | | ☒ | | | | | | | | |
| CS error or disconnected | ☒ | | | | | | | | | | |
| Rating Plug/Installation error(1) | | | | | | ☒ | | | | | |
| Protection timer error | | | | ☒ | | | | | | | |
| Last trip (2) | | | | | | | | | | ☒ | |
| Test button pressed and no failure detected (3) | | | | | | | | | ☒ | | |
| Hardware Trip (4) | | | | | | | | | | ☒(5) | ☒ |
| L pre-alarm | | | | | | | | | | | ☒ |
| Configuration error(6) | | | | | ☒ | | | | | | |
| Settings inconsistency | | | | | | | ☒ | | | | |
| Normal operation of relay (7) | | | | | | | | ☒ | | | |
| CB Undefined or CB status error (8) | | ☒ | | | | | | | | | |

(1) RP disconnected or RP>Iu
(2) Information on the “Last trip” is displayed when the LED relating to the protection unit that has been tripped comes on. The LED remains on for 2 sec, or permanently if an outside power supply (from PR030/B) is being used.
(3) The information is displayed with all LEDs on for as long as the test button is pressed and held, or for 2 sec.
(4) When enabled, hardware trip causes opening of CB in 1 sec., comes on in case of “Cs Error” or “Rating Plug Error” or when Ne protection is set to “ON” on 3p circuit breaker without Ne ext (configuration error).
If Vaux and/or PR030/B (connected during the event) are installed, trip cause (CS Error, Rating Plug Error) is displayed.
If Vaux and/or PR030/B (connected during the event) are not installed, a general “Hw trip” warning is displayed by pressing “I-test” button.
(5) Orange L LED and red I LED are on.
(6) Installed values differ from stored values. Therefore, the relay must be installed (see 2.6.3).
(7) If other signals aren’t present, the unit’s operating mode is indicated 3 sec after the unit has been turned on.
(8) Only if the PR331 is installed on X1 type CB. The error status is determined if I > 0.1 In and $CB_{STATUS}$ is OPEN

### 2.7.2 Troubleshooting

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

**N.B.:**
1. Before consulting the following table, check for a few seconds for any optical signals provided by the LEDs.
2. FN indicates normal operation of the PR331/P unit.
3. When the suggestions proposed do not lead to a solution of the problem, please contact ABB SACE assistance service.

| No. | Situation | Possible causes | Suggestions |
|---|---|---|---|
| 1 | Trip test cannot be run | 1. Busbar current is > 0.<br>2. The TC is not connected<br>3. PR030/B unit is disconnected | 1. FN<br>2. Check TC connection (see par. 2.4.2)<br>3. Connect PR030/B unit. |
| 2 | Trip times lower than expected | 1. Threshold too low<br>2. Curve too low<br>3. Incorrect neutral selection | 1. Correct threshold<br>2. Correct curve<br>3. Correct Neutral adjustment |
| 3 | Trip times higher than expected | 1. Threshold too high<br>2. Curve too high<br>3. Curve type “t=k/I²”<br>4. Incorrect neutral selection | 1. Correct threshold<br>2. Correct curve<br>3. Select curve type “t=k”<br>4. Correct Neutral adjustment |
| 4 | Rapid trip, with I3=Off | Iinst tripped | FN short-circuit with high I |
| 5 | Earth fault current beyond threshold, but no trip occurs | G function automatically inhibited | FN |
| 6 | No expected trip | Function OFF | FN enable protection function if necessary |
| 7 | Abnormal LED switch-on | | See par. 2.7.1 |
| 8 | Unexpected trip | | See par. 2.7.1 |
| 9 | L LED (orange) flashing | | FN |

### 2.7.3 In case of a fault

**If the PR331/P is suspected of being faulty, there are signs of malfunctions or it has generated an unexpected trip, we advise you to strictly follow the recommendations below:**

1. Press “i Test” button (within 48 hours of opening the CB) and make a note of which LED is on, also recording type of CB, number of poles, any connected accessories, In, and serial number (see par. 2.5).
2. Prepare a brief description of opening (when did it take place?, how many times?, was it always under the same conditions? what type of load? what current? is the event reproducible?)
3. Send/communicate all information collected, together with CB circuit diagram, to your nearest ABB Customer Assistance service.

Delivering comprehensive, accurate information to ABB Assistance service will facilitate technical analysis of the problem encountered, and allow us to promptly carry out all actions useful for the user.

## 2.8 Accessories

### 2.8.1 ABB SACE PR010/T test and configuration unit

Testing with SACE PR010/T unit enables monitoring proper operation of thresholds and trip times of protection functions “L”, “S”, “I”, and “G”. The test unit is wired to the relay by a dedicated connector (see ref. 4 par. 2.5).

### 2.8.2 BT030 communication unit

Using the BT030 wireless communication unit, the PR331/P can be connected by radio to a hand-held PC (PDA) or normal PC, thus extending the amount of information available to the user. In fact, using ABB SACE’s SD-Pocket communication software, you can read the values of the currents flowing through the circuit breaker, the value of the last 20 discontinued currents and protection settings.

### 2.8.3 PR021/K and HMI030 units

The PR331/P can also be connected to the optional PR021/K external signalling unit , to signal - by means of no-potential power contacts - alarms and tripped protections, and to the HMI030 unit to view the different types of information on the display.

### 2.8.4 PR030/B power supply unit

PR030/B power supply unit is a separate unit for powering relay, auto test and trip test, and checkings with open CB.

### 2.8.5 Flex Interface

Using the internal bus connections it is possible to connect different accessories modules (belonging to the same family) to the trip unit, by wich some informations are available to the user, like the status and the operating conditions of the unit.
For further detailed informations, see technichal documentation 1SDH000622R0001.

# 3 SACE PR332/P-PR333/P Release - Identification

The PR332/P and PR333/P units available, in accordance with IEC standards, together with various protections and various standard and optional modules, are illustrated in the following figure.



**PR332/P** **PR332/P**

L S I L S I G

**Protections** **PR332/P** **PR332/P**

L I L S I Rc

For all versions U OT

Optional modules available

**PR330/V - MEASURING** UV OV RV RP UF OF

**PR330/D-M - COM**

**BT030**

**Rc**(1)

**PR333/P** **PR333/P**

Protections L S I L S I G

For all versions U OT D UV OV RV RP UF OF

Optional modules available

**PR330/D-M COM**

**BT030**

**Rc**(1)

Note (1): See par. 5.3

## 3.1 Standard

The PR332/P and PR333/P have been designed to work in accordance with the international standard:

- ***IEC 60947-2 Low voltage apparatus. Circuit-breakers*** *(for T7-T8-X1).*
- ***UL 489 Molded-Case Circuit-Breakers, Molded-Case Switches and Circuit Breaker Enclosures*** *(for T7-T8).*
- ***UL 1066 Low voltage power Circuit-breaker.***

## 3.2 Specifications

### 3.2.1 General

The PR332/P and PR333/P are high-performance self-powered protection units with **Protection**, **Measurement**, **Data storage**, **Communication (optional) Self-test, Load control and Zone selectivity** functions for ABB SACE 'Tmax T7-T8' and 'Emax X1' range of 3- and 4-pole low-voltage air circuit breakers. The unit's user interface also enables parameter setup and full prealarm and alarm management for protection and watchdog functions.

Basic protections available are:

| Symbol | Protection against |
|---|---|
| **L** | overload with inverse long time delay |
| **S** | short-circuit with adjustable delay |
| **S2 (for PR333/P only)** | short-circuit with adjustable delay |
| **D (for PR333/P only)** | directional short-circuit with adjustable delay |
| **I** | instantaneous short-circuit |
| **G** | earth fault with adjustable delay |
| **U** | phase current unbalance (for alternative: unbalanced phase-to-phase voltages(3)) |
| **OT** | temperature off-range |
| **MCR**(2) | closing upon short-circuit |
| **UV**(3) | undervoltage |
| **OV**(3) | overvoltage |
| **RV**(3) | residual voltage |
| **RP**(3) | reverse active power |
| **UF**(3) | underfrequency |
| **OF**(3) | overfrequency |

(2) For X1 type CB only.

(3) With PR330/V module only.

The PR332/P and PR333/P can be installed on 3-pole CBs with and without an external neutral, or on 4-pole CBs.
Note that reference current is In (rated current defined by the front Rating Plug) and not Iu (uninterrupted rated current of the CB itself).
Example: CB X1B 800 with a 400 A Rating Plug has an Iu of 800 A and an In of 400 A.
The unit opens the circuit breaker in which it is installed by means of the TC, which takes effect directly on the device's mechanical linkage.
The protection unit is self-powered by current sensors and/or primary voltages via the PR330/V module.
The unit is made using digital microprocessor technology and interfaces with the user by means of a graphic display and keyboard.

### 3.2.2 Electrical characteristics

| | |
|---|---|
| Rated operating frequency | 50/60 Hz ±10% |
| Pass band | 3000 Hz max |
| Peak factor | 6.3 max @ 2 In |
| MTBF (MIL-HDBK-217E) | 15 years @ 45°C |

#### 3.2.2.1 Self-powering

Self-powering enables protection unit to be powered with busbar current using current transformers.
Using this powering mode, unit's protection functions are ensured, however, not the accessory functions regarding the modules. The characteristics are given in the table below:

| General characteristics | relay enabling | display switch-on |
|---|---|---|
| Minimum 3-phase busbar current to enable the relay and switch on the display | >80 A | >160 A |

#### 3.2.2.2 Auxiliary power supply

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

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

Presence of the auxiliary power supply enables the relay unit to be used even with the circuit breaker open, as well as powering all the modules, with the exception of the PR330/V - MEASURING module, which is powered by means of a connection to the busbars.
The characteristics of the power pack are given in the table below.

| Characteristics | PR333/P Version |
|---|---|
| Auxiliary voltage (galvanically separated) | 24V DC ±20% |
| Maximum ripple | 5% |
| Inrush current @ 24 V | ~2 A for 5 ms |
| Rated power @ 24 V | ~3 W |

#### 3.2.2.3 Powered by the PR330/V module

**For a full explanation of PR330/V features, see par. 4.1.**

### 3.2.3 Environmental characteristics

| | |
|---|---|
| Operating temperature | -25 °C ... +70 °C |
| Storage temperature | -40 °C ... +90 °C |
| Relative humidity | 0% ... 98% with condensation |
| Degree of protection (with PR333/P installed in the CB) | IP 30 |

### 3.2.4 Description of inputs/outputs

#### 3.2.4.1 Binary inputs

- **K51/SZin (K51/DFin):** Zone selectivity: input for protection S or "direct" input for protection D (only with Vaux)
- **K51/Gzin (K51/DBin):** Zone selectivity: input for protection G or "reverse" direction input for protection D (only with Vaux)

#### 3.2.4.2 Binary outputs

- **K51/SZout (K51/DFout):** Zone selectivity: output for protection S or "direct" output for protection D (only with Vaux)
- **K51/GZout (K51/DBout):** Zone selectivity: output for protection G or "reverse" direction output for protection D (only with Vaux)

Note: These inputs/outputs will be used only between PR122/PR123 and PR332/PR333 series devices.

### 3.2.5 Communication bus

Internal, local bus on rear connector; RS485 physical interface, Modbus protocol.
External system bus, RS 485 physical interface, Modbus RTU protocol, baud rate 9600-19200 bps.
Test bus on front test connector.

### 3.2.6 Protection functions

The PR332/P and PR333/P units carry out the following independent protection functions:

1. Protection against overload with inverse time "**L**";
2. Protection against short-circuit with adjustable delay "**S**" and "**S2**" (for PR333/P only);
3. Protection against directional short-circuit with adjustable delay "**D**" (for PR333/P only);
4. Protection against instantaneous short-circuit "**I**";
5. Protection against closing upon short-circuit "**MCR**" (for X1 type CB only);
6. Protection against earth fault with adjustable delay "**G**";
7. Protection against instantaneous short circuit at high currents "**I inst**";
8. Protection against phase unbalance "**U**";
9. Protection against overtemperature "**OT**";
10. Protection against undervoltage "**UV**" (with PR330/V module only);

11. Protection against overvoltage "**OV**" (with PR330/V module only);
12. Protection against residual voltage "**RV**" (with PR330/V module only);
13. Protection against reverse active power "**RP**" (with PR330/V module only);
14. Underfrequency "**UF**" (with PR330/V module only);
15. Overfrequency "**OF**" (with PR330/V module only).

The PR332/P and PR333/P units allow processing of current signal of neutral pole with different relationships relative to the value of the phases.
**N.B.: Beyond 15.5xIn of current on the Ne, the protection is considered as being set to 100%.**

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

#### 3.2.6.1 RMS calculation

All protection functions perform their respective processing on the basis of the real rms value of currents and voltages (protection G is disabled for current values greater than 8In (where $I_4 \geq 0.8In$), greater than 6In (where $0.5In \leq I_4 < 0.8In$) and greater than 4In (where $I4 < 0.5In$).
If the waveform is distorted beyond the established limit (6.3@2 In), the tolerance for the calculation 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 voltages.

#### 3.2.6.2 Mains frequency

The PR332/P and PR333/P units constantly measure the voltage frequency of the mains it is connected to.

If frequency is off the permitted range by ±10% in relation to the rated frequency selected (50 or 60 Hz), the "warning" LED comes on and a warning message is displayed (see par. 3.6.3).
Signalling can be combined with S51/P1 relay or to PR021/K unit relays.

#### 3.2.6.3 Harmonic distortion

The PR332/P and PR333/P units signal that a peak factor of 2.1 has been exceeded through a warning message and "warning" LED lighting up (remember that IEC 60947-2 standard annex "F" provides that the protection unit must operate correctly with a peak factor ≤ 2.1, up to 2xIn).
Signalling can be combined with S51/P1 relay or to PR021/K unit relays.

#### 3.2.6.4 Circuit-breaker state

The PR332/P and PR333/P units record the state of the circuit breaker by means of specific wiring on the circuit breaker. When presence of current is determined with the circuit-breaker in the "OPEN" position, a state error is signaled by a warning message being displayed (see par. 3.6) and "warning" LED lighting up.
Signalling can be combined with S51/P1 relay or to PR021/K unit relays.

### 3.2.7 Measurement functions

The current measuring (ammeter) function is available on all versions of the SACE PR333/P unit.
The display shows histograms with three phase and neutral currents on the main page. In addition, the current of the phase under the greatest load is given in numerical form. Where applicable, the earth fault current is displayed on a separate page.
The ammeter functions both in self-powering mode and with auxiliary voltage. In the latter case, ammeter and backlighting are always on. Tolerance for the ammeter measuring chain (current sensor plus ammeter) is described in paragraph 3.2.9.16.
The function is available also with Flex Interface modules installed.

The PR332/P and PR333/P releases provide a complete set of measurements:
- Currents: three phases (L1, L2, L3), neutral (Ne), earth fault
- Voltage: phase-phase, phase-neutral, residual voltage(1)
- Instantaneous voltage values over a given time interval (data logger)(1)
- Power: active, reactive, apparent(1)
- Power factor(1)
- Frequency and peak factor(1)
- Energy: active, reactive, apparent, meter(1)
- Harmonics calculation: up to the fortieth harmonic (waveform and module of the harmonics displayed); up to the thirty-fifth for frequency f=60Hz
- Maintenance: number of operations, percentage of contact wear, opening data storage
- Data Logger: See par. 5.1.

Note(1): with PR330/V module only

The PR333/P can provide a trend of the measurements of certain quantities over an interval P, established by the user; these include: mean active power, maximum active power, maximum current, maximum voltage and minimum voltage. The last 24 P intervals (adjustable from 5 to 120 min) are stored in a non-volatile memory and displayed in a bar graph.
To examine the Measurement functions, see the relevant paragraphs (par. 4.1 and par. 3.5.3) for the PR330/V - MEASURING module.

### 3.2.8 Watchdog

The PR332/P and PR333/P units provide some watchdog functions which can guarantee proper management of relay malfunctions. These functions are as follows:

- ❑ Watchdog for presence of Auxiliary power supply with "plug" icon displayed".
- ❑ Rating Plug validity.
- ❑ Watchdog for proper connection of current sensors (CS). Any faults are indicated by a special alarm message and "alarm" LED coming on, and the circuit breaker opens after 1 s, if trip is enabled.

- ❑ Watchdog for proper connection of Trip Coil (TC). Any faults are indicated by a special alarm message and "alarm" LED coming on; if the PR330/D-M module is installed, this activates the opening coil command (Y0) which opens the CB when trip is enabled.
- ❑ Watchdog for protection of Trip Hw. If the sensors are disconnected or there is a Rating Plug error, a CB opening command is delivered through TC activation when trip is enabled.

### 3.2.9 Description of protection functions

#### 3.2.9.1 Protection "L"

"L" is the only protection that cannot be disabled because it is for self-protection against overloading of the relay. The types of trip curves that can be set are divided into two groups according to the standard they refer to.

**Standard trip curve according to IEC 60947-2**
Only one type of curve can be set ($t=k/I^2$) as defined by IEC 60947-2 standard.
Protection trip time - inverse time - is given by the expression:

$\frac{9 \cdot t_1}{\left(I_f / I_1\right)^2}$ where $I_f \leq 12In$ and 1s where $I_f > 12In$ where $I_f$ is the fault current and $I_1$ the protection threshold.

NB: Time expressed in seconds.

**Standard trip curve according to IEC 60255-3**
There are 3 types of curves that can be set, defined by IEC 60255-3 standard as A, B and C.
Protection trip time - inverse time - is given by the expression:

$t = \frac{k}{(I)^{\alpha} - 1} \bullet b$ where $I = \frac{I_f}{I_1}$ $I_f$ is the fault current and $I_1$ the protection threshold set by user.

NB: Time expressed in seconds.

*a* and *k* are two parameters, suggested by the standard, which vary according to 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. This parameter is automatically calculated by setting parameter t1 (required trip time 3xI1).

##### 3.2.9.1.1 Thermal memory "L"

The thermal memory function can be enabled for cable protection. It is based on the "τL" parameter defined as the trip time of the curve (t1) selected at 1.25xI1.
Release trip time certainly is 100% of the one selected, after a time interval τL has passed since last overload or since last trip. Otherwise, trip time will be reduced, depending on overload occurred and time elapsed.

PR333/P is fitted with two instruments to make up this thermal memory. The first instrument operates when the release is powered (it also records overloads that have not lasted long enough to trip the release), while the second works even when the release is not powered, reducing any trip times in case of an immediate re-closing, and is enabled as soon as the CB is tripped.
It is the PR333/P release that automatically decides which of the two to use, according to the various situations.
NB: The thermal memory function can only be set if the type of curve selected is the standard one ($t=k/I^2$) (see par. 3.2.9.1).

#### 3.2.9.2 Protection "S"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/i^2$) type. In the latter case, trip time is given by the expression

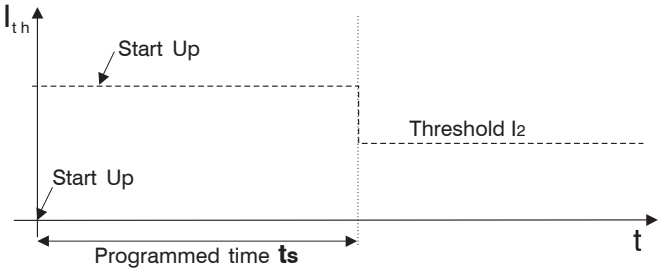
$\max\left[ \frac{100 \cdot t_2}{(I_f / I_n)^2}, t_2 \right]$ where $I_f > I_2$ where $I_f$ is the fault current and $I_2$ the protection threshold.

##### 3.2.9.2.1 Thermal memory "S"

The thermal memory function can be enabled for cable protection in the event that the curve with inverse time is selected. This is based on the "tS" parameter defined as trip time of the curve (t2) selected at 1.5xI2. The other characteristics are the same as those for thermal memory "L" (see par. 4.2.9.1.1).

##### 3.2.9.2.2 Start-up threshold "S"

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

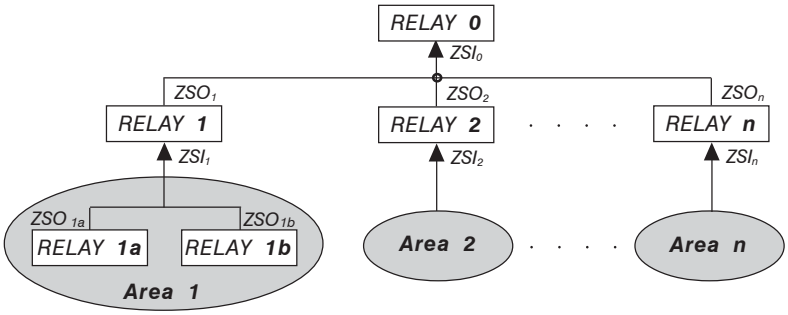



- **Start-up time**

Start-up time is different for all protections concerned.
Range: 0.1 s ... 30 s, with steps of 0.01 s.

#### 3.2.9.2.3 Zone selectivity "S"

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




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

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

**The maximum length of cable for zone selectivity, between two units, is 300 meters.**
**Use corded shielded two-wire cable (see note A to par. 1.2.2).**
**The shield will only be earthed on the circuit-breaker of the supply-side relay (ZSI side).**

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

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

Time $t_2$ must be set at a higher or identical $t_{selectivity\ value}$ +50 ms on the upstream circuit breaker, not necessary on the first of the chain.

#### 3.2.9.3 Double S (for PR333/P only)

Thanks to the new PR333/P release that enables two independent and simultaneously active protection S thresholds to be specified, selectivity can be assured even in critical conditions.
This function enables a better selectivity level to be obtained than using a release without a "double S". This function is valid for t=K only.

#### 3.2.9.4 Directional Protection "D" (for PR333/P only)

The PR333/P unit carries out directional protection against short-circuit with adjustable fixed time (t = k), active both with self-powering and auxiliary power-supply.

Protection functionality is very similar to protection "S" with fixed time, having a capacity to recognize the direction of the current during the fault period as well.
The direction of the current enables determining whether the fault is on the supply side or the load side of the circuit-breaker. Especially in ring distribution systems, this enables the distribution stretch where the fault occurred to be identified and isolated without interfering with the rest of the installation (using zone selectivity).
To determine the direction of the current, the value of the phase reactive powers has to be higher than 2% of the nominal phase power ($P_Q \geq 2\% \cdot P_{nphase}$).

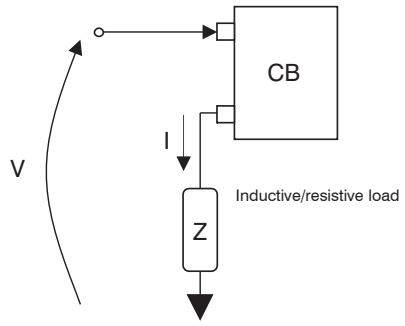
The PR333 enables you to define the power flow in the circuit breaker from the menu:
from high to low (High → Low),
from low to high (Low → High),
selectable in the menu Modules-Measuring Module (PR330/V).

As a result, the currents in the circuit breaker will be defined as “forward” or “backward” if they are in phase or out of phase with the previously-defined power flow (for the default setting, see par. 3.4.4).

In short:

| Ifault ($I_f$) | | Power flow setting High → Low | Power flow setting Low → High |
|---|---|---|---|
| **Value** | **Direction** | **T trip** | **T trip** |
| $I_f < I_7$ | either | No trip | No trip |
| $I_f > I_7$ | High → Low | $t_{7FW}$ | $t_{7BW}$ |
| $I_f > I_7$ | Low → High | $t_{7BW}$ | $t_{7FW}$ |

Example:
Once the power flow has been set as “High → Low”, the direction of the figure alongside is:




positive reactive power in → “forward” direction”;

negative reactive power in → “backward” direction”;

If the preset trip times were $t_{7FW}$ = 200 ms and $t_{7BW}$ = 400 ms, in this case the relay would have opened the circuit breaker after $t_{7FW}$ = 200 ms.

N.B.:
- With the directional protection D activated, if the direction of the power cannot be determined the relay takes effect considering the shorter of the programmed times between $t_7$ fw and $t_7$bw.
- This protection works on the basis of the phase currents, not the neutral current.

#### 3.2.9.4.1 Start-up threshold “D”

The function can be enabled from the menu (see description of the protection menu 3.5.2)
This function behaves exactly the same way as protection “S” (see par. 3.2.9.2.2).

#### 3.2.9.4.2 “D” (directional) zone selectivity

The Directional Zone Selectivity (SdZ D) function is particularly useful in ring and grid type systems where, in addition to the zone, it is essential to define the direction of the power flow that powers the fault.

The SdZ D can be set as an alternative to Zone Selectivity S and G and requires an auxiliary power supply.

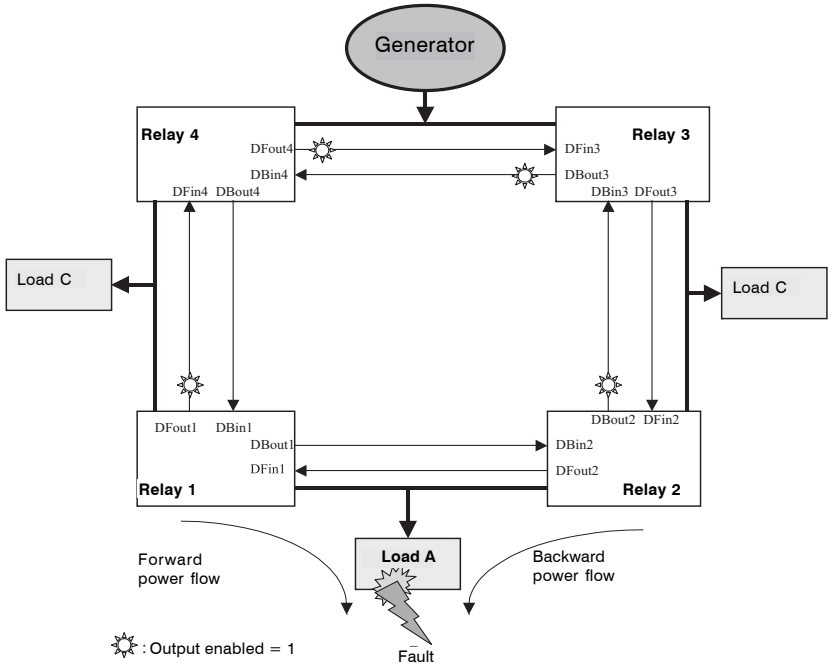
To define the zone and power flow, each relay has two inputs (DFin and DBin) and two outputs (Dfout and DBout), which must be suitably connected to the other relays (see example below).
As in the SdZ S and G, the relays interact with each other, sending cutout signals via the outputs and reading them via the inputs.

The general behavior is summarized in the table below.
(Example with Power flow setting “High → Low”).

| Ifault ($I_f$) | | Outputs status | | Inputs status | | T trip |
|---|---|---|---|---|---|---|
| **Value** | **Direction** | **DFout** | **DBout** | **DFin** | **DBin** | |
| $I_f < I_7$ | either | 0 | 0 | either | either | No trip |
| $I_f > I_7$ | High → Low | 1 | 0 | 0 | either | $t_s$ |
| $I_f > I_7$ | High → Low | 1 | 0 | 1 | either | $t_{7FW}$ |
| $I_f > I_7$ | Low → High | 0 | 1 | either | 1 | $t_{7BW}$ |
| $I_f > I_7$ | Low → High | 0 | 1 | either | 0 | $t_s$ |

If power flow is in phase with the direction set on the relay, output DFout is enabled (1).
Vice versa, if power flow is out of phase, output DBout is enabled (1).

The typical configuration of the system of circuit breakers for which the SdZ D is likely to be used, is the sort of ring illustrated in the following figure.




If a fault is detected (I fault If beyond threshold I7) on one of the sections in the system (Load A), the final circuit breakers for the section in question (Relay1 and Relay2) communicate the presence of the fault to the connected circuit breakers (Relay4 and Relay3) by setting output signals DFout or DBout depending on the direction of the current (DFout1=On, DB2out=On). To be more precise, the circuit breakers that limit the section affected by the fault see the direction of the fault current in different ways (Relay1=forward and Relay2=backward).

The circuit breakers (Relay1 and Relay2) circumscribing the section affected by the fault are tripped with selectivity time ts, while the circuit breakers further away from the fault count down time t7FW (Relay4) and t7BW (Relay3) without opening; in this way, the system is isolated, in ts time, to exclude the part affected by the fault.
Load A, where the fault has occurred, will be disconnected, but loads B and C will continue to be powered normally.

It should be noted that activation of the DBout3 output by relay3 will have no effect on relay4, because the latter is recording not an out-of-phase (backward) fault current, but an in-phase (forward) current with power flow defined previously by user (High -> Low).

N.B.:

- With Zone Selectivity activated, if power direction cannot be determined the relay takes effect considering the shorter of the programmed times between t7fw and t7bw, without enabling any output (DFout or DBout).
- If, for some reason, one of the circuit breakers required to open does not do so, a specific function will activate opening of the first circuit breaker immediately upstream from it, after a further 100 ms approx. In the above example, if the circuit breaker does not open with relay1, only the circuit breaker with relay4 will open after a time ts+100 ms.
- The SdZ D operates on the basis of the phase currents, not of the neutral.

#### 3.2.9.5 Protection “I”

The protection is enabled/disabled from the menu.
In the event zone selectivity “S” is active, during tripping of the relay for “I”, the ZSO output signal is activated to guarantee correct operation of the relay on supply side (and on load side).

##### 3.2.9.5.1 Start-up threshold “I”

The start-up function can be selected.
The function can be enabled from the menu on the protection “I” page.
The function behaves in exactly the same way as protection “S” (see par. 3.2.9.2.2)

#### 3.2.9.6 Protection against closing upon short-circuit “MCR”

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

### 3.2.9.7 Protection "G"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/i^2$) type. In the latter case, trip time is given by the expression

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

NB: Time expressed in seconds.

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

The unit can provide two different types of earth fault protection, **simultaneously**:

***Internal protection G***
This is provided inside the relay by vectorially summing phase and neutral currents. Fault current is defined by the following formula:

$$\overrightarrow{I_G} = \overrightarrow{I_1} + \vec{I}_2 + \vec{I}_3 + \vec{I}_N$$

If the circuit shows no faults, the module of the sum of these currents is always nil; vice versa, the value of the fault current takes on a larger and larger value depending on size of fault. This operating mode is enabled by default.
N.B.: it can be used also with CS for an external neutral.

***Protection G with external toroidal "Source Ground Return" transformer***
Also called "Source Ground return", this can be carried out when there is a need to check operation of a machine (transformer, generator or motor etc.) which has star-configured windings.
The protection is ensured by physically positioning an external toroidal sensor on the cable connected from the star center of the machine to the earthing connection point.
The current induced on the winding of the toroid is proportional to the fault current which, in this case, runs through the above toroid only.
To work in this mode, "Ground protection" must be selected from the Circuit breaker/Settings menu.

**The external toroid must be connected to the PR332/P or to the PR333/P by means of a corded shielded two-wire cable (see note A in par. 1.2.2) with a length not exceeding 15 m.**
**The shield must be earthed both on the circuit-breaker side and on the toroid side.**

It is indispensable for the star center to be securely connected to earth and that it is not used as a neutral conductor too (as in the TNC system), making a protection according to the TT system. Protections G and Gext can be enabled simultaneously. The minimum allowable threshold for the Gext protection is 0.1 x In (where In is the rated current of the homopolar toroidal transformer; the In settings available are 100, 250, 400, 800A).

#### 3.2.9.7.1 Start-up threshold "G"

The start-up function can be selected in the case where the curve with fixed time is selected.
This function can be enabled and disabled in the protection "G" page.
The function behaves in exactly the same way as protection "S" (see par. 3.2.9.2.2)

#### 3.2.9.7.2 Zone selectivity "G"

The zone selectivity function can be enabled providing a fixed time curve is selected, wiring and enabling of zone selectivity "G" are an alternative to the ones for "D" and operation is ensured only if auxiliary voltage is provided.

Zone selectivity "G" can be active at the same time as zone selectivity "S".
Function behavior and wiring are identical to those indicated for zone selectivity "S" (see par. 3.2.9.2.3).

### 3.2.9.8 Protection against phase unbalance "U"

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

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

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

#### 3.2.9.9 Protection against overtemperature inside the relay, "OT"

A sensor inside the PR332/P or the PR333/P unit monitors the temperature of the unit.
This enables signalling of any abnormal temperature conditions, which could cause temporary or continuous failure of the unit's electronic components.

This protection has two states of operation:

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

State of **"ALARM TEMPERATURE"** with ***temp. < –25 °C*** or ***temp. > 85 °C*** : the display is turned off, the "WARNING" and "ALARM" LEDs flash 2 Hz and Trip is activated (if enabled, by means of the "OverTemper. Trip = On" parameter).

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

Protection is always active, both with auxiliary power supply and in self-powering.

**Disabling Trip control of protection means that the PR332/P or the PR333/P unit can work, with the circuit-breaker closed, in a range of temperatures where correct operation of the electronics is not guaranteed.**

#### 3.2.9.10 Load control function

Single loads can be enabled/disabled on the load side before the overload protection L operates and trips the circuit breaker on the supply side. This is done by contactors or switch-disconnectors (wired outside the release), controlled by the PR332/P or PR333/P by means of S51/P1 contact or contacts of the PR021/K external unit.

Current thresholds are lower than those available with protection L, so that the load control can be used to prevent tripping due to overloads. This function is active when an auxiliary power supply is installed, or power comes from PR330/V (see par. 4.1.4).
The operating logic involves activation of three contacts when the preset thresholds LC1, LC2 and $I_w$ are exceeded.
Thresholds LC1 and LC2 are expressed as a percentage of $I_1$ (current threshold set for protection L) while the "warning current" $I_w$ is expressed as an absolute value. The values to be set are given in the following table:

| | |
|---|---|
| Warning current Iw | 0.30 ÷ 10.00 step 0.05xIn |
| Threshold LC1 | 50% ÷ 100%, 1% step x$I_1$ |
| Threshold LC2 | 50% ÷ 100%, 1% step x$I_1$ |

From the PR332/P and PR333/P, (NO or NC) configuration, delay time or latch can be associated to S51/P1 or PR021/K contacts.

#### 3.2.9.11 Voltage protections "UV", "OV", "RV" (with PR330/V module only)

The PR332/P and PR333/P units provide 3 voltage protections, which can be disabled, with fixed adjustable time (t = k), active as to self-powering and auxiliary power supply:
- Undervoltage "UV" (minimum line voltage)
- Overvoltage "OV" (maximum line voltage)
- Residual voltage "RV"
- Unbalance of line voltages "U"

The protections work on line voltages. The threshold voltages indicated refer to line voltage.

Apart from normal timing and "TRIP" operation, voltage protections can be in a state defined as "alarm" (with the "emergency" led on and an alarm message displayed) providing there is an auxiliary power supply or powering from PR330/V module). In fact, should the circuit-breaker be open and no current is detected, timing brings about an "alarm" state and not a "TRIP" state because the fault linked to the voltages may hold on even when the circuit-breaker is open, and the unit would always be in "timing" mode. When circuit-breaker closing or current feed are detected, the state of "alarm" switches immediately to "TRIP" without timing (see par. 3.3.2).

##### 3.2.9.11.1 Protection "UV"

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

##### 3.2.9.11.2 Protection "OV"

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

##### 3.2.9.11.3 Protection "RV"

When residual voltage exceeds the set threshold $U_{10}$ the protection counts down the preset time interval $t_{10}$ and then opens.
The residual voltage $U_0$ is calculated by vectorially summing phase voltages. It is therefore defined by the following formula

$$\overrightarrow{U_0} = \overrightarrow{U_1} + \overrightarrow{U_2} + \overrightarrow{U_3}$$

##### 3.2.9.11.4 Protection "U"

Fixed-time protection - which can be excluded - trips when, for a time greater than or the same as the time **t6** set, an unbalance is determined between two or more line voltages higher than the set threshold **I6**. Range: 2 ... 90%, with 1% steps.

The percentage of unbalance is therefore calculated: $\textit{Voltage unbalance} = \dfrac{\textit{Max. deviation from mean } d_1\ (V_{12}, V_{23}, V_{31})}{\textit{mean } d_1\ (V_{12}, V_{23}, V_{31})}$.

#### 3.2.9.12 Protection against Reverse active power “RP” (with PR330/V module only)

The PR332/P and PR333/P units provide protection (which can be disabled) with an adjustable fixed time (t = k), against reverse power, active as to self-powering and auxiliary supply.
When the total reverse active power (sum of the 3 phase power) exceeds the set reverse active power threshold $P_{11}$, the protection counts down the preset time interval $t_{11}$ and then opens.
The minus sign (‘-’) in front of threshold and power indicates reverse power. Threshold is indicated as a percentage of “Pn”, where “Pn” is the rated power of the circuit-breaker (3 Vn*In).

#### 3.2.9.13 Frequency protections “UF”, “OF” (with PR330/V module only)

Frequency protections record mains frequency variations above an adjustable threshold ($f_{12}$, $t_{12}$) or below ($f_{13}$, $t_{13}$), generating an alarm or opening of the circuit breaker.

#### 3.2.9.14 Double protections setting (for PR333/P only)

Using the double protection setting, the PR333/P can save a set of alternative parameters for all the protections. The second set of parameters (set B) can replace the default set (set A) by means of an external command. The passage from set A to set B can be made when there is a change in the mains configuration or when there is an emergency capable of changing load capacity and short circuit levels.

The second set of parameters (set B) can be enabled by:
- communication network, by means of the PR330/D-M (e.g. when the switch is scheduled);
- directly from user interface on the PR333/P (see settings menu par. 3.5.4);
- with a time that can be specified by set A or set B after the circuit breaker has closed;
- depending on Vaux being installed.

In operation, the state (set A and set B) is indicated on the display.
The double setting is disabled by default. To enable it, see par. 3.5.4.1.

3.2.9.15 **Summary table of the protection function settings for the PR332/P and PR333/P**

| Protection | Disabling | Disabling TRIP only | Zone selectivity | Start-up threshold | Thermal memory | Threshold range | Time range | Threshold tolerance (2) | Time Tolerance (2) |
|---|---|---|---|---|---|---|---|---|---|
| **L** ($t=k/I^2$) curves IEC60255-3 | ☐ | ☐ | ☐ | ☐ | ☒ | 0.4xIn ≤ $I_1$ ≤ 1xIn step 0.01xIn | 3s ≤ $t_1$ ≤ 144s(1), step 3s t1@ 3$I_1$ | Release between 1.05 and 1.2xI1 | ± 10%, $I_f$ ≤ 6 In ± 20%, $I_f$ > 6 In |
| **$S_1$** ($t=k$) | ☒ | ☐ | ☒ | ☒ | ☐ | 0.6 xIn ≤ $I_2$ ≤10xIn step 0.1xIn 0.6 xIn ≤ $I_{2\ start\text{-}up}$ ≤10xIn step 0.1xIn | Min, 0.05s ≤ $t_2$ ≤ 0.8s, step 0.01s 0.10s ≤ $t_{2start\text{-}up}$ ≤ 30s, step 0.01s 0.04s ≤ $t_{2sel}$ ≤ 0.20s, step 0.01s | ± 7%,$I_g$ ≤ 6 In ± 10%,$I_g$ > 6 In | The best of the two data ± 10% or 40 ms |
| **$S_1$** ($t=k/I^2$) | ☒ | ☐ | ☐ | ☐ | ☒ | 0.6xIn ≤ $I_2$ ≤10xIn step 0.1xIn | 0.05s ≤ $t_2$ ≤ 0.8s, step 0.01 at 10xIn | ± 7%,$I_g$ ≤ 6 In ± 10%,$I_g$ > 6 In | ± 15%, $I_g$ ≤ 6 In ± 20%, $I_g$ > 6 In |
| **$S_2$**(3) ($t=k$) | ☒ | ☐ | ☒ | ☒ | ☐ | 0.6xIn ≤ $I_2$ ≤10xIn step 0.1xIn | Min, 0.05s ≤ $t_2$ ≤ 0.8s, step 0.01s 0.10s ≤ $t_{2start\text{-}up}$ ≤ 30s, step 0.01s 0.04s ≤ $t_{2sel}$ ≤ 0.40s, step 0.005s | ± 7%,$I_g$ ≤ 6 In ± 10%,$I_g$ > 6 In | The best of the two data ± 10% or 40 ms |
| **D**(3) ($t=k$) | ☒ | ☐ | ☒ | ☒ | ☐ | 0.6xIn ≤ $I_7$ ≤10xIn step 0.1xIn | 0.20s ≤ $t_7$ ≤ 0.8s, step 0.01s 0.10s ≤ $t_{7start\text{-}up}$ ≤ 30s, step 0.01s 0.13s ≤ $t_{7sel}$ ≤ 0.50s, step 0.01s | ± 10% | The best of the two data ± 10% or 40 ms |
| **I** ($t=k$) | ☒ | ☐ | ☐ | ☒ | ☐ | 1.5xIn ≤ $I_3$ ≤ 15xIn step 0.1xIn | ≤ 30 ms 0.10s ≤ $t_{2\ start\text{-}up}$ ≤ 30s, step 0.01s when I>I4 | ± 10% | |
| **MCR** ($t=k$) | ☒ | ☐ | ☐ | ☐ | ☐ | 6.0xIn ≤ $I_5$ ≤ 15xIn step 0.1xIn | ≤ 30 ms(4) | ± 10% | |
| **G**(5) ($t=k$) | ☒ | ☒ | ☒ | ☒ | ☐ | 0.20xIn ≤ $I_4$ ≤1xIn step 0.02xIn | 0.1s ≤ $t_4$ ≤ 1s, step 0.05s 0.1s ≤ $t_{4\ start\text{-}up}$ ≤ 1s, step 0.02s 0.04s ≤ $t_{4sel}$ ≤ 0.2s, step 0.01s when I>I4 | ± 7% | The best of the two data ± 10% or 40 ms |
| **G**(5) ($t=k/I^2$) | ☒ | ☒ | ☐ | ☐ | ☐ | 0.20xIn ≤ $I_4$ ≤1xIn step 0.02xIn | 0.1s ≤ $t_4$ ≤ 1s, step 0.05s @$I_g$>4In | ± 7% | ± 15% |
| **Gext** ($t=k$) | ☒ | ☒ | ☒ | ☒ | ☐ | 0.20xIn ≤ $I_4$ ≤1xIn step 0.02xIn | 0.1s ≤ $t_4$ ≤ 1s, step 0.05s 0.1s ≤ $t_{4\ start\text{-}up}$ ≤ 30s, step 0.02s 0.04s ≤ $t_{4sel}$ ≤ 0.2s, step 0.01s | ± 7% | The best of the two data ± 10% or 40 ms |
| **Gext** ($t=k/I^2$) | ☒ | ☒ | ☐ | ☐ | ☐ | 0.20xIn ≤ $I_4$ ≤1xIn step 0.02xIn | 0.1s ≤ $t_4$ ≤ 1s, step 0.05s @$I_g$>4In | ± 7% | ± 15% |
| **Rc** (Idn) | ☒ | ☒ | ☐ | ☐ | ☐ | Idn =3.0-5.0-7.0-10-20 30A | 0.06-0.10-0.20-0.30-0.40-0.50 0.80s(4) | ± 20% | 140ms@0.06s(6) 950ms@0.80s(6) |
| **U** ($t=k$) | ☒ | ☒ | ☐ | ☐ | ☐ | 2% ≤ $I_6$ ≤ 90% step 1% | 0.5s ≤ $t_6$ ≤ 60s, step 0.5s | ± 10% | The best of the two data ± 10% or 40 ms |
| **OT** (temp=k) | ☐ | ☒ | ☐ | ☐ | ☐ | Fixed, defined by SACE | Instantaneous | ± 5°C | ––––– |
| **Iinst** | ☐ | ☐ | ☐ | ☐ | ☐ | Automatic, defined by SACE | Instantaneous | | |
| **UV**(7) ($t=k$) | ☒ | ☒ | ☐ | ☐ | ☐ | 0.5xUn ≤ $U_8$ ≤ 0.95xUn step 0.01xUn | 0.1s ≤ $t_8$ ≤ 5s, step 0.1s | ± 5% | ± 20% |
| **OV**(7) ($t=k$) | ☒ | ☒ | ☐ | ☐ | ☐ | 1.05xUn ≤ $U_9$ ≤ 1.2xUn step 0.01xUn | 0.1s ≤ $t_9$ ≤ 5s, step 0.1s | ± 5% | The best of the two data ± 10% or 40 ms |
| **RV**(7) ($t=k$) | ☒ | ☒ | ☐ | ☐ | ☐ | 0.1xUn ≤ $U_{10}$ ≤ 0.4xUn step 0.05 Un | 0.5s ≤ $t_{10}$ ≤ 30s, step 0.5s | ± 5% | The best of the two data ± 10% or 40 ms |
| **RP**(7) ($t=k$) | ☒ | ☒ | ☐ | ☐ | ☐ | - 0.3xPn≤ $P_{11}$ ≤-0.1xPn step 0.02 Pn | 0.5s ≤ $t_{11}$ ≤ 25s, step 0.1s | ± 10% | The best of the two data ± 10% or 40 ms |
| **UF**(7) | ☒ | ☒ | ☐ | ☐ | ☐ | 0.9fn ≤ $f_{12}$ ≤ 0.99fn step 0.01 fn | 0.5s ≤ $t_{12}$ ≤ 3s, step 0.1s | ± 5% | The best of the two data ± 10% or 40 ms |
| **OF**(7) | ☒ | ☒ | ☐ | ☐ | ☐ | 1.01fn ≤ $f_{13}$ ≤ 1.1fn step 0.01 fn | 0.5s ≤ $t_{13}$ ≤ 3s, step 0.1s | ± 5% | The best of the two data ± 10% or 40 ms |

| Protection | Disabling | Disabling TRIP only | Zone selectivity | Start-up threshold | Thermal memory | Threshold range | Time range | Threshold tolerance (2) | Time Tolerance (2) |
|---|---|---|---|---|---|---|---|---|---|
| **Load control LC1/LC2** | ☒ | ☐ | ☐ | ☐ | ☐ | 50%÷100% step 0.05x$I_1$ | | | |
| **Warning Iw** | ☒ | ☐ | ☐ | ☐ | ☐ | 0,3÷10$I_n$ step 0,05x$I_n$ | | ± 10% | 10÷40 ms |

(1) The minimum value of this trip is 1s regardless of the type of curve set (self-protection)
(2) These tolerances apply under the following conditions:
- self-powered relay at full power (without start-up)
- presence of auxiliary power supply
- two-phase or three-phase power supply
- preset trip time ≥ 100ms

(3) For PR333/P only
(4) No-trip time
(5) Protection G is disabled for current values greater than 4In, where I4 < 0.4 In, greater than 6 In, where 0.5 In ≤ I4 < 0.8 In and greater than 8 In where I4 ≥ 0.8 In.
(6) Maximum trip time
(7) With PR330/V module only

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

| Protections | Trip threshold | Trip time |
|---|---|---|
| L | Release between 1.05 and 1.25 x I1 | ± 20% |
| S | ± 10% | ± 20% |
| I | ± 15% | ≤ 60ms |
| G | ± 10% | ± 20% |
| Others | | ± 20% |

### 3.2.9.16 Table of measurements

| Type of measurement | Tolerance | |
|---|---|---|
| | Range | % |
| Phase and neutral currents | 0.3 ... 6 In | 1.5 |
| Internal ground fault current (internal source ground return) | 0.3 ... 4 In | 1.5 |
| External ground fault current (external source ground return) | 0.3 ... 4 In | 1.5 |
| Phase-to-phase and phase voltages (measured at module's input and thus independent of precision relating to use of any VT) | 50 $V_{phase-to-phase}$ ... 1.1x690 $V_{phase-to-phase}$ | 1 |
| Residual voltage (for systems with neutral only) | 50 $V_{phase-to-phase}$ ... 1.1x690 $V_{phase-to-phase}$ | 1 |
| Peak factor | 0.3 ... 6 In | 1.5 |
| Total power factor | 0.5 ... 1 | 2.5 |
| Mains frequency | 35 ... 80 Hz | ± 0.2 |
| Instantaneous active power on a single phase and total system | 0.3 ... 6 Pn | 2.5 |
| Instantaneous reactive power on a single phase and total system | 0.3 ... 6 Pn | 2.5 |
| Instantaneous apparent power on a single phase and total system | 0.3 ... 6 Pn | 2.5 |
| Active energy | 0.3 ... 6 Pn | 2.5 |
| Reactive energy | 0.3 ... 6 Pn | 2.5 |
| Apparent energy | 0.3 ... 6 Pn | 2.5 |

### 3.3.1 Connections

For the connections provided by user, the recommendations contained in this document must be strictly complied with. This will enable us to meet all international reference standards and ensure perfect relay operation even under severe environmental and electromagnetic conditions. Pay special attention to types of cables, connections to earth and recommended maximum distances.

**Maximum length of VT - PR330/V wiring must not exceed 15 meters.**
**Use corded shielded two-wire cable (see note A to par. 1.2.2).**
**The shield must be connected to earth on both sides.**

**Use VTs with a shield, connected to earth (see standard VT par. 3.3.2).**
The VTs should only be used for voltages> 690 V; for lower voltages, presence of PR330/V module connected to lower or higher busbars will be sufficient. With VT available, Voltage Transf. data present should be set and VT primary and secondary phase-to-phase voltage properly adjusted.

#### 3.3.1.1 Current sensor connection for external neutral conductor

When the current sensor for the external neutral conductor has to be connected to a three-pole circuit breaker, remember to set $I_nN$ accordingly. During this procedure, the circuit breaker must be open and preferably isolated.

### 3.3.2 VT connections

Dielectric stiffness tests are not allowed on inputs and outputs of releases or on secondary lines of any connected VTs.

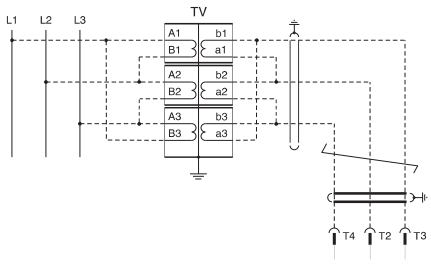
The following is a summary table of standard VT connections according to type of plant.

**VT Standard**: Single standard transformers, see par. 4.1.7.
The VTs must have a performance ranging from 10 to 20 VA included, 4 kV insulation between the primary and secondary

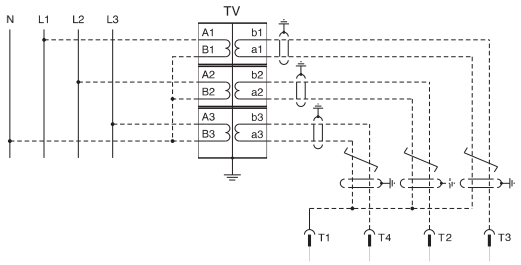
| Installation system | "VT Standard" type transformer (Star/Star) | "VT Standard" type transformer (Delta/Delta) |
|---|---|---|
| | Application diagram | Application diagram |
| TN-C | **B** | **A** |
| TN-S | **B** | **A** |
| IT with neutral | **B** | **A** |
| IT | **n.c** | **A** |
| TT with neutral | **B** | **A** |
| TT without neutral | **n.c** | **A** |

**Note for diagram B:**
- for TN-C systems, connection must be made to PEN
- for TN-S systems, connection must be made to N for configurations with neutral or PE for configurations without neutral; if PE is used, the current thereon could be around some ten mA. If a customer considers this value too high or has a residual current protection which might be tripped, then application diagram A must be used
- for IT and TT systems with neutral, connection must be made to N

**Application diagram A**




**Application diagram B**

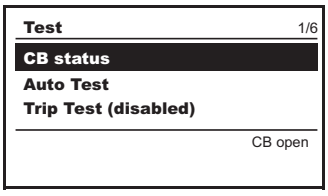



### 4.3.3 CS and TC connection check

**If the PR332/P or PR333/P was installed by user, it is important, before closing the CB, to check the last line on the display when the relay is turned on for the first time via a PR030/B power-supply unit. No CS and/or TC disconnected messages must appear; if they do, do not close the circuit-breaker immediately and connect correctly.**

### 4.3.4 Test

Before commissioning, a test can be conducted by means of the specific "Auto test" function which can be activated on the PR332/P and PR333/P. A positive result is shown on the display.
Then a test can be conducted on the whole TC chain, again using a specific function (Trip test). A positive result is shown by circuit-breaker opening. To run a Trip Test, press the "i Test" button and the "Enter" button simultaneously.
Check open or closed state of circuit-breaker on the same "PR333/P Test" screen, by checking whether CB is closed and off.



### 3.3.5 Initial settings

If the PR332/P or PR333/P is supplied installed in the circuit-breaker, ABB SACE will set all variables referring to the circuit-breaker or specific application correctly (e.g. type of circuit breaker, Rating Plug size, mains frequency ...). If the PR330/V module is installed, user must correctly, set the rated voltage.
Vice versa, if the unit is supplied separately, user will set all necessary parameters correctly.
Note that ABB SACE defines each possible setting according to the content of the paragraph of default parameters (see par. 3.4.4).

**Apart from this, it is absolutely indispensable for user to change the password and carefully define each parameter that can be changed, before commissioning the PR332/P or PR333/P.**

### 3.3.6 Password management

Specify a password? [0***]

To enter “EDIT” mode it is necessary to enter a four-figure numerical password. The values of the password that can be set range from 0000 to 9999. For the default password see par. 3.4.4.
Select the value of the first figure ( ‘0’ to ‘9’ ) by means of the ↑ and ↓ keys and press ↵ to confirm the figure and then proceed to enter the next one.
After entering the fourth figure, check the password you have entered. If the password is correct, “READ” state shifts to “EDIT” state.

If the password is wrong, the message

**Wrong password**

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

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

**Disabling the Password.**
By setting the value of the password to [0000] (on the “Unit Configuration” menu) password prompt is disabled; therefore “READ” can always shift to “EDIT”.

To enter a new password, select “New Password” from “Settings/System” menu.

### 3.3.7 Replacing an electronic release

#### 3.3.7.1 Installation

To complete the procedure for installing PR332/P or PR333/P, take the following steps:

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

Check that there are no configuration errors.

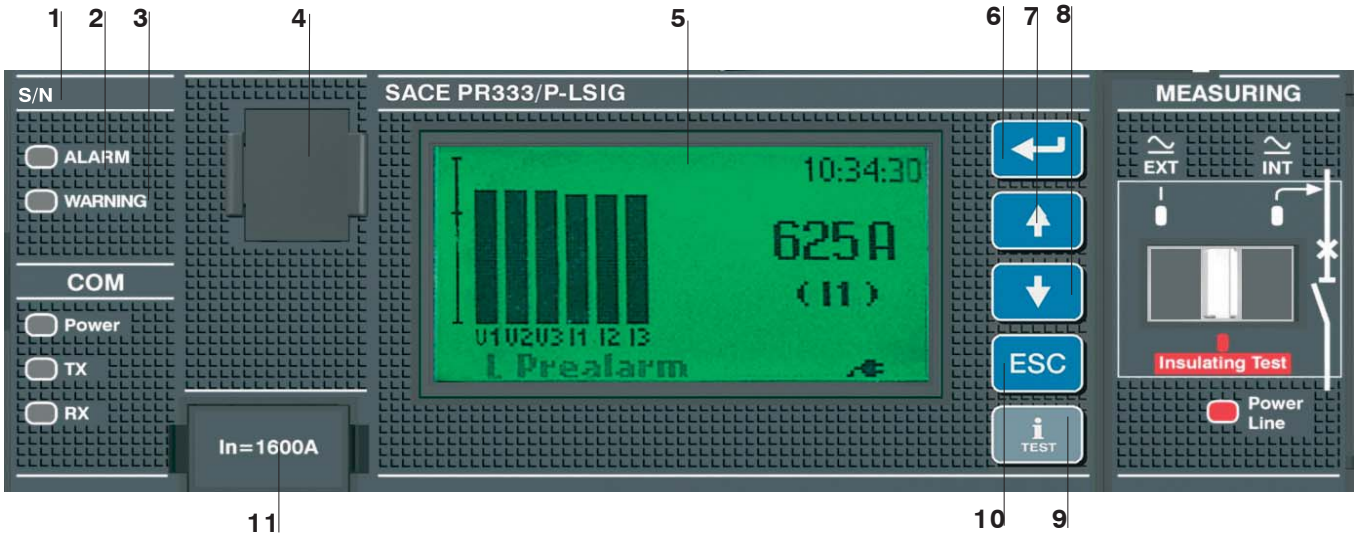
#### 3.3.7.2 Uninstalling

To complete the uninstall procedure of a PR332/P or PR333/P unit, follow the steps below:

1. With the circuit breaker open and/or isolated, power the unit from the PR030/B
2. Enter the unit’s *“Settings”* menu
3. Select *“Circuit breaker”*
4. Select *“Unit installation”*
5. Input the password
6. Select *“Uninstall”* and press *“ENTER”*
7. Remove the PR030/B
8. Remove the PR332/P or PR333/P unit from the circuit breaker

It is not strictly necessary to complete the uninstalling procedure, but this enables the parameters relating to the circuit breaker, such as contact wear and others, to be saved, otherwise these data would be lost. The data in question are then transmitted to the new PR332/P or PR333/P unit installed on the same circuit breaker.

## 3.4 User interface




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

**Description of icons displayed**

| Description | Symbol |
|---|---|
| | Remote control |
| A | Dual setting enabled. A setting performed |
| D | Fixed icon: datalogger enabled<br>Flashing icon: triggering accomplished |
| | Vaux installed |
| | Parameter change |

The Graphic Display is LCD type with 128x64 pixels and when there is an auxiliary voltage, the backlit and the ammeter are always active. The display is also active in self-powering mode with a minimum busbar current or powered from the PR330/V module as defined in par. 3.2.2.1 Contrast on the display can be adjusted by means of the specific function available on the user interface settings menu (par. 3.5.4.1).

### 3.4.1 Use of pushbuttons

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

To confirm programming of previously configured parameters, press **ESC** key to move up through menus until programming confirmation page is displayed; Select confirm and press **ENTER** to program data.

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

### 3.4.2 Read and Edit modes

The menus map (see par. 3.5.1) shows all pages which can be obtained and how to move between them from the keyboard, in the “READ” mode (data reading only) or in the “EDIT” mode (to set the parameters).

Starting from any page displayed after 120 seconds inactivity, the default page will automatically be displayed (see par. 3.5.1).

The allowable functions depending on state are:
“READ”:
- ✓ Consulting measurements and historical data
- ✓ Consulting unit configuration parameters
- ✓ Consulting protection parameters

“EDIT”:
- ✓ Anything allowed in READ mode
- ✓ Configuration of the unit
- ✓ Programming of parameters relative to protections
- ✓ TEST Functions of the unit

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

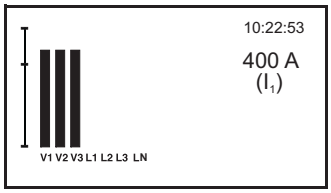
| Key | Function |
|---|---|
|  | Move between pages<br>Move within menus<br>Change parameter values |
|  | End setting phase and confirm result<br>Select menu item |
|  | Access to surfing menus from the default pages<br>Go back to previous level when surfing within the menus, until returning to the default pages<br>Exit the parameter changing phase, aborting the change |
|  | This key is used to re-enable the display after it has gone off within 48 hours of circuit breaker opening in self-powering mode. |

### 3.4.3 Changing parameters

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

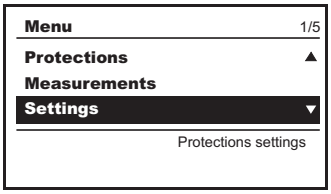
***Procedure not requiring confirmation of any programming***
For instance, to set System Date, the correct sequence is as follows:

Press ESC to access the Main Menu.



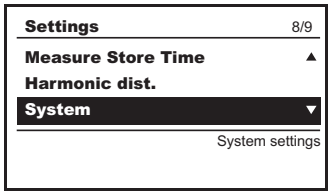

From the Main Menu, select SETTINGS

press the ↵ key (enter)



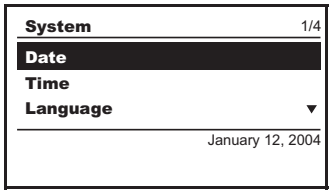

Select SYSTEM

press the ↵ key (enter)



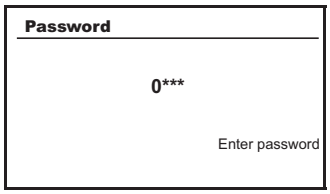

Select the menu item DATE to be changed

press the ↵ key (enter)



You will be prompted to input a Password
complete password entry procedure (par. 3.3.6)

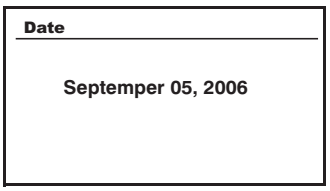
press the ↵ key (enter)




Change the date using the ↓ keys (arrow down),

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

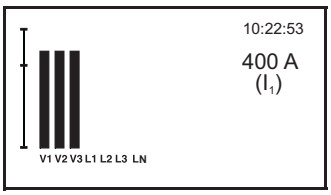
Press ESC twice to return to the Main Menu.




***Procedure requiring confirmation of any programming***

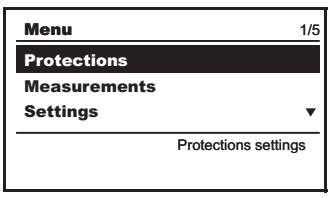
For instance, to change the Curve of Protection L, the correct sequence is as follows:

Press ESC to access the Main Menu.



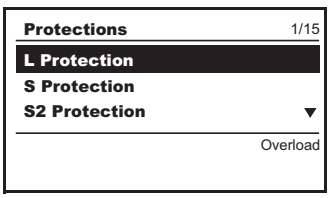

From the Main Menu, select the item PROTECTIONS

press the ↵ key (enter)



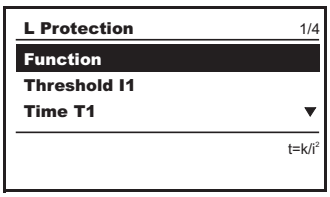

From the Protections Menu, select PROTECTION L

press the ↵ key (enter)




From the Protection L Menu, select the item CURVE

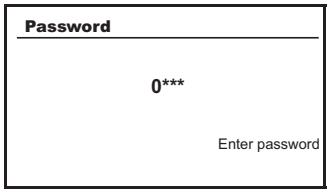
press the ↵ key (enter)



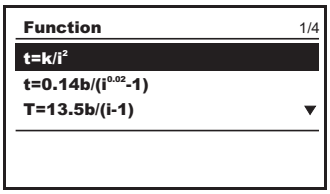

You will be prompted to input a Password

complete password entry procedure (par. 3.3.6)

press the ↵ key (enter)

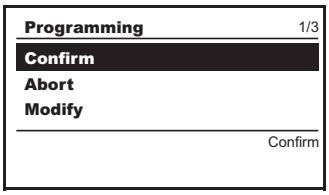


Select the value you want from the list
And confirm by pressing the ↵ key (enter).




Press ESC twice

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




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

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

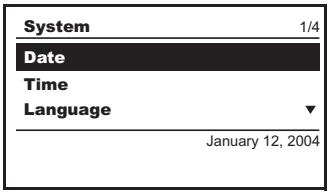
#### 3.4.3.1 Modification of basic configuration

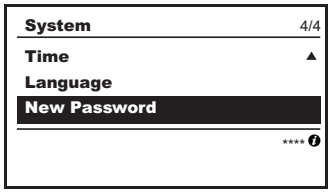
**No parameters can be set** when the PR332/P or PR333/P unit is in alarm conditions.

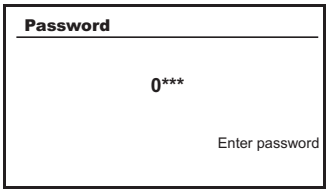
The unit must be configured in EDIT mode.

Following the instructions given in par. 3.4.3, view the following on the display:

Change system date
Change System Time
Select system language

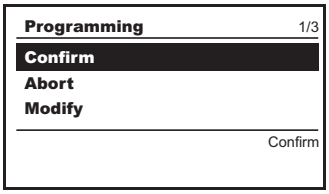



To change system password, select the relevant menu item and press ↵ (enter); then you will be prompted to enter the OLD password, and afterwards you can input the new one twice.
Press ESC twice to return to the Main Menu.

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




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

Note: to set system language check that:
- The relay is set to local (if PR330/D-M is installed)
- CB is open
- Auxiliary power supply is provided (Vaux 24VDC and/or busbar voltage through PR330/V and/or PR030/B).

If one of the conditions mentioned above is not complied with, the relay does not allow changing language.

### 3.4.4 Default settings

The PR332/P and PR333/P are supplied by ABB SACE with the following predefined parameters (Set A and Set B):

| # | Protection | On/Off | Thresholds | Time | Curve | T.M. | ZS | Trip |
|---|---|---|---|---|---|---|---|---|
| 1 | **L** | — | 1 In | 144 s | $I^2t$ | Off | — | — |
| 2 | **S** | Off | 6 In | 50 ms | K | — | Off: 0.04 s | — |
| 3 | **D** | Off | 6 In | 0.2 s-0.2 s | | | Off: 0.13 s | |
| 4 | **I** | On | 4 In | — | — | — | — | — |
| 5 | **G** | Off | 0.2 In | 0.4 s | K | — | Off: 0.04 s | On |
| 6 | **U** | Off | 50 % | 5 s | | | | Off |
| 7 | **OT** | — | | | | | | Off |
| 8 | **K LC1** | Off | 50 % $I_1$ | | | | | |
| 9 | **K LC2** | Off | 75 % $I_1$ | | | | | |
| 10 | **UV** | Off | 0.9 Un | 5 s | | | | Off |
| 11 | **OV** | Off | 1.05 Un | 5 s | | | | Off |
| 12 | **RV** | Off | 0.15 Un | 15 s | | | | Off |
| 13 | **RP** | Off | - 0.1 Pn | 10 s | | | | Off |
| 14 | **UF** | Off | 0.9 Fn | 3 s | | | | Off |
| 15 | **OF** | Off | 1.1 Fn | 3 s | | | | Off |
| 16 | **Language** | — | Engl | | | | | |
| 17 | **Mains frequency** | — | (1) | | | | | |
| 18 | **PR021/K** | Off | | | | | | |
| 19 | **S51/P1** | On | Alarm L | | | | | |
| 20 | **Sel. Neutral** | — | (2) | | | | | |
| 21 | **Sel. toroid** | — | None | | | | | |
| 22 | **Ext. ground tor.**(3) | Off | 100 A | | | | | |
| 23 | **Rated Voltage** | — | 380V/400V/690V | | | | | |
| 24 | **S startup** | Off | 6 In | 100 ms | | | | |
| 25 | **I startup** | Off | 4 In | 100 ms | | | | |
| 26 | **G startup** | Off | 1 In | 100 ms | | | | |
| 27 | **Password** | — | 0001 | | | | | |
| 28 | **Measurement interval** | — | 60 min | | | | | |
| 29 | **Iw** | Off | 3 In | | | | | |
| 30 | **Harmonic dist. warning** | Off | | | | | | |
| 31 | **Power Direction** | — | top → bottom | | | | | |
| 32 | **MCR** | Off | 6In | — | — | — | — | — |

Note:

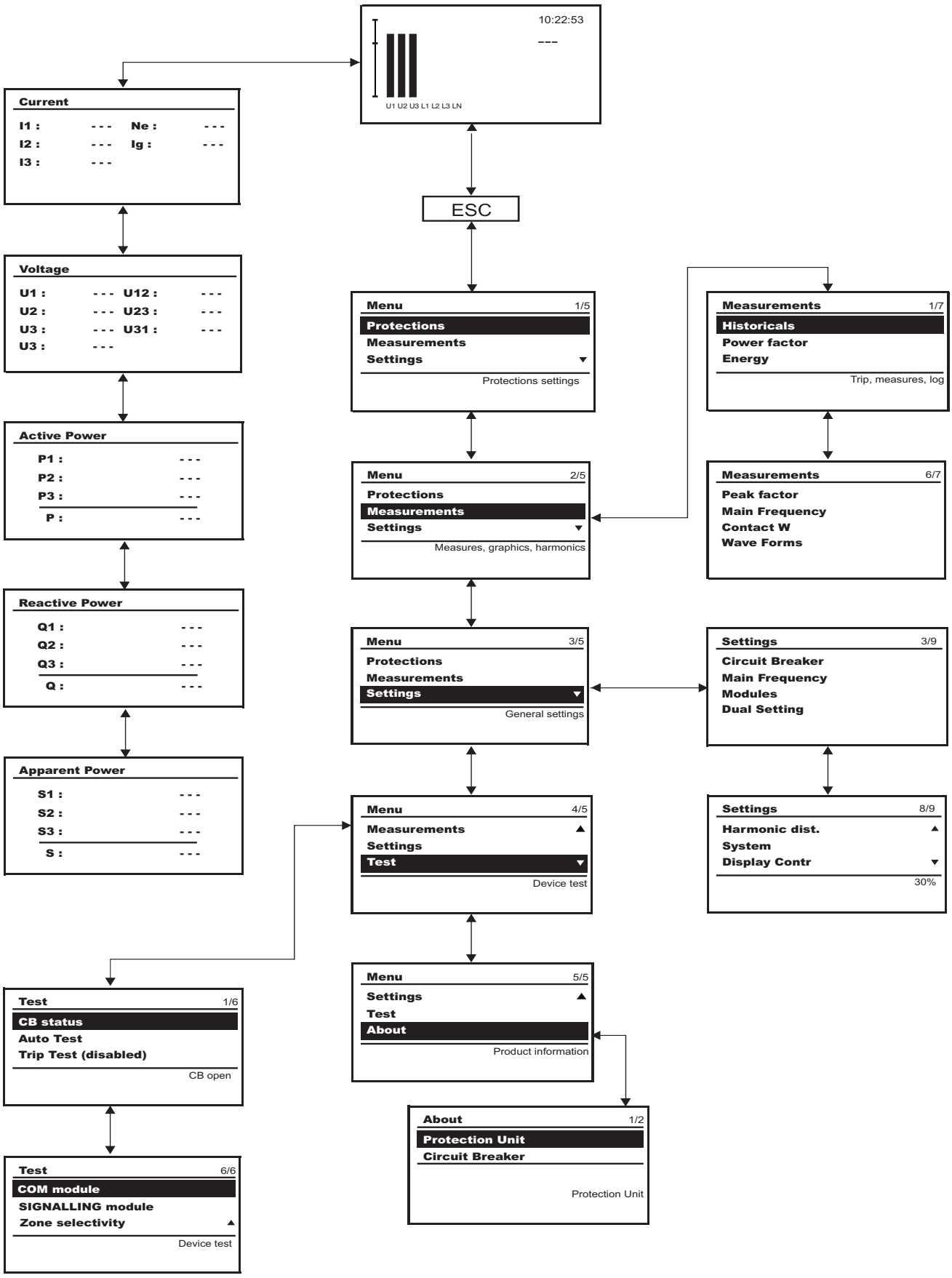
(1) = 50Hz for automatic Circuit-Breakers IEC
60Hz for automatic Circuit-Breakers UL

(2) = off for 3-pole version
50% for 4-pole version

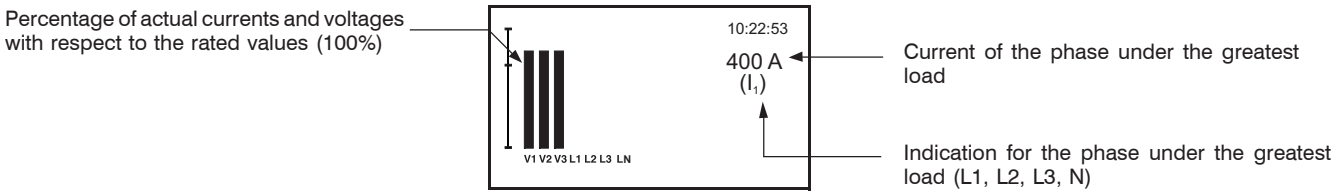
(3) = setting available only for automatic Circuit-Breaker IEC

### 3.5.1 Menu

As seen previously, the PR332/P and PR333/P use the display to show messages, diagrams and menus. These are organized in a logical and intuitive way. The following is a general layout showing how to access the main menu pages.

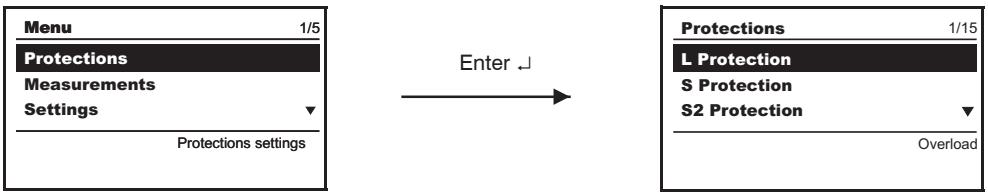


Each time the unit is turned on, or after more than 2 minutes of inactivity on the keyboard, the display indicates the following (default) page:




### 3.5.2 Protections menu

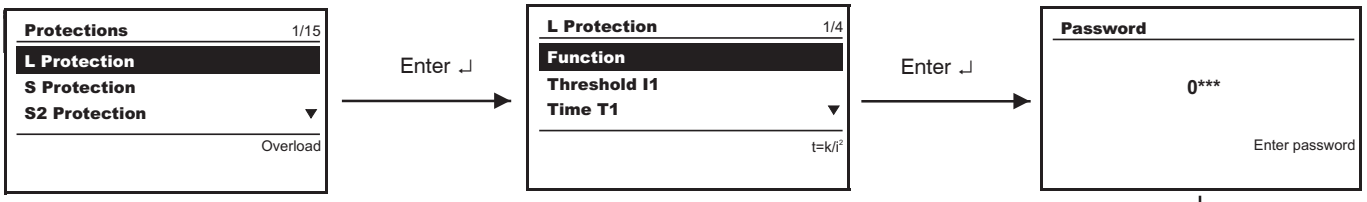
From the interface you can press ENTER to access the menu of the different protections available on the display



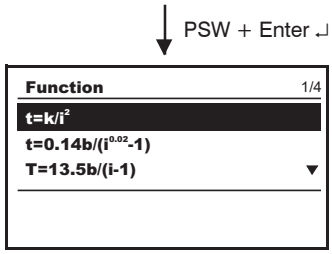

Using the “arrow UP” and “arrow DOWN” you can view the various protections.
On the whole, all data that can be displayed concern protections:
L, S, S2, D, I, G, U, UV, OV, RV, RP, UF, OF, OT, LOAD PROTECTION.

*Example of surfing the Protections Menu*

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




Example of how to select the $t=k/i^2$ curve




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

#### 3.5.2.1 Protections menu table

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

| Protection | Parameter/Function | | |
|---|---|---|---|
| | Enable StartUp | ON / OFF | |
| | StartUp threshold | | |
| | StartUp time | | |
| | | | |
| **S2** | Enable | ON / OFF | (for PR333/P only) |
| | Threshold I2 | | |
| | Time t2 | | |
| | Zone selectivity | ON / OFF | |
| | Selectivity time | | |
| | Enable StartUp | ON / OFF | |
| | StartUp threshold | | |
| | StartUp time | | |
| | | | |
| **D** | Enable | ON / OFF | (for PR333/P only) |
| | Threshold I7 | | |
| | Time t7 Fw | | |
| | Time t7 Bw | | |
| | Zone selectivity | ON / OFF | |
| | Selectivity time | | |
| | Enable StartUp | ON / OFF | |
| | StartUp threshold | | |
| | StartUp time | | |
| | | | |
| **I** | Enable | ON / OFF | |
| | Threshold I3 | | |
| | Enable StartUp | ON / OFF | |
| | StartUp threshold | | |
| | StartUp time | | |
| | | | |
| **G** | Enable | ON / OFF | |
| | Curve | | |
| | Threshold I4 | | |
| | Time t4 | | |
| | Enable Trip | ON / OFF | |
| | Zone selectivity | ON / OFF | |
| | Selectivity time | | |
| | Enable StartUp | ON / OFF | |
| | StartUp threshold | | |
| | StartUp time | | |
| | | | |
| **Gext** | Enable | ON / OFF | |
| | Curve | | |
| | Threshold I4 | | |
| | Time t4 | | |
| | Enable Trip | ON / OFF | |
| | Zone selectivity | ON / OFF | |
| | Selectivity time | | |

| Protection | Parameter/Function | | |
|---|---|---|---|
| | Enable StartUp | ON / OFF | |
| | StartUp threshold | | |
| | StartUp time | | |
| **U** | Enable | ON / OFF | (for PR333/P only) |
| | Function | Currents/Voltages | |
| | Threshold I6 | | |
| | Time t6 | | |
| | Enable Trip | ON / OFF | |
| | | | |
| **UV** | Enable | ON / OFF | (with PR330/V module only) |
| | Threshold U8 | | |
| | Time t8 | | |
| | Enable Trip | ON / OFF | |
| | | | |
| **OV** | Enable | ON / OFF | (with PR330/V module only) |
| | Threshold U9 | | |
| | Time t9 | | |
| | Enable Trip | ON / OFF | |
| | | | |
| **RV** | Enable | ON / OFF | (with PR330/V module only) |
| | Threshold U10 | | |
| | Time t10 | | |
| | Enable Trip | ON / OFF | |
| | | | |
| **RP** | Enable | ON / OFF | (with PR330/V module only) |
| | Threshold P11 | | |
| | Time t11 | | |
| | Enable Trip | ON / OFF | |
| | | | |
| **UF** | Enable | ON / OFF | (with PR330/V module only) |
| | Threshold f12 | | |
| | Time t12 | | |
| | Enable Trip | ON / OFF | |
| | | | |
| **OF** | Enable | ON / OFF | (with PR330/V module only) |
| | Threshold f13 | | |
| | Time t13 | | |
| | Enable Trip | ON / OFF | |
| | | | |
| **OT** | Enable Trip | ON / OFF | |
| **Load control** | Threshold 1<br>Enable<br>Threshold | ON / OFF | |
| | Threshold 2<br>Enable<br>Threshold | ON / OFF | |
| | Threshold Iw<br>Enable<br>Threshold | ON / OFF | |

Note: the characteristics of each single protection and their settings and corresponding curves, are explained in par. 3.2.9.

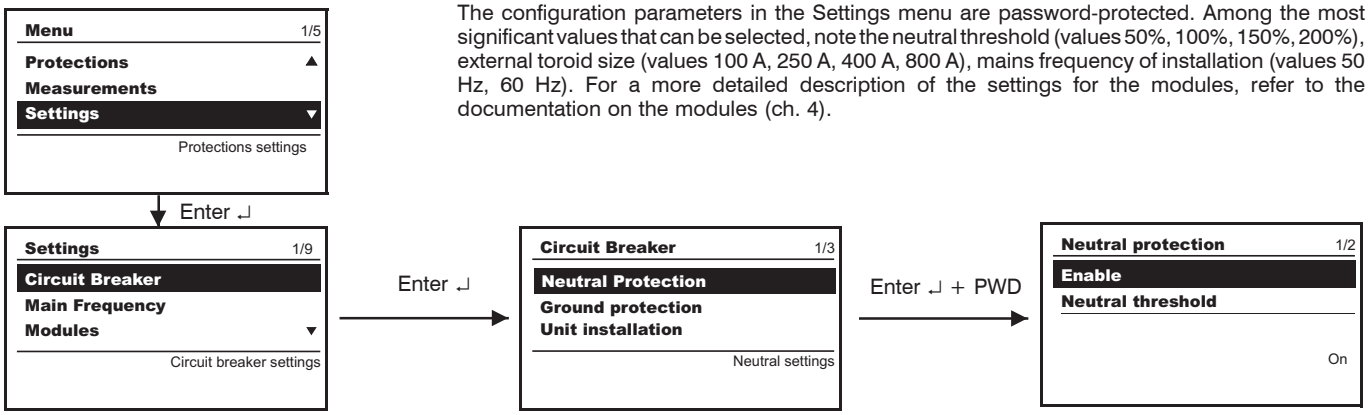
### 3.5.3 Measurements Menu

For a complete description of the functions of PR330/V module, see par. 4.1.
The following is a summary of the parameters accessible from the menu in the PR332/P and PR333/P units.

#### 3.5.3.1 Measurements Menu table

| Setting | Parameter/Function | Values | Notes | |
|---|---|---|---|---|
| **Historical data** | | | | |
| | Trips | | Last trip (20) | |
| | Events | | Events log (80 events max.) | |
| | Measurements | | | |
| | I Max | | Maximum active current | |
| | P Max | | Maximum active power (with PR330/V module only) | |
| | P Mean | | Mean active power (with PR330/V module only) | |
| | U Max | | Maximum voltage (with PR330/V module only) | |
| | U Min | | Minimum voltage (with PR330/V module only) | |
| | Reset measurements | | | |
| **Power factor** | | | cos φ measured | (with PR330/V module only) |
| **Energy** | Energy meters | | | (with PR330/V module only) |
| | Reset meters | | | |
| **Peak factor** | | | | |
| **Mains frequency** | | 50 Hz<br>60 Hz | Measured value | (with PR330/V module only) |
| **Contact wear** | | | Percentage of wear on CB contacts | |
| **Waveforms** | I1, I2, I3 | | Graph, harmonics | |
| | N | | Graph, harmonics | |
| | Voltage 12, 23, 31 | | Graph, harmonics | |

### 3.5.4 Settings Menu




The configuration parameters in the Settings menu are password-protected. Among the most significant values that can be selected, note the neutral threshold (values 50%, 100%, 150%, 200%), external toroid size (values 100 A, 250 A, 400 A, 800 A), mains frequency of installation (values 50 Hz, 60 Hz). For a more detailed description of the settings for the modules, refer to the documentation on the modules (ch. 4).

#### 3.5.4.1 Settings Menu table

| | Parameter/Function | Values | Notes |
|---|---|---|---|
| **Circuit breaker** | (*) Neutral protection | | |
| | Enable | ON/OFF | |
| | Neutral threshold | 50%-100%-150%-200% | |
| | (#) Ground protection | | This protection is provided only in the event of an external toroid being used |
| | External toroidal transformer | Absent, SGR, Rc | |
| | Toroid size SGR | | |
| **Mains frequency** | | 50 Hz - 60 Hz | |
| **Modules** | Module | | |
| | PR330/V - Measuring | if installed | see par. 3.5.4.4.1 |
| | PR330/D-M - COM | if installed | see par. 3.5.4.4.2 |
| | Local Bus unit | Installed-Not installed | |

(*) With the three-pole circuit breaker, the “3P+N” option is displayed and must be enabled if the outside neutral is installed.

(#) Earth protection with outside neutral, see par. 3.2.9.7 (G protection with external toroidal “Source Ground Return” transformer) or par.5.3(Residual Current Protection). Available for IEC type CB only.

| | Parameter/Function | Values | Notes |
|---|---|---|---|
| **Data Logger** | Enable | ON/OFF<br>Sampling frequency<br>Trigger<br>Stopping delay<br>Restart<br>Stop | See Annex par. 5.1 |
| **Dual setting** | Enable<br>Default setting<br>Dual Set CB closure<br>Dual Set with Vaux | ON/OFF<br>SET A/SET B | (for PR333/P only) |
| **Measurement interval** | | from 5 to 120 min, step 5 min | |
| **Harmonic distortion** | | ON/OFF | The warning indicates that the distortion exceeds factor 2.1 |
| **System** | Date<br>Time<br>Language<br>New password | English/Italiano/Français/Deutsch/Español | |
| **Display** | Contrast | | |

For the summary table related to surfing pages concerning S51/P1 contact, see par. 4.3.

#### 3.5.4.2 Adjusting the neutral

Neutral protection is normally set to a current value 50% of the adjustment made on the phases.
In some installations, where particularly high harmonics occur, the current running on neutral may be higher than that of phases.
In the SACE PR332/P and PR333/P releases, this protection can be set for the following values: $I_nN$ = 50% - 100% - 150% - 200% * $I_n$.
The values that can be used to adjust the neutral are given in the table below for the various possible combinations between types of circuit-breaker and adjustment of threshold $I_n$.

Neutral value (InN) adjustment will meet the following formula: $I_1 \times I_nN \leq Iu$
When a 4-pole CB is available, this setting is controlled by the relay which signals the fault through a LED (see par. 3.6.1) , and automatically adjusts the parameter, within the accepted limits.
When a 3-pole CB with external neutral is available, the relay does not perform any control and settings are to be adjusted by user.

E.g.: With CB X1B 800 with Rating Plug at 400A, Iu=800A and I1=1In, adjustment of $I_nN$ may be 50-100-200%
With CB X1B 800 with Rating Plug at 800A, Iu=800A and I1=1In, adjustment of $I_nN$ may be 50-100%

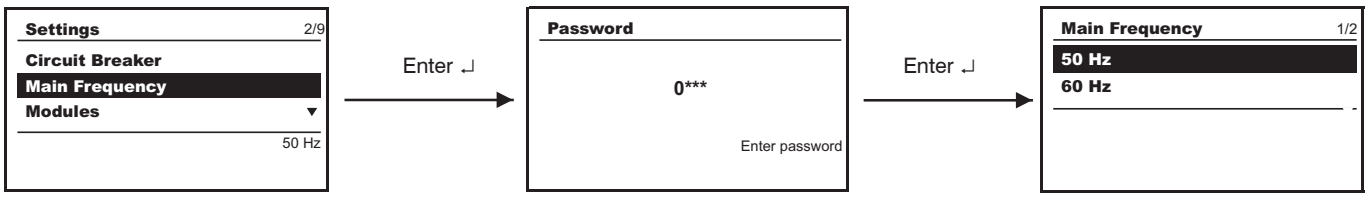
**Note 1:** $I_1=1I_n$ setting is intended as maximum adjustment of protection against overloads. Actual maximum allowable adjustment must take into account any temperature derating, terminals used and altitude, or In (rating plug) ≤ 50% of circuit breaker size.

**Failure to comply with the setting limits for "$I_n$" and "$I_nN$" can cause damage to circuit breaker with consequent risks even for operator.**

In any case, the relay records any setting error between $I_1$ and Neutral setting, and it signals this by means of a warning (see par. 3.6.3). For 4-pole CBs only.

#### 3.5.4.3 Mains frequency settings

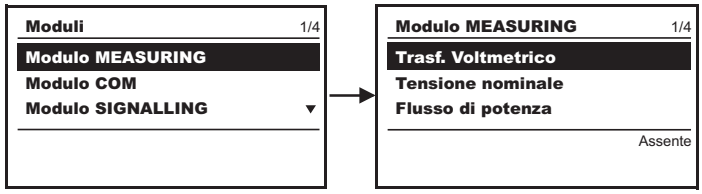
In the Mains frequency menu, frequency values: 50, 60 Hz can be selected.



### 3.5.4.4 Modules

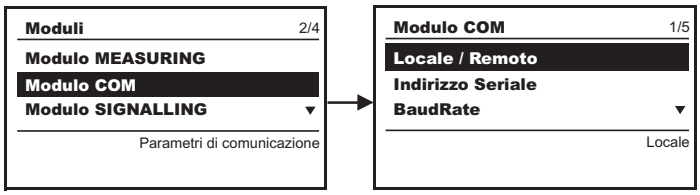
When you access the Settings menu, a set of menus relating to the modules is available.

#### 3.5.4.4.1 PR330/V - MEASURING module




In the measuring module, after entering a password you can opt for the absence or presence of the voltage transformer. Moreover, you can select the values of the phase-to-phase primary voltage (100, 115, 120, ... 1000 V) and secondary voltage (100, 110,..,230 V).
Power flow can be LOW → HIGH or HIGH → LOW. After entering a password you can choose whether neutral connection is to be Absent or Present, for 3-pole circuit-breakers only.

#### 3.5.4.4.2 PR330/D-M - COM module




Local or remote modes can be set after entering a password. The serial address can be displayed after entering a password. Baud Rate can be set to 9600 and 19200 bit/s. The physical protocol provides for options: (8,E,1), (8,O,1), (8,N,2), (8,N,1). Addressing can be selected as standard Modbus or ABB. For further information on the PR330/D-M communication MODULE, see paragraph 4.2 in this manual.

#### 3.5.4.4.3 Programmable contact S51/P1 - SIGNALLING

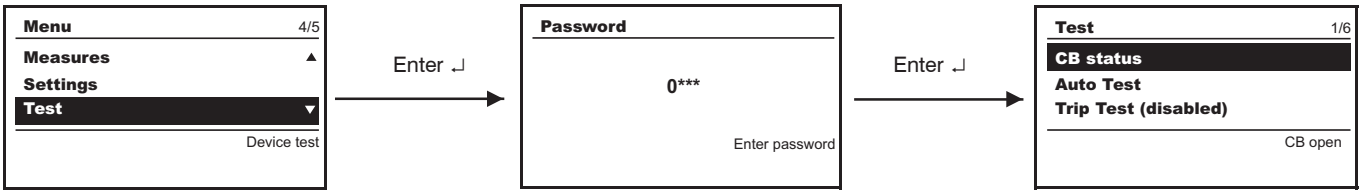
The device houses the programmable S51/P1 contact that can be combined with multiple events. This contact is default-set on Alarm L event, and can be programmed through PR010/T, SD-Testbus 2 or SD-Pocket.

#### 3.5.4.4.4 Settings for the Local Bus unit

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

### 3.5.5 Test Menu

Access to the Test menu is password-protected.




The menu shows the state of the CB; the dialog module (COM module), the state of the springs and the position of the CB; and in this submenu you can have the CB opened or closed.
Using the “Trip Test” function, Trip disabling/enabling can be viewed. When enabled, the circuit breaker is opened. This function is only available with a nil busbar current (use Vaux, PR030/B or PR010/T).
On the page, only with Vaux, you can also see the state of “STATUS” circuit breaker, thus making sure that input is correctly wired.

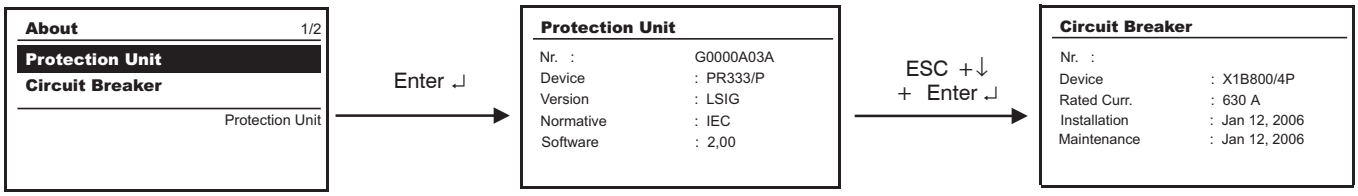
The surfing path is summarized in the following table:

### 3.5.5.1 Test Menu table

| Parameter/Function | | Values | Notes |
|---|---|---|---|
| **CB status** | | Open/Closed/Indefinite | Indefinite only in the event of a fault |
| **Auto Test** | | Display test | |
| **Trip Test** | | Enabled/Disabled | |
| **PR330/D-M module** | State of springs<br>Position of CB<br>Open CB<br>Close CB | Unloaded/Loaded<br>Isolated/Withdrawn | |
| **Zone selectivity** | Protection S/DFW<br>(status) Input<br>Force Output<br>Release Output | ON/OFF | |
| | Protection G/DBW<br>(status) Input<br>Force Output<br>Release Output | ON/OFF | |

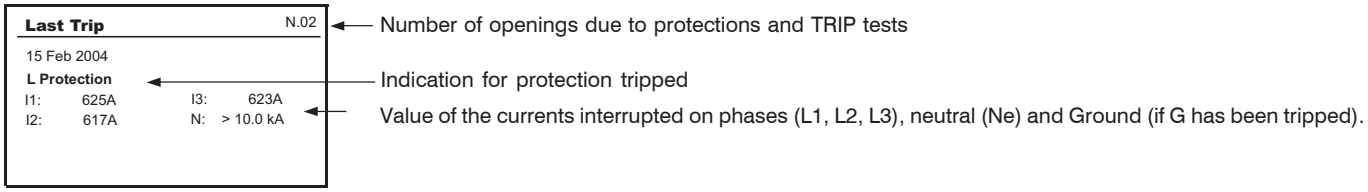
### 3.5.6 Information Menu

The Information Menu enables viewing data relating to protection unit and type of circuit breaker.




### 3.5.6.1 Information on trip and opening data

The PR332/P and PR333/P units save all information relating to type of protection tripped, opening data, date and time. Using the “i Test” key, the release will show all these data directly on the display. There is no need for an auxiliary power supply for this function. With an auxiliary power supply, information is shown immediately on the display without needing to press the “i Test” key, and remains displayed until the key is pressed. Information is available for 48 hours with the relay disconnected. The data relating to the last 20 trips are stored in the unit’s memory. By connecting a PR030/B and PR010/T battery unit or a BT030 wireless communication unit, you can retrieve all information relating to the last 20 trips recorded. Access to view the opening data is via the Historicals submenu in the Measurements menu. The following is an example of the information provided:




Again in the Measurements menu, you can view the percentage of contact wear, which is an indication of the electrical life of the contacts in the circuit breaker.
However, relay functionality is in no way modified by the presence of wear messages.
A prealarm message (wear > 80%, “warning” LED lighting up) indicates that wear has reached a high value. An alarm message (100% wear, “alarm” LED lighting up) indicates that the state of contact wear must be checked.
The percentage of wear depends on type of circuit-breaker and number of openings performed by circuit-breaker and by absolute current interrupted during each opening.

## 3.6 Definition of alarms and signals for the PR332/P and PR333/P units

### 3.6.1 Optical signals

| Signalling | Description |
|---|---|
| **Warning** (yellow permanent) LED | • The prealarm threshold has been exceeded; one or more phases with current values in the range $0.9xI_1 < I < 1.05xI_1$ (on the Ne, it depends on selection made; e.g. at 50%, values are halved);<br>• Presence, between two or three phases, of unbalance above the value programmed for "U" protection, with protection trip disabled;<br>• Presence of distorted wave form with form factor > 2.1;<br>• Contact wear greater than 80% (and less than 100%);<br>• WARNING Threshold $I_w$ exceeded;<br>• Circuit-breaker state error;<br>• Frequency off-range;<br>• Configuration error;<br>• Settings inconsistency. |
| **Warning** LED (yellow 0.5 Hz) | • WARNING threshold for temperature inside relay is exceeded. |
| **Warning** LED (yellow 2 Hz) | • ALARM threshold for temperature inside relay is exceeded. |
| **Alarm** LED (red) | • Presence of one or more overloaded phases with current values I>1.3 I1 (protection "L" timing) (on the Ne, it depends on selection made; e.g. at 200%, values are doubled)*;<br>• Timing in progress for protection function S;<br>• Timing in progress for protection function G;<br>• Timing in progress for the voltage (UV, OV, RV), frequency (OF, UF) protection functions;<br>• Timing in progress for reverse active power protection function (RP);<br>• Timing when unbalance between phases (protection U) exceeds the value set in the configuration with protection trip set to on;<br>• Contact wear = 100%;<br>• Rating Plug disconnected;<br>• Trip Coil (TC) disconnected;<br>• Key plug error;<br>• Current sensors disconnected;<br>• Installation error. |

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

### 3.6.2 Electrical signals

S51/P1 Programmable electric signalling
**K51/p1..p8** Programmable electrical signals, if the PR021/K unit is installed and there is an auxiliary power supply.
Pressing the "i Test" key enables resetting the activated contacts.

### 3.6.3 Table of error and warning messages

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

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

- = Warning signal/Protection in alarm mode, with no trip (trip=off)
- = Protection in alarm mode, with trip on end of timing (trip=on)
- = Information, no action, excepting display by relay

| Alarm message | Description | Notes |
|---|---|---|
| Harmonic dist. | Harmonic distortion alarm | Busbar currents with zone factor > 2.1 |
| Contact wear | Contact wear alarm | Contact wear =100% |
| G (TRIP OFF) | Alarm for protection G | |
| Gext (TRIP OFF) | Alarm for protection Gext | |
| T Alarm | Alarm for protection T | Temperature off-range |
| T (TRIP OFF) | Alarm for protection T | |
| U alarm | Protection U alarm | Protection U under timing |
| UV Alarm | Alarm for protection UV | |
| OV Alarm | Alarm for protection OV | |
| RV Alarm | Alarm for protection RV | |
| RP Alarm | Alarm for protection RP | |
| UF Alarm | Alarm for protection UF | |
| OF Alarm | Alarm for protection OF | |
| LC1 Load | Alarm for load control LC1 | |
| LC2 Load | Alarm for load control LC2 | |
| L1 Sensor | Alarm for L1 phase current sensor | Phase L1 sensor disconnected or faulty |

| Alarm message | Description | Notes |
|---|---|---|
| L2 Sensor | Alarm for L2 phase current sensor | Phase L2 sensor disconnected or faulty |
| L3 Sensor | Alarm for L3 phase current sensor | Phase L3 sensor disconnected or faulty |
| Ne Sensor | Alarm for Ne phase current sensor | Phase Ne sensor disconnected or faulty |
| Gext Sensor | Alarm for Gext current sensor | Gext sensor disconnected or faulty |
| TC disconnected | Trip Coil disconnected or faulty | |
| Rating Plug | Rating Plug Error absent or faulty | |
| Power factor | Alarm for power factor | The power factor module is lower than the specified threshold |
| Phase cycle | Phase cycle inverted | |
| Invalid date | Clock information lost | |
| CB status | CB status error | Probable error in Q26 and/or Q27 |
| Installation | Key plug error | |
| CB not defined | State of circuit breaker inconsistent (Open/Closed) | Probable error in Q26 and/or Q27 |
| Local Bus | Local Bus error | See par. 4.7 |
| Contact wear | Contact wear prealarm | Contact wear ≥ 80% |
| L prealarm | Protection L prealarm | |
| T prealarm | Protection T prealarm | |
| Frequency range | Frequency off-range | |
| Warning Iw | Iw threshold exceeded | |
| Timing L | Timing protection L | |
| Timing S | Timing protection S | |
| Timing S2 | Timing protection S2 | |
| Timing G | Timing protection G | |
| Timing Gext | Timing protection Gext | |
| Timing D | Timing protection D | |
| Timing U | Timing protection U | |
| Timing UV | Timing protection UV | |
| Timing OV | Timing protection OV | |
| Timing RV | Timing protection RV | |
| Timing RP | Timing protection RP | |
| Timing UF | Timing protection UF | |
| Timing OF | Timing protection OF | |

### 3.6.4 Error messages displayed in pop-up window

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

| Error message | Description |
|---|---|
| Wrong password | |
| Session impossible | A programming session cannot be opened due to a contingent situation (e.g. timing in progress) |
| Value off-range | Value beyond the established limits |
| Failed 1001/2001 | Inconsistent thresholds of protections L and S1 (SET1/SET2) |
| Failed 1002/2002 | Inconsistent thresholds of protections I and S (SET1/SET2) |
| Failed 1006/2006 | Inconsistent thresholds of protections I and D (SET1/SET2) |
| Failed 1005/2005 | Inconsistent thresholds of protections L and D (SET1/SET2) |
| Failed 1009/2009 | Zone selectivity enabled in both protection D and S & S2 and in G or Gext |
| Failed 1003/2003 | Inconsistent thresholds of protections L and S2 (SET1/SET2) |
| Failed 1004/2004 | Inconsistent thresholds of protections I and S2 (SET1/SET2) |
| Failed 3001 | Inconsistency as to language change |
| Failed 3002 | Inconsistency on Rc toroid |
| Failed 3003 | Inconsistency as to external Neutral configuration |
| Exception 6 | Control temporarily unavailable |
| Unavailable | Function is not available |

| Error message | Description |
|---|---|
| Invalid date | Date has not been set |
| Parameters revised | Programming session concluded correctly |
| Cancelled | Programming session cancelled |
| Failed | Programming session rejected |

## 3.7 Troubleshooting PR332/P and PR333/P units

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

**N.B.:**
1. Before consulting the following table, check for any error messages appearing for some seconds on the display.
2. FN indicates normal operation of the release.
3. When the suggestions proposed do not lead to a solution of the problem, please contact ABB SACE assistance service.

| No. | Situation | Possible causes | Suggestions |
|---|---|---|---|
| 1 | Trip test cannot be run | 1. Busbar current is > 0<br>2. The TC is not connected | 1. FN<br>2. Check messages on the display |
| 2 | Trip times lower than expected | 1. Threshold too low<br>2. Curve too low<br>3. Thermal memory enabled<br>4. Incorrect neutral selection<br>5. The SdZ is loaded | 1. Correct threshold<br>2. Correct curve<br>3. Exclude if not necessary<br>4. Correct Neutral selection<br>5. Exclude if not necessary |
| 3 | Trip times higher than expected | 1. Threshold too high<br>2. Curve too high<br>3. Curve $I^2t$ enabled<br>4. Incorrect neutral selection | 1. Correct threshold<br>2. Correct curve<br>3. Exclude if not necessary<br>4. Correct Neutral selection |
| 4 | Rapid trip, with I3=Off | Iinst tripped | FN short-circuit with high I |
| 5 | High earth fault current value, but no trip takes place | 1. Incorrect selection of sensor<br>2. Function G prevented with I>4 In | 1. Set int. or ext. sensor<br>2. FN |
| 6 | Display off | 1 No Vaux and current and/or voltage is below the minimum value.<br>2. Temperature off-range | 1. FN, see 3.2.2.1<br>2. FN, see 3.2.9.8 |
| 7 | The display is not back-lit | Current and/or voltages below the limit for lighting the display | FN |
| 8 | Reading of I incorrect | Current below the minimum threshold that can be displayed | FN |
| 9 | Reading of V, W and power factor φ incorrect | 1) Connection error between VT and PR330/V<br>2) VT parameter settings error | 1) Check connections between VT and PR330/V<br>2) Set the correct parameters |
| 10 | "⚠ Local Bus" message on display | No communication between PR332/P or PR333/P and PR021/K | 1. If not connected, disable PR021/K, see 3.5.4.4.4<br>2. Check bus connection<br>3. Check PR021/K |
| 11 | Message ""<br>instead of expected data | Function disabled or data off-range | FN |
| 12 | Expected trip does not take place | Trip function disabled | FN enable trip if necessary |
| 13 | No activation of protection Unbalance U | Values of I out of range | FN, see 3.2.9.5 |
| 14 | No display of opening data | No Vaux , buffer capacitor is discharged | FN, see 3.5.6.1 |
| 15 | The password is not requested | The password has been disabled | FN, re-enter the password with a value other than 0000 |
| 16 | Impossible to change any parameter | Release in an alarm situation | FN |
| 17 | Message " ⚠ Temp. Sensor" or " ⚠ Start-up" | Possible fault inside the relay | Contact ABB Sace |
| 18 | Invalid Date | 1. First installation<br>2. Information lost due to power failure | FN see 3.4.3. |
| 19 | Untimely trip | | see 3.6.3 |
| 20 | LED lighting | | see 3.6.1 |
| 21 | No possibility to change language | 1. Relay is remotely set<br>2. The CB is not open<br>3. Vaux, PR330/V or PR030/B not installed | 1. Set to local<br>2. Open CB<br>3. Power the relay |

### 3.7.1 In case of a fault

**If you think that the PR332/P or PR333/P is faulty, is malfunctioning or has generated an unwanted trip, follow the recommendations below very carefully from the Measurements menu ⟶ Historicals ⟶ Trip:**

1. Make a note of the type of protection that has tripped by accessing the LAST TRIP page if there is an external power supply (Vaux or battery) or by pressing “i Test” if in self-powering mode.
2. Note down type of circuit-breaker, number of poles, any accessories connected, In, Serial Number (see par. 3.4) and SW version.
3. Prepare a brief description of opening (when did it take place?, how many times?, was it always under the same conditions? what type of load? what voltage?, what current? is the event reproducible?)
4. Send/communicate all information collected, together with CB circuit diagram, to your nearest ABB Customer Assistance service.

Delivering comprehensive, accurate information to ABB Assistance service will facilitate technical analysis of the problem encountered, and allow us to promptly carry out all actions useful for the user.

## 3.8 Accessories

### 3.8.1 ABB SACE PR010/T test and configuration unit

Testing with SACE PR010/T unit enables monitoring proper operation of thresholds and trip times of protection functions L, S, I, G, OV, UV, RV, U. The test unit is wired to the relay by a dedicated connector (see par. 3.4).

### 3.8.2 BT030 communication unit

Using the BT030 wireless communication unit, the PR332/P and PR333/P can be connected by radio to a hand-held PC (PDA) or normal PC, thus extending the amount of information available to the user. In fact, using ABB SACE’s SD-Pocket communication software, you can read the values of the currents flowing through the circuit breaker, the value of the last 20 discontinued currents and protection settings.

### 3.8.3 PR021/K and HMI030 units

The PR332/P and PR333/P can also be connected to the optional PR021/K external signalling unit (see par. 6), to signal - by means of no-potential power contacts - alarms and tripped protections, and to the HMI030 unit to view the different types of information on the display.

### 3.8.4 PR030/B power supply unit

PR030/B power supply unit is a separate unit for powering relay, auto test and trip test, checkings with open CB and installation of new replacement units.

### 3.8.5 Flex Interface

Using the internal bus connections it is possible to connect different accessories modules (belonging to the same family) to the trip unit, by wich some informations are available to the user, like the status and the operating conditions of the unit.
For further detailed informations, see technichal documentation 1SDH000622R0001.

# 4 Modules

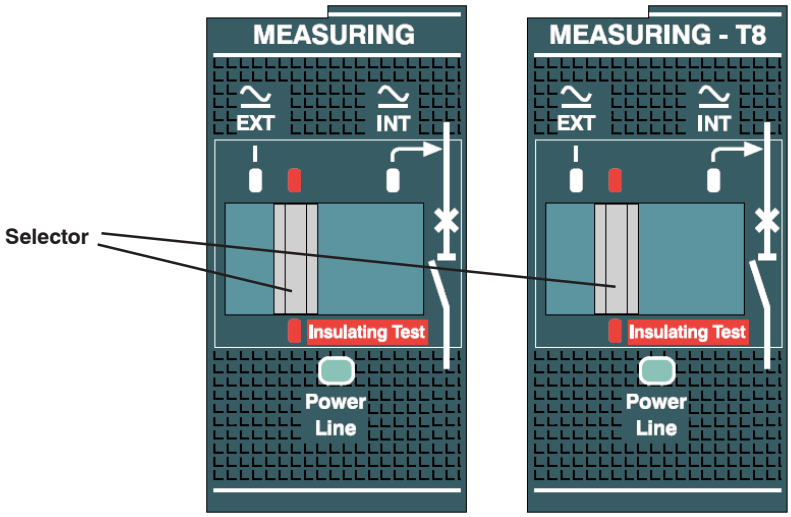
## 4.1 PR330/V - MEASURING Module

### 4.1 General characteristics

The Measuring module detects and processes phase voltages. The measurements are sent by the module to the protection release, enabling implementation of a set of protection and measurement functions. The module comes with a “Power Line” LED and a isolator for dielectric stiffness tests. Further, the module allows powering the relay.

### 4.1.2 Front view

- “Power Line” powering LED
  (lit when busbar voltage is available, see 4.1.4)
- Isolator




**Prior to performing a dielectric strength test, set the selector to Test position while setting the selector switch to “Insulating Test.”**

**Once the dielectric strength test is performed, set the selector to the required position depending on selected system configuration - VTs connected internally or externally – since all voltage protections are disabled when the selector is set to Test.**
**The "INT" selection is possible only with circuit breakers provided for internal connections.**

Dielectric stiffness tests are not allowed on secondary lines of any connected VTs.

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

### 4.1.3 Releases complete with module

- standard for PR333/P
- optional for PR332/P.

### 4.1.4 Powering the PR332/P and PR333/P units via the PR330/V Module

The PR332/P and PR333/P units are powered by the Measuring module via the busbar voltage.
The powering stage is capable of operating starting from an 80 Vrms 2-phase phase-to-phase voltage, up to 897 Vrms (1.3 * 690 Vrms) 3-phase phase-to-phase, at its input (coming directly from the busbars or from a transformer’s secondary winding). In case of three-phase systems with a phase-to-phase rated voltage greater than 690 Vrms, a step-down transformer (with a transformation ratio of less than 1) is used. See par. 4.1.7.

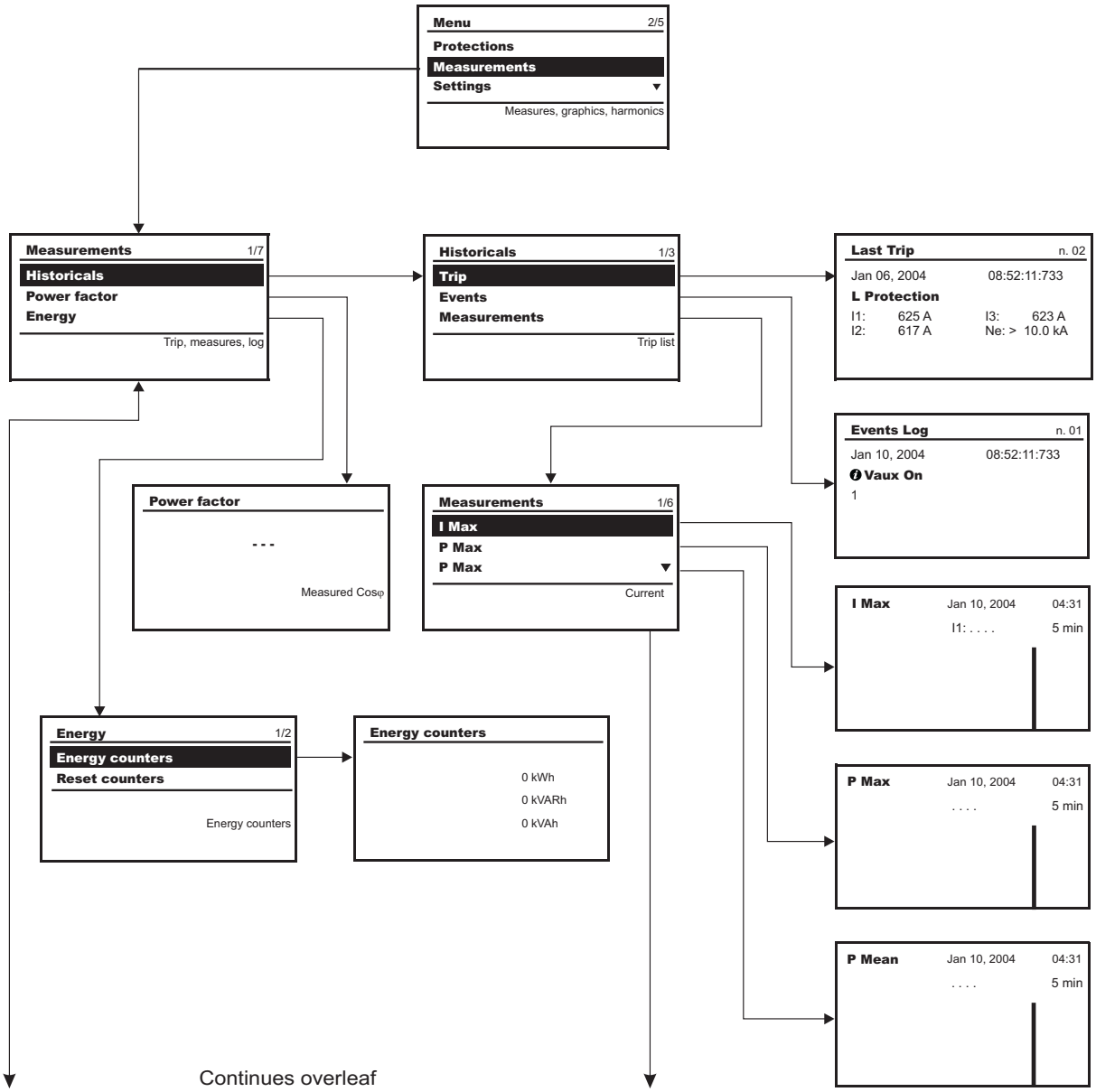
N.B.: to connect the PR330/V module, see figures 43, 44 and 48 of Wiring Diagrams.

| **Activations** | | **3-phase (phase-to-phase voltage)** |
|---|---|---|
| Trip unit start | Display backlit | Activation threshold |
| ☑ | | 60Vrms |
| ☑ | ☑ | 90Vrms |

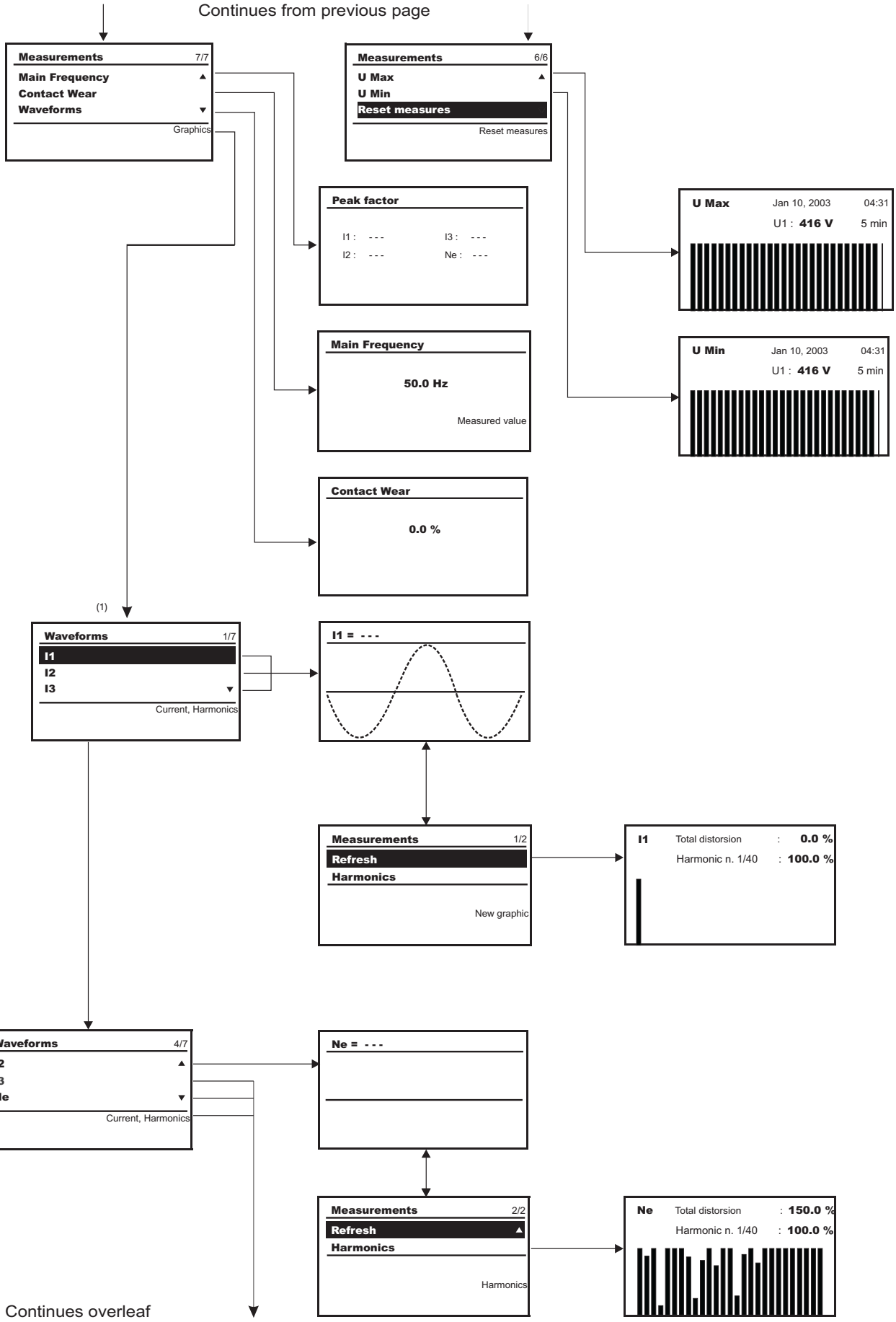
### 4.1.5 Operating instructions/Operation in service

#### 4.1.5.1 Using the Measurement submenus with the PR330/V module

Below is the module surfing menu which is always available on PR333/P, optional for PR332/P.

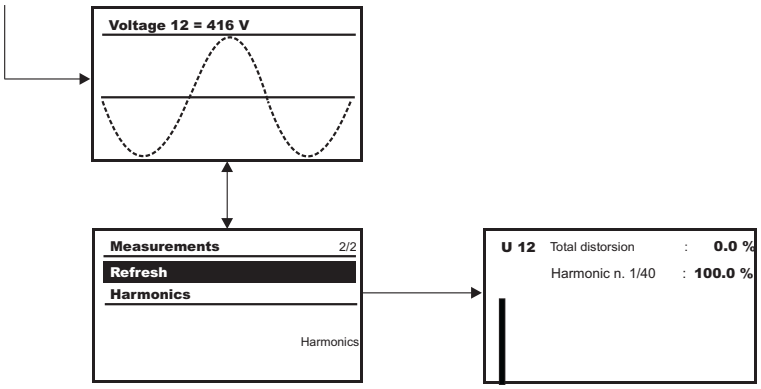


Continues from previous page




Continues overleaf

Continues from previous page




(1) - Valid for PR333 only

#### 4.1.5.2 Table of submenus for the PR330/V Module

The Menu is accessed from "Settings/Modules/PR330/V Module"

| Parameter/Function | Values | Notes |
|---|---|---|
| **Rated voltage** | 100V-115V-120V-190V<br>208V-220V-230V-240V<br>277V-347V-380V-400V<br>415V-440V-480V-500V<br>550V-600V-660V-690V | Voltage transformer set to "Absent"<br>For voltages lower than 690 V |
| **Primary voltage** | 100V-115V-120V-190V<br>208V-220V-230V-240V<br>277V-347V-380V-400V<br>415V-440V-480V-500V<br>550V-600V-660V-690V<br>910V-950V-1000V | Voltage transformer set to "Present"<br>For voltages above 690 V, see par. 4.1.7 |
| **Secondary voltage** | 100V-110V-115V-120V<br>200V-230V | |
| **Power flow** | low → high<br>high → low | PR330/V connected to lower terminals of CB<br>PR330/V connected to upper terminals of CB |
| **Signalling** (1) Phase sequence | | |
| Enable | ON/OFF | |
| Threshold | 123/321 | Can be set if enable is set to ON |
| Cos φ | | |
| Enable | ON/OFF | Can be set if enable is set to ON |
| Threshold | from 0.5 to 0.95 step 0.01 | |

(1) - For PR333 only

#### 4.1.5.3 Measurements Menu table

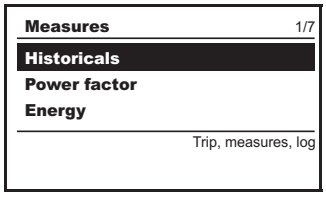
For convenience, the table related to Measurements Menu for release with Measuring module is shown, and is already included in the chapter dedicated to PR332/P and PR333/P.

| | Parameter/Function | Values | Notes |
|---|---|---|---|
| **Historical data** | Trips | | List of trips |
| | Events | | Events Log |
| | Measurements | | |
| | Maximum current | | |
| | Maximum active power | | |
| | Mean active power | | |
| | Maximum voltage | | |
| | Minimum voltage | | |
| | Reset measurements | | |
| | Mean power | | |
| **Power factor** | | | Cos φ measured<br>available under self-powering |
| **Energy** | Energy meters | | |
| | Reset meters | | |

| | | |
|---|---|---|
| **Peak factor** | | Peak value/RMS value<br>Available as self-powering |
| **Mains frequency** | 50-60 Hz | Measured value<br>Available as self-powering |
| **Contact wear** | | Percentage of wear on contacts |
| **Wave forms** | Current I1/I2/I3/Ne<br>Refresh<br>Hamonics<br>Voltage 12/23/31<br>Refresh<br>Hamonics | |

#### 4.1.5.4 Measurements Menu

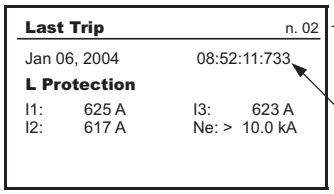
##### 4.1.5.4.1 Historicals




From the “Measurements/Historicals” menu, a whole set of further measurements can be accessed.

##### 4.1.5.4.2 Trips

Below, an example of a page related to a last trip, is included. You can access said page by selecting Trips via the path Measurements/Historicals/ Trips. This page shows the values related to type of protection tripped (L, as regards the example in question).

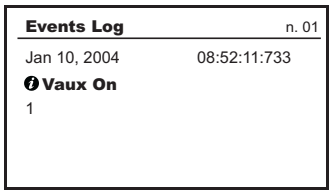



Meter: counts by progression (0 ... 65535) from date of last trip resetting. It displays the latest of the most recent 20 trips that can be selected.

Time (hour and minute) of CB tripping

##### 4.1.5.4.3 Events

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



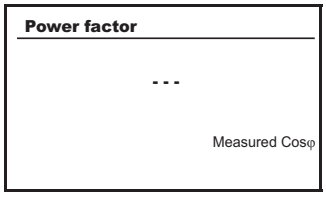

Meter: indicates “Last” and measures the previous events according to a -1, -2 progression to up to -80 (e.g. second-last -1)

##### 4.1.5.4.4 Measurements

It is possible, in this sub-menu, to display the following measurements:

**I max** - Maximum current
**P Max** - Maximum active power
**P Mean** - Mean active power
**U Max** - Maximum (phase-to-phase) line voltage
**U Min** - Minimum (phase-to-phase) line voltage
**Reset** - Reset measurements

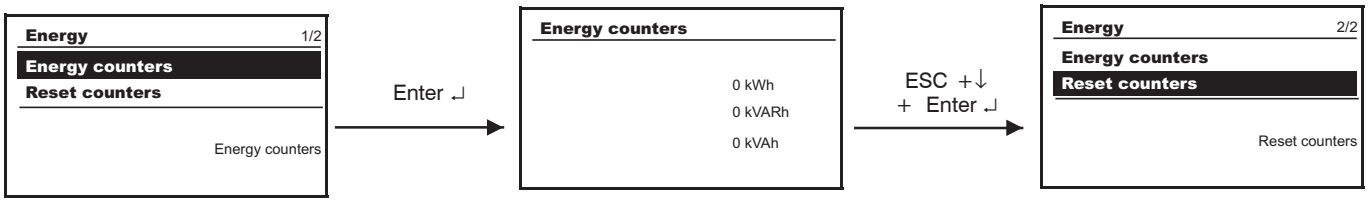
##### 4.1.5.4.5 Power factor



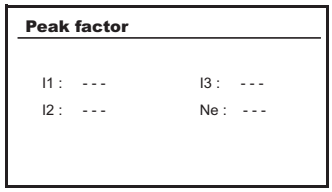

The overall power factor measurement is provided. For phase power under 2% (0.02x$Pn_{phase}$), the value is not displayed, but is replaced by ‘.....’.

#### 4.1.5.4.6 Energy

The unit also provides meter readings 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. Energy meters' full scale is about 2.15 billion kWh/kVARh/kVAh.
By confirming menu's "Reset meters" inside the page, the meter is set to zero.
For range and accuracy, see par. 3.2.9.15.

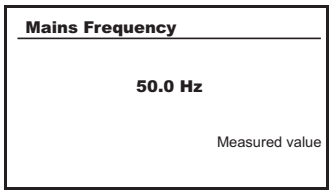



#### 4.1.5.4.7 Peak factor




You can also measure the peak factor - i.e. the relationship between $I_{peak}/I_{rms}$ for each of the phases. This measurement is not displayed for phase currents below 0.3xIn and it is not available for phase currents above 6xIn. For range and accuracy, see par. 3.2.9.15.

#### 4.1.5.4.8 Mains frequency

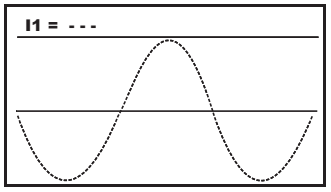



This page enables you to view the mains frequency. This is calculated on the voltages (if Umax > 0.1Un). For range and accuracy, see par. 3.2.9.15.
Measurement is ensured after 5s max by frequency variation.

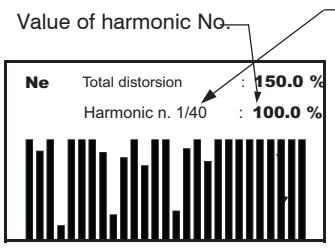
#### 4.1.5.4.9 Contact wear

This submenu displays the percentage of CB contact wear.

#### 4.1.5.4.10 Wave forms




When you access this menu page, 120 samples of the wave form of selected phase are acquired and displayed. When you press the ↵ key, a new wave form is acquired and displayed. Using the ↑ or ↓ keys, you can display the wave forms on the other measurement channels (L1, L2, L3, Ne, V1, V2, V3, Gt).




A harmonic analysis of samples acquired and displayed in the "Wave Forms" pages can be conducted. The page on the left is displayed, containing the module of the harmonics from the 1st to the 40th (up to the 35th for a mains frequency set to 60Hz) given as a percentage of the fundamental harmonic (harmonic no. 1), which is then given as 100%.

Using the ↑ or ↓ keys, you can go to the bar of interest (at the harmonic "No." required, the bar begins to flash) and read the corresponding percentage value.
Measuring accuracy is 5%.

### 4.1.6 Data Logger

The Data Logger is activated by Vaux or by powering from PR330/V.
For further information, see par. 5.1

#### 4.1.7 Electrical characteristics of the transformers

If phase-to-phase line voltage exceeds 690 VAC, use a step-down VT to be fitted between busbars and PR330/V module. Voltage transformers can be installed at a max distance of 15 m from PR330/V module to which they are connected.
Correct operation is ensured for star/star or delta/delta configurations.
The rated voltages of primary and secondary windings that can be used and to be set on the unit, are specified in Table 4.1.5.2.

*Mechanical characteristics*

| | |
|---|---|
| Securing | busbar DIN EN 50022 |
| Material | self-extinguishing thermoplastic |
| Degree of protection | IP30 |
| Electrostatic protection | with shield to be earthed |

*Electrical characteristics*

| | |
|---|---|
| Precision class | cl. 0.5 |
| Performance | ≥ 10VA, ≤ 20VA |
| Overload | 20% permanent |
| Insulations | 4 kV between inputs and outputs<br>4 kV between shield and outputs<br>4 kV between shield and inputs |
| Operating frequency range | 50 Hz to 60 Hz, ±10% |

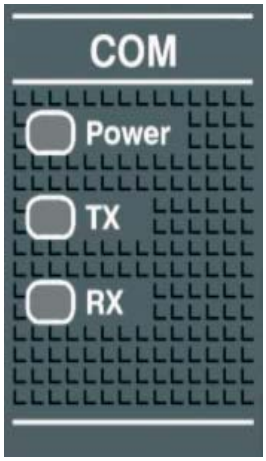
## 4.2 PR330/D-M - COM communication module

#### 4.2.1 General characteristics

The communication module is used to connect the relay to a Modbus network for remote supervision and control of circuit breakers.

#### 4.2.2 Front view

- "Power" LED on (lit with Vaux)
- LED RX/TX (data send/receive signal)




#### 4.2.3 Releases complete with module

- optional for PR332/P
- optional for PR333/P

#### 4.2.4 Power supply

The PR330/D-M - COM module is powered by the relay only when 24V auxiliary voltage is available.

#### 4.2.5 Communication functions available

The communication function on the PR332/P, PR333/P releases with PR330/D-M - COM, is listed in the table:

PR332/P or PR333/P + PR330/D-M - COM

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

#### 4.2.6 Command function

Matching PR330/D-M + PR330/R + CB with YO and YC accessories installed, allow the remote command Open/Close of the CB itself.

#### 4.2.7 PR330/D-M - COM Module Menu

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

## 4.3 Programmable contact S51/P1

#### 4.3.1 General characteristics

The contact allows local alarm and CB trip signalling.

#### 4.3.2 Releases complete with module

- standard on PR331/P
- standard on PR332/P
- standard on PR333/P

#### 4.3.3 Characteristics of the signalling contacts

The following data are defined for resistive loads (cos $\varphi = 1$)

#### 4.3.4 Power supply

The S51/P1 signalling contact is self-powered, by auxiliary power from the relay and/or PR330/V.

| **Type of contact** | **SPST** | |
|---|---|---|
| Maximum switching voltage | 130 Vdc | 380 Vac |
| Maximum switching current | 5 A | 8 A |
| Maximum switching power | 175 W | 2000 VA |
| | | |
| Breaking capacity @ 35 Vdc | 5 A | —— |
| Breaking capacity @ 120 Vdc | 0.2 A | —— |
| Breaking capacity @ 250 Vac | —— | 8 A |
| Breaking capacity @ 380 Vac | —— | 5.2 A |
| | | |
| Contact/coil insulation | | 4000 V eff |
| Contact/contact insulation | | 1000 V eff |

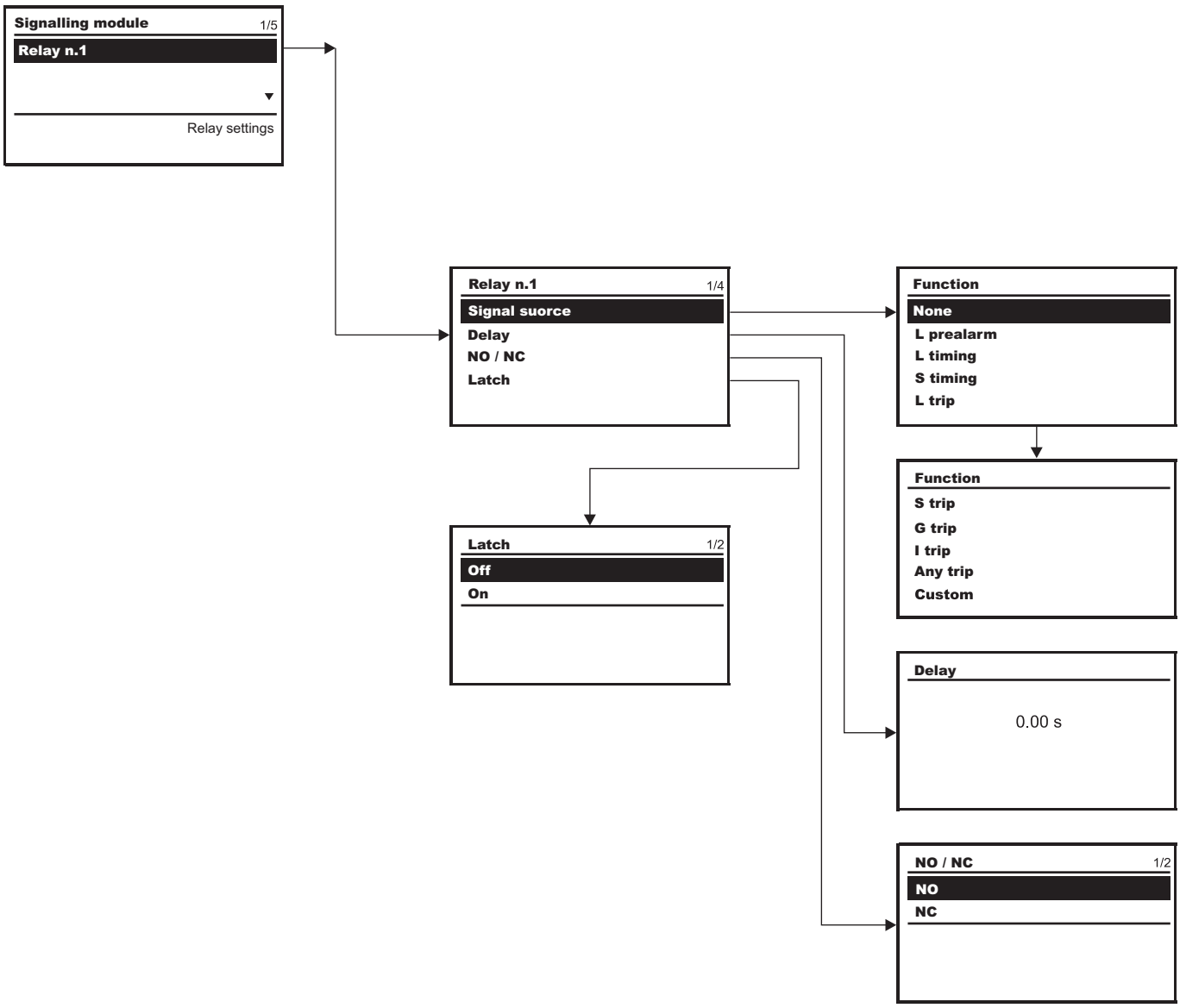
#### 4.3.5 S51/P1 Contact Menu

This contact can signal different situations selectable by user from among those given in the standard list, whereas customizations can be programmed by selecting “custom” on the menu and setting the signal required with a PDA, SD-Testbus or PR010/T.

| | Parameter/Function | Values | Notes |
|---|---|---|---|
| **Relay no. 1** | | | |
| (S51/P1) | Signal source | Standard or custom | - see chapter 4.3.6 |
| | Delay | 0...100 s step 0.01s | - Intentional delay before enabling contact |
| | NO/NC | NO/NC | - Contact normally open (NO) or normally closed (NC) |
| | Latch | ON/OFF | - With “ON”, the contact, once enabled, remains switched.<br>To reset, a specific reset action is needed. |

### 4.3.6 S51/P1 contact surfing diagram

The surfing path related to relay no. 1 (S51/P1) is displayed.



# 5 Appendices

## 5.1 Data Logger (recorder)

The Data Logger function is available on the PR332/P and PR333/P units and can be used to automatically save the instantaneous values of certain analog and digital measurements in a large-sized memory buffer. The data can easily be downloaded from the unit by means of the SD-Pocket applications using a Bluetooth or SD-TestBus port, by means of a Modbus bus, and transferred to any personal computer for processing.

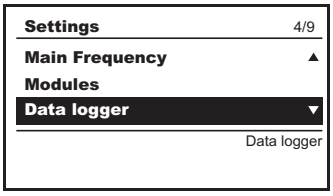
The function stops recording every time a trip occurs in order to facilitate failure analysis.

### 5.1.1 General characteristics

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

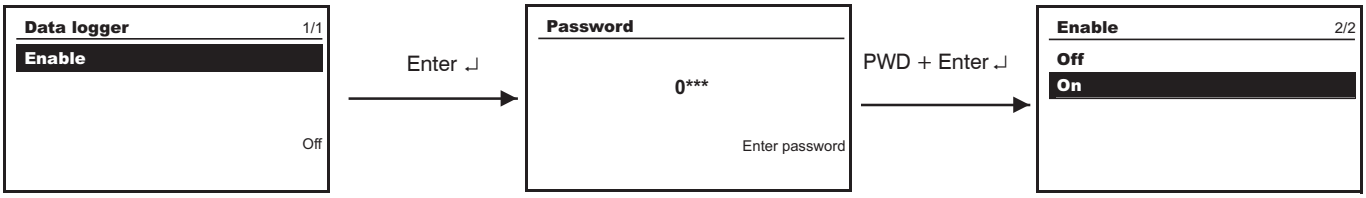
### 5.1.2 Description of the Data Logger menu

From the Settings Menu of PR332/P and PR333/P units, access is given to Data Logger's surfing menu:



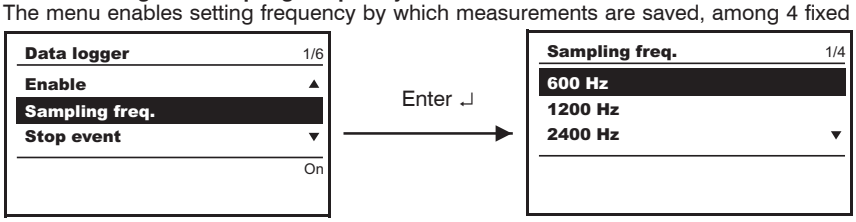

#### 5.1.2.1 Data Logger enabling

The Data Logger can be enabled by entering a password:




#### 5.1.2.2 Setting the sampling frequency

The menu enables setting frequency by which measurements are saved, among 4 fixed frequencies: 600 Hz, 1200 Hz, 2400 Hz or 4800 Hz.




Maximum duration of stored data recording (also see par. 5.1.3) depends on the frequency selected, and is given in the following table:

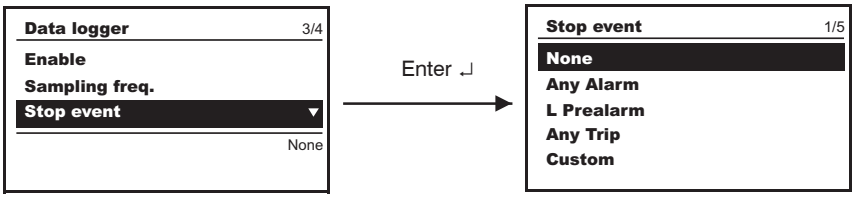
| Frequency | RECORDING TIME |
|---|---|
| 600 Hz | 27.3 s |
| 1200 Hz | 13.6 s |
| 2400 Hz | 6.8 s |
| 4800 Hz | 3.4 s |

Note: Selection of sampling frequency is an important factor. As a matter of fact, presence of high-order harmonic waves may give rise to aliasing on processing of collected data. Maximum frequency should be used in case of harmonic distortion, or else data processing may give results that do not match actual system conditions.

#### 5.1.2.3 Setting the standard triggers

It is possible to select one of the following triggers.

1. **None**
2. **Every alarm**
3. **L timing**
4. **Every trip**



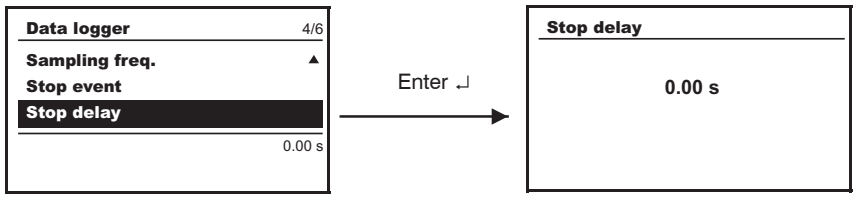
By setting trigger “None”, the Data Logger can be stopped only by a stop command from operator panel, system or after a trip caused by the relay.

#### 5.1.2.4 Events and display of custom Triggers

From the system, custom Triggers can be set to match the events given in par. 5.2.
In case of custom trigger, the following page will be displayed:


#### 5.1.2.5 Setting the stopping delay

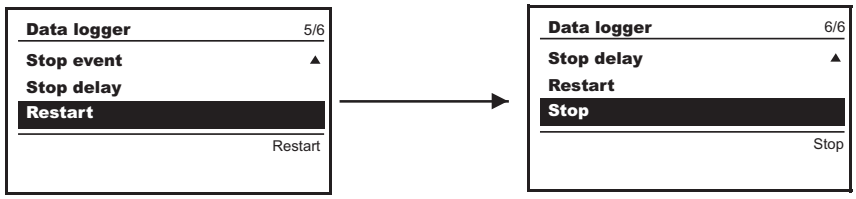
Stopping delay can be set within the range 0.00 [s] to 10.00 [s], by 0.01 [s] steps.




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

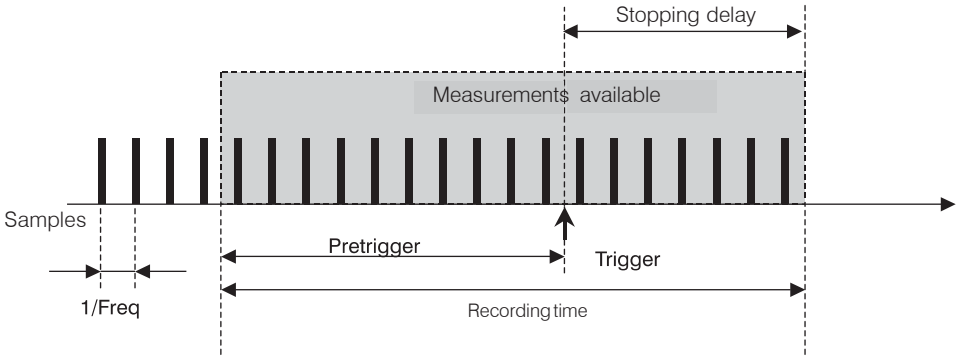
#### 5.1.2.6 Restart/Stop Data Logger

By means of the Restart/Stop options, Data Logger recording may be restarted/stopped.

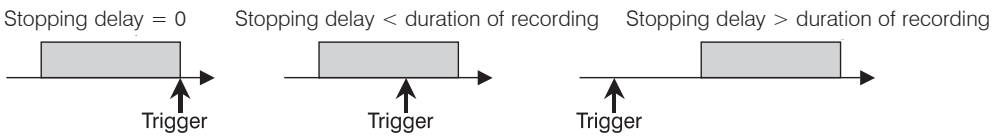



### 5.1.3 Recording time windows

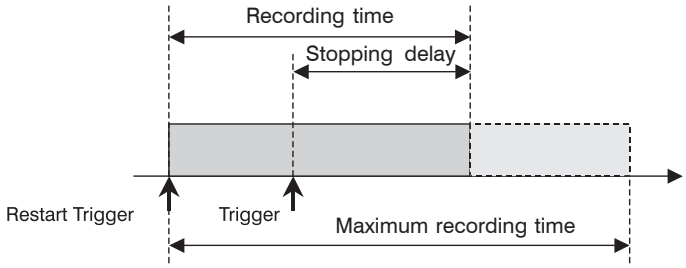
The measurements are recorded in a time window, the duration of which is defined and synchronized by a selectable event (Trigger).
The following figure displays time window, trigger and samples available:




User may select sampling frequency (see par. 5.1.2.2), type of Trigger event (see par. 5.1.2.3) and stopping delay (see par. 5.1.2.4) so as to obtain a required pre-triggering over the selected event.
According to the value set, stopping delay may have a zero, lower or higher duration over recording duration, as given in the following figure:



Maximum recording duration is defined by the sampling frequency set as described in the table in par. 5.1.2.2; recording duration may be lower than maximum duration allowed if the sum of stopping delay and time elapsed between a restart trigger and a trigger is lower to maximum value, as given in the following figure:




If the parameters relating to the Data Logger are changed while it is operating, the recording underway is terminated and a new recording begins on the basis of the new parameters (following a restart trigger command).

### 5.1.4 Description of the information given by the Data Logger system

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

By connecting to the separate release bus, parameters, triggers or Data Logger commands can be set, or types and sequences of stored data can be read.

Device combinations and consequent software combinations allowing this function are as follows:

**1) PR332/P + BT030+SD-Pocket**
**2) PR332/P + PR330/D-M + SD-Testbus or remote system**
**3) PR333/P + BT030+SD-Pocket**
**4) PR333/P + PR330/D-M + SD-Testbus or remote system**
**5) PR332/P + PR010/T ***
**6) PR333/P + PR010/T ***

* By these combinations, stored data sequences cannot be downloaded.

In this manual, the phrase “from (the) system” is used to define either the operations to be performed using one of the combinatios fitted with SD-Pocket or SD-Testbus or those which provide connection to a remote system.

#### 5.1.4.2 Access to saved data from the system

When the event associated to a trigger takes place or a stopping command is given, the following data will be stored in the recorder:

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

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

1. **current sample L1**
2. **current sample L2**
3. **current sample L3**
4. **current sample Ne**
5. **voltage sample U12**
6. **voltage sample U23**
7. **voltage sample U31**
8. **digital input/output (from 16 available. E.g.: inputs/outputs Zone Selectivity, S51/P1 contact status, ...)**
9. **alarms1 (from 16 available. E.g.: L timing, G alarm, Prealarm)**
10. **alarms2 (from 16 available. E.g.: UF timing, OV timing, Frequency error, RP timing)**
11. **trips (from 16 available. E.g.: trip of L, S, I, G, UV, OF, ...)**

#### 5.1.4.3 Information from the system on configuration and status of Data Logger

The following information is provided on the status of Data Logger:

| STATUS | |
|---|---|
| **Waiting trigger:** | this means that the Data Logger is enabled and waiting for the event selected as trigger to occur |
| **Data Logger triggered:** | this indicates that the trigger event has occurred and the Data Logger is recording |
| **Data Logger stopped:** | this means that recording has been terminated either because it has been completed or because a Data Logger stop command has been received |

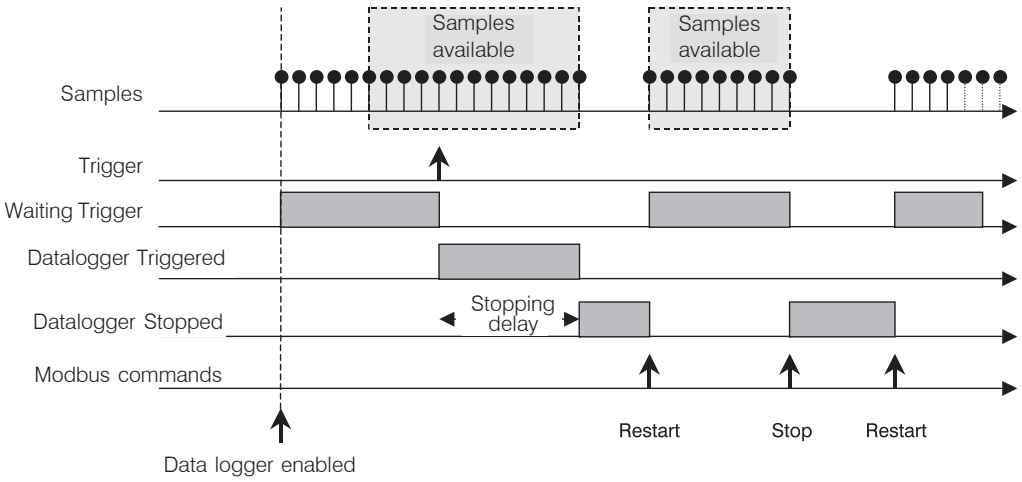
| CONFIGURATION | |
|---|---|
| **Data Logger Config:** | indicates whether or not the Data Logger is enabled |
| **Data Logger Trigger Type:** | indicates setting of trigger |
| **Data Logger Stopping delay:** | indicates Stopping Delay |

#### 5.1.5 Data Logger commands from system

As a consequence of a Stop Data Logger command, storage will be stopped from system. Any subsequent recording is enabled following a Restart trigger command. The same operations can be performed from the operator panel as given in par. 5.1.2.6.

**Example of Data Logger operation**

The following figure shows an example of how trigger and Data Logger operate, and influence of stopping delay and restart and subsequent stoppage of the data storage phase.




### 5.2 Event list table

#### 5.2.1 "Standard" events for S51/P1 and PR021/K that can be selected from the relay

| Event no. | Description | |
|---|---|---|
| 0. | None | (none enabled) |
| 1. | L prealarm | (L protection prealarm) |
| 2. | L timing | (L protection timing) |
| 3. | S timing | (S protection timing) |
| 4. | L trip | (L protection trip) |
| 5. | S trip | (S protection trip) |
| 6. | I trip | (I protection trip) |
| 7. | G trip | (G protection trip) |
| 8. | Any trip | (tripping of any protection) |

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

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

### 5.2.3 Examples of “custom” events for Data Logger function, S51/P1 and PR021/K

| No. (decimal) | Event | Notes | PR332 | PR333 |
|---|---|---|---|---|
| 1920 | G timing | | x | x |
| 2894 | L1 or L2 or L3 sensor error or Trip Coil error | | x | x |
| 2688 | LC1 alarm | | x | x |
| 2049 | G alarm | | x | x |
| 2306 | UV timing | | x | x |
| 4124 | UV or OV or RV tripped | | x | x |
| 33672 | CB connected and spring loaded | | x | x |
| 1793 | Harmonic distortion > 2.1 | | x | x |

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

### 5.2.4 Combining the devices needed to customize settings

“Custom” events can be selected using a remote control system, SD-Pocket, or SD-TestBus.
The devices needed to do so can be selected from among the following:

**1) PR332/P + BT030 + SD-Pocket**
**2) PR332/P + PR330/D-M + SD-Testbus or remote system**
**3) PR332/P + PR010/T**
**4) PR333/P + BT030 + SD-Pocket**
**5) PR333/P + PR330/D-M + SD-Testbus or remote system**
**6) PR123/P + PR010/T**

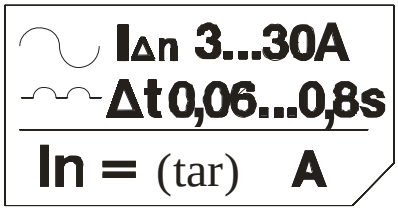
## 5.3 Residual current protection function (for IEC type CB only)

### 5.3.1 General Description

“TmaxT7-T8” and “Emax X1” series circuit breakers may have a toroid fitted at the rear of the CB (to a max distance of ten meters) so as to ensure residual current protection against earth faults.
In particular, the types of electronic release which can ensure this function are as follows:

- PR332/P LSIRc,
- PR332/P LSIG fitted with PR330/V module,
- PR333/P LSIG.

The residual current protection function is available only when a dedicated rating plug is installed, on which sensitivity ranges ad no trip times that characterize this function, are given.




The following table shows available calibrations:

| Available calibrations | CB frame size |
|---|---|
| 400 | T7 - X1 |
| 630 | T7 - X1 |
| 800 | T7 - X1 |
| 1000 | T7 - T8 - X1 |
| 1250 | T7 - T8 - X1 |
| 1600 | T7 - T8 - X1 |
| 2000 | T8 |
| 2500 | T8 |

The following table shows protection thresholds and times that can be set:

| Thresholds | Times |
|---|---|
| 3 A | 0.06 s |
| 5 A | 0.10 s |
| 7 A | 0.20 s |
| 10 A | 0.30 s |
| 20 A | 0.40 s |
| 30 A | 0.50 s |
| | 0.80 s |

The PR332/P LSIRc unit provides all functions of PR332/P LSI, however with additional residual current fault protection.
By using PR332/P LSIG with additional PR330/V module, residual current protection is added to a unit having the same characteristics as PR332/P LSI and all additional features described for the PR330/V, see par. 4.1.
With a PR333/P LSIG unit, the Rc protection function replaces external G function (Gext); however, G function remains enabled.

**The Rc protection is enabled only when a rating plug dedicated to Rc function is available, and after correctly performing unit installation procedures.**
**The protection cannot be disabled.**

### 5.3.2 Commissioning

The PR332/P LSIRc unit is supplied configured by SACE.
When using a PR332/P LSIG or PR333/P LSIG, follow te directions given herein to update the unit.

1. Remove all power supplies,
2. Replace the rating plug with one supplied by SACE for Rc application,
3. Install the toroid on the busbars as shown in 1SDH000579R0514,
4. Connect toroid to release as per wiring diagrams: 1SDM000051R0001 for T7, 1SDM000057R0001 for X1 and 1SDM000061R0001 for T8.
5. Power the unit through PR030/B then proceed to installation according to the following path: settings, circuit breaker, earth protection, external toroid, Rc. Confirm changes,
6. Check that no faults are signalled,
7. Set Rc protection threshold and times,
8. Conduct an Rc test, see par. 5.3.3; check for correct operation.

### 5.3.3 Rc test Menu

Rc protection test page can be accessed by pressing the “iTest” key for 7 seconds, or by reaching the Rc test page through the following path: test; Rc (Idn). The Rc test page will appear, press the “iTest” key once again to conduct the test.
The successful results are proved by CB opening according to the pre-set time.

**In case of faults related to the connections between toroid and protection unit, the display will show the wording:**  **GText sensor.**

### 5.4 Other informations

Further details of functioning of other signalling units that can be combined with PR331/P, PR332/P and PR333/P releases or regarding dedicated software tools, such as SD TestBus and SD Pocket, are available inside the Tmax (T7-T8) and X1 circuit-breakers technical catalogs.

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.

1SDH000587R0002 L3821

**ABB S.p.A.**
*ABB SACE Division*
Via Baioni, 35 - 24123 Bergamo - Italy
Tel.: +39 035.395.111 - Telefax: +39 035.395.306-433

***http://www.abb.com***