
Medium Voltage Products

# PR512
# Microprocessor-based self-supplied protection relays

Power and productivity
for a better world™

1 DESCRIPTION 3

2 CHARACTERISTICS AND ORDERING CODES 7

3 PR512/P (50-51) UNIT 11

4 PR512/P (50-51-50N-51N) UNIT 15

5 PR512/PD (50-51-50N-51N + DIALOGUE) UNIT 21

6 TIME-CURRENT CURVES 25

7 OVERALL DIMENSIONS 31

8 ELECTRICAL CIRCUIT DIAGRAM 33

# 1

# DESCRIPTION


| | |
|---|---|
| Special features | 4 |
| Protection always active | 5 |
| Use | 5 |
| Electromagnetic compatibility | 6 |
| Service conditions | 6 |
| Degrees of protection | 6 |
| Technical documentation | 6 |
| Quality System and Environmental Management System | 6 |

# DESCRIPTION

The PR512 relays are devices using digital microprocessor-based technology to obtain data processing regarding the protection.
The PR512 are used as switchboard protection units and provide protection of the installations, combined with ABB medium voltage HD4 series circuit-breakers.

## Special features

- Trip precision
- Wide setting range
- Operation ensured even with the primary circuit with single-phase power supply
- No limitation of the rated breaking capacity and short-time withstand current of the circuit-breaker even for the lowest rated currents of the relay
- Single and simultaneous adjustment of the three phases
- Constancy of characteristics and operating reliability
- Processing of the RMS value to express the true energy content of the current.

**PR512/P (50-51)**
- provides the protection functions against overload (51), instantaneous or delayed short-circuit (50)
- displays the phase current with the highest load.

**PR512/P (50-51-50N-51N)**
- provides the protection functions against overload (51), instantaneous or delayed short-circuit (50), earth fault (51) and instantaneous of delayed earth fault (50N)
- displays the phase current with the highest load.

**PR512/PD (50-51-50N-51N + dialogue)**
- provides the protection functions against overload (51), instantaneous or delayed short-circuit (50), earth fault (51) and instantaneous of delayed earth fault (50N)
- displays the phase current with the highest load
- has the dialogue function and allows connection to the electrical installation management system.

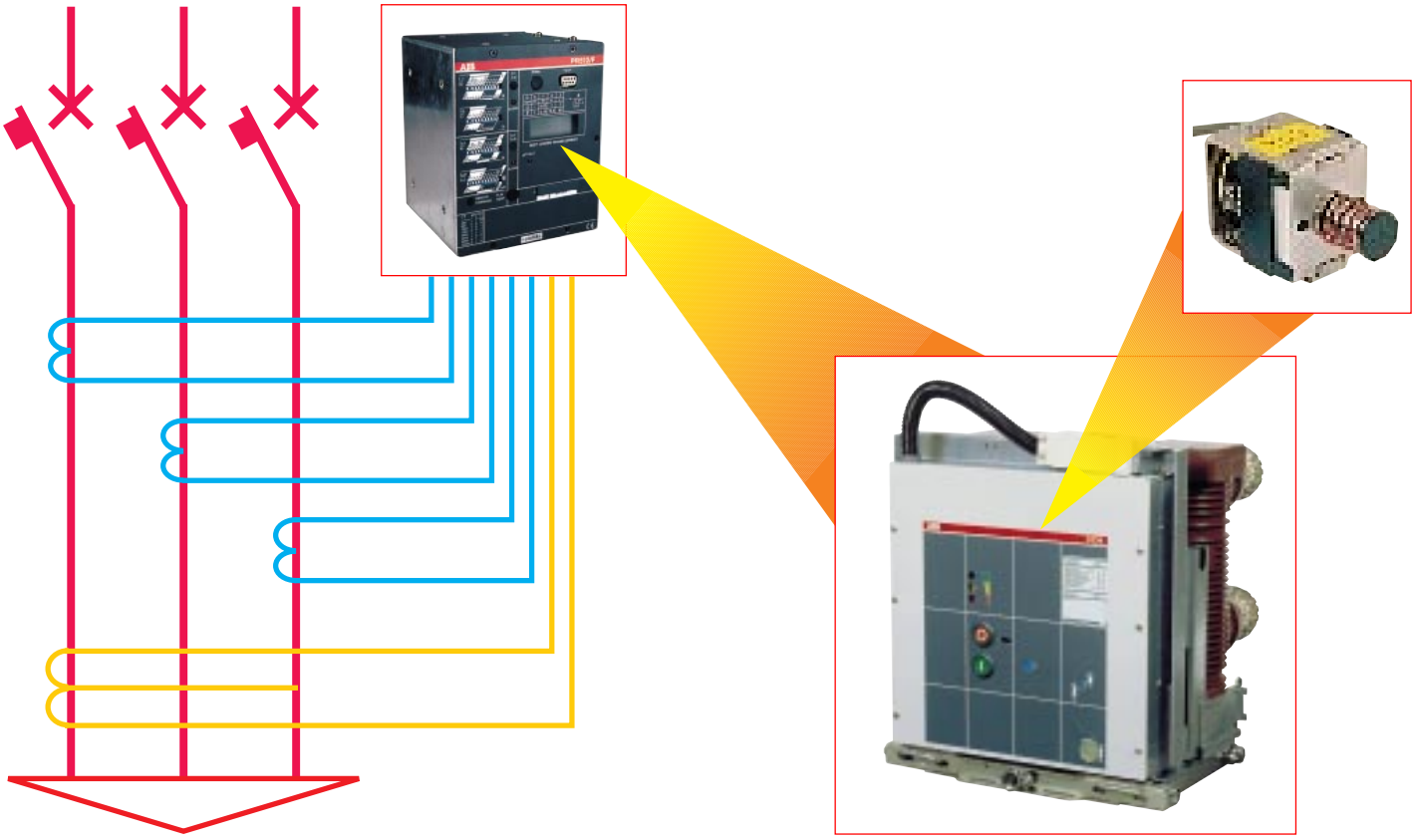
## Protection always active

The PR512 are the self-supplied type of relay and ensure complete installation protection even without an auxiliary power supply.
The energy for correct operation and for circuit-breaker tripping is supplied by the same current transformers which also make the current signal to be processed available.
Operation is ensured even with the primary circuit with single-phase power supply.

Thanks to these characteristics, the PR512 are also suitable for use in unmanned distribution substations without auxiliary services.

## Use

The PR512 relays can be installed in medium voltage primary or secondary distribution switch-boards for protection of MV/LV lines and trans-formers.



# DESCRIPTION

## Electromagnetic compatibility

The PR512 microprocessor-based protection relays ensure correct operation and are immune to unwarranted trips, even in the presence of interference caused by electronic apparatus, by stormy weather conditions or electric discharges. Moreover they do not interfere with any electronic apparatus near the installation.
These performances are obtained thanks to the following construction characteristics:
– the galvanised iron box provides efficient electromagnetic screening
– special filters on the current transformer inputs guarantee immunity against conducted interference
– the precise construction technique of the printed circuit helps to keep the level of electromagnetic sensitivity very low.

The above is in compliance with the EN 50081, 50082 and IEC 255-22 Standards as well as with European Directive EEC 89/336 regarding electromagnetic compatibility )EMC), in respect of which the releases are marked with the CE mark.

## Service conditions

– Operating temperature:
  - 5 °C ... + 40 °C
– Storage temperature:
  - 40 °C ... + 90 °C
– elative humidity without condensation: 90%
– MTBF: 15 years at an operating temperature of +45°C.

## Degrees of protection

The degree of protection of the units mounted in a switchboard is IP30.
For higher degrees of protection, please consult ABB.

## Technical documentation

For in-depth technical and application aspects, please ask for the following publications:

| | |
|---|---|
| – UniMix switchboards | 1VCP000008 |
| – UniAir switchboards | 1VCP000065 |
| – SafePlus switchboards | 1VCP000086 |
| – SD-View systems | 1VCP000176. |

**Quality System and Environmental Management system:** these comply with the ISO 9001 and ISO 14001 Standards respectively and are certified by an independent body.

**UniAir: air-insulated metal-enclosed switchboards for secondary distribution**

| | |
|---|---|
| Rated voltage | **... 24 kV** |
| Rated current | **... 1250 A** |
| Short-time withstand current | **... 20 kA** |

**SafePlus: gas-insulated metal-enclosed switchboards for ring main units**

| | |
|---|---|
| Rated voltage | **... 24 kV** |
| Rated current | **... 630 A** |
| Short-time withstand current | **... 20 kA** |

# 2

# CHARACTERISTICS AND ORDERING CODES


| | |
|---|---|
| Current transformers | 8 |
| Overload values | 8 |
| Earth fault external toroid | 8 |
| Power supply | 8 |
| Opening solenoid | 8 |
| Protection and trip signals | 8 |
| Binary input for control function | 9 |
| TEST function | 9 |
| Signalling outputs | 10 |
| Technical data of the relay contacts | 10 |
| Measuring function | 10 |
| Ordering codes | 10 |

## Current transformers

The current transformers (CT) (two or three according to the protection functions selected) must have the following characteristics:

| | |
|---|---|
| – rated secondary current | 1 A |
| – performance | 2.5 VA |
| – precision | 5 P 10 |
| – safety factor | 15 |
| – thermal performance (Ith) | 25 kA (1s - 50 Hz) |
| – service frequency | 50-60 Hz |

– for correct ammeter reading, the CT must be combined with the following rated primary currents: 40 A, 80 A, 100 A, 150 A, 200 A, 250 A, 600 A, 1250 A.
The rated current of the CT must be adjusted by means of the Dip Switches on the front of the relay. For CTs with other rated currents, the ammeter reading can be taken as a percentage of the rated value. In this case, preparation for a 100 A CT is set

## Overload values

The overload values allowed are as follows:

– 1.5 x In (continuous)

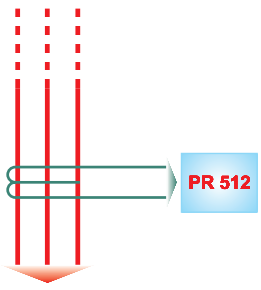
– 6 x In for 30 s

– 25 kA for 1 s.

## Earth fault external toroid

The PR512 relay can be used with an external toroid to detect the earth fault current, as long as it has the following characteristics:

| | |
|---|---|
| – rated primary current | at customer's choice |
| – rated secondary current | 1 A |
| – performance at 1 x In | 1 VA |
| – precision class | 3 or higher |
| – ultimate precision factor | at the customer's choice according to the total precision class required |
| – service frequency | 50-60 Hz |




## Power supply

The self-supply circuit, through the current transformers, activates the protection and measuring functions, even in the absence of an auxiliary power supply, starting from a minimum value of primary current of 0.2 x In on at least one phase fitted with CT.
The external toroid (for the protection functions 50N - 51N) does not contribute to the self-supply.
The unit can be fitted with an auxiliary power supply with 24 Vd.c. rated voltage, should the protection, measuring and control functions be required with the primary current less than 0.2 x In.
This power supply is always indispensable for the control and dialogue functions in the PR512/PD version.
The auxiliary voltage must be supplied from a feeder with galvanic insulation.

### Characteristics of the auxiliary power supply

| | |
|---|---|
| – Input voltage | 24 Vcc –20%<br>... 30 Vcc +10% |
| – Max. ripple | ± 5% |
| – Max. absorbed current | PR52/P: 50 mA<br>PR512/PD: 150 mA |

The apparatus remains galvanically insulated by this power supply by means of an internal DC/DC converter.
The auxiliary power supply must be made b means of a static continuity group independent of or derived from a busbar system on the supply side of the circuit-breaker.

## Opening solenoid

Circuit-breaker tripping takes place by means of an opening solenoid with demagnetisation which acts directly on the circuit-breaker operating mechanism. The solenoid receives the energy required for operation directly from the PR512 unit, and does not therefore require any auxiliary power supply.

## Protection and trip signals

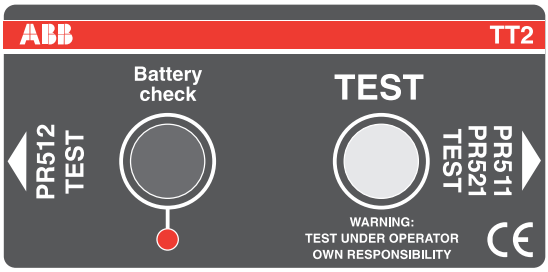
The releases have optic indicators on the front and bistable contacts. The detailed description of these is given in the paragraphs below.

## Binary input for control function

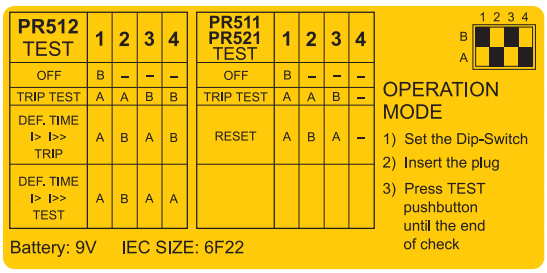
This input allows remote opening of the circuit-breaker.
The input must be made with a screened two-pole cable. Screening must be earthed on the metal box of the PR512 (please refer to the connection diagram enclosed with the circuit-breaker).
By connecting an unsupplied external contact (e.g. the contact of a Buchholz relay) to the special input connector, it is possible to control circuit-breaker opening remotely through the PR521 when the primary current exceeds the value of 0.2 x In on at least one phase fitted with a current sensor.
Should tripping for phase currents under 0.2 x In have to be guaranteed, the auxiliary power supply is required.
The maximum length of the connection is 30m.
The connection must be made with a screened two-pole cable.

## TEST function

By using the TT2 accessory (Test Unit supplied on request), the overall functionality **TEST** of the relay release (electronic part and YO3 opening solenoid) can be carried out.
By means of the 9 PIN connector, the TT2 Test unit allows the **TEST** to be carried out on functions 50-51 in the configuration with definite time curve (DT). The above-mentioned **TEST** can be carried out with the YO3 opening solenoid activated (**TRIP**) or de-activated (**TEST**).



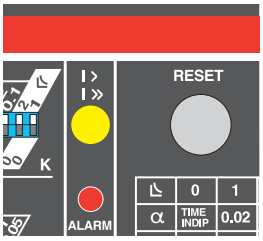

Front view of the TT2 Test Unit




Rear view of the TT2 Test Unit

### Use of the TT2 unit

– Put **Dip Switch 1** in position **A** to enable TT2 for operation. This also enables the test unit power supply with the display therefore lighting up.
In this case, it is also possible to carry out hardware resetting of the protection and resetting of the K51/YO3 signalling relays.
– Put **Dip Switch**es **1** and **2** in position **A** and press the TEST pushbutton to release the YO3 opening solenoid with consequent circuit-breaker opening.
– Put **Dip Switch**es **1** and **3** in position **A** and press the TEST pushbutton to check functions I> and I>> (only for the fixed time curves) and start selected function timing with subsequent release of the YO3 opening solenoid and consequent circuit-breaker opening.
– Put **Dip Switch**es **1, 3** and **4** in position **A** if the YO3 opening solenoid opening command is to be disabled during checking of function I> and I>>.
– To carry out self-diagnosis of the battery charge and correct operation of the TT2, put **Dip Switch 1** in position **A**, press the CHECK pushbutton and verify that the LED lights up. If the LED is off, the battery must be replaced.




## Signalling outputs

- **Signalling output by means of closing contact.**

A closing contact is available to signal relay trip (K51/YO3).
The contact is of the bistable type and belongs to a relay which keeps its sate even with a power cut and until the **RESET** operation.
After protection trip and circuit-breaker opening, the contact can be reset by means of the **RESET** pushbutton on the front of the relay, ensuring one of the following conditions:

a) 24 Vdc auxiliary voltage present (display lit);
b) circulating primary current higher than 0.2 x In (display lit with indication of the circulating current);
c) application of the TT2 unit to the **TEST** connector on the front of the release (optional accessory).

**N.B.** This signalling contact is not enabled if a remote circuit-breaker opening command is given. Resetting takes place 1 s after the pushbutton is pressed.

- **Microprocessor fault signalling output.**

A closing contact is available to signal a permanent fault in the microprocessor.
The contact is of the bistable type and belongs to a relay which keeps the state even in the absence of the power supply and until the **RESET** operation).

## Technical data of the relay contacts

The signalling relay contacts have the following electrical characteristics:

| | |
|---|---|
| – maximum interrupted current | 0.8 A |
| – maximum interrupted voltage | 110 Vca/Vcc |
| – maximum interrupted load at 24 Vdc: | |
| – inductive (L/R = 7 ms) | 10 W |
| – resistive | 24 W |
| – maximum interrupted load at 48 Vac: | |
| – inductive (cosφ = 0.4) | 15 VA |
| – resistive | 30 VA |
| – contact/contact insulation | 500 Veff |
| – contact/coil insulation | 1000 Veff |

## Measuring function

The liquid crystal display allows the most highly loaded phase current to be shown (this measurement is a function of the rated current of the CT set by means of **Dip Switch**es on the front of the unit).
When there is no auxiliary power supply, the minimum value displayed is 0.21 x In single-phase and 0.18 x In two-phase. With an auxiliary power supply, it guarantees a minimum value displayed of 0.05 x In. Under this value -LL- (Low Load) is displayed.
Precision is 5% ± 1 LSD (Least Significant Digit) for current values from 0.5 to 1.5 x In.

PR 512/P

PR 512/PD

PR 512/PD with dialogue

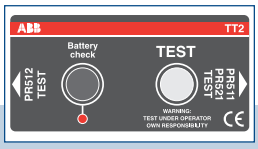
## Ordering codes

### Protection relay

| Description | Code UXAB |
|---|---|
| PR 512/P (50-51) | **399101001** |
| PR 512/P (50-51-50N-51N) | **399101002** |
| PR 512/PD (50-5150N-51N + Dialogue) | **399101003** |

### TT2 test unit

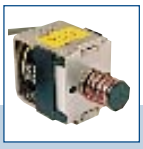
| Description | Code UXAB |
|---|---|
| TT2 | **379602231** |




TT2 test unit

### Opening solenoid (YO3)

| Description | Code UXAB |
|---|---|
| Solenoid for HD4 circuit-breaker | **349700311** |



Opening solenoid YO3

### External toroidal transformer

| Description | Code UXAB |
|---|---|
| Toroid with closed core internal diameter 110 mm - 50/1 A | **379602301** |
| Toroid with split core internal diameter 110 mm - 50/1 A | **379602302** |

External toroidal transformer

# 3

# PR512/P UNIT (50-51)


| | |
|---|---|
| Protection functions | 12 |
| Protection against overcurrent (51) | 12 |
| Selection of threshold I> value | 12 |
| Selection of type of I> curve | 12 |
| Selection of t> trip time | 13 |
| Protection against instantaneous or delayed short-circuit (50) | 13 |
| Selection of I>> threshold value | 13 |
| Selection of t>> trip time | 14 |
| Rated and setting currents | 14 |

## Protection functions

The PR512/P protection unit (50-51) carries out two independent protection functions which can be excluded:
– **51** protection against overcurrent:
  • 0.2 ≤ I ≤ 2 In (rms)
  • 2 ≤ I ≤ 20 In (peak);
– **50** protection against instantaneous or delayed short-circuit (operation on peak value).

## Protection against overcurrent (51)

This function makes four different groups of protection curves available, defined as follows (IEC255-3):
– definite time-delay
– normal inverse time-delay
– very inverse time-delay
– extremely inverse time-delay.

The threshold value of this protection is indicated by **I>**, whereas the relative trip time is indicated by **t>**.
Start of timing is signalled by the **ALARM LED** lighting up whereas circuit-breaker opening having taken place is signalled on the front by the magnetic flag **I> I>>**, turned to the yellow position.
To reset signalling, the **FLAG RESET** pushbutton on the front of the release must be pressed, ensuring one of the following conditions:
a) 24 Vdc auxiliary voltage present (display lit);
b) primary circulating current more than 0.2 x In (display lit with indication of the circulating current);
c) application of the TT2 unit to the **TEST** connector on the front of the release (optional accessory).

## Selection of threshold I> value

Setting of **I>** threshold is carried out by using the Dip Switches (see page 13).
The sum of the values selected represents the fraction of **In** which corresponds to **I>**.
32 threshold values are available, defined from 0.2 .... 1 x In with steps of 0.025 x In.
The protection can be excluded by positioning the first Dip Switch in the **OFF** position.

The following settings are possible:

• **32 threshold current values (I>)** (1)

| | | | | |
|---|---|---|---|---|
| 0.200 | 0.225 | 0.250 | 0.275 | |
| 0.300 | 0.325 | 0.350 | 0.375 | |
| 0.400 | 0.425 | 0.450 | 0.475 | |
| 0.500 | 0.525 | 0.550 | 0.575 | |
| | 0.625 | 0.650 | 0.675 | |
| 0.700 | 0.725 | 0.750 | 0.775 | |
| 0.800 | 0.825 | 0.850 | 0.875 | |
| 0.900 | 0.925 | 0.950 | 0.975 | |
| 1.000 | | | | **x In** |
| **OFF** | | | | |

(1) The unit guarantees non-entry into threshold for currents under 1.05 x I> set and guarantees entry into threshold for currents above 1.30 x I> set.

## Selection of threshold I> value

Four different time-current relationships can be selected.

**Fixed time curve ($\beta$ = 2)**
For protection with definite time (DT), the trip time is given by the following relationship:

$$t> = K \times \beta$$

## Definite time-delay curves

For definite time-delay protection, the relationship between trip time and overcurrent is given by the following formula.

$$t> = K \times \frac{\beta}{\left[\frac{I}{I>}\right]^{\alpha} - 1}$$

**Caption**

**t>** trip time
**k** parameter set by the user to select the trip curve
$\alpha$, $\beta$ pair of parameters, depending on the type of protection selectable
**I** fault current
**I>** trip threshold selectable by the user

Parameters α and β can take on the following values according to the curve selected.

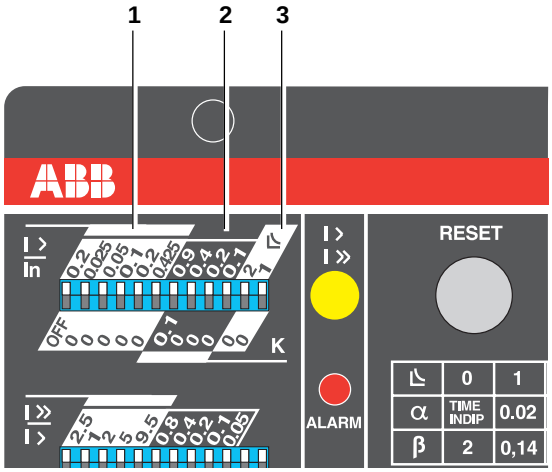
- Normal inverse time-delay curve (NI):
  α **= 0.02** β **= 0.14.**
- Very inverse time-delay curve (VI):
  α **= 1** β **= 13.5.**
- Extremely inverse time-delay curve EI):
  α **= 2** β **= 80.**

## Selection of t> trip time

The trip time of the protection is adjusted by using the Dip Switches as shown in the figure.
By means of the Dip Switches, the value of **K** is set which, when replaced in the previous relationships, determines trip time **t>**.
The following settings are possible:

- **16 trip times (t>),**
  **(K = 0.1...1.6 with steps of 0.1)**

| | | | | | |
|---|---|---|---|---|---|
| 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | |
| 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | |
| 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 |




**Caption**

**1** Dip Switch for setting the trip threshold of protection I>
**2** Dip Switch for setting timing K of protection I>
**3** Dip Switch for selecting the type of curve for protection I>:
- **DT** curve with definite time
- **NI** curve with normal inverse time
- **VI** curve with very inverse time
- **EI** curve with extremely inverse time.

## Protection against instantaneous or delayed short-circuit (50)

This function makes a family of definite adjustable time curves available, indicated by the symbol **I>>**. The corresponding trip time is indicated by the symbol **t>>**.
Start of timing is signalled by the **ALARM LED** lighting up, whereas circuit-breaker opening is signalled on the front by the magnetic flag **I> I>>**, turned to the yellow position. To reset signalling, the **FLAG RESET** pushbutton on the front of the release must be pressed, ensuring one of the following conditions:
a) 24 Vdc auxiliary voltage present (display lit);
b) primary circulating current higher than 0.2 x In (display lit with indication of the circulating current);
c) application of the TT2 unit to the **TEST** connector on the front of the release (optional accessory).

## Selection of I>> threshold value

Setting the **I>>** threshold is carried out by working on the Dip Switches as shown in the figure below. The sum of the values selected represents the multiple of **I>** and corresponds to threshold **I>>**.
**N.B.** Even if protection I> is OFF, the first **Dip Switch** takes on the value 0.2.

The following settings are possible:

- **16 threshold current values (I>>)**

| | | | | |
|---|---|---|---|---|
| 2.5 | 3.5 | 4.5 | 5.5 | |
| 7.5 | 8.5 | 9.5 | 10.5 | |
| 12 | 13 | 14 | 15 | |
| 17 | 18 | 19 | 20 | **x I>** |
| **OFF** | | | | |

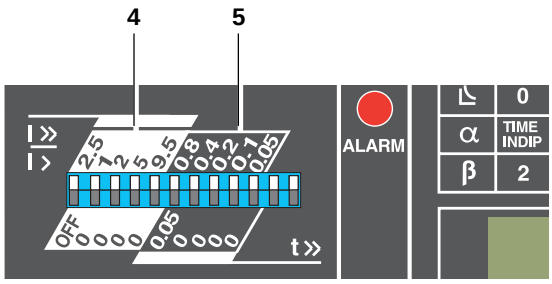
## Selection of t>> trip time

The function of protection **I>>** has a single definite curve adjustable to 31 values. The trip time of the protection is set by using the Dip Switches as shown in the figure.

The following settings are possible:

- **31 trip times (t>>), (0.05...1.55 with steps of 0.05)**

| | | | | | |
|---|---|---|---|---|---|
| 0.05 | 0.10 | 0.15 | 0.20 | 0.25 | |
| 0.30 | 0.35 | 0.40 | 0.45 | 0.50 | |
| 0.55 | 0.60 | 0.65 | 0.70 | 0.75 | |
| 0.80 | 0.85 | 0.90 | 0.95 | 1.00 | |
| 1.05 | 1.10 | 1.15 | 1.20 | 1.25 | |
| 1.30 | 1.35 | 1.40 | 1.45 | 1.50 | |
| 1.55 | | | | | **s** |




### Caption

**4** Dip Switch for adjusting the trip threshold of protection I>>.

**5** Dip Switch for adjusting the trip time t>> if protection I>>.

## Rated and setting currents

| **Current transformer (CT)** | **Protection functions** | | | |
|---|---|---|---|---|
| **In [A]** | **I> 0.2 ... 1 x In [A]** | **I>> 2.5 ... 20 x I> [A]** | **Io> 0.1 ... 1 x In [A] (1)** | **Io>> 2.5 ... 20 x Io> [A] (1)** |
| 40 | 8 ... 40 | 20 ... 800 | 4 ... 40 | 10 ... 800 |
| 80 | 16 ... 80 | 40 ... 1600 | 8 ... 80 | 20 ... 1600 |
| 100 | 20 ... 100 | 50 ... 2000 | 10 ... 100 | 25 ... 2000 |
| 150 | 30 ... 150 | 75 ... 3000 | 15 ... 150 | 37.5 ... 3000 |
| 200 | 40 ... 200 | 100 ... 4000 | 20 ... 200 | 50 ... 4000 |
| 250 | 50 ... 250 | 125 ... 5000 | 25 ... 250 | 62.5 ... 5000 |
| 600 | 120 ... 600 | 300 ... 12000 | 60 ... 600 | 150 ... 12000 |
| 1250 | 250 ... 1250 | 625 ... 25000 | 125 ... 1250 | 32.5 ... 25000 |

In = rated current of current transformer
I> = setting value of overload current (51)
I>> = setting value of short-circuit current (50)
Io> = setting value of earth fault current (first threshold) (51N)
Io>> = setting value of earth fault current (second threshold) (50N)
(1) If an external toroidal current transformer is used, recalculate the setting values according to its primary rated current.

# 4

# PR512/P (50-51-50N-51N) UNIT


| | |
|---|---|
| Protection functions | 16 |
| Earth fault external toroid | 16 |
| Protection against earth fault (51N) | 16 |
| Selection of threshold Io> value | 16 |
| Selection of type of Io> curve | 17 |
| Selection of to> trip time | 17 |
| Protection against instantaneous or delayed earth fault (50N) | 18 |
| Selection of Io>> threshold value | 18 |
| Selection of to>> trip time | 18 |
| Rated and setting currents | 19 |

## Protection functions

The PR512/P (50-51-50N-51N) unit carries out all the functions of the PR512/P (50-51) unit as well as the following protection functions:
– **51N** protection against earth fault:
  • 0.2 ≤ I ≤ 2 In (rms)
  • 2 ≤ I ≤ 20 In (peak);
– **50N** protection against instantaneous or delayed earth fault (operation on peak value).

The homopolar current is calculated as the vectorial sum of the three phase currents. This sum is done by the toroidal current transformer inside the release or by means of an external toroidal current transformer connected to the special input.

Protection against earth fault is possible if the release is connected to three phase CTs or to two phase CTs and to the external toroidal transformer.
When the release is self-supplied, the **Io>** and **Io>>** protection functions are only activated if the primary current exceeds the value of 0.2 x In (In is the rated current of the phase CTs).
For higher performances, a 24 V dc auxiliary power supply unit must be provided.

## Earth fault external toroid

The value of the rated homopolar fault current (In) varies according to whether the external or internal toroid is used:
– with an internal toroid: In = rated current of the phase CT
– with an external toroid: In = rated current of the external toroidal current transformer.

The solution with the external toroid allows any homopolar current to be controlled.
The toroid characteristics are described on page 8.

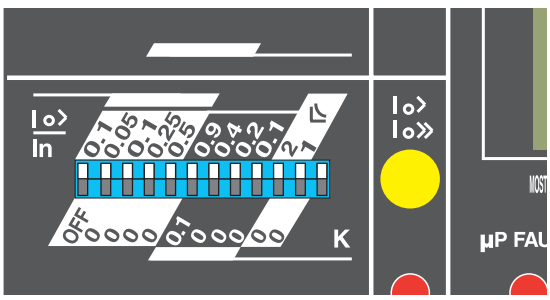
## Protection against earth fault (51N)

This function makes four different families of protection curves available, defined as follows (IEC255-3):
– definite time
– normal inverse time
– very inverse time
– extremely inverse time.

The threshold value of this protection is indicated by **Io>**, whereas the relative trip time is indicated by **to>**.
Start of timing is signalled by the **ALARM LED** lighting up, whereas circuit-breaker opening is signalled on the front by the magnetic flag **Io> Io>>**, turned to the yellow position. To reset signalling, the **FLAG RESET** pushbutton on the front of the release must be pressed, ensuring one of the following conditions:
a) 24 Vdc auxiliary voltage present (display lit);
b) primary circulating current higher than 0.2 x In (display lit with indication of the circulating current);
c) application of the TT2 unit to the **TEST** connector on the front of the release (optional accessory).

## Selection of threshold Io> value

Setting the **Io>** threshold is carried out using the Dip Switches (see figure on page 17).
The sum of the values selected is the fraction of In corresponding to **Io>**.
16 threshold values are available defined from 0.1 to 1 x In with steps of 0.05 x In.
The protection can be excluded by positioning the first Dip Switch in the **OFF** position.
Remember that the Io> function with an internal toroid is disabled when the fault current is higher than 3 x In; with an external toroid no disablement is foreseen.



The following settings are possible:

- **16 threshold current values (Io>)** (1)

| | | | | |
|---|---|---|---|---|
| 0.100 | 0.150 | 0.200 | 0.250 | |
| 0.350 | 0.400 | 0.450 | 0.500 | |
| 0.600 | 0.650 | 0.700 | 0.750 | |
| 0.850 | 0.900 | 0.950 | 1 | **x In** |
| OFF | | | | |

(1) The unit guarantees no entry in the threshold for currents under 1.05 x Io> set and guarantees entry in the threshold for currents higher than 1.30 x Io> set.

## Selection of type of Io> curve

Four different time-current relationships can be selected.

**Fixed time curve ($\beta$ = 2)**
For protection with fixed time (DT), the trip time is given by the following relationship.

$$to> = K \times \beta$$

**Definite time curve**
For protection with definite time, the relationship between trip time and overcurrent is given by the following formula.

$$to> = K \times \frac{\beta}{\left[\frac{I}{Io>}\right]^{\alpha} - 1}$$

**Caption**

**to>** trip time
**k** parameter set by the user to select the trip curve
$\alpha$, $\beta$ pair of parameters, depending on the type of protection selectable
**I** earth fault current
**Io>** trip threshold selectable by the user.

Parameters $\alpha$ and $\beta$ can take on the following values according to the curve selected.

- Normal inverse time curve (NI):
  $\alpha$ **= 0.02** $\beta$ **= 0.14.**
- Very inverse time curve (VI):
  $\alpha$ **= 1** $\beta$ **= 13.5.**
- Extremely inverse time curve (EI):
  $\alpha$ **= 2** $\beta$ **= 80.**

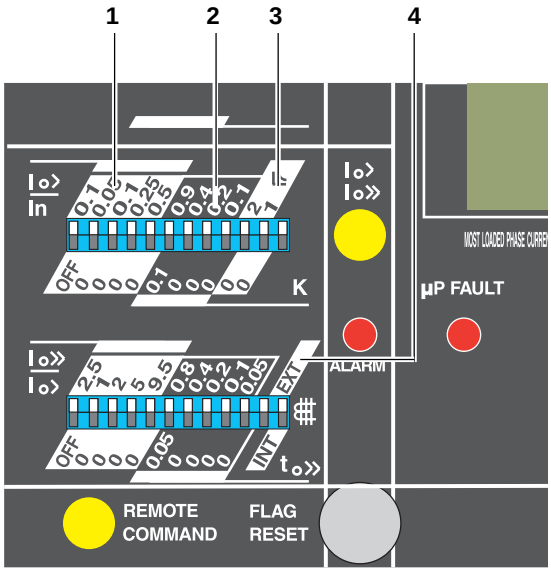
## Selection of to> trip time

The trip time of the protection is adjusted by using the Dip Switches as shown in the figure.
By means of the Dip Switches, the value of **K** is set which, when replaced in the previous relationships, determines trip time **to>**.

The following settings are possible:

- **16 trip times (to>),**
  **(K = 0.1...1.6 with steps of 0.1)**

| | | | | | |
|---|---|---|---|---|---|
| 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | |
| 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | |
| 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 |




**Caption**

**1** Dip Switch for setting the trip threshold of protection Io>
**2** Dip Switch for setting timing K of protection Io>
**3** Dip Switch for selecting the type of curve for protection Io>:
- **DT** curve with definite time
- **NI** curve with normal inverse time
- **VI** curve with very inverse time
- **EI** curve with extremely inverse time.

**4** Dip Switch for selection of type of toroid for earth fault (internal/ external)

### Protection against instantaneous or delayed earth fault (50N)

This function makes a family of definite adjustable time curves available, indicated by the symbol **Io>>**.
The corresponding trip time is indicated by the symbol **to>>**.
Start of timing is signalled by the **ALARM LED** lighting up, whereas circuit-breaker opening is signalled on the front by the magnetic flag **Io> Io>>**, turned to the yellow position. To reset signalling, the **FLAG RESET** pushbutton on the front of the release must be pressed, ensuring one of the following conditions:
a) 24 Vdc auxiliary voltage present (display lit);
b) primary circulating current higher than 0.2 x In (display lit with indication of the circulating current);
c) application of the TT2 unit to the **TEST** connector on the front of the release (optional accessory).

### Selection of Io>> threshold value

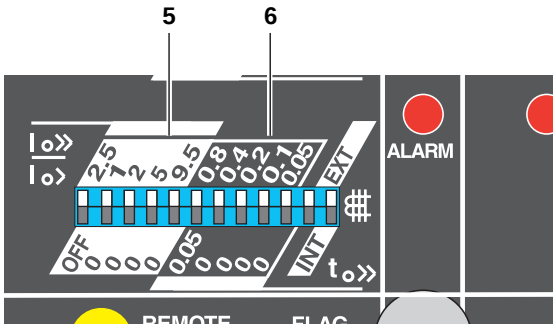
Setting the **Io>>** threshold is carried out by working on the Dip Switches as shown in the figure below.
The sum of the values selected represents the multiple of **Io>** and corresponds to threshold **Io>>**.
**N.B.** Even if protection Io> is **OFF**, the first Dip Switch takes on the value 0.1.

Also remember that the **Io>>** function with internal toroid is disabled when the fault current exceeds 3 x In, regardless of the value set for the threshold. With an external toroid no disablement is foreseen.

The following settings are possible:

- **16 threshold current values (Io>>)**

| | | | | | |
|---|---|---|---|---|---|
| 2.5 | 3.5 | 4.5 | 5.5 | 7.5 | |
| 8.5 | 9.5 | 10.5 | 12 | 13 | |
| 14 | 15 | 17 | 18 | 19 | |
| 20 | | | | | **x Io>** |
| **OFF** | | | | | |




**Caption**

**5** Dip Switch for setting the trip threshold of protection Io>>.
**6** Dip Switch for setting trip time to>> of protection Io>>

### Selection of to>> trip time

The function of protection **Io>>** has a single definite time curve adjustable to 31 values. The values available are between 0.05 s and 1.55 s with steps of 0.05 s.

The following settings are possible:

- **31 trip times (to>>), (0.05...1.55 with steps of 0.05)**

| | | | | | |
|---|---|---|---|---|---|
| 0.05 | 0.10 | 0.15 | 0.20 | 0.25 | |
| 0.30 | 0.35 | 0.40 | 0.45 | 0.50 | |
| 0.55 | 0.60 | 0.65 | 0.70 | 0.75 | |
| 0.80 | 0.85 | 0.90 | 0.95 | 1.00 | |
| 1.05 | 1.10 | 1.15 | 1.20 | 1.25 | |
| 1.30 | 1.35 | 1.40 | 1.45 | 1.50 | 1.55 **s** |

## Rated and setting currents

| Current transformer (CT) | Protection functions | | | |
|---|---|---|---|---|
| **In [A]** | **I> 0.2 ... 1 x In [A]** | **I>> 2.5 ... 20 x I> [A]** | **Io> 0.1 ... 1 x In [A] (1)** | **Io>> 2.5 ... 20 x Io> [A] (1)** |
| 40 | 8 ... 40 | 20 ... 800 | 4 ... 40 | 10 ... 800 |
| 80 | 16 ... 80 | 40 ... 1600 | 8 ... 80 | 20 ... 1600 |
| 100 | 20 ... 100 | 50 ... 2000 | 10 ... 100 | 25 ... 2000 |
| 150 | 30 ... 150 | 75 ... 3000 | 15 ... 150 | 37.5 ... 3000 |
| 200 | 40 ... 200 | 100 ... 4000 | 20 ... 200 | 50 ... 4000 |
| 250 | 50 ... 250 | 125 ... 5000 | 25 ... 250 | 62.5 ... 5000 |
| 600 | 120 ... 600 | 300 ... 12000 | 60 ... 600 | 150 ... 12000 |
| 1250 | 250 ... 1250 | 625 ... 25000 | 125 ... 1250 | 32.5 ... 25000 |

In = rated current of current transformer
I> = setting value of overload current (51)
I>> = setting value of short-circuit current (50)
Io> = setting value of earth fault current (first threshold) (51N)
Io>> = setting value of earth fault current (second threshold) (50N)
(1) If an external toroidal current transformer is used, recalculate the setting values according to its primary rated current.

# 5

# PR512/PD (50-51-50N-51N + DIALOGUE) UNIT


| | |
|---|---|
| Protection and dialogue functions | 22 |
| Binary inputs | 22 |
| Outputs for controlling the shunt opening and closing releases | 22 |
| Dialogue function | 22 |
| Electrical characteristics of the relay contacts | 24 |

# PR512/PD (50-51-50N-51N + DIALOGUE) UNIT

## Protection and dialogue functions

The PR512/PD (50-51-50N-51N + dialogue) unit carries out all the functions of the PR512/P (50-51-50N-51N) unit as well as also offering the possibility of remote control of the circuit-breaker, of its protection functions and of current measurement.
To obtain the dialogue function, a 24 V dc (± 20%) auxiliary power supply must be provided for the PR512/PD.

## Binary inputs

**Inputs for acquiring the circuit-breaker state**
By means of these inputs the signals regarding the state of the circuit-breaker can be acquired. In particular the following are available:

a) Input to acquire the **OPEN** circuit-breaker state
b) Input to acquire the **CLOSED** circuit-breaker state
c) Input to acquire the state of the springs (**CHARGED/DISCHARGED**)
d) Input to acquire the physical position of the circuit-breaker (**CONNECTED/ISOLATED**).

## Outputs for controlling the shunt opening and closing releases

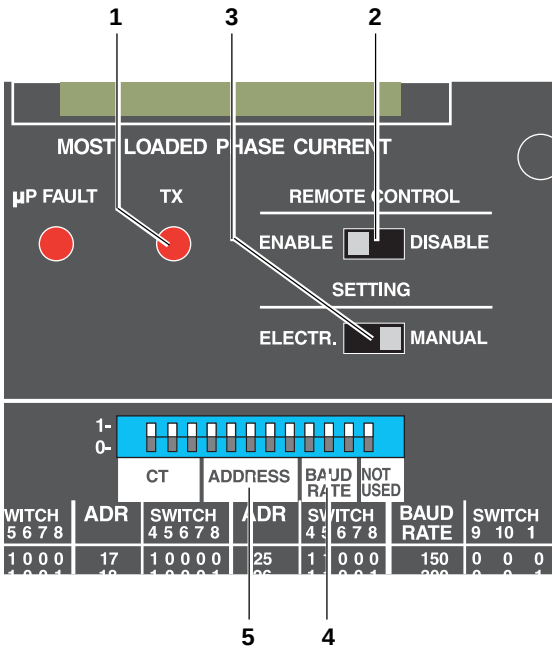
Two relays are integrated in the PR512/PD unit with normally open contacts through which circuit-breaker opening and closing can be controlled remotely.

## Dialogue function

Dialogue with the centralised system.
The serial interface used complies with the EIA RS485 Standard and therefore the connections must be made respecting the rules of this standard.
For further details, ABB can be asked for the following documents:

- **401517** Examples of EIA RS485 type serial communication distribution;
- **601823** Requirements for EIA RS485 type serial communication cable laying.

The protocol used is ABB INSUM described in document TN6567.
The EIA RS485 Standard defines a differential serial, multi-point communication system in current ring which foresees a Master (central unit) and up to 32 Slaves (PR512/PD).
Consequently each slave must be found by means of a distinct address, made available previously by means of Dip Switches on the front of the unit.
It is not permitted to have several units with the same address.
The transmission speed can be programmed from 150 to 19200 Baud (bit/s) by means of the special Dip Switches.
Unit transmission activity with the centralised control system is signalled by the TC LED flashing.




**Caption**

**1** LED for signalling serial communication active
**2** Change-over switch disabling remote closing and opening command from system
**3** Change-over switch for enabling manual or electronic programming from remote supervision system
**4** Dip Switch for adjusting serial transmission speed (baud rate)
**5** Dip Switch for adjusting unit address

**Data transmitted**

The PR512/PD unit is able to transmit the following information:

a) number of circuit-breaker mechanical operations
b) parameters of the protection functions
c) phase and homopolar currents (with minimum value of 5% In)
d) "Low current" indication with current less than 5% In
e) currents relative to the last trip
f) state of the protection functions:
  – normal operation
  – alarm (I>, I>>, Io>, Io>>)
  – relay tripped
g) state of the internal bus
h) state of the circuit-breaker:
  – circuit-breaker open
  – circuit-breaker closed
  – circuit-breaker connected or isolated
  – state of the operating mechanism springs: discharged or charged.

**Data received**

The PR512/PD unit can receive the following data from the centralised control system:

a) all the parameters of the protection functions
b) circuit-breaker opening command
c) circuit-breaker closing command.

**Disablement of opening – closing command**

By means of the REMOTE CONTROL change-over switch on the front of the unit, which is easily accessible, the circuit-breaker opening and closing commands coming from the centralised control system can be disabled (**DISABLE** position).

**Setting the parameters to manual or electronic mode**

By means of the **SETTING** change-over switch on the front of the unit, it is possible to enable manual setting, operated by means of the Dip Switches on the front of the unit (**MANUAL** position), or electronic setting by means of the centralised system (**ELECTR**. position).

### Electrical characteristics of the relay contacts

The YO and YC control relay contacts have the following electrical characteristics:

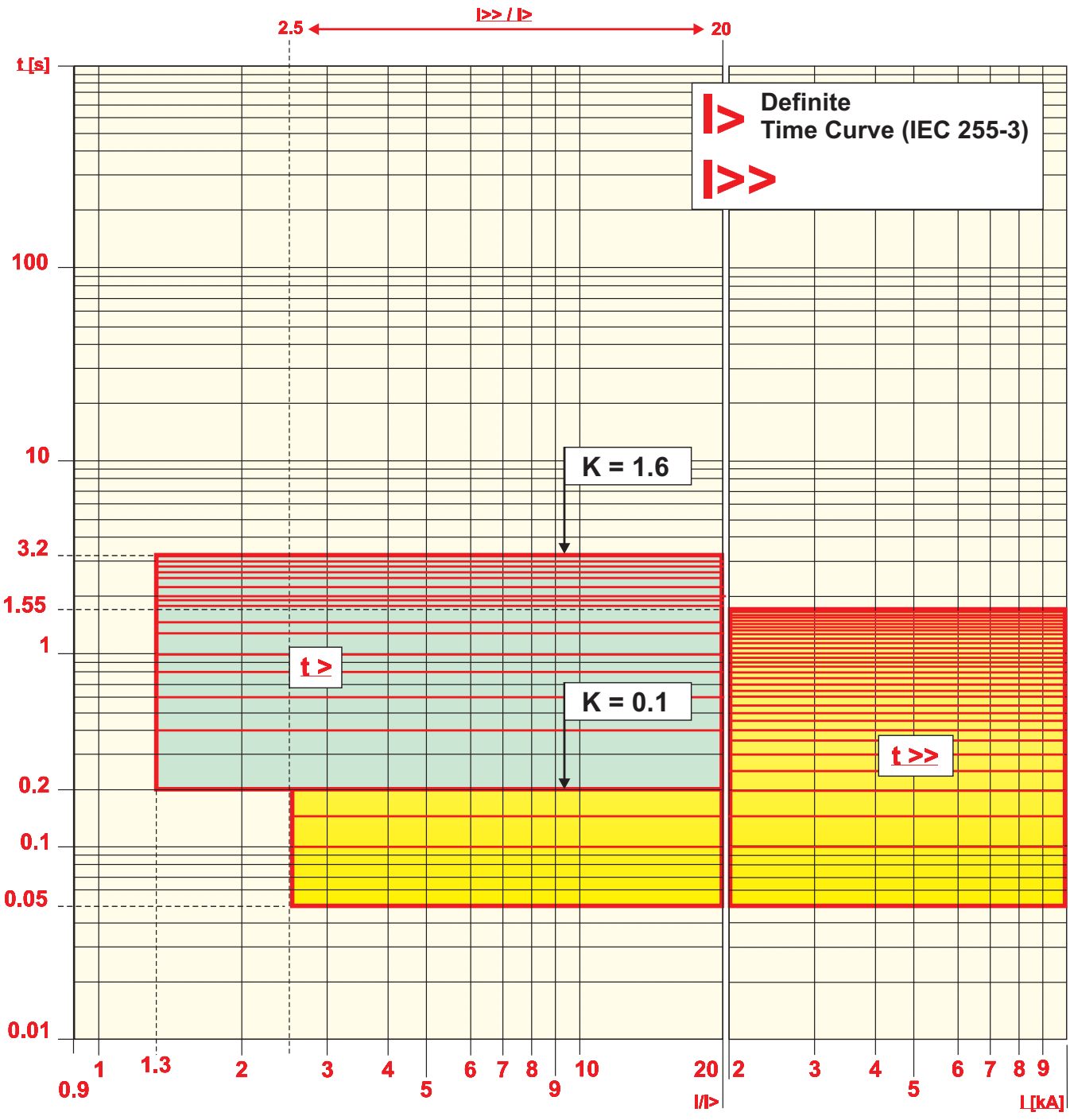
| | |
|---|---|
| – maximum interrupted current: | 5 A |
| – maximum interrupted voltage: | 250 Vca<br>130 Vcc |
| – maximum interrupted load at 48 Vdc: | |
| – inductive (L/R = 7 ms) | 25 W |
| – resistive | 50 W |
| – maximum interrupted load at 220 Vac: | |
| – inductive (cosφ = 0.4) | 500 VA |
| – resistive | 800 VA |
| – contact/contact insulation | 1000 Veff |
| – contact/coil insulation | 2000 Veff |

# 6

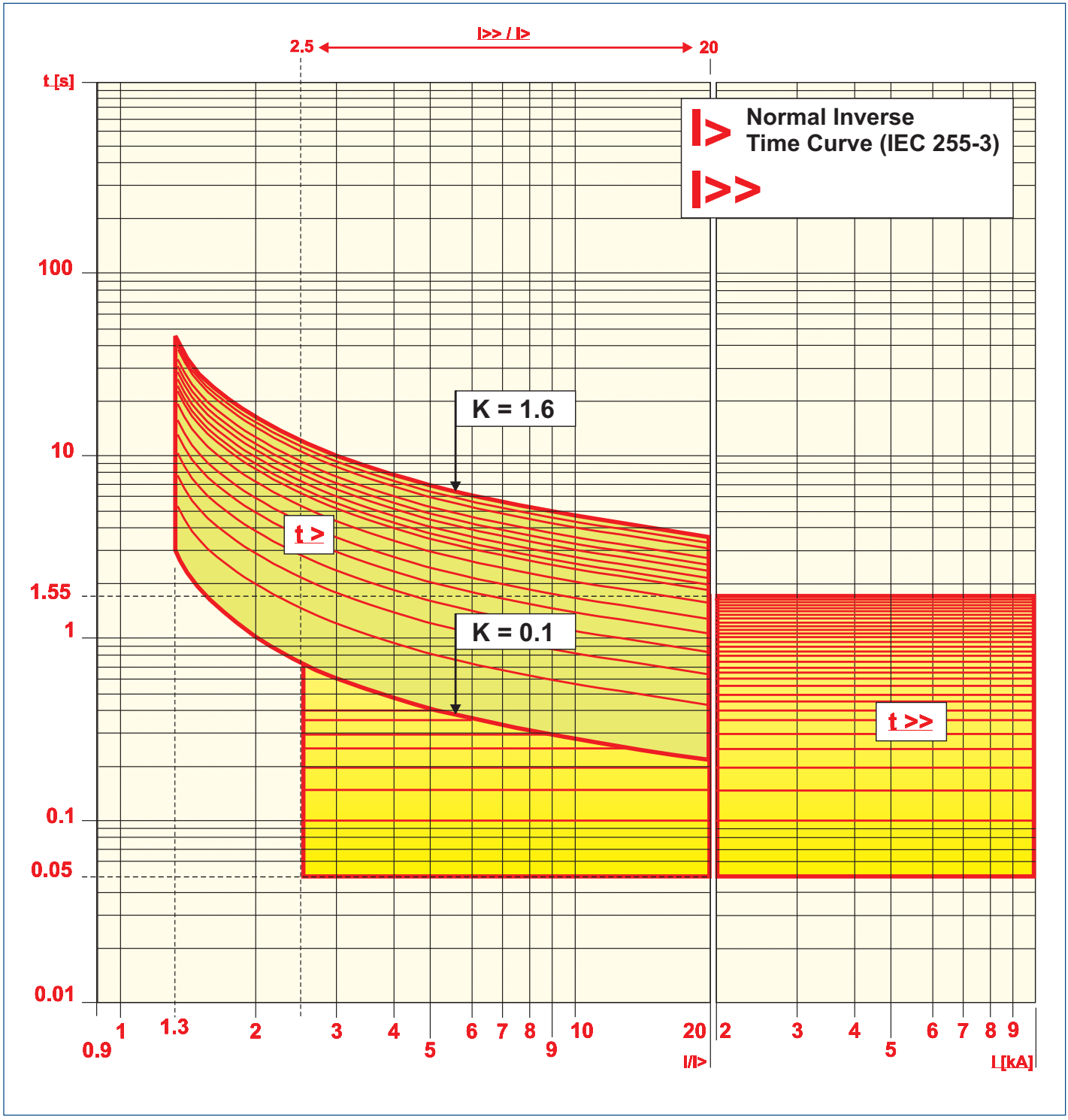
# TIME-CURRENT CURVES


| | |
|---|---|
| Definite time curve (DT) | 26 |
| Normal inverse time-delay curve (NI) | 27 |
| Very inverse time-delay curve (VI) | 28 |
| Extremely inverse time-delay curve (EI) | 29 |
| Time-current curves for earth fault | 30 |

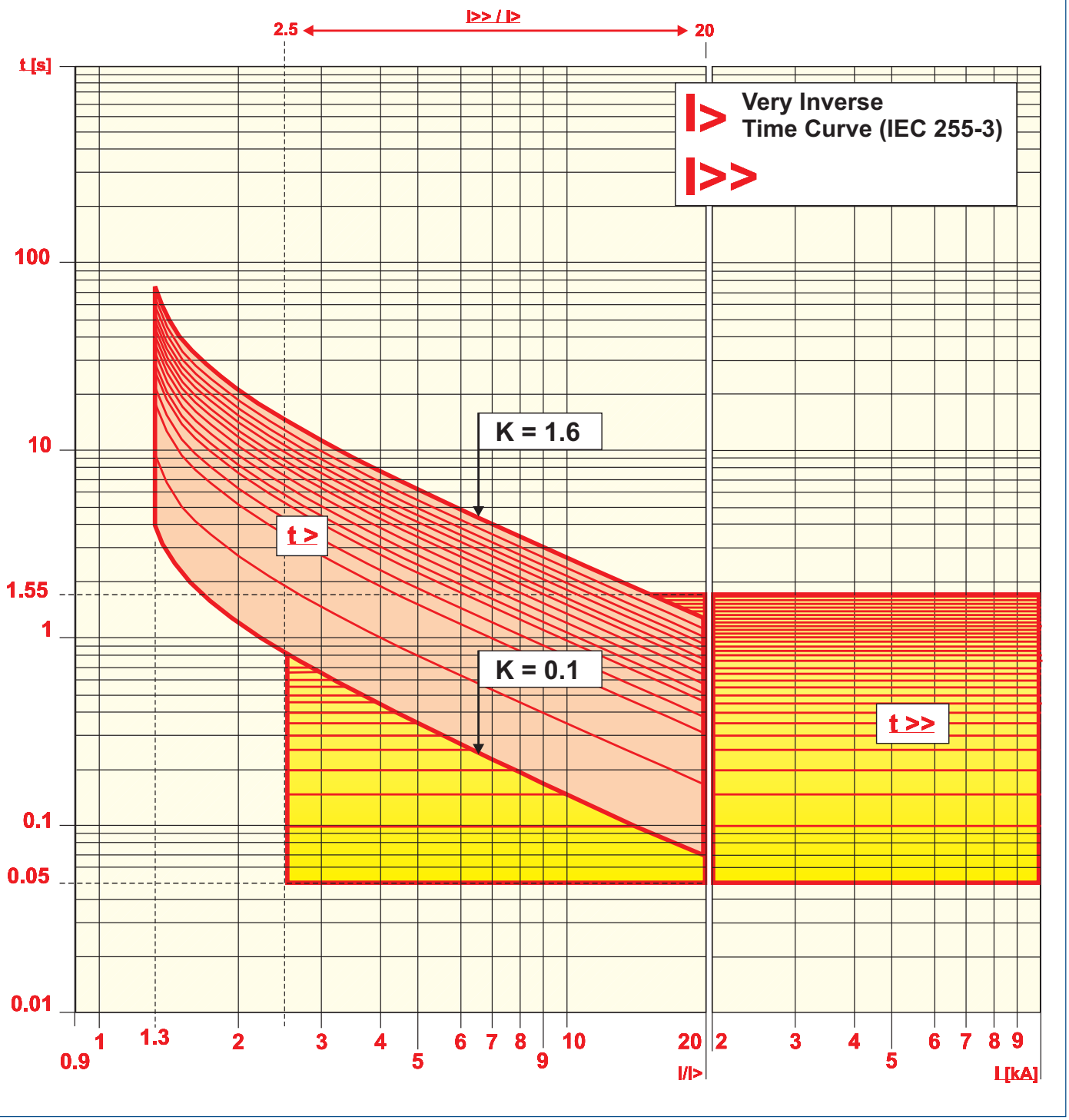
**Definite time curve (DT)**



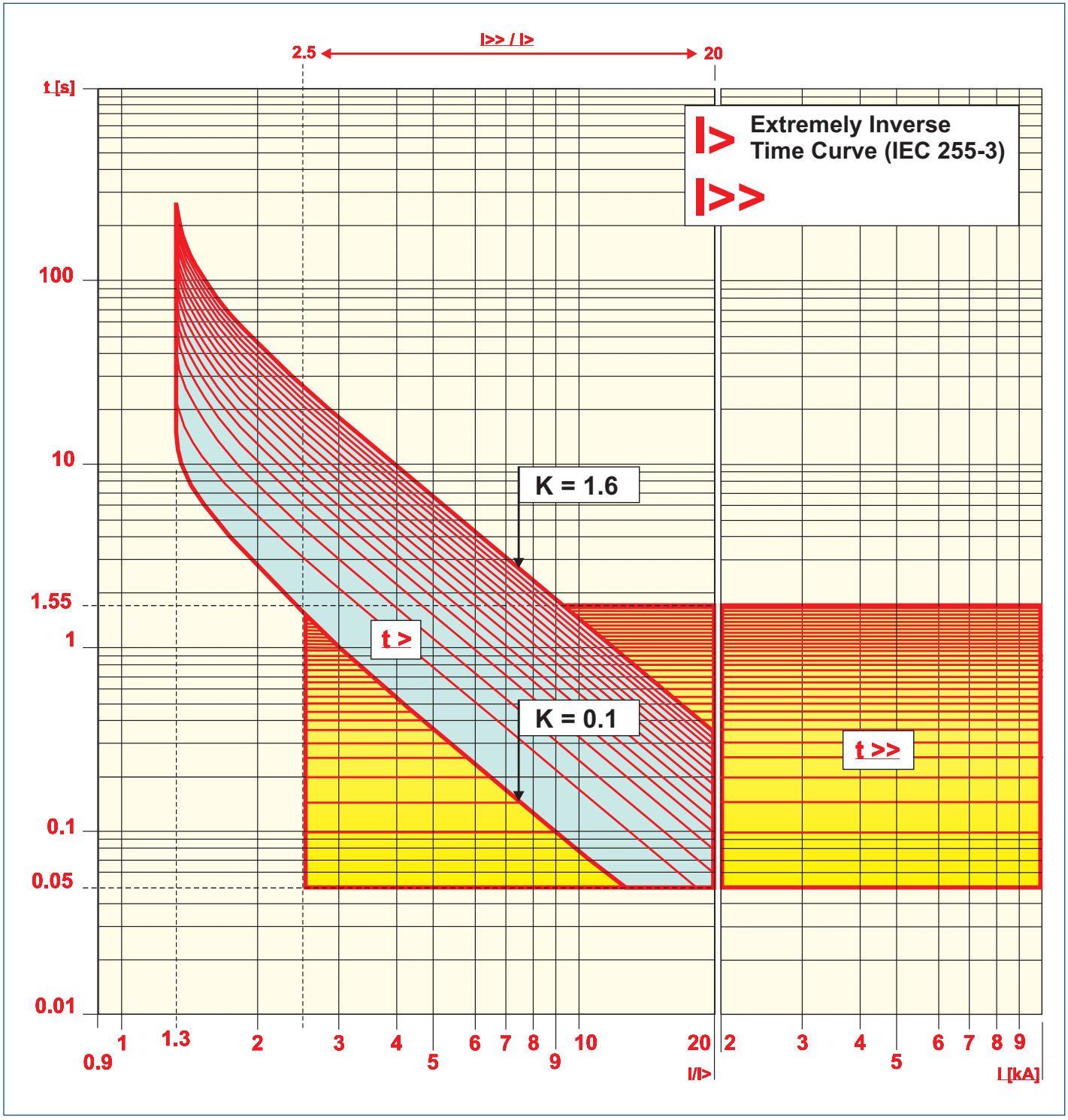
**Normal inverse time-delay curve (NI)**



**Very inverse time-delay curve (VI)**



**Extremely inverse time-delay curve (EI)**



# TIME-CURRENT CURVES

## Time-current curves for earth fault

The time-current curves for homopolar earth fault (**Io>; Io>>**) are identical to those for protection against overload and against short-circuit (**I>; I>>**). For the operating fields, please see what is indicated on page 25 and following pages.

# 7

# OVERALL DIMENSIONS

Dimensions and fixing 32

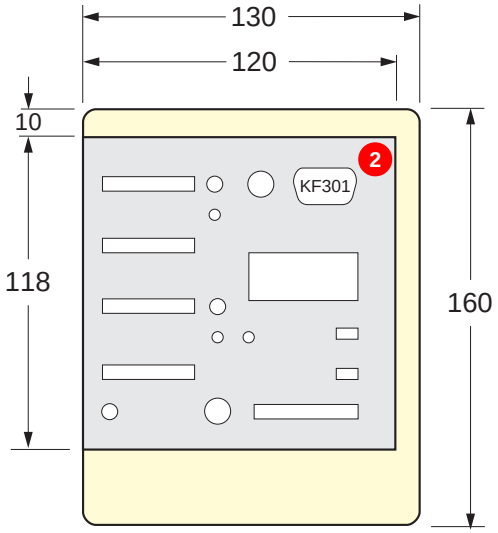
# OVERALL DIMENSIONS

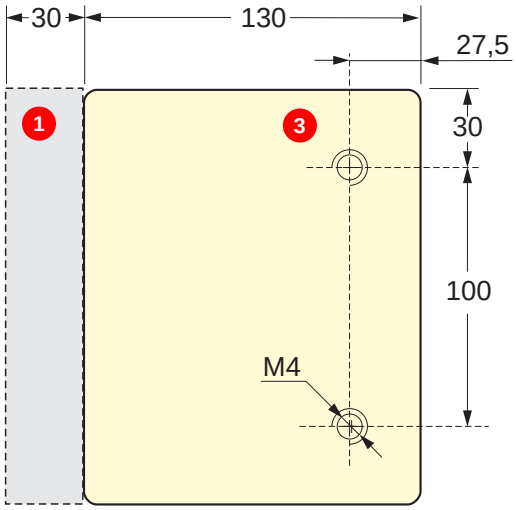
## Dimensions and fixing

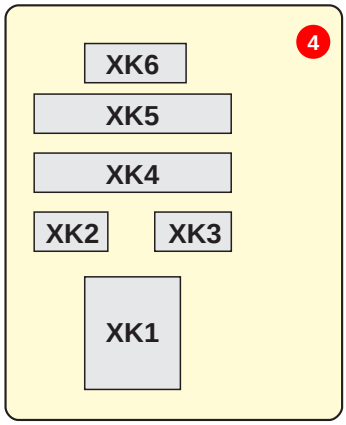
The overall dimensions are as follows:
– height 160 mm
– width 130 mm
– depth 160 mm.

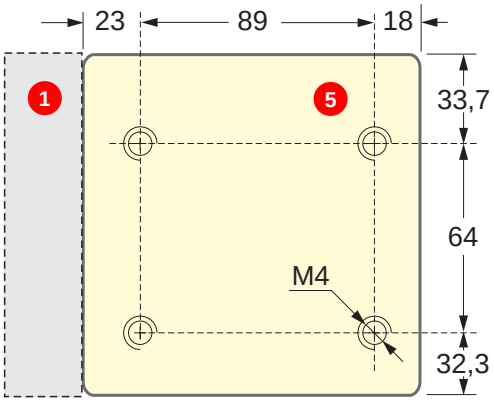
Threaded holes are provided on the release box for application of the fixing brackets for assembly on the compartment door.

**N.B.** The dimensions indicated include the overall dimensions of the connection connectors.




**Caption**

1. Connector area
2. Compartment door drilling
3. Holes for fixing the unit to the support square
4. Rear view of connectors
5. View from above.

# 8

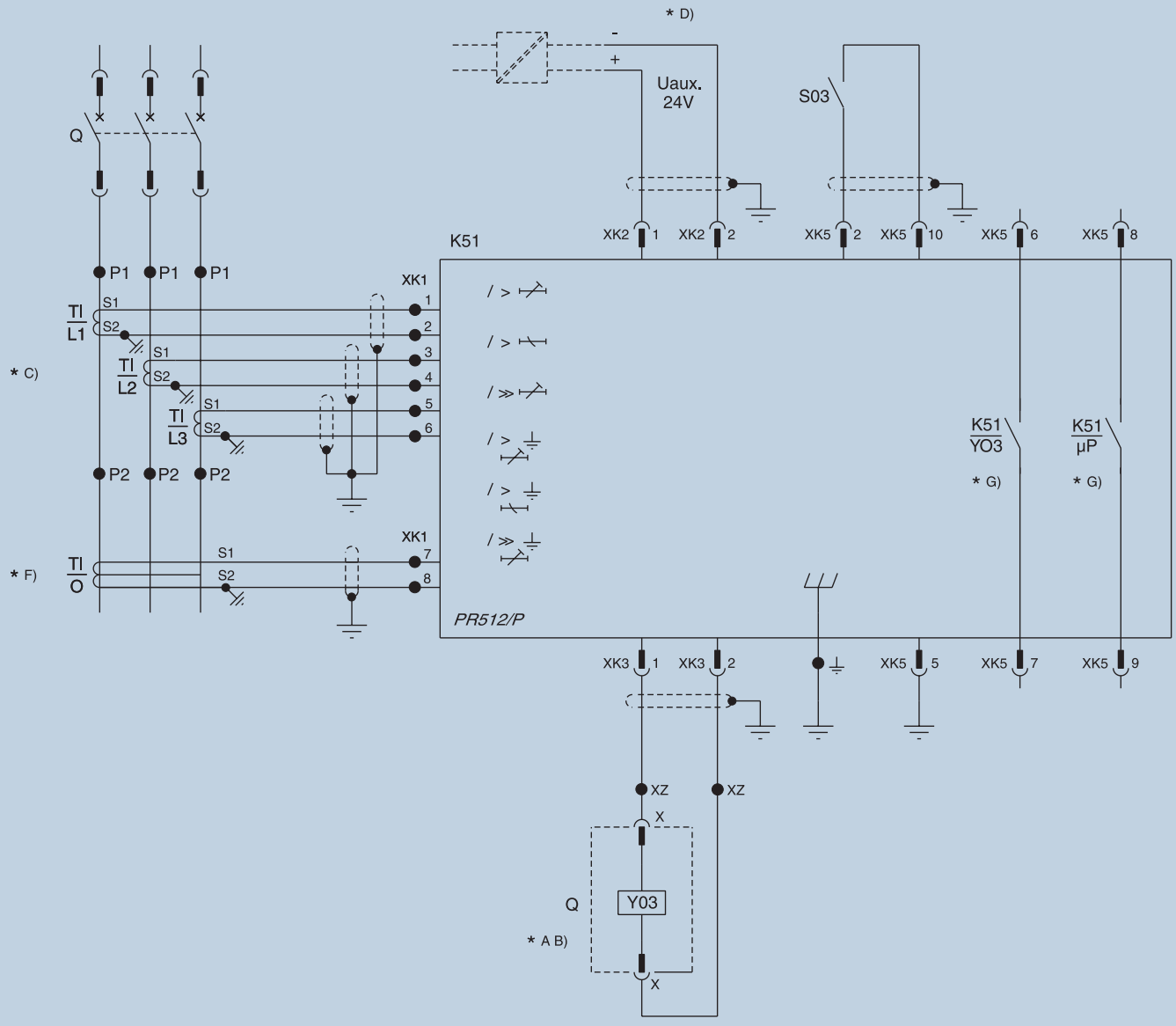
# ELECTRICAL CIRCUIT DIAGRAM


| | |
|---|---|
| Diagrams of the applications | 34 |
| Operating state shown | 35 |
| Caption | 36 |
| Notes | 37 |
| Connections | 38 |
| Graphic symbols for electrical diagrams | 38 |

### Diagrams of the applications

The diagrams shown correspond with ABB 401530 document.
However, they are for indicative purposes. In case of use, it is advisable to ask for the latest updated document.
To take evolution of the product into consideration, it is useful to refer to the circuit diagram supplied with each circuit-breaker.

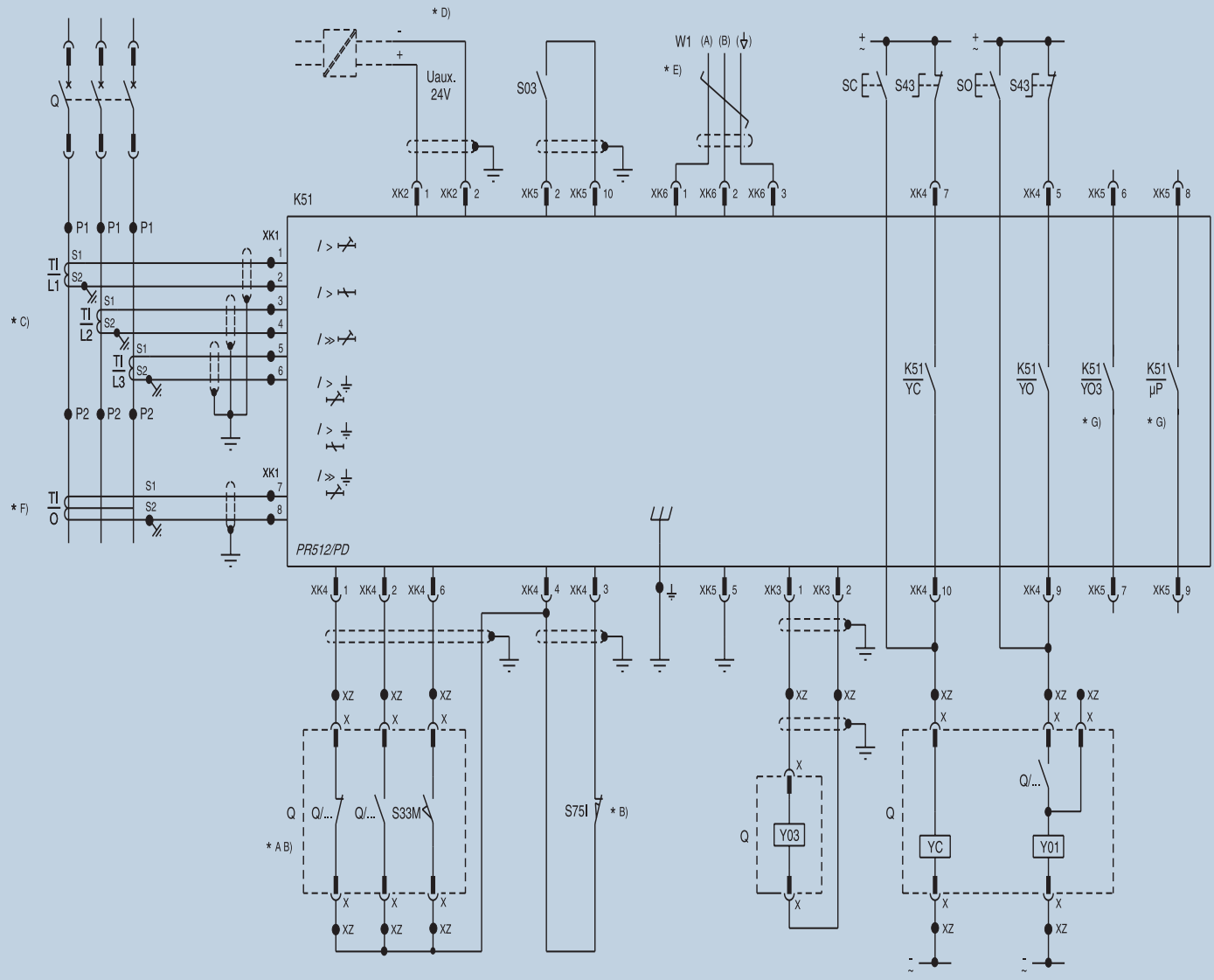
**PR512/P (50-51)**



## Operating state shown

The diagram is shown under the following conditions:
– circuit-breaker open and connected (see note B)
– circuits de-energised
– circuit-breaker closing springs discharged
– overcurrent release not tripped

### PR512/PD (50-51-50N-51N)



# ELECTRICAL CIRCUIT DIAGRAM

**Caption**

| | |
|---|---|
| * | = See note indicated by the letter |
| K51 | = Microprocessor-based type PR512/P (protection) or PR512/PD (protection and dialogue) type overcurrent release, with the following protection functions (see note C):<br>– against overload with long definite, inverse, very inverse or extremely inverse trip time<br>– against short-circuit with definite short trip time<br>– against earth fault with long definite, inverse, very inverse or extremely inverse trip time (with the PR512/P unit this function is only supplied on request)<br>– against earth fault with definite short time trip (with the PR512/P unit this function is only supplied on request) |
| K51/YC | = Closing command from PR512/PD release |
| K51/YO | = Opening command from PR512/PD release |
| K51/YO3 | = Contact for electrical signalling of YO3 solenoid tripped due to overcurrent |
| K51/µP | = Contact for electrical signalling of anomalies in microprocessor operation |
| Q/... | = Circuit-breaker auxiliary contacts |
| S33M | = Spring charging motor limit contact |
| S43 | = Remote/local control setting change-over switch |
| S75I | = Contact for electrical signalling of circuit-breaker in connected position, located in the enclosure (see note B) |
| SC | = Pushbutton or contact for the circuit-breaker closing |
| SO | = Pushbutton or contact for circuit-breaker opening |
| SO3 | = Contact for circuit-breaker opening by means of YO3 solenoid |
| TI/L1...L3 | = Current transformer on phases L1-L2-L3 (note C) |
| TI/O | = Toroidal current transformer for measuring the earth fault current (see note F) |
| Uaux. | = Auxiliary power supply voltage (see note D) |
| W1 | = Serial interface with the control system (EIA RS485 interface of PR512/PD relay (note E) |
| X | = Circuit-breaker control circuit connector (note B) |
| XK1 | = PR512 release current circuit terminal box |
| XK2...XK6 | = PR512 release auxiliary circuit connectors |
| XZ | = Terminal box in switchboard (see note B) |
| YC | = Circuit-breaker shunt closing release |
| YO1 | = Circuit-breaker shunt opening release |
| YO3 | = Circuit-breaker opening solenoid with trip for overcurrent |

## Notes

A) For the circuit-breaker auxiliary circuits, see the specific diagram of the circuit-breaker itself.

B) This diagram shows a withdrawable version circuit-breaker but is also valid for fixed version circuit-breakers. In that case, it is necessary to short-circuit poles XK4-3 and XK4-4 of the PR512/PD release. Moreover, the circuit-breaker auxiliary circuits are terminated at a terminal box called XV instead of at connector X and at terminal board XZ.

C) When only 2 current transformers are provided on phases L1 and L3 (only to be used with networks with insulated neutral and negligible earth fault currents), terminals XK1-3 and XK1-4 of the PR512 must be short-circuited.

D) The Uaux. auxiliary power supply is needed to guarantee that the following functions operate correctly even without self-supply (primary currents lower than 0.2 In):
- external opening control (SO3) and relative signals (signalling lamp and optic indicator)
- current measurement
- earth fault protection and relative signals (K51/YO3 and K51/mP signalling contacts, signalling lamp and optic indicators)
- reset of signalling contacts and optic indicators.

The Uaux. auxiliary power supply is always needed to guarantee correct dialogue operation (only for PR512/PD relay).
The presence of primary current $\geq$ 0.2 In on at least one phase fitted with current transformer ensures correct operation of all the protection, measuring and control functions.

E) For connection of the EIA RS485 serial line, see the following documentation:
- examples of distribution of the EIA RS485 serial communication 401517
- requirements for cable laying for serial EIA RS485 serial communication 601823.

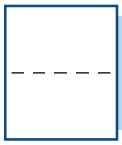
F) The TI/O homopolar current transformer, outside the circuit-breaker and with connections to be made by the customer, is only supplied on request. Should the TI/O transformer not be used, short-circuit terminals XK1-7 and XK1-8.

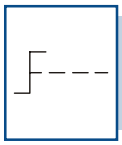
G) The K51/YO3 and K51/$\mu\Pi$ signalling contacts have the following electrical characteristics:
- maximum interrupted current 0.8A
- maximum interrupted voltage 110Vdc - 100Vcc
- maximum interrupted load at 24Vdc
  - inductive (L/R = 7ms) 10W
  - resistive 24W
- maximum interrupted load at 48Vac
  - inductive (cos$\varphi$ = 0.4) 15VA
  - resistive 30VA.

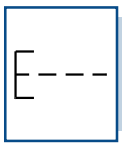
## Connections

For the PR512 release connections use the following types of cable:
– auxiliary power supply (Uaux.) = screened cable TI4069/2x0.2 code 07108
– external opening control (SO3) = screened cable TI4069/2x0.2 code 07108 (max. length: 30 m)
– S33M and Q/… binary inputs = screened cable TI4069/4x0.2 code 07109
– S751 binary input = screened cable TI4069/ 2x0.2 code 07108
– serial interface (W1) = screened cable T54566 code 56884
– opening solenoid (YO3) = screened cable TI4065/2x1 code 07136
– current transformer circuits (TI/… = screened cable TI4065/2x1 code 07136
– remaining circuits = cables T14018.

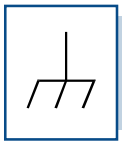
## Graphic symbols

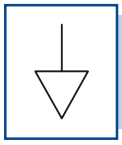

Mechanical, pneumatic or hydraulic connection

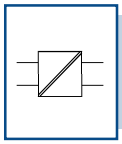

Rotary control

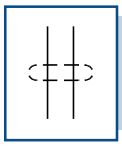

Pushbutton control

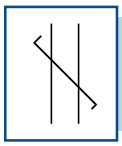

Earth (general symbol)

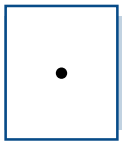
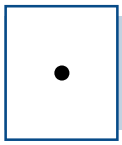
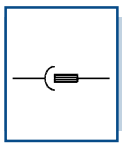
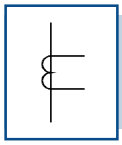
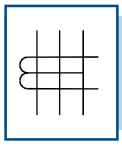
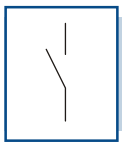
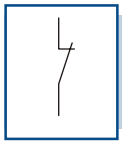
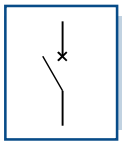
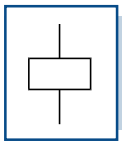
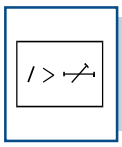
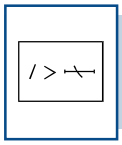
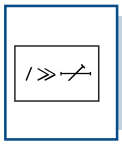
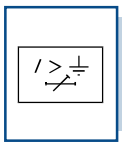
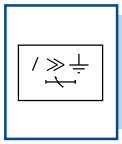
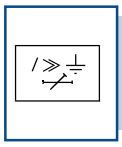

Mass, frame


Equipotentiality


Converter with galvanic separation


Screened cable conductors (example with two conductors)


Corded conductors or cables (example with two conductors)

| | |
|---|---|
|  | Conductor connections |
|  | Terminal or clamp |
|  | Socket and plug (female and male) |
|  | Current transformer |
|  | Current transformer with wound secondary and with primary consisting of three bushing conductors |
|  | Make contact |
|  | Break contact |
|  | Closing position contact (limit switch) |
|  | Opening position contact (limit switch) |
|  | Power circuit-breaker |
|  | Control coil (general sign) |
|  | Overcurrent unit with long adjustable time-delay characteristic |
|  | Overcurrent unit with long inverse adjustable time-delay characteristic |
|  | Overcurrent unit with short adjustable time-delay characteristic |
|  | Overcurrent unit for earth fault with long adjustable time-delay characteristic |
|  | Overcurrent unit for earth fault with long inverse time-delay characteristic |
|  | Overcurrent unit for earth fault with short adjustable time-delay characteristic |

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