ORION ITALIA

INSTRUCTION MANUAL

IPR-A

Current protection relay

CE

SAFETY NORMS AND GENERAL WARNINGS

For a proper installation of the unit the technicians must read carefully and understand the instructions provided by the Constructor.
All the installation operations must be carried out by suitably qualified technicians with adequate knowledge of the unit and of the content of this manual.

1. Check that the installation room (spaces, segregation and environmental conditions) are suitable for the electrical and electronic apparatus and in particular that:
   - the room conditions are in compliance with the information contained in SPECIFICATION;
   - the ratings of the unit (voltages, frequencies, etc.) are coherent with the features of the electric system.

2. Make sure that the Standard and Legal requirements are followed during installation, service and maintenance, in order to construct installations according to good technical and safety working practices.

The unit must be used EXCLUSIVELY for the purposes described in the Chapter GENERAL INFORMATION.

Disconnect the unit before carrying out any hipot testing on the installation.

Do not carry out any installation/maintenance operations requiring the disassembling and the removal of the unit from the panel on which it is mounted when the unit is live: make sure it has been disconnected.

For any request please contact:
ORION ITALIA TECHNICAL ASSISTANCE

TEL: +39 0523 591161   **FAX**: +39 0523 593898   **INTERNET**: www.orionitalia.com

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SYMBOLS IN THE TEXT AND THEIR MEANINGS

It indicates an OBLIGATION, an operation that must be obligatory followed. Pay attention to the information signalled by this symbol, as it refers to situations that require CAUTION AND WARNING: any operations not in compliance with what is indicated could provoke damages to objects or people.

Pay particular ATTENTION to the parts indicated by this symbol: they are live.

It indicates a DANGER, a situation or operation requiring the MAXIMUM ATTENTION: any actions not in compliance with what is indicated could provoke really serious damages to objects and even mortal injuries to people.

It indicates INFORMATION or REMARKS that must be read with particular attention.

I N D E X

1. General information

1.1 DESCRIPTION

Thanks to the measuring of phase and ground currents by means of current transformers (CT), IPR-A current protection relay can perform protection functions according to ANSI, IAC or IEC standards. Thanks also to the indications at the digital inputs the device can inform for example about the status of circuit breaker or disconnector to which it is coupled, operate on the outputs and disable some functions.

1.2 APPLICATIONS

- Primary or secondary protection for generation and distribution systems.
- Protection of transformers, overhead lines, cables, motors and generators.
- It allows the opening of the disconnector within the limits of its capacity, leaving the circuit interruption to the back-up fuses in case of short-circuit.

1.3 PROTECTION AND FUNCTIONALITY

Description   ANSI

- CT primary ratio selectable in 5 A steps (10 A ÷ 6000 A).
- Inverse-time phase overcurrent **51**
  and Inverse-time ground overcurrent .... **51N / 51G**
  with curve selection according to ANSI, IAC or IEC/BS142:
  - moderately inverse
  - normally inverse
  - very inverse
  - extremely inverse
  - definite time
- Instantaneous phase overcurrent **50**
- Instantaneous ground overcurrent .... **50N / 50G**
- Overload alarm level
- KA accumulated per phase on circuit breaker interruption
- Integral relay test with or without the output contacts intervention
- 1 trip relay
- 3 auxiliary relays that can be associated with the various functions (2 programmable relays and 1 relay controlling any loss of auxiliary voltage -SERVICE-).

Information

The following information concerns the use of the Actual values and the Setpoints.

OVERCURRENT PROTECTION

IPR-A continuously checks the 3 phase currents and the ground current in the line by means of its CTs and activates an alarm and/or the circuit breaker trip when a value exceeds the set level (called *Pickup* level):

1. possibility of separately setting of the timed and instantaneous overcurrent;
2. no intrinsic delay of the device is added to the instantaneous intervention;
3. separate managing of the phase and ground overcurrent setpoints;
4. phase and ground overcurrent alarm and trip delay according to time-current curve set and to the entity of current.

The 5 selectable time-current curve shapes are the following:
-   moderately inverse
-   normally inverse
-   very inverse
-   extremely inverse
-   definite time

The 3 programmed curve types are the following:
-   ANSI
-   IAC
-   IEC / BS142

All curve shapes have a time multiplier (M) allowing modifying the trip time.

For the 3 possible curve types and their shapes see: → Appendix A

REMARK: when selecting the curve for the circuit breaker trip, make sure the max. input current to IPR-A does not exceed 100 A for more than 1 second ⇒ the wrong combination of time and current could damage the unit and consequently provoke the loss of protection.

1.4 DIGITAL MEASUREMENT

1. RMS current of each phase
2. Ground RMS current

1.5 SIGNALLING AND PROGRAMMING

- LCD & LED display indication
- Indication and storage of fault conditions and their values
- Indication on the system status

SYSTEM STATUS	LED
- circuit breaker or disconnector closed	[BREAKER CLOSED]
- circuit breaker or disconnector open	[BREAKER OPEN]
- circuit breaker or disconnector earthed	[BREAKER EARTHED]
- disconnector current (*current superior to the rated current of the fuse coupled to the disconnector or to the rated current of the disconnector*)	[SWITCH CURRENT]
- reaching of the inverse-time overcurrent pickup level	PICKUP I > (51)
- reaching of the instantaneous phase overcurrent pickup level	PICKUP I >> (50)
- reaching of the inverse-time ground overcurrent pickup level	PICKUP I_o > (51N/G)
- reaching of the of the instantaneous ground overcurrent pickup level	PICKUP I_o>> (50N/G)

- Indication of the relay status

RELAY STATUS	LED
- <u>LED "On"</u>: the output relay has tripped to open the circuit breaker or disconnector. It stays "on" even when the output relay is programmed with PULSED mode - <u>LED "Off"</u>: it switches off when pressing RESET key only if the condition causing the fault is no more present	[TRIP]
- intervention for reaching the phase or ground currents alarm setpoint	[ALARM]
- relay "out of service" due to power supply droop or to internal fault	[OUT OF SERVICE]

1.6 COMMUNICATION

- Remote communication using a PC or a PLC by 2 RS485 ports or 1 RS232 port
- Local and remote setting of the relay protections and features
- Fault and event recorder for statistical analysis
- Self-explicative program requiring no additional programming
- Remote opening or closing of the circuit breaker or disconnector

1.7 SPECIFICATION

SUPPLY VOLTAGE
24÷310 Vdc, –15%, +10%
24÷240 Vac, –15%, +10%, 50/60Hz

POWER CONSUMPTION
7W, 12 VA (max)

TEMPERATURE RANGES
Operational: from 0 °C to +50 °C
Storage: from –20 °C to + 70 °C

RELATIVE HUMIDITY
Max.: 90% (non condensing)

DIELECTRIC WITHSTAND VOLTAGE
2 KV 60 s

ENVIRONMENTAL FEATURES
The relay must be installed in a room with the following features:
- indoor,
- dry, not dusty and not corrosive atmosphere.

CONSTRUCTION
In compliance with VDE, UL, CEI standards.

DIGITAL INPUT

Type:	Dry contacts
Output:	24 Vdc, 10 mA (stabilized)

COMMUNICATIONS

Type:	1 4-wire RS232 port + 2 2-wire RS485 ports, Full duplex, 1200÷19200 baud
Protocol:	Modbus RTU
Functions:	Reading/Writing of setpoints
	Reading of actual values
	Executing of commands

FRAME
Auto-extinguishing ABS with frontal in polycarbonate (IP54).

DIMENSION
144 x 144 x 141 mm (→ Fig. 2.1 – IPR-A overall dimensions)

WEIGHT
1.5 Kg

PHASE AND GROUND CT INPUTS

Secondary rated current:	CT: 1 A or 5 A (specify with order).
Sampling:	True RMS at 16 samples per cycle.
Bandwidth:	0÷100 Hz
CT burden:	0.25 VA per phase at rated secondary current.
Continuous:	10 A
Current withstand capacity:	100 A per 1 s

INVERSE-TIME PHASE OVERCURRENT (51)

Pickup level:	4÷300% CT, Steps: 1%
Time multiplier:	0.1÷20.0; Steps: 0.1
Dropout level:	Time resets to zero whenever current level drops below the pickup level.
Accuracy:	± 3% of the setting.
Delay:	included in ± 3% or in ±20 ms, per >150% of pickup level.

BURN IN
48 hours at 50 °C

OUTPUT CONTACT

Load:	resistive (p.f.= 1)
	inductive (p.f.= 0.4; L/R = 7 ms)
Rated load:	250 Vac, 8 A or 30 Vcc, 8 A with p.f.=1
	250 Vac, 5 A or 30 Vcc, 5 A with p.f.=0.4
Max. operating Voltage:	250 Vac, 125 Vcc
Max. operating Current:	8 A
Capacity:	2000 VA, 240 W with p.f.=1
	1250 VA, 150 W with p.f.=0.4

LED INDICATORS

Relay status:	Trip, Alarm, Service
System status:	Closed circuit breaker, open circuit breaker, earthed circuit breaker, disconnector current and reaching of:
	Pickup level I > (51)
	Pickup level I >> (50)
	Pickup level I_0 > (51N/G)
	Pickup level I_0 >> (50N/G)
Display (LCD):	16 x 2 digits
Display accuracy:	Load current: ±1% @ 100% CT

TERMINAL BLOCK
Fixed, for cables with section: 4 mm^2 (12 AWG).

MOUNTING
The relay has to be jointed to the structure fixing it by stirrup with screws.

FRONT PANEL CUT-OUT
137 x 137 mm

APPLICABILITY

System:	three-phase;
Frequency:	50/60 Hz;
Current:	max. 6000 A;

OVERCURRENT CURVES
Selection of phase and ground curves according to ANSI, IAC or IEC.
- Moderately inverse
- Normally inverse
- Extremely inverse
- Definite time

The curves are valid up to 18 times the CT rated current

INSTANTANEOUS OVERCURRENT (50)

Pickup level:	4÷1800% of CT, Steps: 10%
Current accuracy:	± 3% of the setting
Time accuracy:	35 ms max. per > 150% of the set value
Saturation:	18 times the CT rated current.

INVERSE-TIME GROUND OVERCURRENT (51G/51N)

Pickup level:	4÷300% CT, Steps: 1%
Time multiplier:	0.1÷20.0; Steps: 0.1
Dropout level:	Time resets to zero whenever current level drops below the pickup level.
Current accuracy:	± 3% of the setting.
Time accuracy:	included in ± 3% or in ±20 ms, per >150% of the set value.

GROUND INSTANTANEOUS OVERCURRENT (50G/50N)

Pickup level:	4÷1800% of CT, Steps: 10%
Current accuracy:	± 3% of the set value.
Time accuracy:	35 ms max. per > 150% of the set pickup level.
Saturation:	18 times the CT rated current.

EMISSIONS TEST

1. **Radiated emissions**
   Reference norms: EN 55011;
   Port: enclosure.
2. **Conducted emissions**
   Reference norms: EN 55011;
   Port: AC mains.

IMMUNITY TESTS

1. **Conducted disturbances induced by RF field**
   Reference norms: EN 61000-4-6;
   Port: AC mains and signal lines.
2. **Radiated electromagnetic field**
   Reference norms: EN 61000-4-3; ENV 50204;
   Port: enclosure.
3. **Electrostatic discharge**
   Reference norms: EN 61000-4-2;
   Port: enclosure.
4. **Fast transients**
   Reference norms: EN 61000-4-4;
   Port: AC mains and signal lines.
5. **Surge**
   Reference norms: EN 61000-4-5;
   Port: AC mains.
6. **Voltage dips and short interruptions**
   Reference norms: EN 61000-4-11;
   Port: AC mains.

1.8   HOW TO READ THE ORDER CODE

The CT secondary must be specified when ordering (1 A or 5 A).
The meaning of the order code is the following:

$$IPR - A\ X\ X\ X$$

MODEL
1: Standard
X: Special Version

PHASE SECONDARY CT
1: 1 Ampere
5: 5 Ampere

GROUND SECONDARY CT
1: 1 Ampere
5: 5 Ampere
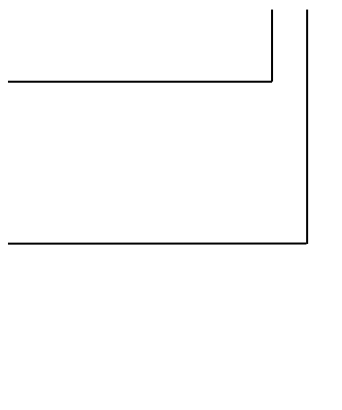
2. Installing

2.1 IDENTIFICATION

On the plate on the rear side of the IPR-A you can find the following information:

ORION ITALIA	Manufacturer
PIACENZA 29122	Manufacturer's address
TEL.: 0523 – 591161	
FAX: 0523 – 593898	
www.orionitalia.com	Internet
MADE IN ITALY	
MODEL: IPR-A	Model name
SERIAL No.	Serial number of the relay
MFG. DATE	Date of manufacture
CURRENT CTs (SEC)	Phase CT installed: 1 A or 5 A
GROUNG CTs (SEC)	Ground CT installed: 1 A or 5 A

2.2 UNPACKING

The shipping container includes:

- IPR-A relay
- the fixing elements
- this instruction manual
- the Test certificate (if required)

As soon as you receive the unit, inspect it and inform ORION ITALIA of any damage.
If reshipment is required, the original container and packing should be used.

2.3 MOUNTING

The mounting should be carried out as follows:
1. Install the relay in a place where the humidity and temperature are those for which it has been designed [→ § 1.7 – "Specification"] and away from current conductors and sources of strong magnetic fields.
2. Put the relay inside a panel and place it so that the keypad is easily accessible and the display is visible.
3. Make a cutout in the panelboard of 137 x 137 mm [→ Fig. 2.1] and fix the relay by using the fixing elements provided with the relay.
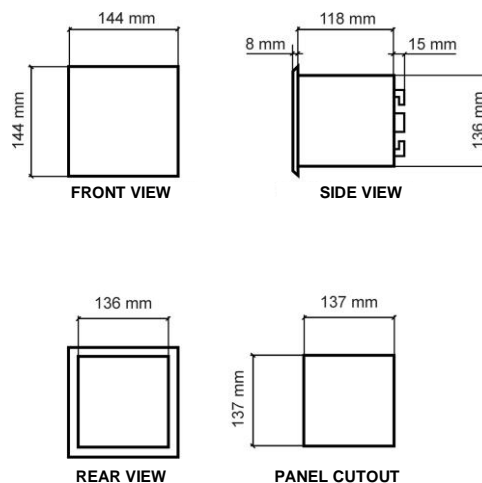
Figure 2.1 –**IPR-A overall dimensions**

2.4 WIRING – OUTPUT RELAY AND DIGITAL INPUTS

Before carrying out the installation of the unit, it is necessary to read and understand the indications provided by the Constructor.
All the installation operations must be carried out by qualified personnel with adequate knowledge of the functioning of the unit and of the content of this manual.

Terminal blocks in the rear side of the unit make the electrical connections.
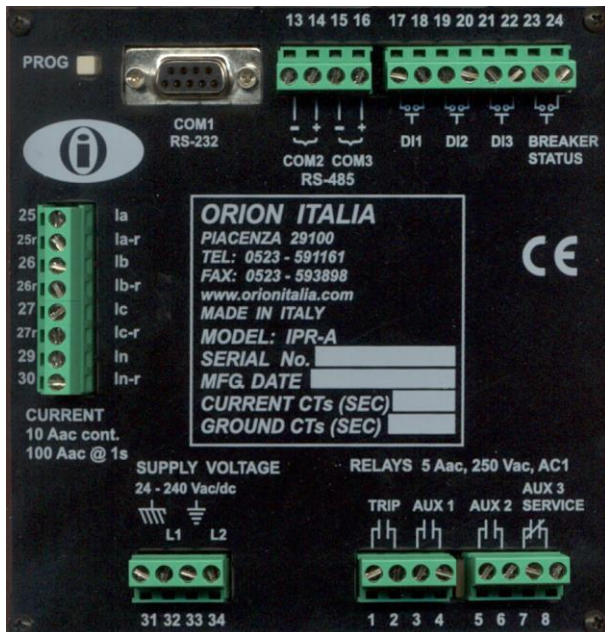
DIGITAL INPUT	TERMINALS No.
DIGITAL INPUT 1	**17 – 18**
DIGITAL INPUT 2	**19 – 20**
DIGITAL INPUT 3	**21 – 22**
BREAKER STATUS	**23 –24**

Figure 2.2 – **Rear view**

The 4 output relays on the IPR-A are the following:

Relay	Type	Note	Terminals
TRIP	N.O.	Programmable: "pulsed" or "latched"	1 - 2
AUX1	N.O.	Programmable: "pulsed" or "latched"	3 - 4
AUX2	N.O.	Programmable: "pulsed" or "latched"	5 - 6
AUX 3 - SERVICE	N.C.	Programmable: "pulsed" or "latched" [if set as SERVICE: used for signalling any control power drop or internal fault]	7 - 8

- In Fig. 2.3 the relays contacts are represented in condition of no power supply.
- Generally, the circuit breaker AUX 52a contact is connected in series to IPR-A TRIP contact for cutting the current to the coil. For high-absorption trip coils an auxiliary relay is needed.
- The service contact is failsafe: it reacts in case of control power drop or of internal fault of the unit. The contact is N.C.. Connect the SERVICE relay to an external alarm system. For configuring AUX3 relay as a service relay: → "Setpoint Page 2 - OUT OF SERVICE ON AUX3".

The digital inputs must be connected only to dry-contact circuits so as to avoid damaging the IPR-A.
No external voltage should be applied to the corresponding terminals as they are internally energized from the IPR-A and opto-coupled to the sensing circuitry.
Digital outputs should be isolated from each other for correct operation. The maximum input impedance to these digital outputs is 2 kΩ.

The power supply must be connected to terminals **32** and **34**.

For further information: → § 1.7 – "Specification"

MODALITA DI COLLEGAMENTO CON TOROIDI
CURRENT TRANSFORMER CONNECTIONS TYPES
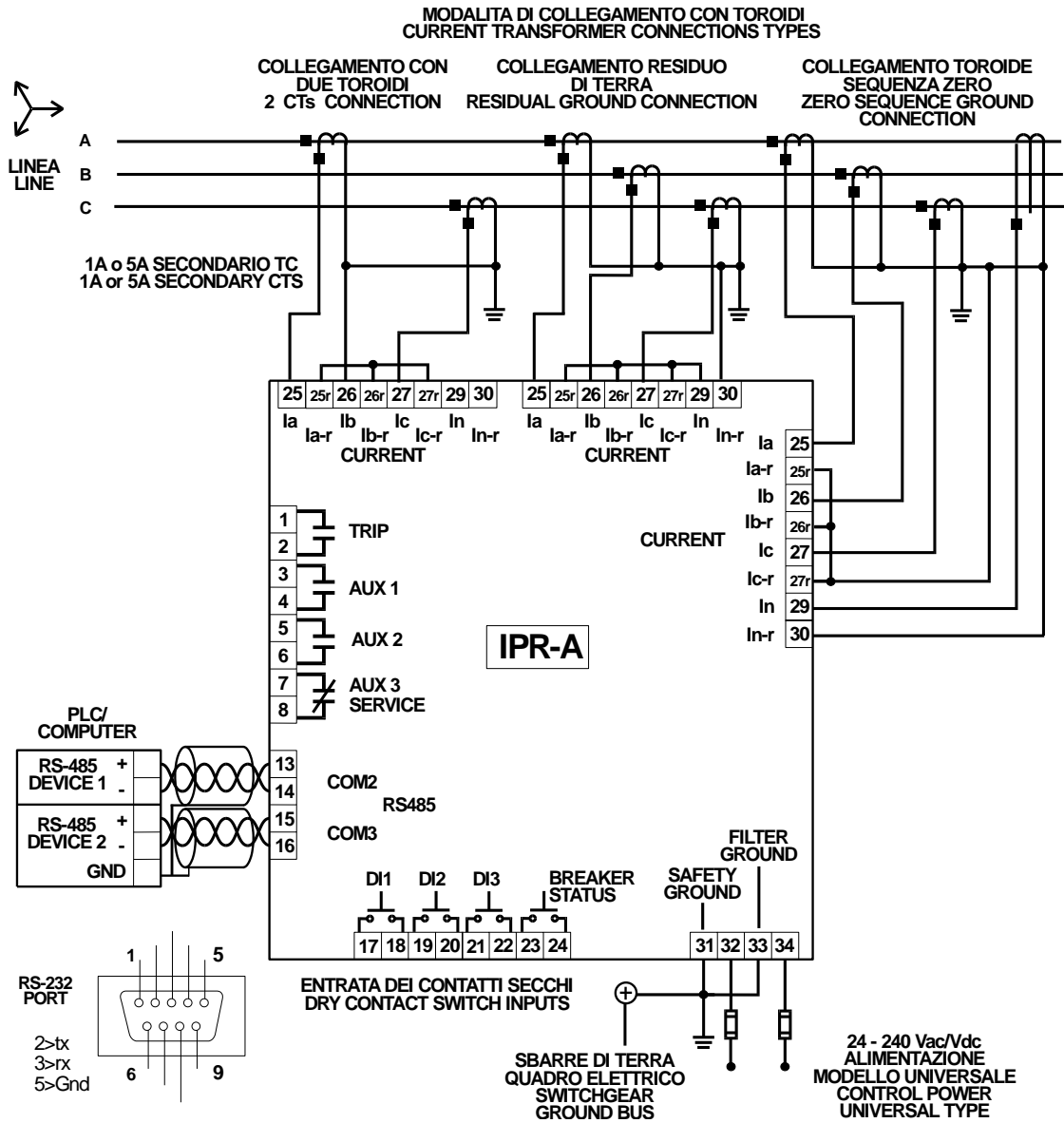
Figure 2.3 – **Wiring diagram**

2.5 CURRENT TRANSFORMERS (CT)

CTs with 1 A or di 5 A secondary rated current must be used for current sensing. The choice of the CTs performances must ensure a sufficient power and the non-saturation in case of short circuit.

The 3 or 4 transformers providing a current that is proportional to the phase or ground current must be connected to terminals from no. **25** to no. **30** [→ Fig. 2.3].

Normally IPR-A uses the "RESIDUAL GROUND CONNECTION" [→ Fig. 2.3] to sense ground current.

When using shielded wires (using the 4th Zero Sequence toroid), if the shield passes through the CT, the conductor earthing the shield must pass again through the CT window in the opposite direction in order to nullify any contribution of the shield in the calculation of the current to ground [→ Fig. 2.4].
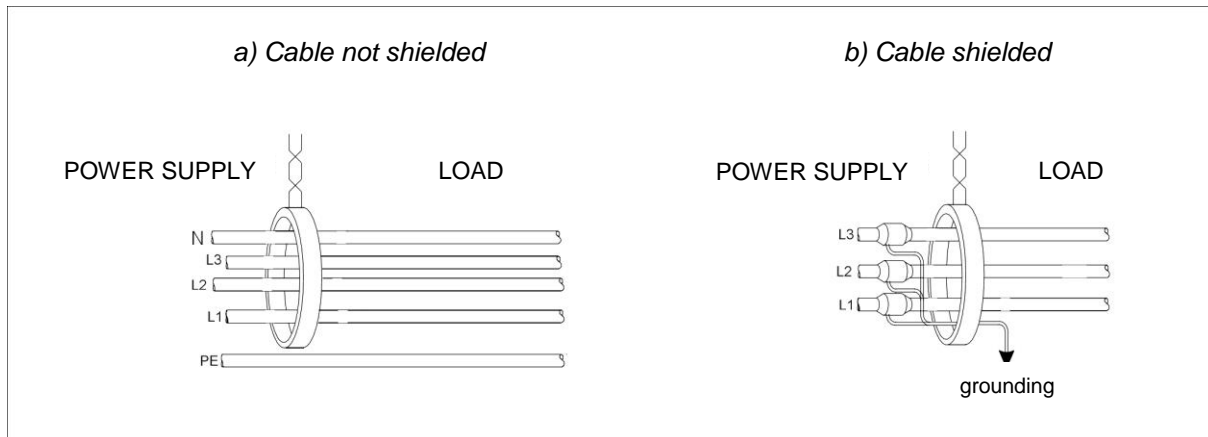
Figure 2.4 – **Cable shield**

Observe correct polarity when connecting the CTs to the relay. The CT secondary marked terminal (usually with the S1 mark on it) must be connected to the relay terminal marked with **Ia**, **Ib** or **Ic**. Each CT should have the same orientation and the points identifying the magnetic directions must be connected as shown in Fig. 2.3.

2.6 CIRCUIT BREAKER STATUS AND CONTROL CONNECTIONS

Connect the circuit breaker AUX 52a/52b contacts to terminals **23** and **24** to display the circuit breaker status on IPR-A.

2.7 COMMUNICATIONS

Thanks to the serial ports, a PC or PLC can make the monitoring and controlling of the relay.

Two-wire RS485 port ⇒ 1 conductors pair transmitting and receiving alternatively is used for the data TX and RX.

The ports CANNOT be used at the same time.
The serial port protocol is a subset of the AEG Modicon Modbus protocol.

> For the RS-485 port use shielded, twisted-pair connecting wires to minimize communications errors from noise.
> A suitable type of wire is:
> **BELDEN#9841 AWG 24** shielded and with an impedance of **120 Ω**.

Ground the shield at one point only [→ Fig. 2.3] to avoid ground loops.

Correct polarity for RS485 → Figure 2.5

The connections are cascade-type and end on the converter. Avoid star or loop connections.

A maximum of 32 relays can be daisy-chained together in parallel mode on a communication channel for a MAXIMUM DISTANCE OF 1000 METERS.

For increasing the number of relays on a single channel to more than 32 refer to ORION ITALIA.
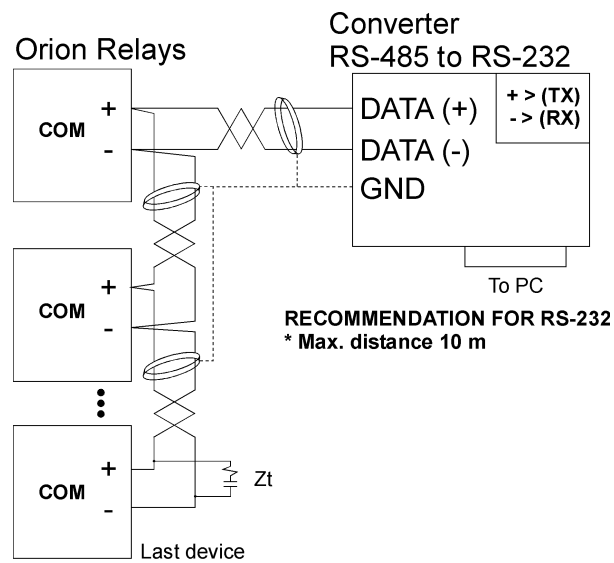
Figure 2.5 – **Communications diagram**

2.8   CONTROL POWER

- Voltage ranges for **IPR-A** ....**20 ÷ 341 Vdc**
  20 ÷ 264 Vac
- Power supply connection terminals ....**32** and **34**.

> No internal or external adjustments are required to use any of the voltages included in the two indicated intervals.
> For the external protection, IPR-A has no internal fuses.

2.9   SYSTEM GROUNDING

On the rear side of the relay there are two separate grounds [→ Fig. 2.2]:

- Internal metal chassis parts and external shield safety ground terminal **31**

- Surge suppression components ground terminal (grounded to separate filter ground) **33**

For reliable operation both grounds must be connected directly to the ground bus bars of the switchgear. Do not connect the ground connection to the switchgear metal frame because low impedance to ground cannot be guaranteed.

2.10   HIPOT TESTING

Hipot testing carried out by the Manufacturer:
- Voltage ....**2000 Vac, 50 Hz**
- Time (under voltage) ....**1 minute**

> Disconnect the communication terminals and filter ground during dielectric strength testing (hipot) or damages to the internal surge protection devices may occur.

If hipot testing is to be performed on an installed relay for insulation verification, all remaining terminals except for:

- Safety ground terminal + external shield **31**
- Surge suppression components ground terminal (grounded to separate filter ground) **33**

should be connected in parallel.

3. How to use the menu

3.1 MENU STRUCTURE

IPR-A menu is a tree-structure type, consisting of:

- **PAGE** → function access;
- **LINE** → for each PAGE.

3.2 MENU ACCESS

You can have access to the menu by pressing one of the following keys:

☐ **SET POINTS**   ⇒   *It activates the menu for setting functions and variables*.
☐ **ACTUAL VALUES** ⇒   *It activates the menu for selecting the actual values to be displayed*.

3.3 MENU SURFING

For menu surfing, use one of the following keys:

▲**PAGE**   ⇒   *Next PAGE*.
▼**PAGE**   ⇒   *Previous PAGE*.
☐ **LINE**   ⇒   *Next LINE in the actual PAGE*.

3.4 SELECTING AND STORING KEYS

Use the following keys for selecting and storing data:

▲**VALUE**   ⇒   *For scanning the values or the options to the end of the actual range*.
▼**VALUE**   ⇒   *For scanning the values or the options to the beginning of the actual range*.
☐ **STORE**   ⇒   • *For storing the newly entered data*.
                                              • *It requires the entering of the access code* (111).
                                              • *It switches the keypad operation mode for entering the digits (1 to 9) positioned as shown in the figure*.
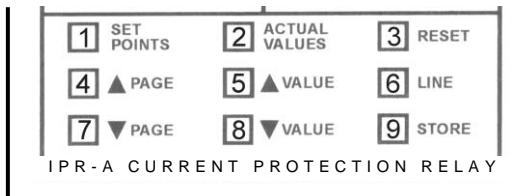
PROG key is positioned on the back of the relay. It can be used to enter new data in SETPOINTS or ACTUAL VALUES menu (range: YES/NO) <u>without entering the access code</u>.

Press **PROG** key instead of: **ENTER ACCESS CODE +** ☐ **STORE** Key

3.5 QUICK SURFING GUIDE

The operation mode of the **PAGE, LINE**, **VALUE** and **STORE** keys is described in details only in the description of the PAGE 1 of the SETPOINT Menu. As the mode for surfing is the same in the other pages, the use of these keys, starting from the second PAGE of the Menu, will not be repeated.

The following summary is intended to be a <u>QUICK SURFING GUIDE</u>:

PAGE: these two keys allow going from one PAGE to the next one [▲] or to the previous one [▼].

LINE: this key allows going from one SETPOINT to the next inside the same PAGE. At the last SETPOINT of the PAGE, it allows to go to the next PAGE.

VALUE: these two keys allow to select <u>range</u> values, decreasing [▼] or increasing [▲]**,** or to select two or more <u>options</u> [for example NO and YES].

STORE: this key allows to store the data and to enter the access code.
<u>Any modifying not confirmed by **STORE** will be ignored</u>.

3.6 SYMBOLS USED IN THE TEXT

<u>The IPR-A display is represented by this figure</u>.

Next to each Setpoint, on the right side of the display, "RANGE:" will be displayed and followed by digits or options separated by the following symbols:

Symbol	Meaning
;	You can select only among the elements of the list that are all clearly listed and separated by the "semi-colon".
÷	You can select among all values included in the limits indicated.

<u>F</u>OR EXAMPLE:

RANGE: 2; 3; 6   ⟹ <u>you can select only one of the three digits: **2**, or **3**, or **6**</u>.

RANGE: 2 ÷ 6   ⟹   <u>you can select **2**, or **3**, or **4**, or **5**, or **6**</u>.

In the SETPOINT Pages (except for PAGE 1), the value indicated in this manual in the 2nd line of the display has been set by the Manufacturer of the relay.

<u>This symbol indicates the key that must be pressed</u>.

3.7   MENU STRUCTURE

The following page includes the complete structure of the IPR-A Menu Pages.

The following keys can activate the two menus represented:

SET POINTS

⇒   It allows programming the relay by setting the parameters and the electrical variables values.

ACTUAL VALUES

⇒   This menu allows displaying or clearing some of the parameters monitored or calculated by the relay.

Before reading the map, study carefully the information in the previous paragraphs: 3.1; 3.2; 3.3; 3.4; 3.5 and 3.6.

3.7   MENU STRUCTURE

```
┌──────────────────────────┐              ┌───┐  SET
│ SETPOINT PAGE 1          │     ⇐════     │ ✓ │  POINTS
│ SETPOINT ACCESS          │              └───┘
└──────────────────────────┘
       ▼    PAGE    ▲
┌──────────────────────────┐
│ SETPOINT PAGE 2          │
│ SYSTEM SETUP             │
└──────────────────────────┘
       ▼    PAGE    ▲                ┌───┐  ACTUAL             ┌──────────────────────────┐
┌──────────────────────────┐        │ ✓ │  VALUES  ═══⇒       │ ACTUAL VALUES 1          │
│ SETPOINT PAGE 3          │        └───┘                     │ CURRENT DATA             │
│ Ph. PROTECTIONS          │                                  └──────────────────────────┘
└──────────────────────────┘                                         ▼    PAGE    ▲
       ▼    PAGE    ▲                                          ┌──────────────────────────┐
┌──────────────────────────┐                                  │ ACTUAL VALUES 2          │
│ SETPOINT PAGE 4          │                                  │ LAST TRIP DATA           │
│ Gnd. PROTECTIONS         │                                  └──────────────────────────┘
└──────────────────────────┘                                         ▼    PAGE    ▲
       ▼    PAGE    ▲                                          ┌──────────────────────────┐
┌──────────────────────────┐                                  │ ACTUAL VALUES 3          │
│ SETPOINT PAGE 5          │                                  │ EVENTS                   │
│ OUTPUT RELAYS            │                                  └──────────────────────────┘
└──────────────────────────┘                                         ▼    PAGE    ▲
       ▼    PAGE    ▲                                          ┌──────────────────────────┐
┌──────────────────────────┐                                  │ ACTUAL VALUES 4          │
│ SETPOINT PAGE 6          │                                  │ MAINTENANCE DATA         │
│ DIGITAL INPUTS           │                                  └──────────────────────────┘
└──────────────────────────┘                                         ▼    PAGE    ▲
       ▼    PAGE    ▲                                          ┌──────────────────────────┐
┌──────────────────────────┐                                  │ END OF                   │
│ SETPOINT PAGE 7          │                                  │ ACTUAL VALUES            │
│ EVENT RECORDER           │                                  └──────────────────────────┘
└──────────────────────────┘
       ▼    PAGE    ▲
┌──────────────────────────┐
│ SETPOINT PAGE 8          │
│ DATE & TIME              │
└──────────────────────────┘
       ▼    PAGE    ▲
┌──────────────────────────┐
│ SETPOINT PAGE 9          │
│ COMMUNICATIONS           │
└──────────────────────────┘
       ▼    PAGE    ▲
┌──────────────────────────┐
│ SETPOINT PAGE 10         │
│ CALIBRATION MODE         │
└──────────────────────────┘
       ▼    PAGE    ▲
┌──────────────────────────┐
│ END OF                   │
│ SETPOINTS                │
└──────────────────────────┘
```
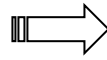
3.8 HOW TO USE SETPOINTS AND ACTUAL VALUES KEYS

[✓] **SET POINTS**

SETPOINT PAGE 1
SETPOINT ACCESS

⇩

[✓] **LINE** ⟹ ENTER ACCESS
CODE: **X X X**

⇩

SETPOINT ACCESS
ENABLED

[✓] **LINE**

ENTER NEW ACCESS   ⟹ Select: **NO** or **YES**   [✓] **▲VALUE** or **▼VALUE**
CODE: **Y/N**

⇩

ENTER NEW ACCESS   ⟸ [✓] **STORE** (*)
CODE: **X X X**

[1] SET POINTS	[2] ACTUAL VALUES	[3] RESET
[4] ▲ PAGE	[5] ▲VALUE	[6] LINE
[7] ▼ PAGE	[8] ▼VALUE	[9] STORE

I P R - A   C U R R E N T   P R O T E C T I O N   R E L A Y

⟸▐▌
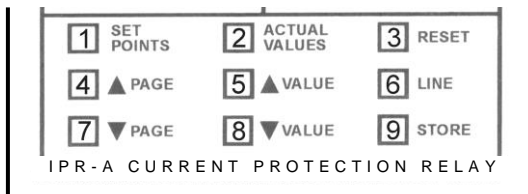
PAY ATTENTION to position of digits!

[✓] **LINE**

IPR-A RELAY:
IPR-A – FIRMWARE

[✓] **LINE**

END OF PAGE
SETPOINT ACCESS

[?i] **(*)** If YES has been selected, by pressing **STORE** key, all the nine keys on the front panelboard modify their functions and allow to enter the digits from 1 to 9, according to the correspondence represented in the diagram.

4. "SETPOINTS" menu

Before carrying out the programming of the unit, it is necessary to read and understand the indications provided by the Manufacturer. All the programming must be carried out by qualified personnel with adequate knowledge of the functioning of the unit and of the content of this manual.

4.1 Setpoints page 1: SETPOINT ACCESS

SETPOINTS PAGE 1 **SETPOINT ACCESS**	*This PAGE contains messages for Setpoint access.* *Press **LINE** key to pass to next Line.*
ENTER ACCESS CODE: X X X	*Enter the <u>THREE-DIGIT</u> access code using the digits from1 to 9.* [→ § 3.8 ?i]. **Manufacturer code: 111.**
SETPOINT ACCESS ENABLED	*It indicates that <u>the entered code is right</u> and that the SETPOINT values can be modified.*
SETPOINT ACCESS ONLY VIEW	*It indicates that <u>the entered code is not right</u> and that the SETPOINT values can <u>only be read.</u>*

ENTER NEW ACCESS
CODE?   NO
	RANGE:...NO; YES
	The user can enter his own customized access code.
	• *<u>to confirm the code programmed by the Constructor</u>.*
	   1. *press **LINE** key to pass to **IPR-A RELAY: IPR-A – FIRMWARE***
	• *<u>to replace the code programmed by the Constructor with the customized one</u>:*
	   1. *press ▲**VALUE** key→ **YES** will be displayed (<u>the following line will be displayed</u>);*
	   2. *press **STORE** key;*
	   3. *enter the new code that is automatically confirmed after entering;*
	   4. *press **LINE** key to pass to the following line.*

ENTER NEW ACCESS CODE: X X X Displayed only if "YES" has been selected in the previous line.	*Enter the <u>THREE-DIGIT</u> access code using the digits from1 to 9.* [→ § 3.8 ?i]. **Manufacturer code: 111.**
NEW ACCESS CODE STORED = X X X	*It indicates that the new access code has been stored.*
IPR-A RELAY: IPR-A - FIRMWARE	*It indicates the IPR-A firmware version.*
END OF PAGE	*Last LINE of PAGE 1.* *Press **LINE** or ▲**PAGE,** to pass to the first line of PAGE 2.*

4.1.1 Relationship between Function and Output Relay

In the following pages the output relays must be selected for each protection function. Carry out the following procedure for selection:

(For explaining purposes reference is made to the function: PHASE TIMED O/C).

PHASE TIMED O/C RELAY: – – – –

The 4 symbols "– – – –" are displayed and by **VALUE** ▲ and **VALUE** ▼ keys:
the 1st symbol can be changed in **T = TRIP**
the 2nd symbol can be changed in **1 = AUX1**
the 3rd symbol can be changed in **2 = AUX2**
the 4th symbol can be changed in **3 = AUX3**

PROCEDURE

1. As soon as the selection of the outputs is required, the first symbol available starts blinking.

2. Commutation of the 1st symbol:
   Press **VALUE** ▲ or **VALUE** ▼ and confirm by **STORE + ACCESS CODE** (if required). The cursor will blink in correspondence of the 1st symbol. Modify the selection, if necessary, or press **LINE** to pass to the second symbol.

   Passage to the 2nd symbol without commuting the 1st one:
   Press **LINE**.

3. Repeat the procedure for all 4 symbols: "– – – –".

Example: For selecting **T – 2 –**

PHASE TIMED O/C RELAY: ∗ – – –

The first cursor blinks ⇒ Press **VALUE** ▲ and **T** will be displayed.
Press **STORE + ACCESS CODE** (if required) ⇒ **T** is confirmed and **T** will blink.

PHASE TIMED O/C RELAY: T ∗ – –

Press **LINE**: the second cursor will blink.

PHASE TIMED O/C RELAY: T – ∗ –

Press **LINE** to pass to the third cursor that will start blinking: press **VALUE** ▲ and **2** will be displayed. Press **STORE + ACCESS CODE** (if required) ⇒ **2** is confirmed and **T** will blink.

PHASE TIMED O/C RELAY: T – 2 ∗

Press **LINE** for 3 times ⇒ the fourth cursor will blink.

PHASE TIMED O/C RELAY: T – 2 –

Press **LINE**: the selection: **T – 2 –** has been completed and you pass to the following Line of the active Setpoint.

4.2   Setpoints page 2: SYSTEM SETUP

SETPOINTS PAGE 2 SYSTEM SETUP	*This page allows entering the IPR-A parameter values for the system in which it will operate.*

SAMPLING FREQUENCY: 50 Hz	RANGE: ....50 Hz; 60 Hz *Enter the system frequency.*

PHASE CT RATING PRIMARY: 50 A	RANGE:..5 A ÷ 6000 A STEPS:...5 A *Enter the primary current rating of the phase current transformers being used. This value is on the transformer plate. In case your transformer has a rating not included in this range, please contact ORION ITALIA.* *All three current transformers must have the same rating.*

GROUND SENSING RESIDUAL	RANGE:...RESIDUAL; ZERO SEQUENCE *It asks if your system uses a separate zero sequence CT or if the CTs are connected in a residual sensing configuration to detect ground current.*

GROUND CT RATING PRIMARY: 50 A	RANGE:..5 A ÷ 6000 A STEPS:...5 A *Enter the primary current rating of the ground CT being used.* • *This line is displayed only if **ZERO SEQUENCE** has been selected in **GROUND SENSING**.*

BREAKER TYPE CIRCUIT BREAKER	RANGE:......................................CIRCUIT BREAKER; DISCONNECTOR *Select the type of device used:* DISCONNECTOR CIRCUIT BREAKER • *The next lines displayed when pressing LINE key will depend on the selection made.* ⇒ *under each following line of this PAGE you will find the selection for displaying it.*

DISCONNECTOR NOM CUR: 100 A If "BREAKER TYPE" = DISCONNECTOR	RANGE:..10 A ÷ 6000 A STEPS:...5 A *Enter the disconnector rated current.* *This value is used for enabling the opening of the disconnector only if:* ⇒ *current rating in all phases < set value.* *If the disconnector uses fuses, the fuse rated current will be the limit for the analysis. IPR-A allows the opening of the disconnector within the limits of its opening capacity, leaving the circuit interruption to the back-up fuses in case of short circuit.*

DISCONNECTOR WITH FUSES? YES If "BREAKER TYPE" = DISCONNECTOR	RANGE:...YES ÷ NO *Enter the type of disconnector:* **NO** ⇒ disconnector only **YES** ⇒ disconnector with fuses • *If **YES** is selected, the following line displayed when pressing **LINE key** is **FUSE NOMINAL CURRENT**.*

FUSE NOMINAL CURRENT: 100 A	RANGE:..5 A ÷ 6000 A STEPS:...1 A; 5A *Enter the fuses rated current.* *This value is used for enabling the opening of the disconnector only if:* ⇒ *current rating in the phases < set value.*

WARNING:
The fuses current must be inferior to the disconnector opening rated current.

OUT OF SERVICE ON AUX3: YES	*When selecting **YES** AUX3 relay will perform the **SERVICE** function: once the power is applied, the relay will make AUX3 react and the related contact will be opened. In case of fault of the relay (OUT OF SERVICE led "On") or of loss of power supply, AUX3 will pass to stand-by position and close its contact.* *When selecting **NO** AUX 3 will be managed as AUX1, AUX2 and TRIP; remark that, unlike these last ones, AUX3 contact is normally closed.*
BLOCK TRIP DELAY: 0.15 S	*Enter the time of TRIP intervention blocking.* *For enabling BLOCK TRIP function a digital input must be configured as BLOCK TRIP (see setpoint page 6 DIGITAL INPUT)*
BREAKER DISCREP. RELAY: – – – –	*It allows selecting the output signalling the discrepancy between the trip command sent by the protection relay and the signal received at the BREAKER STATUS input from the circuit breaker or disconnector auxiliary contact.* *This error information signals that the trip command has not provoked the opening or that the auxiliary contact (52a) does not operate properly.* *Disable this function in case of no connection between 52a auxiliary contact and BREAKER STATUS input.* *For disabling the function ⇒ select "– – – –".* **REMARK**: The procedure for selection is described at page 4.2
BREAKER DISCREP. DELAY: 1000 ms If "BREAKER DISCREP. RELAY" ≠ – – – –	RANGE: .... 10 ms ÷ 2500 ms STEPS: ....10 ms *Delay for the circuit breaker auxiliary contacts to signal the opening. If a correct reply is not obtained in this delay, an event for circuit breaker discrepancy will be displayed and the selected contact will activate.*
MECH. OPERATIONS RELAY: – – – –	*Select the relays to be activated when reaching the max. number of mechanical operations set in the next Line.* **REMARK**: The procedure for selection is described at page 4.2
MECH. OPERATIONS MAXIMUM: 3000 If "MECH. OPERATION RELAY" ≠ – – – –	RANGE: ....5 ÷ 9995 STEPS: ....5 *Enter the max. number of mechanical operations.* *This value represents the granted quantity of mechanical operations carried out by the circuit breaker and the event indicates that maintenance is required.*
ACCUMULATED AMP RELAY: – – – –	*It allows selecting the outputs signalling the accumulated kA set in ACCUMULATED AMP LEVEL have been reached.* *The accumulated kA are measured for each of the three phases and they result from the summation of the current ratings interrupted by the circuit breaker (pre-trip data) at each trip command.* *With disconnector, the current at each opening is the disconnector rated current.* *For disabling the function ⇒ select: "– – – –".*
ACCUMULATED AMP LEVEL: 300 KA If "ACCUMULATED AMP RELAY" ≠ – – – –	RANGE: .... 10 kA ÷5000 kA STEPS: .... 1 kA *Enter the KA accumulated alarm level.* *This function informs about the wear of the circuit breaker pole; the alarm can be used to indicate that an inspection is required.* *This line is displayed only if:* • ***Accumulated Amp Relay** ≠ "– – – –"*
END OF PAGE	*Last LINE of PAGE 2.* *Press **LINE** or ▲**PAGE**, to pass to the first line of PAGE 3.*

4.3   Setpoints page 3: Ph. PROTECTIONS

> **SETPOINTS PAGE 3**
> **Ph. PROTECTIONS**

This PAGE allows setting the phase overcurrent protection.

> PHASE TIMED O/C
> RELAY: – – – –

Select the outputs to be activated by the phase timed overcurrent protection (ANSI 51).
For disabling the function ⇒ select "– – – –".

REMARK: The procedure for selection is described at page 4.2

> PHASE TIMED O/C
> PICKUP: 4% CT

If
"PHASE TIMED O/C RELAY"
≠
– – – –

RANGE:...4% ÷ 300% CT
STEPS:...1% CT
Enter the inverse overcurrents pickup level in percentage of the transformer primary current. This level determines the current level at which the relay will start counting the overcurrent protection delay according to the protection curve selected.
Example: if entering 50% as percentage value, the relay starts counting the intervention delay of the selected relay when at least one of the phase currents arrives at 50% of the value entered in **PHASE CT RATING PRIMARY** of **SETPOINT PAGE 2: SYSTEM SETUP**.

> PHASE O/C CURVE
> ANSI MOD INV

If
"PHASE TIMED O/C RELAY"
≠
– – – –

RANGE........................ DEFINITE TIME, ANSI MOD INV, ANSI NORMAL INV;
                            ANSI VERY INV, ANSI EXTREM INV, IAC SHORT
                            TIME, IAC INVERSE, IAC VERY INV, IAC EXTREM
                            INV, IEC SHORT TIME, IEC-A NORMAL INV, IEC-B
                            VERY INV, IEC-C EXTREM INV

Enter the phase overcurrent protection curve shape required.

> PHASE TIMED O/C
> DELAY: 1.0 Sec

RANGE:..0.05 s÷ 600 s
STEPS...0.01 s / 0.1 s / 1 s
Enter the overcurrent protection (ANSI 51) pickup delay value. The delay allows avoiding false alarms caused by intense temporary currents like the ones generated during the operation of very powerful devices.
If:
current increases above the intervention value set for a time < time delay selected,
⇒   no intervention will be activated.

This line is displayed only if:
• *Phase Timed O/C Relay ≠" – – – –" and Phase O/C Curve = DEFINITE TIME*

> Ph. O/C CURVE
> MULTIPLIER: 0.1

RANGE:.. 0,1 ÷ 20,0
STEPS:.. 0,1
Enter the phase overcurrent multiplier to select the curve required.
[→ Appendix A].

This line is displayed only if:
• *Phase Timed O/C Relay ≠ " – – – –" and Phase O/C Curve ≠ DEFINITE TIME*

The next 3 lines are displayed only if **CIRCUIT BREAKER** has been selected in line **BREAKER TYPE** of **SETPOINT SYSTEM SETUP**.

> PHASE INST. O/C
> RELAY: T– – –

Select the outputs to be activated by the phase instantaneous overcurrent protection (ANSI 50).

REMARK: The procedure for selection is described at page 4.2

PHASE INST. O/C
PICKUP: 40% CT

If
"PHASE INST. O/C RELAY"
≠
– – – –

RANGE: ....4% ÷ 1800% CT
STEPS:1% CT / 10% CT

Enter the phase overcurrents pickup level in percentage of the transformer primary current. This level determines the current level at which the relay will start counting the overcurrent protection delay according to the protection curve selected.
Example: *if entering 50% as percentage value, the relay starts counting the intervention delay of the selected output when at least one of the phase currents arrives at 50% of the value entered in* **PHASE CT RATING PRIMARY** *of* **SETPOINT PAGE 2: SYSTEM SETUP.**

PHASE INST. O/C
DELAY: 0 ms

RANGE: ....0 s ÷ 2000 ms
STEPS: ....10 ms

Enter the phase instantaneous overcurrent protection intervention delay. The time delay allows avoiding false alarms caused by intense temporary currents like the ones generated during the operation of very powerful devices.
If:
current increases above the intervention value set for a time < time delay selected,
⇒ no intervention will be activated.

PHASE O/C ALARM
RELAY: – – – –

Select the outputs to be activated by the phase overcurrent alarm.
REMARK: The procedure for selection is described at page 4.2

PHASE O/C ALARM
PICKUP: 4%CT

If
"PHASE O/C ALARM RELAY"
≠
– – – –

RANGE: .... 4% CT ÷ 300% CT
STEPS .... 1% CT

Enter the phase overcurrent alarm level in percentage of the transformer primary current. This level determines the current level at which the relay will activate the overcurrent alarm.
Example: *if entering 50% as percentage value, the relay starts counting the alarm delay when at least one of the phase currents arrives at 50% of the value entered in* **PHASE CT RATING PRIMARY** *of* **SETPOINT PAGE 2: SYSTEM SETUP.**

PHASE O/C ALARM
DELAY: 1.0 Sec

If
"PHASE O/C ALARM RELAY"
≠
– – – –

RANGE: ....0.05 s ÷ 600 s

Enter the phase overcurrent alarm delay. The time delay allows avoiding false alarms caused by intense temporary currents like the ones generated during the operation of very powerful devices.
If:
current increases above the alarm level set for a time < time delay selected,
⇒ no intervention will be activated.

END OF PAGE

Last LINE of PAGE 3.
Press **LINE** *or* **▲PAGE,** *to pass to the first line of PAGE 4.*

4.4   Setpoints page 4: Gnd. PROTECTIONS

SETPOINTS PAGE 4
Gnd. PROTECTIONS

This PAGE allows setting the ground current protections.

GROUND TIMED O/C
RELAY: – – – –

Select the outputs to be activated by the ground timed overcurrent protection (ANSI 51 N/G).
● *If "– – – –" is selected, the two following lines displayed when pressing* **LINE** *key are* **GROUND INST. O/C RELAY** *and* **GROUND O/C ALARM RELAY**.

REMARK: The procedure for selection is described at page 4.2

GROUND TIMED O/C
PICKUP: 12% CT

If
"GROUND TIMED O/C RELAY"
≠
– – – –

RANGE:.. 4% ÷ 300% CT
STEPS:...1% CT

*Enter the ground overcurrent pickup level. This level determines the current level at which the relay will start counting the circuit breaker/disconnector trip time according to the protection curve selected in the following line: **GROUND O/C CURVE**.*

GROUND O/C CURVE
ANSI MOD INV

If
"GROUND TIMED O/C RELAY"
≠
– – – –

RANGE:......................... DEFINITE TIME; ANSI MOD INV; ANSI NORMAL INV; ANSI VERY INV; ANSI EXTREM INV; IAC SHORT TIME; IAC INVERSE; IAC VERY INV; IAC EXTREM INV; IEC SHORT TIME; IEC-A NORMAL INV; IEC-B VERY INV; IEC-C EXTREM INV

Enter the ground overcurrent protection curve shape required:
- *If **DEFINITE TIME** is selected, the two following lines displayed when pressing **LINE** key are: **GROUND TIMED O/C DELAY** and **Gnd. O/C CURVE MULTIPLIER**.*

GROUND TIMED O/C
DELAY: 1.0 Sec

RANGE:...0.05 s ÷ 600 s
STEPS:...0.01 s / 0.1 s / 1 s

Enter the ground alarm delay. The related output will activate if the current rating is superior to "GROUND TIMED O/C PICKUP" for a longer time than the set one.

This line is displayed only if:
- ***Ground Timed O/C Relay** ≠ "– – – –" and **Ground O/C Curve** = **DEFINITE TIME***

Gnd. O/C CURVE
MULTIPLIER: 1.0

RANGE:... 0.1 ÷ 20.0
STEPS:.. 0.1

Set the ground overcurrent multiplier to select the curve required.

This line is displayed only if:
- ***Ground Timed O/C Relay** ≠ "– – – –" and **Ground O/C Curve** ≠ **DEFINITE TIME***

The next 3 lines are displayed only if **CIRCUIT BREAKER** has been selected in line **BREAKER TYPE** of **SETPOINT SYSTEM SETUP**.

GROUND INST. O/C
RELAY: – – – –

Select the outputs to be activated by the ground instantaneous overcurrent protection (ANSI 51N). Select "– – – –" for disabling the protection.

REMARK: The procedure for selection is described at page 4.2

GROUND INST. O/C
PICKUP 120% CT

If
"GROUND INST O/C RELAY"
≠
– – – –

RANGE:... 4% ÷ 1800% CT
STEPS:... 1% CT / 10% CT

Enter the instantaneous overcurrent pickup level. This level determines the current level at which the relay will start counting the time for the activation of the related output.

GROUND INST. O/C
DELAY: 0 ms

If
"GROUND INST O/C RELAY"
≠
– – – –

RANGE:...0 ms ÷ 2000 ms
STEPS: ....10 ms

Enter the intervention delay for ground instantaneous overcurrent protection.
If:
the ground current increases above the value entered in "GROUND INST. O/C PICKUP" for a time > delay time selected,
⇒ the output will activate.

GROUND O/C ALARM
RELAY: – – – –

Select the outputs to be activated by the ground overcurrent alarm. Select "– – – –" for disabling the alarm.

REMARK: The procedure for selection is described at page 4.2

GROUND O/C ALARM PICKUP: 12% CT	RANGE: ....4% ÷ 300% CT STEPS: .... 1% CT

If
"GROUND O/C ALARM RELAY"
≠
− − − −

Enter the ground overcurrent alarm level. This level determines the current level at which the relay will start counting the time for the activation of the alarm.

GROUND O/C ALARM DELAY: 1.0 Sec	RANGE: ....0.05 s ÷ 600 s STEPS: .... 0.01 s / 0.1 s / 1 s

If
"GROUND O/C ALARM RELAY"
≠
− − − −

Enter the delay for the ground overcurrent alarm activation.
If:
the ground current increases above the value entered in "GROUND O/C ALARM DELAY" for a time > delay time selected,
⇒ the output will activate.

END OF PAGE

Last LINE of PAGE 4.
*Press **LINE** or ▲**PAGE,** to pass to the first line of PAGE 5.*

4.5   Setpoint page 5: OUTPUT RELAYS

SETPOINT PAGE 5 OUTPUT RELAYS

This PAGE allows setting the features of the relay output contacts.

TRIP OUTPUT RELAY: LATCHED	RANGE: ....LATCHED; PULSED

- PULSED operation:
  *In case of fault condition due to which the related output must activate, this output will be energized for a time as the one set in **TRIP RELAY PULSE TIME**; after this time the output relay will de-energize and the contact will return to the stand-by condition. The output will repeat this operation every 3 seconds in case the fault condition is still present.*

- LATCHED operation:
  In case of fault condition due to which the related output must activate, this output will be energized for an indefinite time. The output relay will de-energize only when the fault condition is no more present and the unit is RESET.

TRIP RELAY PULSE TIME: 0.2 Sec	RANGE: ....0.1 s ÷ 2.0 s STEPS: ....0.1 s

If
"TRIP OUTPUT RELAY"
=
PULSED

Enter the delay for the trip relay de-energizing.

AUX1 OUTPUT RELAY: LATCHED	RANGE: ....LATCHED; PULSED

- PULSED operation:
  *In case of fault condition due to which the related output must activate, this output will be energized for a time as the one set in **AUX1 RELAY PULSE TIME**; after this time the output relay will de-energize and the contact will return to the stand-by condition.*

- LATCHED operation:
  In case of fault condition due to which the related output must activate, this output will be energized for an indefinite time. The output relay will de-energize only when the fault condition is no more present and the unit is RESET.

AUX1 RELAY PULSE TIME: 0.2 Sec	RANGE: ....0.1 s ÷ 2.0 s STEPS: ....0.1 s

If
"AUX1 OUTPUT RELAY"
=
PULSED

Enter the delay for AUX 1 relay de-energizing.

AUX2 OUTPUT RELAY: LATCHED	RANGE:... LATCHED; PULSED

- PULSED operation:
  *In case of fault condition due to which the related output must activate, this output will be energized for a time as the one set in **AUX2 RELAY PULSE TIME**; after this time the output relay will de-energize and the contact will return to the stand-by condition.*

- LATCHED operation:
  In case of fault condition due to which the related output must activate, this output will be energized for an indefinite time. The output relay will de-energize only when the fault condition is no more present and the unit is RESET.

AUX2 RELAY PULSE TIME: 0.2 Sec	RANGE:... 1.0 s ÷ 2.0 s
If "AUX2 OUTPUT RELAY" = PULSED	STEPS:..0.1 s *Enter the delay for AUX 2 relay de-energizing.*

AUX3 OUTPUT RELAY: LATCHED	RANGE:... LATCHED; PULSED

- PULSED operation:
  *In case of fault condition due to which the related output must activate, this output will be energized for a time as the one set in **AUX3 RELAY PULSE TIME**; after this time the output relay will de-energize and the contact will return to the stand-by condition.*

- LATCHED operation:
  In case of fault condition due to which the related output must activate, this output will be energized for an indefinite time. The output relay will de-energize only when the fault condition is no more present and the unit is RESET.

AUX3 RELAY PULSE TIME: 0.2 Sec	RANGE:... 1.0 s ÷ 2.0 s
If "AUX2 OUTPUT RELAY" = PULSED	STEPS:..0.1 s *Enter the delay for AUX 3 relay de-energizing.*

END OF PAGE	*Last LINE of PAGE 5.* *Press **LINE** or ▲**PAGE**, to pass to the first line of PAGE 6.*

For AUX3 display the information at page 4.4 "OUT OF SERVICE ON AUX 3".

4.6   Setpoint page 6: DIGITAL INPUTS

SETPOINT PAGE 6 DIGITAL INPUTS	*This PAGE allows setting the digital inputs.*

INPUT 1 FUNCTION BREAKER EARTHED	RANGE:...............................NONE; BREAKER EARTHED; EXTERNAL RESET; REMOTE TRIP; BLOCK TRIP; ACTIVATE AUX1; ACTIVATE AUX2; ACTIVATE AUX3 *Select the function to be associated with INPUT 1.*

INPUT 1 ACTIVE WHEN: CLOSED	RANGE:..CLOSED; OPENED *Configure digital input INPUT 1:* CLOSED ⇒ *INPUT 1 will be active when the related contacts are closed.* OPENED ⇒ *INPUT 1 will be active when the related contacts are open.*

INPUT 2 FUNCTION EXTERNAL RESET	RANGE:...............................NONE; BREAKER EARTHED; EXTERNAL RESET; REMOTE TRIP; BLOCK TRIP; ACTIVATE AUX1; ACTIVATE AUX2; ACTIVATE AUX3 *Select the function to be associated with INPUT 2.*

INPUT 2 ACTIVE WHEN: CLOSED	RANGE: .... CLOSED; OPENED *Configure digital input INPUT 2:* CLOSED ⇒ *INPUT 2 will be active when the related contacts are closed.* OPENED ⇒ *INPUT 2 will be active when the related contacts are open.*
INPUT 3 FUNCTION NONE	RANGE: .... NONE; BREAKER EARTHED; EXTERNAL RESET; REMOTE TRIP; BLOCK TRIP; ACTIVATE AUX1; ACTIVATE AUX2; ACTIVATE AUX3 *Select the function to be associated with INPUT 3.*
INPUT 3 ACTIVE WHEN: CLOSED	RANGE: .... CLOSED; OPENED *Configure digital input INPUT 3:* CLOSED ⇒ *INPUT 3 will be active when the related contacts are closed.* OPENED ⇒ *INPUT 3 will be active when the related contacts are open.*
END OF PAGE	*Last LINE of PAGE 6.* *Press **LINE** or **▲ PAGE**, to pass to the first line of PAGE 7.*

4.7 Setpoint page 7: EVENT RECORDER

SETPOINT PAGE 7 EVENT RECORDER	*This PAGE allows to enable/disable the recording of the events, up to 10 max., according to FIFO (First-In, First-Out) mode. Once 10 events are stored, the oldest event is cleared by the new one occurred.*
Ph. PROTECTIONS EVENTS: ON	RANGE: .... ON; OFF *It enables/disables phase current protection events recording.*
Gnd. PROTECTIONS EVENTS: ON	RANGE: .... ON; OFF *It enables/disables ground current protection events recording.*
SYSTEM ALARM EVENTS: ON	RANGE: .... ON; OFF *It enables/disables alarms events recording.*
OUTPUT RELAYS EVENTS: ON	RANGE: .... ON; OFF *It enables/disables output contacts events recording.*
DIGITAL INPUTS EVENTS: ON	RANGE: .... ON; OFF *It enables/disables digital inputs events recording.*
END OF PAGE	*Last LINE of PAGE 7.* *Press **LINE** or **▲ PAGE**, to pass to the first line of PAGE 8.*

4.8 Setpoint page 8: DATE & TIME [future option]

SETPOINT PAGE 8	*This PAGE allows setting date and time.*

DATE & TIME	

Jun 9, 2001 16:54:02.10	*Actual date and time are displayed.*

SET DATE & TIME?
NO
	RANGE:..YES; NO
	It asks if you want to modify date and time:
	• *to confirm the actual data:*
	   1. Press **LINE** to pass to **END OF PAGE – SETPOINT VALUES**
	• *to modify date and time:*
	   1. Press ▲ **VALUE** → **YES** will be displayed;
	   2. Press **STORE** and enter access code (if required)
	   3. Modify the blinking data by using ▲ **VALUE** and ▼ **VALUE**;
	   4. Press **LINE** to pass to next lines;
	   5. Press **STORE** after modifying.

Jun 9, 2001 16:54:02.10	RANGE:..JAN ÷ DEC.

Jun **9**, 2001 16:54:02.10	RANGE:..1 ÷ 31

Jun 9, **2001** 16:54:02.10	RANGE:..2000 ÷ 2099

Jun 9, 2001 **16**:54:02.10	RANGE:..0 ÷ 23

Jun 9, 2001 16:**54**:02.10	RANGE:..0 ÷ 59

Jun 9, 2001 16:54:**02**.10	RANGE:..0 ÷ 59

END OF PAGE	*Last LINE of PAGE 8.* *Press **LINE** or ▲**PAGE**, to pass to the first line of PAGE 9.*

4.9 Setpoint page 9: COMMUNICATIONS

SETPOINT PAGE 9 COMMUNICATIONS	*This PAGE allows setting the features for the communications between IPR-A and other devices.*

RELAY ADDRESS 1	RANGE:..1 ÷ 247 *Assign its own address to the relay in order to differentiate it from other relays connected to the same communication network.*

COM1 RS-232 BAUDRATE 9600	RANGE:...1200; 2400; 4800; 9600; 19200 *Select the Baud rate.*

COM2 RS-485 BAUDRATE 9600	RANGE:...1200; 2400; 4800; 9600; 19200 *Select the Baud rate.*

COM3 RS-485 BAUDRATE 9600	RANGE:...1200; 2400; 4800; 9600; 19200 *Select the Baud rate.*

END OF PAGE	*Last LINE of PAGE 9.* *Press **LINE** or ▲**PAGE**, to pass to the first line of PAGE 10.*

4.10 Setpoint page 10: CALIBRATION MODE

SETPOINT PAGE 10 CALIBRATION MODE	*This PAGE allows testing the operation of the inputs and the output relays.*
RELAYS TEST NONE	RANGE: ....TRIP; AUX1; AUX2; AUX 3; ALL *Select the involved output for testing the correct operation of the output relays by using VALUE ▲ and VALUE ▼ and press STORE. Press RESET to return to the normal condition.*
DIGITAL INPUT 1 DEACTIVATED	RANGE: .... DEACTIVATED; ACTIVATED *This message allows controlling the status (DEACTIVATED or ACTIVATED) of external contact DIGITAL INPUT 1.*
DIGITAL INPUT 2 DEACTIVATED	RANGE: .... DEACTIVATED; ACTIVATED *This message allows controlling the status (DEACTIVATED or ACTIVATED) of external contact DIGITAL INPUT 2.*
DIGITAL INPUT 3 DEACTIVATED	RANGE: .... DEACTIVATED; ACTIVATED *This message allows controlling the status (DEACTIVATED or ACTIVATED) of external contact DIGITAL INPUT 3.*
UPDATE FIRMWARE NO	RANGE:..YES; NO *By selecting YES the relay firmware can be updated by RS-232 serial port. Before confirming YES, read the Upgrading Instruction. The instruction will be given by Orion Italia for each available upgrade.*
END OF PAGE	*Last LINE of PAGE 10.*

5. "ACTUAL VALUES" menu

5.1 Actual values 1: CURRENT DATA

| ACTUAL VALUES 1 CURRENT DATA | *This PAGE includes the actual values of the system phase and ground currents.* |

| A: 0.00   B: 0.00 C: 0.00   Amp | *It indicates true RMS of each phase current.* |

| GROUND CURRENT 0.00 Amp | *It indicates true RMS of the ground current.* |

| END OF PAGE | *Last LINE of PAGE 1. Press **LINE** or ▲**PAGE,** to pass to the first line of PAGE 2.* |

5.2 Actual values 2: LAST TRIP DATA

| ACTUAL VALUES 2 LAST TRIP DATA | *This PAGE includes the electrical variables values at the latest trip made by IPR-A; these variables can be displayed immediately after the trip.* ***For example:*** *After the overcurrent trip, the phase currents can be displayed to check the phase/s that have/s caused the problem.* *The data are stored even in case of no control power to the relay.* |

| LAST TRIP CAUSE NO TRIP DATA | *It indicates that, after pressing LINE key, the cause of the latest trip will be displayed.* |

✓ **STORE** ⇒ *It displays date and time of the latest trip.*
        [Future function]

| A: 0.00   B: 0.00 C: 0.00   Amp | *It displays phase current ratings when the trip occurred.* |

| GROUND CURRENT 0.00 Amp | *It displays ground current rating when the trip occurred.* |

| END OF PAGE | *Last LINE of PAGE 2. Press **LINE** or ▲**PAGE,** to pass to the first line of PAGE 3.* |

5.3   Actual values 3: EVENTS

ACTUAL VALUES 3 EVENTS

It displays the events [→ Chapter 7 – EVENT RECORDER].
In case of no control power supply, the cause, the electrical variables values related to each event and the moment of the fault [future function] would not be lost.

EVENT 10 EVENT CAUSE

It indicates the number of the event and its cause.

✓ **VALUE ▲** or **VALUE ▼** ⇒ *It displays the latest events or previous ones.*

✓ **STORE** ⇒ *It displays date and time* [Future function].

✓ **LINE** ⇒ *It displays phase and ground currents RMS values.*

✓ **LINE** ⇒ *It displays the message for the clearing of events.*
    YES ⇒ events clearing
    NO ⇒ events are not cleared
    STORE ⇒ to confirm the selection

CLEAR ALL EVENTS? NO

Confirm any clearing of events.
YES ⇒ events clearing
LINE ⇒ events are not cleared
STORE ⇒ to confirm the selection

END OF PAGE

Last LINE of PAGE 3. Press **LINE** *or* **▲PAGE,** *to pass to the first line of PAGE 4.*

5.4   Actual values 4: MAINTENANCE DATA

ACTUAL VALUES 4 MAINTENANCE DATA

This PAGE includes:
1. the number of trips (due to intervention by protections) or openings carried out
2. KA accumulated in each phase,
stored for managing the maintenance.

TRIPS COUNTER 0

It indicates the number of trips caused by the intervention of the protections.

ACCUMULATED AMP Ph. A   0 KA

It indicates the kA accumulated in phase A during the trips by IPR-A.
The total measuring resulting from the addition of the value detected when the trip has occurred to the previous total value gives an indication about the wear of the opening device.

ACCUMULATED AMP Ph. B   0 KA

It indicates the kA accumulated in phase B during the trips by IPR-A.
The total measuring resulting from the addition of the value detected when the trip has occurred to the previous total value gives an indication about the wear of the opening device.

ACCUMULATED AMP Ph. C   0 KA

It indicates the kA accumulated in phase C during the trips by IPR-A.
The total measuring resulting from the addition of the value detected when the trip has occurred to the previous total value gives an indication about the wear of the opening device.

PHASE O/C TRIPS 0

It counts the times the circuit breaker or disconnector controlled by IPR-A has tripped due to the intervention of ⇒ <u>phase overcurrent</u> protection.

GROUND O/C TRIPS 0

It counts the times the circuit breaker or disconnector controlled by IPR-A has tripped due to the intervention of ⇒ ground overcurrent protection.

OPENING COUNTER 0

It counts the breaker or disconnector openings.

MAINTENANCE DATA CLEAR?   NO

It allows the clearing of the data accumulated in Actual Values 4: MAINTENANCE DATA. Use VALUE UP key or VALUE DOWN key to select the answers: YES or NO and press STORE to confirm the selection.

*If the access is enabled, **DATA CLEARED** will be displayed.*

END OF PAGE

Last LINE of PAGE 4.

END OF ACTUAL VALUES

End of Actual Values.

6. AUTOMATIC OPERATION

6.1 AUTOMATIC OPERATION CONDITION

When starting the IPR-A or after 5 minutes from the last operation carried out on the front keyboard, the relay cyclically displays the following information:

- current of each phase
- ground current
- cause of the latest intervention.

When supplying the power to the IPR-A, the following message is displayed:

> **ORION ITALIA**
> **IPR-A RELAY**

and then these messages will be displayed:

> PHASE A CURRENT
> XXXX A

It indicates the actual current true RMS in phase A.

> PHASE B CURRENT
> XXXX A

It indicates the actual current true RMS in phase B.

> PHASE C CURRENT
> XXXX A

It indicates the actual current true RMS in phase C.

> GROUND CURRENT
> XXXX A

It indicates the actual ground current true RMS.

> LAST TRIP CAUSE
> XXXXXXXXXXXXXXX

It indicates the cause of the latest trip by IPR-A.

If any fault has caused the protection relay intervention and consequently the device turning off due to voltage loss, when the power supply is restored the relay will activate and make the following leds blink: TRIP led and the led related to the cause of the trip (50, 51, 50N or 51N).
This indication does not signal that TRIP contact is active but signals that the device has switched off due to a trip caused by a fault.
Press RESET to stop the signalling.

7. Events recorder

Press ACTUAL VALUE and select the page: EVENT [→ Actual value 3: EVENTS] to display the last 10 events.

7.1 DEFINITION OF "EVENT" AND STORING

IPR-A is equipped with an Event recorder in which the following data are stored:
- intervention of protection or alarm due to phase overcurrent,
- intervention of protection or alarm due to ground overcurrent,
- changing of status of an output contact,
- changing of status of a digital input,
- system status (circuit breaker status, discrepancy signalling, reaching of the limit of mechanical operations or kA accumulated, remote trip commands, block trip and other events non included in the previous points)

during the operation of the relay.

All events, up to 10 max., will be stored in a memory buffer operating in FIFO (First-In, First-Out) mode. Once 10 events are stored, the oldest event is cleared by the new one occurred.

7.2 EVENTS FORMAT

Each event is characterized by the line parameters values when the event is occurring. The stored parameters are the following:
- description of the event,
- each of the 3 phase currents,
- ground current,
- event date and time [future function].

8. Troubleshooting

PROBLEM	SOLUTION	REFERENCE
The display does not turn on.	1. Check the power supply to the auxiliary terminals. 2. Check the power supply voltage is the same as the one indicated on the plate (on the back of the relay).	*Wiring diagram*
The display is "On" but no message is displayed.	1. Check the power supply voltage is the same as the one indicated on the plate (on the back of the relay).	*Wiring diagram*
The phase current is not displayed.	1. Check the current reading is enabled. 2. Check the wiring of phase CT.	*Actual values 1* *Wiring diagram*
Wrong displaying of the phase current reading.	1. Measure the current input in the terminals of IPR-A by using a clamp meter. 2. Check the CT primary current has been correctly entered and stored in Setpoint Page 2.	 *Page 2 of Setpoint*
The ground current is not displayed.	1. Check the active ACTUAL VALUES PAGE is the right one. 2. Check the ground CT primary current has been correctly entered, ZERO SEQUENCE has been set in Setpoint 2 and the ground CT connections. 3. Check the CTs right connection according to "Residual" entering if RESIDUAL has been set in Setpoint 2.	*Actual values 1* *Page 2 of Setpoint* *Wiring diagram* *Page 2 of Setpoint* *Wiring diagram*

9.   Warranty

ORION ITALIA warrants that the materials and the labouring of every relay have no faults with normal use and working conditions for a period of 12 months starting from the date of shipping from the manufacturer.

In case of fault included in the warranty conditions, ORION ITALIA takes full responsibility for repairing or replacing the product without any extra fees for the buyer. The warranty is always considered free-port to our head office in Piacenza.

The costs for the Buyer are the following:
- the round-trip shipping for the repairing or the overhauling of the relay;
- the travelling expenses for the technician in charge of the repairing and the overhauling.

In case of controversy, the place of jurisdiction is the one of Piacenza.

This warranty is not valid for any device that has been subject to incorrect use, negligence, accidents, incorrect installation or that has not been used in accordance with the instructions, or for any device tampered outside the factory. ORION ITALIA will not be responsible for the consequences of any damages, even indirect, for the loss of gain or for the eventual costs deriving from any malfunctioning or from any incorrect use or setting of our devices.

ORION ITALIA reserves the right to modify the device and/or replace what is described in this manual without any previous notice.

APPENDIX A

TABLES AND TIME-CURRENT CURVES

This appendix includes the 3 curve types and their related shapes.

ANSI CURVES
Moderately inverse
Normally inverse
Very inverse
Extremely inverse

IAC CURVES
IAC Short time
IAC Normally inverse
IAC Very inverse
IAC Extremely inverse

IEC/BS 142 CURVES
IEC Short time
IEC A Normally inverse
IEC B Very inverse
IEC C Extremely inverse

ANSI CURVES

$$T = M * \left(A + \frac{B}{\left(\dfrac{I}{Ipu} - C\right)} + \frac{D}{\left(\dfrac{I}{Ipu} - C\right)^2} + \frac{E}{\left(\dfrac{I}{Ipu} - C\right)^3} \right)$$

ANSI CURVE CONSTANTS	A	B	C	D	E
Moderately Inverse	0.1735	0.6791	0.8	-0.08	0.1271
Normally Inverse	0.0274	2.2614	0.3	-4.19	9.1272
Very Inverse	0.0615	0.7989	0.34	-0.284	4.0505
Extremely Inverse	0.0399	0.2294	0.5	3.0094	0.7222

TRIP TIME (SEC)	T
CURVE MULTIPLIER SETPOINT	M
INPUT CURRENT	I
PICKUP CURRENT SETPOINT	Ipu

MULT.	I/Ipu												
(M)	1.0	1.5	2	3	4	5	6	7	8	9	10	15	20
ANSI - MODERATELY INVERSE													
0.5	8.728	0.675	0.379	0.239	0.191	0.166	0.151	0.141	0.133	0.128	0.123	0.110	0.104
0.8	13.965	1.081	0.606	0.382	0.305	0.266	0.242	0.225	0.213	0.204	0.197	0.177	0.167
1	17.457	1.351	0.757	0.478	0.382	0.332	0.302	0.281	0.267	0.255	0.247	0.221	0.209
1.2	20.948	1.621	0.909	0.573	0.458	0.399	0.362	0.338	0.320	0.306	0.296	0.265	0.250
1.5	26.185	2.026	1.136	0.716	0.573	0.499	0.453	0.422	0.400	0.383	0.370	0.331	0.313
2	34.913	2.702	1.515	0.955	0.764	0.665	0.604	0.563	0.533	0.511	0.493	0.442	0.417
3	52.370	4.053	2.272	1.433	1.145	0.997	0.906	0.844	0.800	0.766	0.740	0.663	0.626
4	69.826	5.404	3.030	1.910	1.527	1.329	1.208	1.126	1.066	1.021	0.986	0.884	0.835
6	104.74	8.106	4.544	2.866	2.291	1.994	1.812	1.689	1.600	1.532	1.479	1.326	1.252
8	139.65	10.807	6.059	3.821	3.054	2.659	2.416	2.252	2.133	2.043	1.972	1.768	1.669
10	174.57	13.509	7.574	4.776	3.818	3.324	3.020	2.815	2.666	2.554	2.465	2.210	2.087
15	261.85	20.264	11.361	7.164	5.727	4.986	4.531	4.222	3.999	3.830	3.698	3.315	3.130
20	349.13	27.019	15.148	9.552	7.636	6.647	6.041	5.630	5.332	5.107	4.931	4.419	4.173
ANSI - NORMALLY INVERSE													
0.5	10.659	2.142	0.883	0.377	0.256	0.203	0.172	0.151	0.135	0.123	0.113	0.082	0.066
0.8	17.054	3.427	1.412	0.603	0.410	0.325	0.276	0.242	0.216	0.197	0.181	0.132	0.106
1	21.317	4.284	1.766	0.754	0.513	0.407	0.344	0.302	0.270	0.246	0.226	0.165	0.133
1.2	25.580	5.141	2.119	0.905	0.615	0.488	0.413	0.362	0.324	0.295	0.271	0.198	0.159
1.5	31.976	6.426	2.648	1.131	0.769	0.610	0.517	0.453	0.406	0.369	0.339	0.247	0.199
2	42.634	8.568	3.531	1.508	1.025	0.814	0.689	0.604	0.541	0.492	0.452	0.329	0.265
3	63.951	12.853	5.297	2.262	1.538	1.220	1.033	0.906	0.811	0.738	0.678	0.494	0.398
4	85.268	17.137	7.062	3.016	2.051	1.627	1.378	1.208	1.082	0.983	0.904	0.659	0.530
6	127.90	25.705	10.594	4.524	3.076	2.441	2.067	1.812	1.622	1.475	1.356	0.988	0.796
8	170.54	34.274	14.125	6.031	4.102	3.254	2.756	2.415	2.163	1.967	1.808	1.318	1.061
10	213.17	42.842	17.656	7.539	5.127	4.068	3.445	3.019	2.704	2.458	2.260	1.647	1.326
15	319.76	64.263	26.484	11.309	7.691	6.102	5.167	4.529	4.056	3.688	3.390	2.471	1.989
20	426.34	85.684	35.312	15.078	10.254	8.136	6.889	6.039	5.408	4.917	4.520	3.294	2.652
ANSI - VERY INVERSE													
0.5	7.354	1.567	0.663	0.268	0.171	0.130	0.108	0.094	0.085	0.078	0.073	0.058	0.051
0.8	11.767	2.507	1.060	0.430	0.273	0.208	0.173	0.151	0.136	0.125	0.117	0.093	0.082
1	14.709	3.134	1.325	0.537	0.341	0.260	0.216	0.189	0.170	0.156	0.146	0.116	0.102
1.2	17.651	3.761	1.590	0.644	0.409	0.312	0.259	0.227	0.204	0.187	0.175	0.139	0.122
1.5	22.063	4.701	1.988	0.805	0.512	0.390	0.324	0.283	0.255	0.234	0.218	0.174	0.153
2	29.418	6.268	2.650	1.074	0.682	0.520	0.432	0.378	0.340	0.312	0.291	0.232	0.204
3	44.127	9.402	3.976	1.611	1.024	0.780	0.648	0.566	0.510	0.469	0.437	0.348	0.306
4	58.835	12.537	5.301	2.148	1.365	1.040	0.864	0.755	0.680	0.625	0.583	0.464	0.408
6	88.253	18.805	7.951	3.221	2.047	1.559	1.297	1.133	1.020	0.937	0.874	0.696	0.612
8	117.67	25.073	10.602	4.295	2.730	2.079	1.729	1.510	1.360	1.250	1.165	0.928	0.815
10	147.09	31.341	13.252	5.369	3.412	2.599	2.161	1.888	1.700	1.562	1.457	1.160	1.019
15	220.63	47.012	19.878	8.054	5.118	3.898	3.242	2.831	2.550	2.343	2.185	1.739	1.529
20	294.18	62.683	26.504	10.738	6.824	5.198	4.322	3.775	3.399	3.124	2.913	2.319	2.039
ANSI - EXTREMELY INVERSE													
0.5	9.157	2.000	0.872	0.330	0.184	0.124	0.093	0.075	0.063	0.055	0.049	0.035	0.030
0.8	14.651	3.201	1.395	0.528	0.294	0.198	0.148	0.119	0.101	0.088	0.079	0.056	0.048
1	18.314	4.001	1.744	0.659	0.368	0.247	0.185	0.149	0.126	0.110	0.098	0.070	0.060
1.2	21.977	4.801	2.093	0.791	0.442	0.297	0.223	0.179	0.151	0.132	0.118	0.084	0.072
1.5	27.471	6.001	2.616	0.989	0.552	0.371	0.278	0.224	0.189	0.165	0.147	0.105	0.090
2	36.628	8.002	3.489	1.319	0.736	0.495	0.371	0.298	0.251	0.219	0.196	0.141	0.119
3	54.942	12.003	5.233	1.978	1.104	0.742	0.556	0.447	0.377	0.329	0.295	0.211	0.179
4	73.256	16.004	6.977	2.638	1.472	0.990	0.742	0.596	0.503	0.439	0.393	0.281	0.239
6	109.88	24.005	10.466	3.956	2.208	1.484	1.113	0.894	0.754	0.658	0.589	0.422	0.358
8	146.51	32.007	13.955	5.275	2.944	1.979	1.483	1.192	1.006	0.878	0.786	0.562	0.477
10	183.14	40.009	17.443	6.594	3.680	2.474	1.854	1.491	1.257	1.097	0.982	0.703	0.597
15	274.71	60.014	26.165	9.891	5.519	3.711	2.782	2.236	1.885	1.646	1.474	1.054	0.895
20	366.28	80.018	34.887	13.188	7.359	4.948	3.709	2.981	2.514	2.194	1.965	1.405	1.194

IAC CURVES

$$T = M * \left(A + \frac{B}{\left(\dfrac{I}{Ipu} - C\right)} + \frac{D}{\left(\dfrac{I}{Ipu} - C\right)^2} + \frac{E}{\left(\dfrac{I}{Ipu} - C\right)^3} \right)$$

IAC CURVE CONSTANTS	A	B	C	D	E		
Short Inverse	0.0428	0.0609	0.62	-0.001	0.0221	TRIP TIME (SEC)	T
Normally Inverse	0.2078	0.863	0.8	-0.418	0.1947	CURVE MULTIPLIER SETPOINT	M
Very Inverse	0.09	0.7955	0.1	-1.289	7.9586	INPUT CURRENT	I
Extremely Inverse	0.004	0.638	0.62	1.787	0.246	PICKUP CURRENT SETPOINT	Ipu

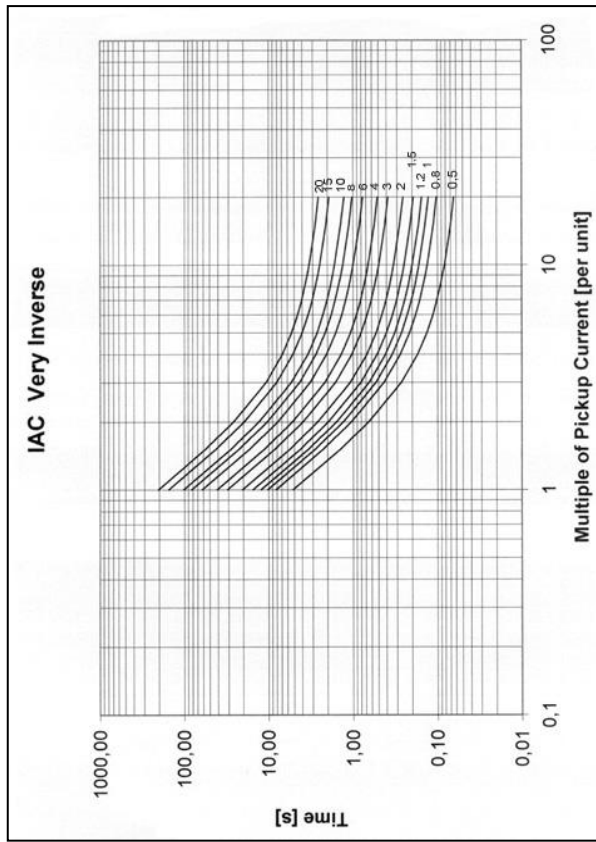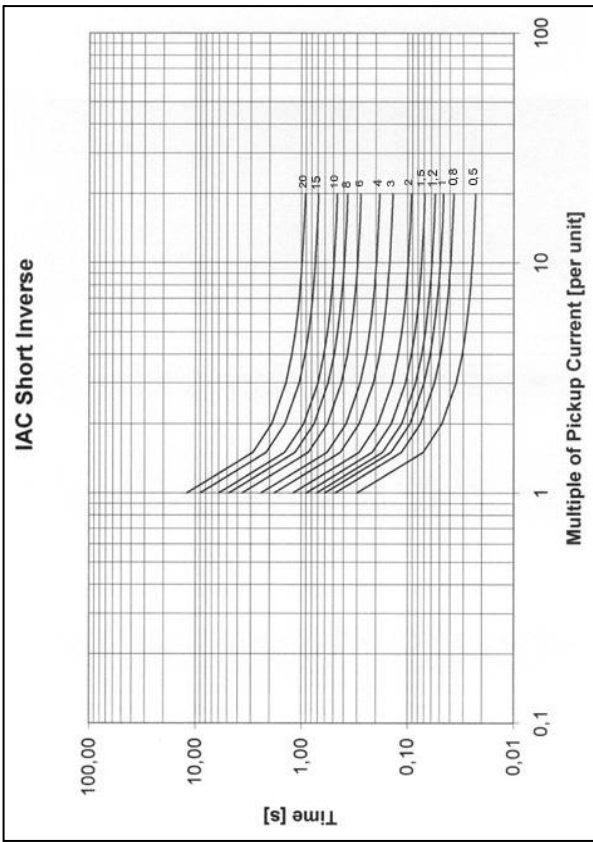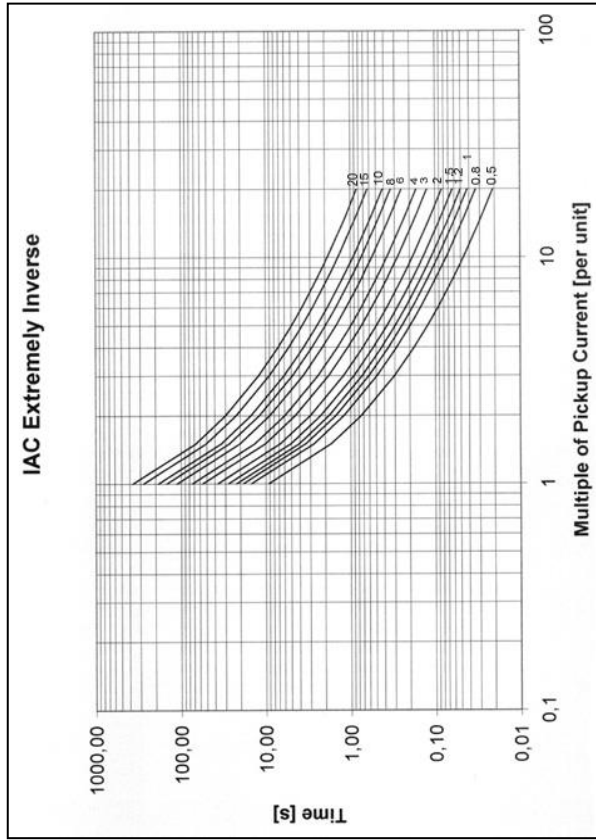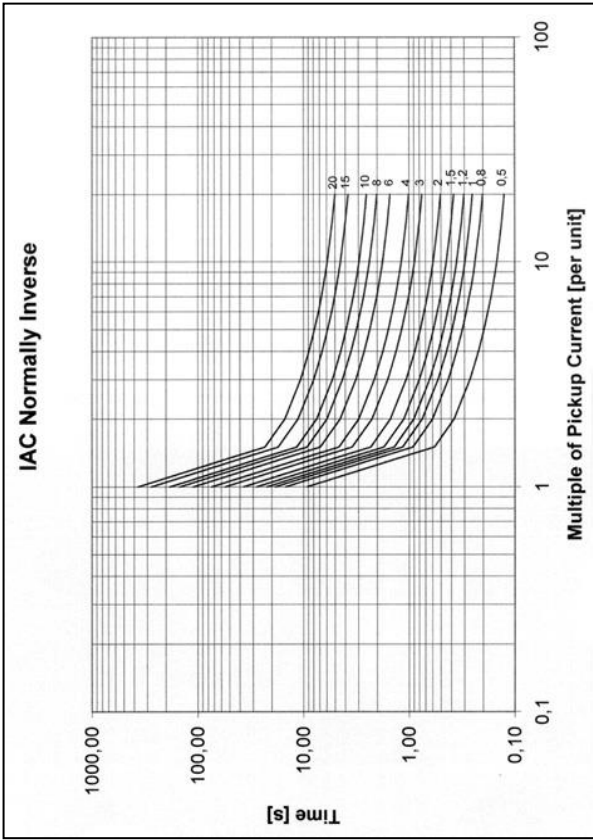| MULT.	I/Ipu												
(M)	1.0	1.5	2	3	4	5	6	7	8	9	10	15	20
IAC SHORT INVERSE													
0.5	0.299	0.072	0.047	0.035	0.031	0.028	0.027	0.026	0.026	0.025	0.025	0.024	0.023
0.8	0.479	0.115	0.076	0.056	0.049	0.046	0.043	0.042	0.041	0.040	0.039	0.038	0.037
1	0.599	0.143	0.095	0.070	0.061	0.057	0.054	0.052	0.051	0.050	0.049	0.047	0.046
1.2	0.719	0.172	0.114	0.084	0.074	0.068	0.065	0.063	0.061	0.060	0.059	0.056	0.055
1.5	0.898	0.215	0.142	0.105	0.092	0.085	0.081	0.079	0.077	0.075	0.074	0.071	0.069
2	1.198	0.286	0.190	0.140	0.123	0.114	0.108	0.105	0.102	0.100	0.099	0.094	0.092
3	1.797	0.429	0.284	0.210	0.184	0.171	0.163	0.157	0.153	0.150	0.148	0.141	0.138
4	2.396	0.573	0.379	0.279	0.245	0.228	0.217	0.210	0.204	0.200	0.197	0.188	0.184
6	3.593	0.859	0.569	0.419	0.368	0.341	0.325	0.314	0.307	0.301	0.296	0.282	0.276
8	4.791	1.145	0.759	0.559	0.490	0.455	0.434	0.419	0.409	0.401	0.394	0.376	0.368
10	5.989	1.431	0.948	0.699	0.613	0.569	0.542	0.524	0.511	0.501	0.493	0.470	0.459
15	8.983	2.147	1.422	1.048	0.920	0.854	0.813	0.786	0.766	0.751	0.740	0.706	0.689
20	11.978	2.863	1.896	1.397	1.226	1.138	1.085	1.048	1.022	1.002	0.986	0.941	0.919
IAC NORMALLY INVERSE													
0.5	9.205	0.578	0.375	0.266	0.221	0.196	0.180	0.168	0.160	0.154	0.148	0.133	0.126
0.8	14.728	0.924	0.599	0.426	0.354	0.314	0.288	0.270	0.256	0.246	0.238	0.213	0.201
1	18.410	1.155	0.749	0.532	0.443	0.392	0.360	0.337	0.320	0.307	0.297	0.267	0.252
1.2	22.092	1.386	0.899	0.638	0.531	0.471	0.432	0.404	0.384	0.369	0.356	0.320	0.302
1.5	27.615	1.733	1.124	0.798	0.664	0.588	0.540	0.505	0.480	0.461	0.445	0.400	0.377
2	36.821	2.310	1.499	1.064	0.885	0.784	0.719	0.674	0.640	0.614	0.594	0.533	0.503
3	55.231	3.466	2.248	1.596	1.328	1.177	1.079	1.011	0.960	0.922	0.891	0.800	0.755
4	73.641	4.621	2.997	2.128	1.770	1.569	1.439	1.348	1.280	1.229	1.188	1.066	1.007
6	110.46	6.931	4.496	3.192	2.656	2.353	2.158	2.022	1.921	1.843	1.781	1.599	1.510
8	147.28	9.242	5.995	4.256	3.541	3.138	2.878	2.695	2.561	2.457	2.375	2.133	2.013
10	184.10	11.552	7.494	5.320	4.426	3.922	3.597	3.369	3.201	3.072	2.969	2.666	2.516
15	276.15	17.329	11.240	7.980	6.639	5.883	5.395	5.054	4.802	4.608	4.454	3.999	3.775
20	368.21	23.105	14.987	10.640	8.852	7.844	7.194	6.739	6.402	6.144	5.938	5.331	5.033
IAC VERY INVERSE													
0.5	5.150	1.451	0.656	0.269	0.172	0.133	0.113	0.101	0.093	0.087	0.083	0.070	0.064
0.8	8.240	2.321	1.050	0.430	0.275	0.213	0.181	0.162	0.149	0.140	0.132	0.112	0.102
1	10.300	2.901	1.312	0.537	0.343	0.266	0.227	0.202	0.186	0.174	0.165	0.140	0.128
1.2	12.360	3.481	1.574	0.645	0.412	0.320	0.272	0.243	0.223	0.209	0.198	0.168	0.153
1.5	15.450	4.352	1.968	0.806	0.515	0.399	0.340	0.304	0.279	0.262	0.248	0.210	0.192
2	20.601	5.802	2.624	1.075	0.687	0.533	0.453	0.405	0.372	0.349	0.331	0.280	0.255
3	30.901	8.704	3.936	1.612	1.030	0.799	0.680	0.607	0.559	0.523	0.496	0.420	0.383
4	41.201	11.605	5.248	2.150	1.374	1.065	0.906	0.810	0.745	0.698	0.662	0.560	0.511
6	61.802	17.407	7.872	3.225	2.061	1.598	1.359	1.215	1.117	1.046	0.992	0.840	0.766
8	82.402	23.209	10.497	4.299	2.747	2.131	1.813	1.620	1.490	1.395	1.323	1.120	1.022
10	103.00	29.012	13.121	5.374	3.434	2.663	2.266	2.025	1.862	1.744	1.654	1.400	1.277
15	154.50	43.518	19.681	8.061	5.151	3.995	3.398	3.037	2.793	2.616	2.481	2.100	1.916
20	206.01	58.024	26.241	10.748	6.869	5.327	4.531	4.049	3.724	3.488	3.308	2.800	2.555
IAC EXTREMELY INVERSE													
0.5	9.271	1.699	0.749	0.303	0.178	0.123	0.093	0.074	0.062	0.053	0.046	0.029	0.021
0.8	14.833	2.718	1.199	0.485	0.284	0.197	0.149	0.119	0.099	0.085	0.074	0.046	0.033
1	18.541	3.398	1.498	0.606	0.356	0.246	0.186	0.149	0.124	0.106	0.093	0.057	0.042
1.2	22.250	4.077	1.798	0.727	0.427	0.295	0.223	0.179	0.149	0.127	0.111	0.069	0.050
1.5	27.812	5.096	2.247	0.909	0.533	0.369	0.279	0.223	0.186	0.159	0.139	0.086	0.063
2	37.083	6.795	2.997	1.212	0.711	0.491	0.372	0.298	0.248	0.212	0.185	0.114	0.083
3	55.624	10.193	4.495	1.817	1.067	0.737	0.558	0.447	0.372	0.318	0.278	0.171	0.125
4	74.166	13.590	5.993	2.423	1.422	0.983	0.744	0.595	0.495	0.424	0.371	0.228	0.167
6	111.25	20.385	8.990	3.635	2.133	1.474	1.115	0.893	0.743	0.636	0.556	0.343	0.250
8	148.33	27.181	11.986	4.846	2.844	1.966	1.487	1.191	0.991	0.848	0.741	0.457	0.334
10	185.41	33.976	14.983	6.058	3.555	2.457	1.859	1.488	1.239	1.060	0.926	0.571	0.417
15	278.12	50.964	22.474	9.087	5.333	3.686	2.789	2.233	1.858	1.590	1.389	0.856	0.626
20	370.83	67.952	29.966	12.116	7.111	4.915	3.718	2.977	2.477	2.120	1.853	1.142	0.834

IEC CURVES

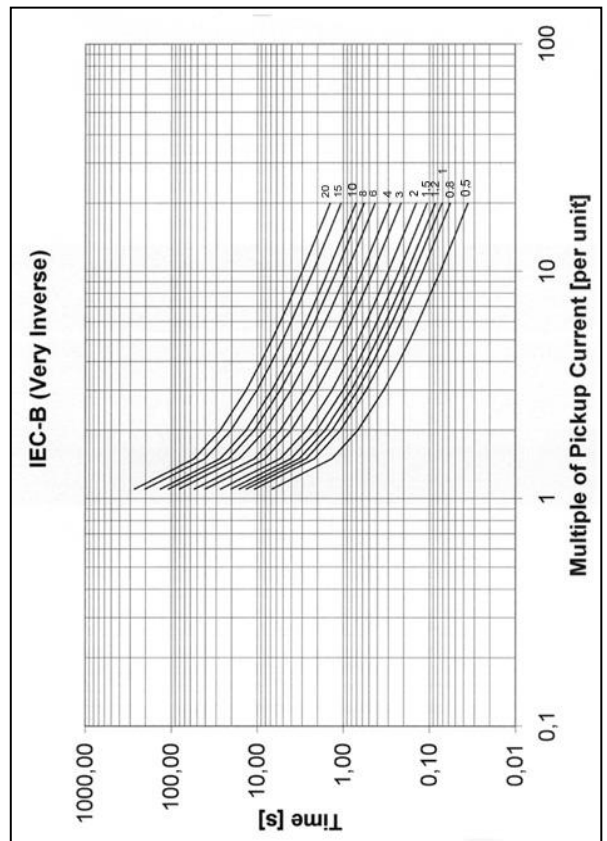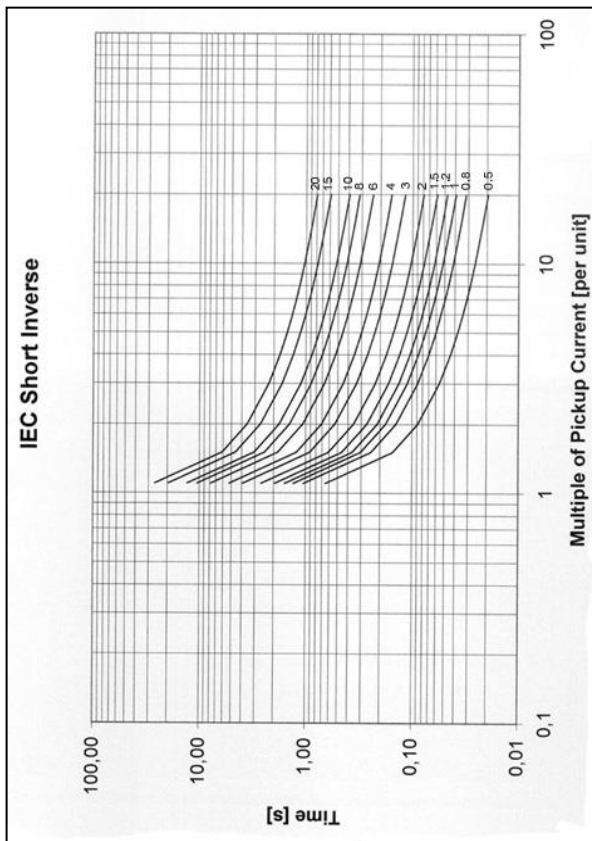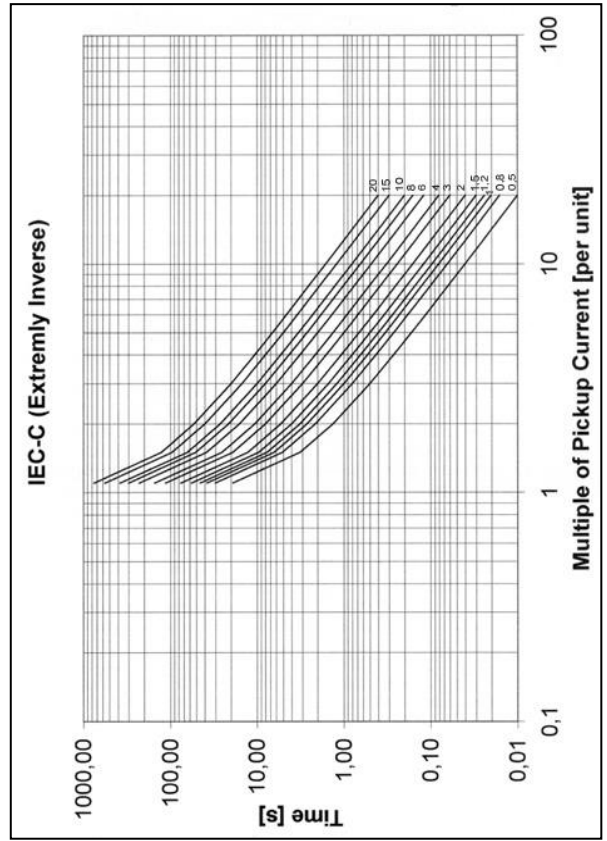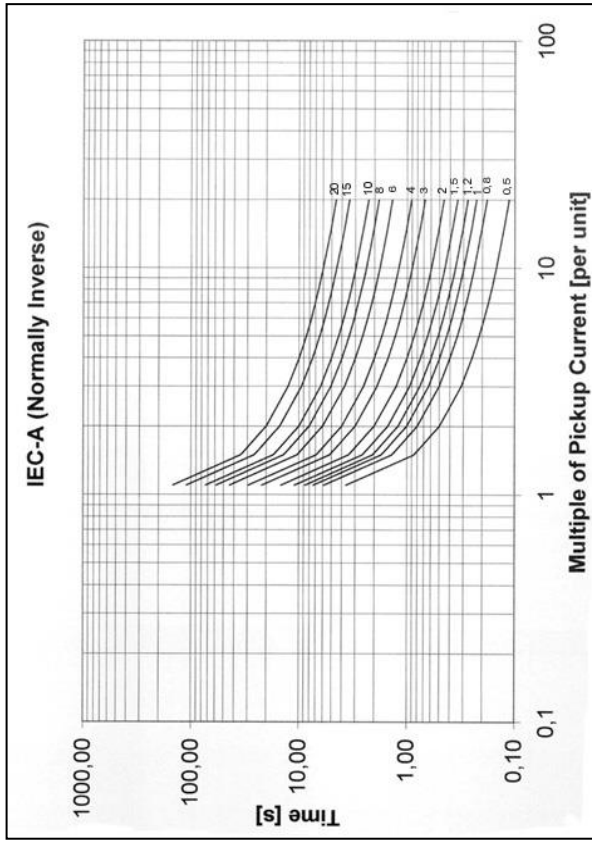$$T = \frac{M}{10} * \left(\frac{K}{\left(\dfrac{I}{Ipu} \right)^{E} - 1} \right)$$

IEC CURVE CONSTANTS	K	E
Short Time	0.05	0.04
Curve A	0.14	0.02
Curve B	13.5	1
Curve C	80	2

TRIP TIME (SEC)   T
CURVE MULTIPLIER SETPOINT   M
INPUT CURRENT   I
PICKUP CURRENT SETPOINT   Ipu

MULT.	I/Ipu												
(M)	1.1	1.5	2	3	4	5	6	7	8	9	10	15	20
IEC SHORT TIME													
0.5	0.655	0.153	0.089	0.056	0.044	0.038	0.034	0.031	0.029	0.027	0.026	0.022	0.020
0.8	1.047	0.245	0.142	0.089	0.070	0.060	0.054	0.049	0.046	0.044	0.041	0.035	0.031
1	1.309	0.306	0.178	0.111	0.088	0.075	0.067	0.062	0.058	0.054	0.052	0.044	0.039
1.2	1.571	0.367	0.213	0.134	0.105	0.090	0.081	0.074	0.069	0.065	0.062	0.052	0.047
1.5	1.964	0.459	0.267	0.167	0.132	0.113	0.101	0.093	0.086	0.082	0.078	0.066	0.059
2	2.618	0.612	0.356	0.223	0.175	0.150	0.135	0.124	0.115	0.109	0.104	0.087	0.079
3	3.927	0.917	0.534	0.334	0.263	0.226	0.202	0.185	0.173	0.163	0.155	0.131	0.118
4	5.236	1.223	0.711	0.445	0.351	0.301	0.269	0.247	0.231	0.218	0.207	0.175	0.157
6	7.854	1.835	1.067	0.668	0.526	0.451	0.404	0.371	0.346	0.327	0.311	0.262	0.236
8	10.472	2.446	1.423	0.890	0.702	0.602	0.538	0.494	0.461	0.435	0.415	0.350	0.314
10	13.090	3.058	1.778	1.113	0.877	0.752	0.673	0.618	0.576	0.544	0.518	0.437	0.393
15	19.635	4.587	2.668	1.669	1.315	1.128	1.009	0.927	0.865	0.816	0.777	0.656	0.589
20	26.180	6.116	3.557	2.226	1.754	1.504	1.346	1.235	1.153	1.089	1.037	0.874	0.786
IEC CURVE A (NORMALLY INVERSE)													
0.5	3.669	0.860	0.501	0.315	0.249	0.214	0.192	0.176	0.165	0.156	0.149	0.126	0.113
0.8	5.870	1.376	0.802	0.504	0.398	0.342	0.307	0.282	0.264	0.249	0.238	0.201	0.181
1	7.337	1.719	1.003	0.630	0.498	0.428	0.384	0.353	0.330	0.312	0.297	0.252	0.227
1.2	8.805	2.063	1.203	0.756	0.598	0.514	0.460	0.423	0.396	0.374	0.356	0.302	0.272
1.5	11.006	2.579	1.504	0.945	0.747	0.642	0.576	0.529	0.495	0.467	0.446	0.377	0.340
2	14.675	3.439	2.006	1.260	0.996	0.856	0.767	0.706	0.659	0.623	0.594	0.503	0.453
3	22.012	5.158	3.009	1.891	1.494	1.284	1.151	1.058	0.989	0.935	0.891	0.755	0.680
4	29.350	6.878	4.012	2.521	1.992	1.712	1.535	1.411	1.319	1.247	1.188	1.006	0.907
6	44.025	10.317	6.017	3.781	2.988	2.568	2.302	2.117	1.978	1.870	1.782	1.509	1.360
8	58.700	13.755	8.023	5.042	3.984	3.424	3.070	2.822	2.637	2.493	2.376	2.012	1.814
10	73.374	17.194	10.029	6.302	4.280	4.280	3.837	3.528	3.297	3.116	2.971	2.516	2.267
15	110.06	25.791	15.044	9.453	7.470	6.420	5.756	5.292	4.945	4.675	4.456	3.773	3.401
20	146.75	34.388	20.058	12.604	9.960	8.559	7.674	7.055	6.594	6.233	5.941	5.031	4.535
IEC CURVE B (VERY INVERSE)													
0.5	6.750	1.350	0.675	0.338	0.225	0.169	0.135	0.113	0.096	0.084	0.075	0.048	0.036
0.8	10.800	2.160	1.080	0.540	0.360	0.270	0.216	0.180	0.154	0.135	0.120	0.077	0.057
1	13.500	2.700	1.350	0.675	0.450	0.338	0.270	0.225	0.193	0.169	0.150	0.096	0.071
1.2	16.200	3.240	1.620	0.810	0.540	0.405	0.324	0.270	0.231	0.203	0.180	0.116	0.085
1.5	20.250	4.050	2.025	1.013	0.675	0.506	0.405	0.338	0.289	0.253	0.225	0.145	0.107
2	27.000	5.400	2.700	1.350	0.900	0.675	0.540	0.450	0.386	0.338	0.300	0.193	0.142
3	40.500	8.100	4.050	2.025	1.350	1.013	0.810	0.675	0.579	0.506	0.450	0.289	0.213
4	54.000	10.800	5.400	2.700	1.800	1.350	1.080	0.900	0.771	0.675	0.600	0.386	0.284
6	81.000	16.200	8.100	4.050	2.700	2.025	1.620	1.350	1.157	1.013	0.900	0.579	0.426
8	108.00	21.600	10.800	5.400	3.600	2.700	2.160	1.800	1.543	1.350	1.200	0.771	0.568
10	135.00	27.000	13.500	6.750	4.500	3.375	2.700	2.250	1.929	1.688	1.500	0.964	0.711
15	202.50	40.500	20.250	10.125	6.750	5.063	4.050	3.375	2.893	2.531	2.250	1.446	1.066
20	270.00	54.000	27.000	13.500	9.000	6.750	5.400	4.500	3.857	3.375	3.000	1.929	1.421
IEC CURVE C (EXTREMELY INVERSE)													
0.5	19.048	3.200	1.333	0.500	0.267	0.167	0.114	0.083	0.063	0.050	0.040	0.018	0.010
0.8	30.476	5.120	2.133	0.800	0.427	0.267	0.183	0.133	0.102	0.080	0.065	0.029	0.016
1	38.095	6.400	2.667	1.000	0.533	0.333	0.229	0.167	0.127	0.100	0.081	0.036	0.020
1.2	45.714	7.680	3.200	1.200	0.640	0.400	0.274	0.200	0.152	0.120	0.097	0.043	0.024
1.5	57.143	9.600	4.000	1.500	0.800	0.500	0.343	0.250	0.190	0.150	0.121	0.054	0.030
2	76.190	12.800	5.333	2.000	1.067	0.667	0.457	0.333	0.254	0.200	0.162	0.071	0.040
3	114.29	19.200	8.000	3.000	1.600	1.000	0.686	0.500	0.381	0.300	0.242	0.107	0.060
4	152.38	25.600	10.667	4.000	2.133	1.333	0.914	0.667	0.508	0.400	0.323	0.143	0.080
6	228.57	38.400	16.000	6.000	3.200	2.000	1.371	1.000	0.762	0.600	0.485	0.214	0.120
8	304.76	51.200	21.333	8.000	4.267	2.667	1.829	1.333	1.016	0.800	0.646	0.286	0.160
10	380.95	64.000	26.667	10.000	5.333	3.333	2.286	1.667	1.270	1.000	0.808	0.357	0.201
15	571.43	96.000	40.000	15.000	8.000	5.000	3.429	2.500	1.905	1.500	1.212	0.536	0.301
20	761.90	128.00	53.333	20.000	10.667	6.667	4.571	3.333	2.540	2.000	1.616	0.714	0.401

ANSI Moderately Inverse

ANSI Extremely Inverse

ANSI Normally Inverse

ANSI Very Inverse

IAC Normally Inverse

IAC Extremely Inverse

IAC Short Inverse

IAC Very Inverse

IEC-A (Normally Inverse)

IEC-C (Extremly Inverse)

IEC Short Inverse

IEC-B (Very Inverse)