DIVISIONE ELETTRONICA E SISTEMI

IAD3N

DIGITAL DIRECTIONAL EARTH FAULT
OR
DIRECTIONAL POWER RELAY

USER MANUAL

P500D806 **October 2007**

INDEX

1 GENERAL CHARACTERISTICS

The protection relay IAD3N is designed to perform one of the following functions:

Function	ANSI	Measures
Directional earth fault	67N	Io, Vo
Directional overcurrent and directional power detection (active or reactive)	67 - 32	I1, V23

The IAD3N relay as directional earth fault relay is used in electrical systems with:

- unearthed neutral
- neutral solidly earthed
- neutral earthed through a resistor
- neutral earthed through transformer
- neutral earthed through Petersen coil

All the set-up and measured parameters can be visualized on the front panel display and transmitted on the RS485 communication serial port.

THRESHOLDS - the IAD3N relay manages up to 3 independent directional thresholds (S1, S2 and S3); each threshold is defined by the following programmable information:

- current threshold Is>
- voltage threshold Us>
- characteristic angle and sector width

The directional earth-fault function can be selected as:

- 3 INDEPEDENT DIRECTIONAL thresholds
- DIRECTIONAL with NON operating zone around the origin (see fig. 1)

The available settings for each threshold are listed in Table A; the operation of the directional thresholds is described in paragraph 1.1.

TRIP DELAYS - a programmable time delay (TI) is available for each threshold; the first threshold (S1) can be programmed as time definite or time dependent in compliance with IEC 255-4 standard.

For each threshold programmed as definite time, an additional programmable time delay (TA) is available; the additional time delay is added to time delay TI. The additional time delay activation is controlled by the digital inputs to allow the use of the IAD3N relay with cooperating protection relays.

The available settings for each time delay are listed in Table A.

OUTPUT RELAYS - the IAD3N controls 4 output relays (named R1, R2, R3 and R4); these relays can be programmed to be activated on START or TRIP conditions of one or more thresholds.

START	instantaneous activation of the output relay when electrical parameters exceed the programmed threshold values.
TRIP	activation of the output relay when the programmed time delay (TI or TI+TA) related to a threshold expires.

The quiescent state of each single relay R1, R2, R3 and R4 can be programmed as normally energized (ON) or normally de-energized (OFF).

An additional relay R5 (normally energized) is controlled by the self-diagnosis routines to report detected fault conditions.

Related to each threshold, partial and total counters of TRIP conditions are available.

DIGITAL INPUTS - there are available 3 digital inputs to activate the following functions (when enabled by the programmed set-up):

- additional time delay (related to one or more thresholds)
- on/off thresholds
- STATUS function (recording of measures on external event)
- pilot wire fault monitoring (only DIG2)

For each digital input can be programmed the condition that activates the related functions:

HI voltage =	> 20 V dc / ac
LO voltage =	0 ÷ 10 V dc / ac

The digital input acquisition is valid when the voltage value stays in the range HI or LO for at least 40 ms.

DISPLAY OF MEASURES - the user can select the continuous display of a measured parameter (current, voltage, phase); all the measured and computed parameters can be transmitted to an external controller through the RS485 port.

EVENTS - information related to the last 8 events (TRIP or STATUS) are recorded in the EEPROM memory.

Information includes the threshold set-up and activated relays (TRIP event only), the measured current, voltage, phase, the digital input status, date and time of the event.

SELF-DIAGNOSIS - the software includes a non stop monitoring module that controls the functionality of all hardware and software resources of the protection relay.

Detected fault conditions are reported by:

- diagnostic message on the display
- glow of a red LED on front panel

- R5 output relay drop-off

The fault condition signaling stays until faults are pointed out by the monitoring module; during this condition the protection functions are suspended to avoid unsuitable tripping.

STATUS FUNCTION - when the STATUS function is activated by one of the digital input (when programmed) the protection relay memorizes information related to measured parameters and digital input status (see par. 5.11 - EVENTS). The recorded information allows an analysis of trip causes in co-operative protection relays systems.

PILOT WIRE FAULT MONITORING - when the function is programmed, the digital input DIG2 is used to control the correct functionality of the pilot wire. Digital input DIG2 is always expected to be complementary of DIG1 input (HI-LO or LO-HI) to identify faults on pilot wire.

The fault condition is reported as detected by the self-diagnosis module but the protection functions are not suspended; only the functions related to DIG1 digital input are suspended as the DIG1 status cannot be longer considered as true.

The fault condition is reported when DIG1 and DIG2 signals are not complementary for more then 100 ms.

REMOTE COMMUNICATION - the opto-insulated serial port RS485 can communicate with a personal computer or a remote control and monitoring system equipped with an RS485 interface or with a standard RS485/RS232 converter.

It is possible to select the communication standard between STANDARD (ASCII 7 bit - Seb protocol) or MODBUS (ASCII mode, SLAVE).

All the set-up and measured parameters can be transmitted on the RS485 communication serial port; when communication is active (LED REMOTE glows), the operator on front panel can view the relay set-up but changes of parameters are disabled (ENTER and buttons disabled).

VOLTAGE MEMORY FUNCTION - when the relay is working as directional power relay (ANSI 67-32) the VOLTAGE MEMORY function can be programmed by the operator.

When the function is active, if a close fault condition occurs and the reference voltage suddenly drops to very small values (lower than the threshold Us> related to the directional overcurrent thresholds S1, S2, S3) the protection relay keeps for 500 ms a memorized reference voltage corresponding to the system voltage prior to the fault and thus the relay can operate properly.

The memorized reference voltage is related to system frequency before the incidence of the fault.

1.1 Directional thresholds

The IAD3N protection relay measures a voltage, a current and computes the phase angle between the voltage (reference - Vo or V23) and the current (Io or I1). The nominal current and voltage are programmable; two current inputs are available (1 A and 5 A) to match the nominal current of plant CT.

Three independent directional thresholds S1, S2 and S3 are available; each threshold is defined by the following parameters:

Isx>	overcurrent threshold
Usx>	overvoltage threshold
Φsx<	angular sector threshold

ANGULAR SECTOR THRESHOLD - the threshold is defined by the following parameters:

Φx	characteristic angle (e.g.: Φ1 related to directional threshold S1)
DΦx	sector width (e.g.: DΦ1 related to directional threshold S1)

Characteristic angle - The characteristic angle is defined with the measured voltage as reference (straight line C in figure 2).

The characteristic angle can be programmed from +180° to -180° and it is shown using the notation **Φx**. The angle **Φx** of the sector axis is positive when lagging the voltage vector (see figure 2).

Sector width - the sector width is symmetrically defined referred to the straight line C. The sector width can be programmed from +15° to +180° and it is shown using the notation **DΦx**.

DIRECTIONAL THRESHOLD OPERATION - The directional threshold S1 operates when the following conditions are verified:

- the measured current is greater than the threshold Is1>
- the measured voltage is greater than the threshold Us1>
- the measured current phasor is within the sector defined by the parameter Φ1 and DΦ1

therefore if the following characteristic angle is programmed:

Φ1 = +90°	DΦ1 = 15°

the directional threshold will operate if the angle of the measured current phasor is lagging the voltage phasor from +75° to +105° (+90° ± 15°).

For the available settings of the thresholds **Isx>**, **Usx>** and of the parameters **Φx** and **DΦx** please refer to Table A.

NON DIRECTIONAL THRESHOLDS - When the sector width **DΦx** is defined equal to 180° the threshold becomes non-directional and the voltage threshold is indifferent (only the modules of the measured currents are taken into consideration by the protection relay).

This functionality allows the programming of additional non-directional thresholds to obtain a higher degree of protection.

Every threshold can be programmed ON / OFF or disabled with an external command through digital inputs.

1.2 Directional earth-fault - 3 independent thresholds

The 3 independent directional earth-fault thresholds are defined by the followings:

threshold **S1** - Is1>, Us1>, Φs1< (parameters DΦ1 and Φ1)
threshold **S2** - Is2>, Us2>, Φs2< (parameters DΦ2 and Φ2)
threshold **S3** - Is3>, Us3>, Φs3< (parameters DΦ3 and Φ3)

Each current threshold **Isx>**, voltage threshold **Usx>** and each angular sector (characteristic angle **Φx** and sector width **DΦx)** is independently programmable; the threshold **S1** can be programmed as definite time or dependent time, whilst the remaining thresholds are time definite only (see curves paragraph 7).

Each threshold **S1**, **S2** and **S3** can be activated or disabled by the user. The protection operates on the directional threshold Sx if AT THE SAME TIME the measured current and voltage are greater than the thresholds Isx> and Usx> and if the current phasor is in the angular sector Φsx< defined as Φx ± DΦx (with the measured voltage as reference).

The available settings for each time delay are listed in Table A

1.3 Directional earth-fault with non-operating zone around the origin

The thresholds **S1** and **S2** (current thresholds Is1> and Is2> and voltage thresholds Us1> and Us2>) are logically combined (OR) to obtain the threshold **SA** and they allow you to have an operating voltage-current characteristic as showed in figure 1 (for any angular sector **ΦA<**); this characteristic allows very low voltage and current thresholds with a NON operating zone around the origin; the threshold **S3** remains independent.

The threshold **SA** has only one angular sector threshold **ΦA<** defined by the parameters **ΦA** and **DΦA**.

That is: SA → logical OR threshold S1 → Is1>, Us1>
threshold S2 → Is2>, Us2>

angular sector threshold ΦA< = ΦA ± DΦA

The constraints on the current and voltage thresholds are the followings:

Is1> ≤ Is2> Us1> ≥ Us2>

These constraints are verified by the protection relay during the set-up and an error message will be displayed if required.

The **S3** threshold operates normally with the parameters Is3>, Us3> and Φs3<.

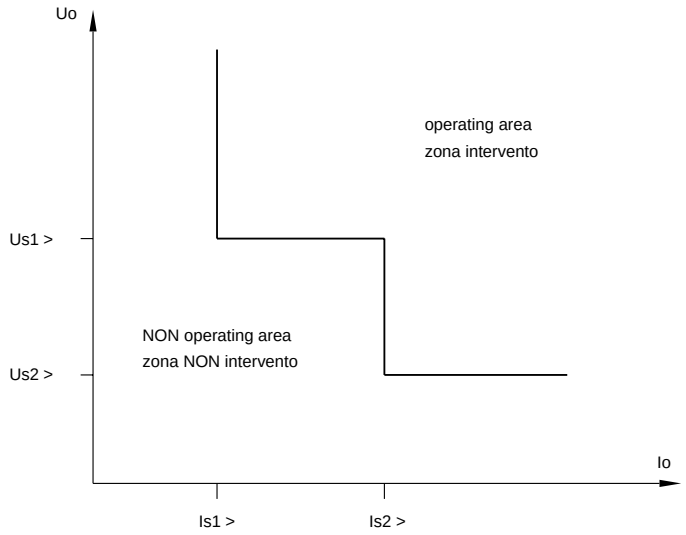


Figure 1

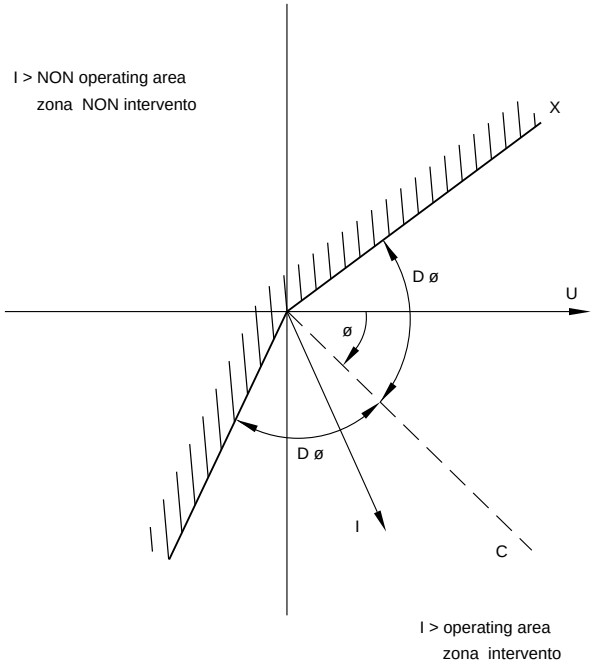


Figure 2

1.4 Directional earth-fault characteristic angles

When it operates as directional earth-fault the following characteristic angles **ΦSx** (where x = 1, 2, 3, A) are suggested:

- unearthed + 90°
- solidly earthed - 75°
- via earthing resistor + 180°
- via earthing transformer - 90°
- via Petersen coil + 180°

The suggested sector width **DΦx** in the first 4 cases is 85°.

With unearthed systems the threshold **S3** could be programmed with -90° characteristic angle to be used as reserve function against earth faults on different lines.

With solidly earthed system it is suggested to use the phase overcurrent threshold ANSI 67.

1.5 Directional overcurrent or power detection (ANSI 67-32)

There are available 3 directional overcurrent independent thresholds defined by the following current and voltage thresholds and angular threshold parameters:

threshold **S1** - Is1>, Us1>, Φs1< (parameter DΦ1 and Φ1)
threshold **S2** - Is2>, Us2>, Φs2< (parameter DΦ2 and Φ2)
threshold **S3** - Is3>, Us3>, Φs3< (parameter DΦ3 and Φ3)

Each current threshold **Isx>** and each angular sector (characteristic angle **Φx** and sector width **DΦx**) is independently programmable; the voltage thresholds **Us2>** and **Us3>** are equal to **Us1>**.

The threshold S1 can be programmed as definite time or dependent time, whilst the remaining thresholds are time definite only (see curves paragraph 7).

The insertion diagram is presented in figure 7; the IAD3N relay is a single-phase relay therefore it can be used in system assumed to be balanced (generators).

The current and the voltage must be applied as following (cross polarization):

Current Ir	Voltage U s-t
Current Is	Voltage U t-r
Current It	Voltage U r-s

The following characteristic angles are suggested, as presented in figure 8:

Directional active power	-90°
Directional reactive power	0°

With these angles set-up the IAD3N relay will operate when the active or reactive power is negative.

It is available a VOLTAGE MEMORY FUNCTION. When the function is active, if a close fault condition occurs and the reference voltage suddenly drops to very small values (lower than the threshold Us1> related to the directional overcurrent thresholds S1, S2, S3) the protection relay keeps for 500 ms a memorized reference voltage corresponding to the system voltage prior to the fault and thus the relay can operate properly.

The memorized reference voltage is related to system frequency before the incidence of the fault.

2 FRONT PANEL KEYS

The 5 push-buttons on the front panel allow to visualize all the protection parameters and to modify the protection set-up.

right arrow

down arrow

programming session activation or parameter confirmation

change or increment of the selected parameter

reset of the protection relay (ref. Par. 4.3)

VISUALIZATION OF PARAMETERS

- all visualizations are circular and they can be displayed using the two arrow push-buttons.
- the structure of the visualizations and their contents are showed in Fig. 3, 4 and 5.
- when the sealable transparent front panel is installed only the arrow push-buttons and the RESET push-button are accessible to prevent unauthorized modification of the protection set-up.

MODIFICATION OF PARAMETERS

- remove the transparent sealable front panel to access [ENTER] and  push-buttons.

3 FRONT PANEL LED SIGNALING

POWER (green) ⊗ auxiliary supply available

FAIL (red) ⊗ fault condition detected by SELF-DIAGNOSIS software or by PILOT WIRE FAULT MONITORING function

REMOTE (red) ⊗ communication session active on RS485 port

S1 SA (red) ⊗ trip condition on S1 or SA thresholds

S2 SA (red) ⊗ trip condition on S2 or SA thresholds

S3 (red) ⊗ trip condition on S3 threshold

The last trip condition (threshold indication) is also showed on front panel display; more information on trip condition are presented in the recorded EVENT (see par. 5.11).

4 PROGRAMMING AND TEST

The protection relay is easily programmable following the instructions in the next paragraphs:

- HOW TO PROGRAM THE PROTECTION RELAY
- HOW TO MODIFY A VISUALIZED PARAMETER

All parameters can be freely modified; the proper protection set- up as required by the plant management is submitted to the operator's judgment.

4.1 How to program the protection relay

The programmable parameters are showed in Figures 3, 4 and 5 at the following references:

B2÷B7	relay address (RS485) and date/time
C1	protection function
D1÷D6	nominal values, contrast etc.
E1÷E9	thresholds and time delays
F1÷F6	output relays functions
G1÷G3	digital input functions
H1	voltage memory
R1÷R11	partial trip counters reset

The programming sequence is the following:

1) **SELECT** the visualization (on display) of the parameter to be modified using the arrow push-buttons

2) **ACTIVATE** the PARAMETER MODIFICATION session depressing the [ENTER] push-button and modify the parameter value

3) **END** the parameter modification session depressing again the [ENTER] push-button

4) **REPEAT** the procedure from 1) to 3) for all the parameters required to obtain the new protection relay set-up

5) **CONFIRM** the new protection relay set-up at the visualization CONFIRM PROG? (Fig. 3, ref. J1) within 5 minutes depressing the push-buttons [ENTER] and ⊞ up to visualize **YES** and [ENTER] again to confirm.

NOTE: The protection relay continues to operate using the previous set-up until the new set-up is confirmed as at point 5) above; the visualization of the modified parameters before the new set-up confirmation is only temporary to allow an easy definition of the new protection set-up.

If the new set-up is not confirmed within 5 minutes from the last pressed push-button, the protection relay visualizes again the previous set-up (the parameters set-up that the protection relay is still using).

4.2 How to modify a visualized parameter

When the parameter to be modified is visualized on front panel display do the following sequence:

1) PRESS [ENTER] to activate the parameter modification session

If one or more parameters are modifiable, on the first of them will appear a blinking cursor.

If no parameters are modifiable, no blinking cursor will appear.

2) MODIFY THE PARAMETER pressing the arrow push-buttons and

when two parameters are modifiable, the push-button allows to point-out the parameter to be modified (the selected parameter will blink)

when numerical parameters are pointed-out the push-button allows to select the digit to be modified

increasing of the parameter

a) the digits are increased by 1 unit

b) the other parameters are presented following the selection list

3) PRESS [ENTER] to end parameter modification session

The modification session is ended and the parameter stops to blink

NOTE: if a numerical parameter is selected out of the accepted range (as shown in Table A) when the push-button **[ENTER]** is pressed for few seconds an error message will be displayed as:

```
Data
Error
```

and the parameter will be displayed again with the former value.

4.3 Reset

When the push-button **[RESET]** is pressed, the protection relays returns to the standard condition:

- reset of glowing LED's
- drop-off of tripped relays
- reset of any parameter changed but not confirmed (parameters are shown as confirmed at the end of the last programming session)

- display on STANDARD MODE (Fig. 3, ref. A1 – par. 5.1)

4.4 Test of output relays

When the output relays test is selected (Fig. 4, ref. F6) it is possible to command an output relay (one at the time) to trip from the current status allowing functional tests on electrical plants.

The output relays are activated with the following sequence:

1) **SELECT THE VISUALIZATION** of the desired output relay to be tested

```
TEST R1
OFF
```

2) **PRESS [ENTER]** to activate the test session; the message OFF will start to blink.

3) **PRESS** [+] and the message on the display will change as:

```
TEST R1
ON
```

4) **PRESS [ENTER]** to command the instantaneous trip of the output relay (change of the current status).

The relay will stay on the new condition until:

- the [⇨] or **[RESET]** push-button is pressed
- the [**ENTER**] push-button is pressed and the sequence at points 3 and 4 is repeated (presenting OFF condition)

The same procedure will be used for R2, R3 and R4 relays.

5 DISPLAY AND PROGRAMMING

The contents and the structure of the displayed messages are shown in figures 3, 4 and 5; the references A1, B1, B2 etc. identify specific displayed messages in the figures.

5.1 Standard display

A1 - STANDARD DISPLAY (fig. 3)

It is the standard displayed message without operator's intervention (no push-buttons pressed for at least 5 minutes) or when the RESET push-button has been pressed.

The displayed information is function of the protection relay status.

NORMAL FUNCTIONING
During this state the following information can be visualized (as defined by set-up):

- **Protection function (ANSI code)** - the display shows the ANSI codes of the main selectable functions (ref. C1 - FUNCTION SELECTION).

- **Measured parameters** - the display shows one of the measures (current, voltage, angle).

The measure is visualized as primary values.

ON TRIP CONDITION
When a trip condition occurs the protection relay visualizes the TRIP message that includes the threshold related to the trip; the displayed messages are as the following:

TRIP S1	TRIP S2	TRIP S3	TRIP SA

The information of the trip, as well the glowing of the related LED's, is displayed until the [RESET]. push-button is pressed.

If a new trip condition occurs, the displayed information will be updated; information related to previous trips are recorded in EVENTS memory.

FAULT CONDITION
When a permanent or temporary fault condition is detected by the self-diagnosis module, the following message will be displayed:

FAIL eeeeeeee

The string **eeeeeeee** can be:

F.PILOT Detected fault condition on pilot wire; the function related to DIG1 digital input is suspended
Corrective action - verify pilot wire (short or open circuit)

HARDWARE Detected fault condition on hardware or software resources of the protection relay; all functions are suspended.
Corrective action - replace the protection relay and contact SEB post sales service

5.2 Visualization structure

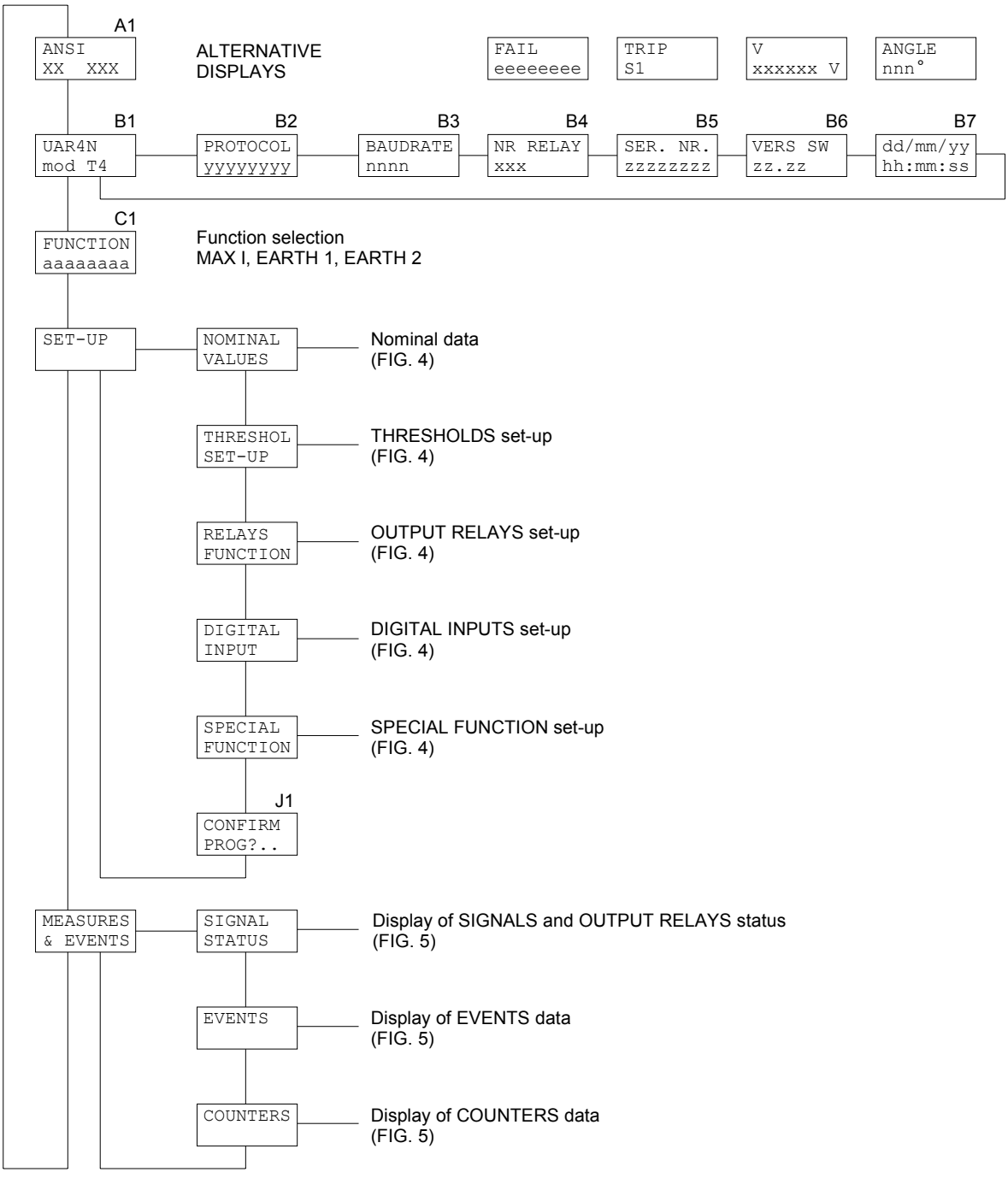


Figure 3

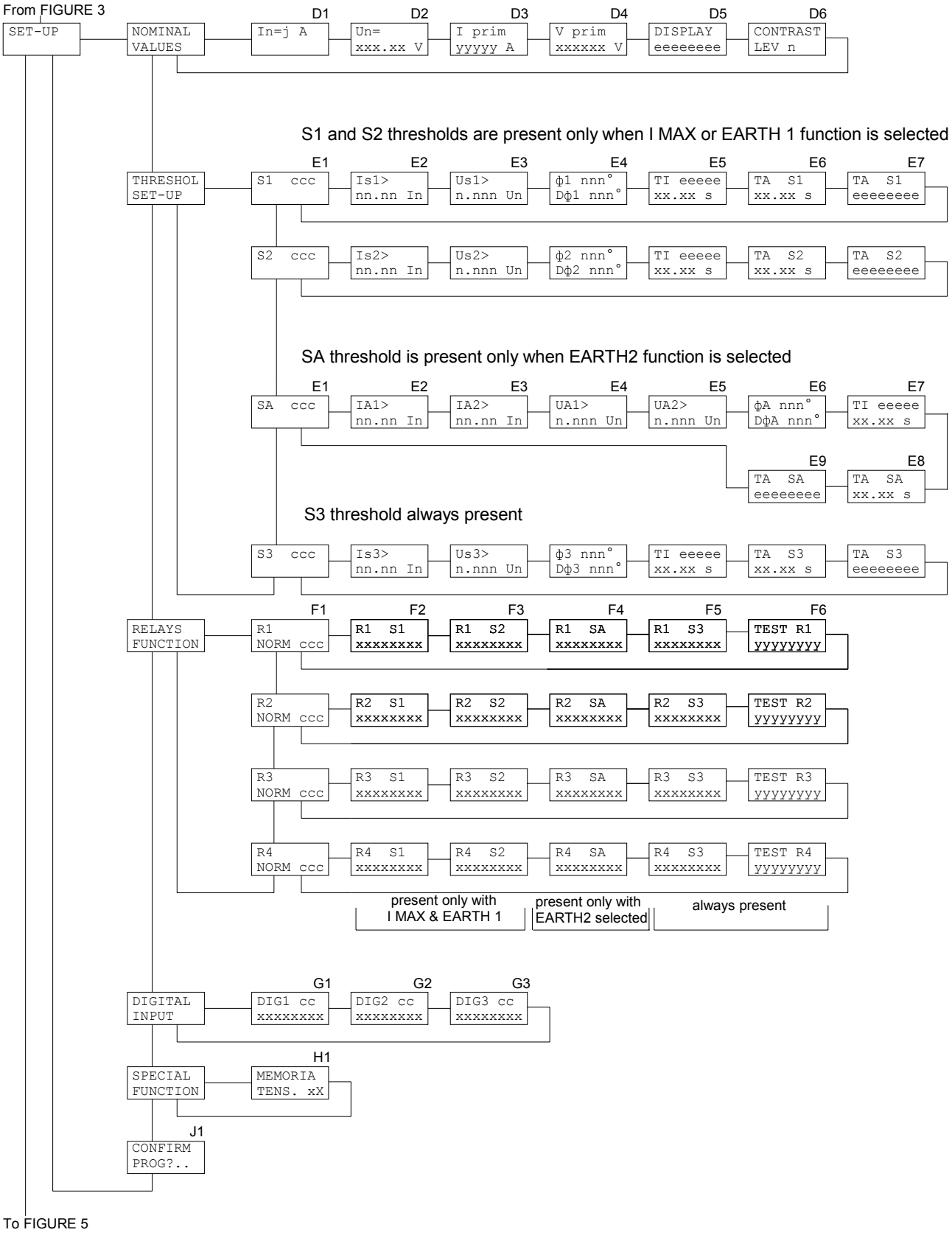

From FIGURE 3
SET-UP
NOMINAL VALUES
D1 In=j A
D2 Un= xxx.xx V
D3 I prim yyyyy A
D4 V prim xxxxxx V
D5 DISPLAY eeeeeeee
D6 CONTRAST LEV n
S1 and S2 thresholds are present only when I MAX or EARTH 1 function is selected
THRESHOL SET-UP
E1 S1 ccc
E2 Is1> nn.nn In
E3 Us1> n.nnn Un
E4 ϕ1 nnn° Dϕ1 nnn°
E5 TI eeeee xx.xx s
E6 TA S1 xx.xx s
E7 TA S1 eeeeeeee
S2 ccc
Is2> nn.nn In
Us2> n.nnn Un
ϕ2 nnn° Dϕ2 nnn°
TI eeeee xx.xx s
TA S2 xx.xx s
TA S2 eeeeeeee
SA threshold is present only when EARTH2 function is selected
SA ccc
IA1> nn.nn In
IA2> nn.nn In
UA1> n.nnn Un
UA2> n.nnn Un
ϕA nnn° DϕA nnn°
TI eeeee xx.xx s
E9 TA SA eeeeeeee
E8 TA SA xx.xx s
S3 threshold always present
S3 ccc
Is3> nn.nn In
Us3> n.nnn Un
ϕ3 nnn° Dϕ3 nnn°
TI eeeee xx.xx s
TA S3 xx.xx s
TA S3 eeeeeeee
RELAYS FUNCTION
F1 R1 NORM ccc
F2 R1 S1 xxxxxxxx
F3 R1 S2 xxxxxxxx
F4 R1 SA xxxxxxxx
F5 R1 S3 xxxxxxxx
F6 TEST R1 yyyyyyyy
R2 NORM ccc
R2 S1 xxxxxxxx
R2 S2 xxxxxxxx
R2 SA xxxxxxxx
R2 S3 xxxxxxxx
TEST R2 yyyyyyyy
R3 NORM ccc
R3 S1 xxxxxxxx
R3 S2 xxxxxxxx
R3 SA xxxxxxxx
R3 S3 xxxxxxxx
TEST R3 yyyyyyyy
R4 NORM ccc
R4 S1 xxxxxxxx
R4 S2 xxxxxxxx
R4 SA xxxxxxxx
R4 S3 xxxxxxxx
TEST R4 yyyyyyyy
present only with I MAX & EARTH 1
present only with EARTH2 selected
always present
DIGITAL INPUT
G1 DIG1 cc xxxxxxxx
G2 DIG2 cc xxxxxxxx
G3 DIG3 cc xxxxxxxx
SPECIAL FUNCTION
H1 MEMORIA TENS. xX
J1 CONFIRM PROG?..
To FIGURE 5

Figure 4

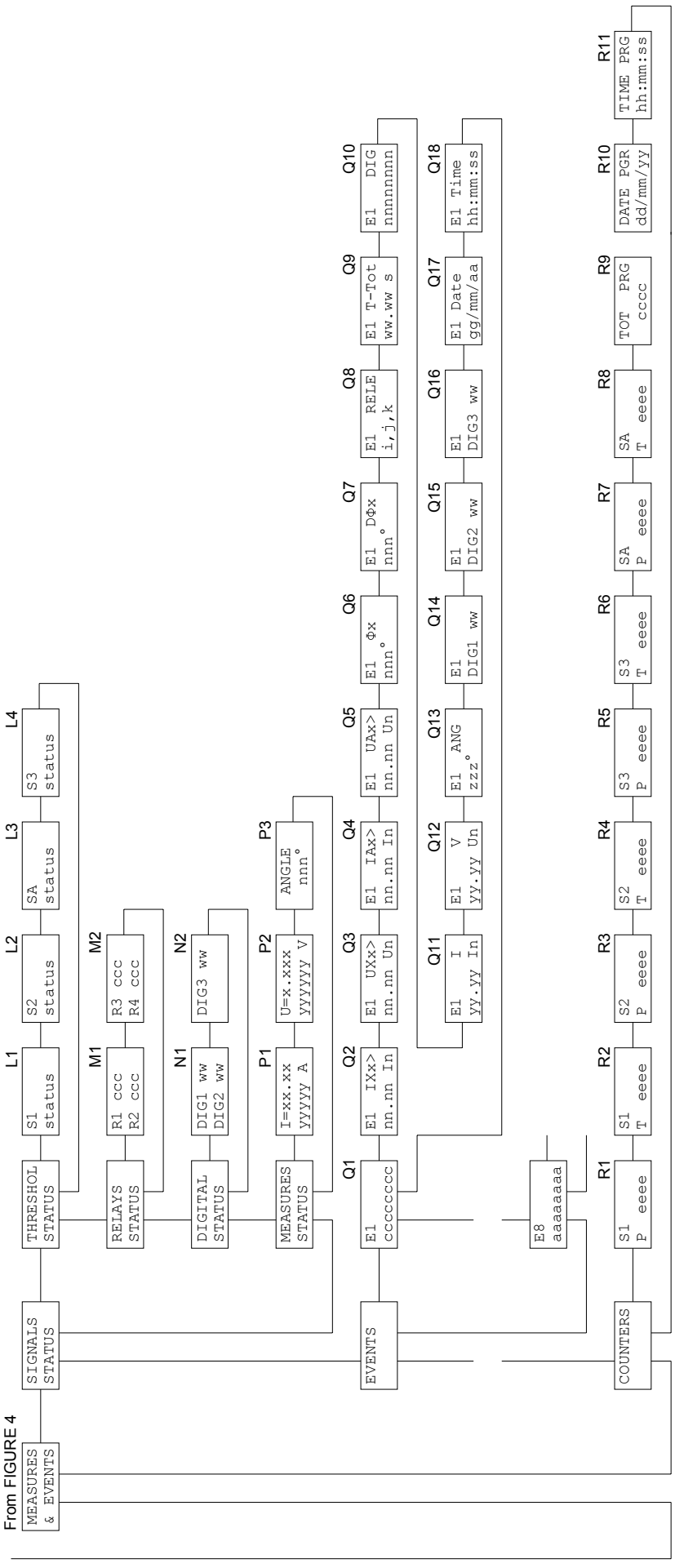

From FIGURE 4
MEASURES & EVENTS
SIGNALS STATUS
THRESHOL STATUS
L1
S1 status
L2
S2 status
L3
SA status
L4
S3 status
RELAYS STATUS
M1
R1 ccc
R2 ccc
M2
R3 ccc
R4 ccc
DIGITAL STATUS
N1
DIG1 ww
DIG2 ww
N2
DIG3 ww
MEASURES STATUS
P1
I=xx.xx
yyyyy A
P2
U=x.xxx
yyyyyy V
P3
ANGLE
nnn°
EVENTS
Q1
E1
ccccccccc
Q2
E1 IXx>
nn.nn In
Q3
E1 UXx>
nn.nn Un
Q4
E1 IAx>
nn.nn In
Q5
E1 UAx>
nn.nn Un
Q6
E1 Φx
nnn°
Q7
E1 DΦx
nnn°
Q8
E1 RELE
i,j,k
Q9
E1 T-Tot
ww.ww s
Q10
E1 DIG
nnnnnnn
Q11
E1 I
yy.yy In
Q12
E1 V
yy.yy Un
Q13
E1 ANG
zzz°
Q14
E1
DIG1 ww
Q15
E1
DIG2 ww
Q16
E1
DIG3 ww
Q17
E1 Date
gg/mm/aa
Q18
E1 Time
hh:mm:ss
E8
aaaaaaaa
COUNTERS
R1
S1
P eeee
R2
S1
T eeee
R3
S2
P eeee
R4
S2
T eeee
R5
S3
P eeee
R6
S3
T eeee
R7
SA
P eeee
R8
SA
T eeee
R9
TOT PRG
cccc
R10
DATE PGR
dd/mm/yy
R11
TIME PRG
hh:mm:ss

Figure 5

5.3 Address and time (fig. 3)

B1 - RELAY MODEL (not programmable)

```
IAD3N
```

The same protection relay can be used with CT's rated 1 A or 5 A.

B2 - COMMUNICATION PROTOCOL (programmable)

B2

```
PROTOCOL
xxxxxxxx
```

The communication protocol is programmable between the followings:

STANDARD	ASCII Seb protocol
MODBUS	Modbus protocol (SLAVE)

When the MODBUS protocol is selected the following display is showed to allow the selection of the transmission speed:

B3

```
BAUDRATE
xxxx
```

The xxxx parameter is selectable between the followings:

300 - 600 - 1200 - 2400 - 4800 - 9600

When the STANDARD protocol is selected the baud rate is automatically selected by the protection relay.

B4 - ADDRESS (programmable)

```
NR RELAY
001
```

Programmable address from 001 to 255.

The number is used on RS485 port to address a specific relay when two or more protection relays are linked on the same serial line.

B5 - RELAY SERIAL NUMBER (not programmable)

```
SER. NR
0012345
```

B6 - SOFTWARE REVISION LEVEL (not programmable)

```
SW REV
zz.zz
```

B7 - TIME / DATE (programmable)

```
dd/mm/yy
hh:mm:ss
```

Time and date are programmable and they are used to mark recorded events.

NOTE the clock is not provided with back-up battery, therefore a loss of auxiliary supply will force time/date to the following condition:

```
01/01/90
00:00:00
```

5.4 Function selection (fig. 3)

C1 - FUNCTION SELECTION (programmable)

```
FUNCTION
xxxxxxxx
```

The function selection defines the available thresholds.

FUNCTION	ANSI	SELECTIONS	THRESHOLDS
Directional earth-fault with 3 independent thresholds	67N	**EARTH 1**	S1, S2, S3
Directional earth-fault with NON operating zone	67N	**EARTH 2**	SA, S3
Directional power relay	67 - 32	**MAX I**	S1, S2, S3

Examples:

```
FUNCTION
MAX I
```

```
FUNCTION
EARTH 1
```

```
FUNCTION
EARTH 2
```

5.5 Nominal values set-up (fig. 4)

D1 - NOMINAL CURRENT SELECTION In (programmable)

```
In = xA
```

In: nominal phase current programmable 1 A or 5 A

D2 - NOMINAL VOLTAGE SELECTION - Un (programmable)

```
Un =
xxx.xx V
```

Un: nominal voltage selection (nominal secondary voltage of plant VT) selectable between the followings:

57.73 - 63.50 - 72.16 - 100 - 110 - 125 - 190 - 220 - 230 - 380 - 400

D3 - PRIMARY CT's CURRENT (programmable)

```
I prim
xxxxx A
```

I prim: primary phase current value of the installed CT; it is programmable from 0001 to 18500 A.

D4 - PRIMARY VT's VOLTAGE (programmable)

```
V prim
xxxxxx V
```

V prim: primary voltage value of the installed VT; it is programmable from 000001 to 999999 V.

D5 - STANDARD DISPLAY SELECTION (programmable)

```
DISPLAY
eeeeeeee
```

It allows to select the standard displayed information (ref. A1) when no trip condition occurs and no fault condition has been detected by the self-diagnosis module; the available selections are the following:

ANSI	ANSI code of the available functions
CURRENT	Measured current
VOLTAGE	Measured voltage
ANGLE	Measured angle between voltage and current

Examples:

```
DISPLAY
ANSI
```

```
DISPLAY
CURRENT
```

```
DISPLAY
ANGLE
```

D6 - DISPLAY CONTRAST LEVEL (programmable)

```
CONTRAST
LEV x
```

The display contrast level is programmable from 0 to 9. The backlighted display is switched off if no push-button is pressed for at least 5 minutes; when one of the front panel push- button is pressed the display is switched on.

5.6 Thresholds and time delays set-up (fig. 4)

Only the thresholds enabled at the FUNCTION SELECTION (ref. C1) are presented.

Selection MAX I thresholds S1, S2, S3

Selection	EARTH 1	thresholds S1, S2, S3
Selection	EARTH 2	thresholds SA, S3

5.6.1 S1, S2 and S3 thresholds programming (fig. 4)

The information and set-ups related to threshold S1 in the following points are effective for the thresholds S2 and S3 (if not specifically written) just taking into consideration the change of the threshold identification.

The available settings for each threshold are listed in Table A.

E1 - ON / OFF THRESHOLD (programmable)

```
S1  ccc
```

ccc ON - enabled threshold
OFF - disabled threshold (available but not active)

E2 - CURRENT THRESHOLD LEVEL SET-UP (programmable)

```
Is1>
nn.nn In
```

Threshold level referred to the current nominal value (In)

nn.nn directional power relay (ANSI 67 - 32)
n.nnn directional earth fault (ANSI 67N)

Examples:

```
Is1>
01.50 In
```

```
Is2>
02.00 In
```

```
Is3>
0.500 In
```

E3 - VOLTAGE THRESHOLD LEVEL SET-UP (programmable)

```
Us1>
n.nnn Un
```

n.nnn threshold level referred to the voltage nominal value (Un)

Examples:

```
Us1>
0.050 Un
```

```
Us2>
0.200 Un
```

```
Us3>
1.000 Un
```

When the measured voltage is lower than the threshold the voltage memory function (if enabled) will be activated (see par. 1. and par. 5.9).

NOTE when selected the MAX I function (ref. function selection C1) the voltage thresholds **Us2>** and **Us3>** are equal to the programmed value **Us1>** and they are not programmable.

E4 - ANGOLAR SECTOR THRESHOLD SET-UP (programmable)

Φ1 ±nnn°
DΦ1 nnn°

nnn threshold parameters expressed in degree (ref. paragraph 1.1)

Φ1 characteristic angle (programmable from -180° to +180°)

DΦ1 sector width (programmable from 015° to 180°)

Please use the right arrow push-button to select the sign or the digit to be modified and the down arrow push-button to select the parameter to be modified.

Examples:

Φ1 +030°	Φ2 -090°	Φ3 +000°
DΦ1 090°	DΦ2 075°	DΦ3 180°

NOTE When a sector width **DΦ1** is defined equal to 180° the related threshold **Φ1<** becomes NON-directional and it will be sensible only to the earth current threshold (the overvoltage threshold **Us1>** will be indifferent) as ANSI 51N.

E5 - TIME DELAY SET-UP (programmable)

TI eeeee
xx.xx s

Set-up of the time-delay to the activation (TRIP) of the programmed output relays when the **S1** directional threshold operates .

Parameter TI eeeee: time delay characteristic

For the **S1** threshold the time delay can be selected between one of the followings:

INDIP	definite time delay
DIP=A	time delay as curve A IEC 255-4 (inverse time)
DIP=B	time delay as curve B IEC 255-4 (very inverse time)
DIP=C	time delay as curve C IEC 255-4 (extremely inverse time)

For the thresholds S2 and S3 the TI parameter is fixed as INDIP (definite time).

Parameter xx.xx:

Time definite - time delay (seconds) to activate the programmed output relays: the output relay trips when the measured current exceeds the threshold level (programmable from 00.02 to 99.99 s).

Time dependent - value of the parameter K (see formulas paragraph 7).

TI DIP=B	TI DIP=A	TI INDIP
02.50 K	10.00 K	03.25 s

NOTE: the index K or s is shown coherently to the selected time-delay characteristic when the push-button ENTER is pressed.

E6 - ADDITIONAL TIME DELAY SET-UP (programmable)

The selection is displayed only when a TIME DEFINITE characteristic has been selected (TI INDIP at ref. E5); when TIME DEPENDENT characteristic has been programmed, the selection will not be displayed.

```
TA    S1
xx.xx s
```

The additional time delay TA is programmable from 00.00 to 99.99 seconds; please note that at least one of the digital inputs should be programmed to activate the time delay function (ref. G1 ÷ G3 – paragraph 5.8).

The additional time delay TA is added to the time delay TI to obtain the output relay trip when the TI+TA time expires.

The additional time delay TA will be added if the time delay TI is programmed at least equals to 50 ms (digital input acquisition time - 40 ms)

E7 - DIGITAL INPUT ACTIVE ON THRESHOLD (non programmable)

```
TA     S1
eeeeeeee
```

It shows the digital input programmed to activate the additional time delay TA on the displayed threshold.

The parameter eeeeeeee can show one of the following values:

DISABLED	none of the digital inputs has been programmed to activate an additional time delay related to the threshold S1
DIG1	digital input DIG1 activates the TA delay on threshold S1
DIG2	digital input DIG2 activates the TA delay on threshold S1
DIG3	digital input DIG3 activates the TA delay on threshold S1

When a TIME DEPENDENT characteristic threshold has been programmed the visualization is omitted as no additional time delays can be defined and programmed on time dependent delays.

More than one digital input can activate the same additional time delay (e.g. DIG 1,3).

Please note that to activate the additional time delay at least one of the digital inputs should be programmed (ref. G1 ÷ G3 - paragraph 5.8).

5.6.2 SA threshold programming - (fig. 4)

E1 - ON / OFF THRESHOLD (programmable)

SA ccc

ccc ON - enabled threshold
OFF - disabled threshold (available but not active)

E2 - E3 - CURRENT THRESHOLDS SET-UP (programmable)

E2	E3
IA1> n.nnn In	IA2> n.nnn In

n.nnn threshold level referred to the current nominal value (In)

Examples:

IA1> 0.050 In	IA2> 0.100 In

NOTE The threshold level **IA2>** must be greater or equal to the threshold level **IA1>**; if the condition is not verified, an error message will be displayed.

E4 - E5 - OVERVOLTAGE THRESHOLDS LEVEL SET-UP (programmable)

E4	E5
UA1> n.nnn Un	UA2> n.nnn Un

n.nnn threshold level referred to the voltage nominal value (Un)

Examples:

UA1> 0.500 Un	UA2> 0.100 Un

NOTE The threshold level **UA1>** must be greater or equal to the threshold level **UA2>**;it the condition is not verified, an error message will be displayed.

E6 - ANGOLAR SECTOR THRESHOLD SET-UP (programmable)

ΦA ±nnn° DΦA nnn°

nnn threshold parameters expressed in degree (ref. paragraph 1.1)

ΦA characteristic angle (programmable from -180° to +180°)

DΦA sector width (programmable from 015° to 180°)

Please use the right arrow push-button to select the sign or the digit to be modified and the down arrow push-button to select the parameter to be modified.

Examples:

ΦA +090°
DΦA 090°

NOTE: When a sector width DΦA is defined equal to 180° the related threshold SA becomes NON-directional and it will be sensible only to the earth current threshold (the overvoltage threshold UA> will be indifferent) as ANSI 51N.

It is suggested to use as non-directional threshold the threshold **S3** instead of the threshold SA.

E7 - TIME DELAY SET-UP (programmable)

TI INDIP
xx.xx s

Set-up of the time-delay to the activation (TRIP) of the programmed output relays when the SA directional threshold operates.

Parameter **xx.xx**: time delay (seconds) to activate the programmed output relays: the output relay trips when the measured current exceeds the threshold level (programmable from 00.02 to 99.99 s).

TI INDIP
01.50 s

E8 - ADDITIONAL TIME DELAY SET-UP (programmable)

TA SA
xx.xx s

The additional time delay TA is programmable from 00.00 to 99.99 seconds; please note that at least one of the digital inputs should be programmed to activate the time delay function (ref. G1, G2, G3 - paragraph 5.8).

The additional time delay TA is added to the time delay TI to obtain the output relay trip when the TI+TA time expires.

The additional time delay TA will be added if the time delay TI is programmed at least equals to 50 ms (digital input acquisition time - 40 ms)

E9 - DIGITAL INPUT ACTIVE ON THRESHOLD (non programmable)

TA SA
xx.xx s

It shows the digital input programmed to activate the additional time delay TA on the displayed threshold.

The parameter **eeeeeeee** can show one of the following values:

DISABLED	none of the digital inputs has been programmed to activate an additional time delay related to the threshold SA
DIG1	digital input DIG1 activates the TA delay on threshold SA
DIG2	digital input DIG2 activates the TA delay on threshold SA
DIG3	digital input DIG3 activates the TA delay on threshold SA

More than one digital input can activate the same additional time delay (e.g. DIG 1,3).

Please note that to activate the additional time delay at least one of the digital inputs should be programmed (ref. G1, G2, G3 - paragraph 5.8).

5.7 Output relays programming (fig. 4)

The session allows to program the activation of the output relays R1, R2, R3 or R4 on START or TRIP conditions for each threshold.

In the programming session are displayed only the active thresholds depending on selections.

Equivalent information and set-up related to relay R1 is available for the relays R2, R3 and R4 just changing the relay identification.

F1 - OUTPUT RELAY R1 QUIESCENT STATUS (programmable)

```
R1
NORM xxx
```

Programming of the R1 relay status when no START or TRIP conditions are activated.

NORM OFF:	normally de-energized (energized status on activation)
NORM ON:	normally energized (de-energized status on activation)

F2 - OUTPUT RELAY ACTIVATION ON THRESHOLD S1 (programmable)

```
R1     S1
xxxxxxxx
```

The parameter xxxxxxxx is selectable as the following:

START	instantaneous output relay R1 activation when the threshold operates
TRIP	output relay R1 activation when the threshold is operating for at least TI or TI+TA seconds
NONE	no activation related to threshold

F3 ÷ F5 - OUTPUT RELAYS ACTIVATION ON THRESHOLDS S2, SA and S3 (programmable)

Examples:

```
R1     S2
xxxxxxxx
```

```
R1     SA
xxxxxxxx
```

```
R1     S3
xxxxxxxx
```

Output relays activation on START or TRIP conditions related to S2, SA and S3 thresholds (as threshold S1 - ref. F2).

F6 - TEST OF OUTPUT RELAYS R1

```
TEST  R1
xxxxxxxx
```

See paragraph 4.4

5.8 Digital inputs function programming (fig. 4)

For each digital input one of the following functions are selectable:

a) additional time delay (related to one or more thresholds - only time definite threshold)

b) ON / OFF threshold (see paragraph 1.1)

c) STATUS function (recording of measures on external command)

d) pilot wire fault monitoring (only DIG2 monitors DIG1)

When the function of more than one digital input refers to a threshold, the priority will be the following:

a) OF selection (threshold disabled) has the priority on TA function (additional time delay)

b) the ALL selection (ALL the thresholds) has the priority on single threshold selection.

G1 - DIGITAL INPUT DIG1 SET-UP (programmable)

```
DIG1  cc
xxxxxxxx
```

Programming of the function related to digital input channel 1 (DIG1).

Parameter cc programming of the condition that activates the function related to digital input DIG1; the condition is selectable between HI and LO.

Parameter xxxxxxx: programming of the function related to digital input DIG1; the following functions are selectable (only the active thresholds are presented - ref. E1):

NONE	no functions active related to digital input DIG1
TA S1	additional time delay on the threshold S1
TA S2	additional time delay on the threshold S2
TA S3	additional time delay on the threshold S3
TA SA	additional time delay on the threshold SA
TA ALL	additional time delay on all thresholds
OF S1	threshold S1 disabled
OF S2	threshold S2 disabled
OF S3	threshold S3 disabled

OF SA	threshold SA disabled
OF ALL	all thresholds disabled
STATUS	activation of status function (see paragraph 1)

G2 - DIGITAL INPUT DIG2 SET-UP (programmable)

```
DIG2  cc
xxxxxxxx
```

Programming of the function related to digital input channel 2 (DIG2); the selections available are the same as presented for DIG1 (ref. G1) plus the following:

MONITOR	activation of pilot wire monitor function.

G3 - DIGITAL INPUT DIG3 SET-UP (programmable)

```
DIG3  cc
xxxxxxxx
```

Programming of the function related to digital input channel 3 (DIG3); the selections available are the same as presented for DIG1 (ref. G1).

5.9 Special function - voltage memory function (fig. 4)

When the relay is working as directional power relay (ANSI 67-32 - function I MAX) the VOLTAGE MEMORY function can be programmed by the operator.

When the function is active, if a close fault condition occurs and the reference voltage suddenly drops to very small values (lower than the threshold **Us1>** related to the directional overcurrent thresholds **S1**, **S2**, **S3**) the protection relay keeps for 500 ms a memorized reference voltage corresponding to the system voltage prior to the fault and thus the relay can operate properly.

The memorized reference voltage is related to system frequency before the incidence of the fault.

```
MEMORIA
TENS.cc
```

cc	ON	- enabled function
	OFF	- disabled function

5.10 Parameter values visualization (fig. 5)

L1 ÷ L4 - THRESHOLDS STATUS

The actual status of each threshold is displayed; only the thresholds actionable as function of the FUNCTION SELECTION are presented.

For each threshold are displayed the threshold identification (S1, SA etc.) and the threshold status; the status can show one of the following values:

ON	active threshold
OFF	disabled threshold (programmed OFF at ref. E1 - see par. 5.6)

OFF_DIG threshold programmed active but disabled by a digital input actual status (ref. G1 ÷ G3 see par. 5.8).

Examples:

S1 ON	S2 ON	SA OFF

M1 - M2 - OUTPUT RELAY STATUS

The actual status of each output relay is displayed; for each relay the following information is displayed:

- relay identification (R1, R2, R3, R4)
- relay status (ON - activated, OFF - non activated)

Note that ON/OFF do not necessary mean energized or de-energized (see ref. G1).

N1 - N2 - DIGITAL INPUT STATUS

The actual status of each digital input is displayed.

For each digital input the following information is presented:

- digital input identification (DIG1, DIG2, DIG3)
- digital input status (HI or LO)

P1 - P2 - P3 - MEASUREMENT DISPLAY

The actual values of the measures and of the computed parameters are displayed (currents, voltages, phase angles); the parameters related to disabled thresholds are not displayed.

For each measure the following information is displayed:

measure identification (I, V, ANGLE)
actual values expressed as Amperes, Volts and degrees

5.11 Events (fig. 5)

On the display are shown the memorized information related to the last 8 TRIP or STATUS events.

The 8 events are recorded and identified with a progressive number from 1 to 8; the more recent event shows a lower number.

Q1 - EVENT NUMBER

E1 cccccccc

The index E1, E2 … E8 identifies the memorized event.

The parameter cccccccc gives information on the kind of event and it can show one of the following values:

NONE	no event memorized
S1	event on trip threshold S1
S2	event on trip threshold S2
S3	event on trip threshold S3
SA	event on trip threshold SA
STATUS	information recorded on external command
POWER ON	switch-on of the protection relay (auxiliary power)

For the events NONE and POWER ON no other information is presented; for the other events the following displays give more detailed information on the event.

Q2 - Q7 - PARAMETERS RELATED TO THE TRIP THRESHOLD

The parameters of the threshold that caused the TRIP condition and their values are shown. This information is not presented on STATUS event.

Q2, Q4	current thresholds (Q4 showed only for threshold SA)
Q3, Q5	voltage thresholds (Q5 showed only for threshold SA)
Q6	characteristic angle (ΦX where X = 1, 2, 3, A)
Q7	sector width (DΦX, where X = 1, 2, 3, A)

Q2

```
E1  IA1>
y.yyy In
```

Q3

```
E1  UA1>
y.yyy Un
```

Q4

```
E1  IA2>
y.yyy In
```

Q5

```
E1  UA2>
y.yyy Un
```

Q6

```
E1   ΦA
  +090°
```

Q7

```
E1   DΦA
   45°
```

Q8 - ACTIVATED OUTPUT RELAYS

```
E1 RELAY
nnnnnnn
```

It shows the list of the output relay activated by the threshold trip.

Examples:

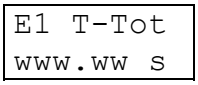
```
E1 RELAY
1,3,4
```

```
E3 RELAY
1,4
```

When no output relays have been activated (no relays programmed to TRIP on the threshold) the following message will be displayed:

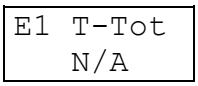
```
E1 RELAY
NONE
```

Q9 - TOTAL TIME DELAY ON TRIP



It is shown the total delay to the TRIP of the output relays from the overcurrent detection; when additional delays are activated, the change of the status of the digital input that controls the additional delay during the delay itself could bring to a total time different from the sum of the programmed delays. If the total time is greater than 999 seconds the display of tenths is omitted.

When the event is memorized on the external command (STATUS), the message N/A (Not Applicable) is shown instead of the number of seconds.



Q10 - DIGITAL CHANNELS RELATED TO MEMORIZED EVENT

The list of the digital inputs related to the memorized event is displayed (STATUS function command or additional time TA enabled - ref. par. 5.6).

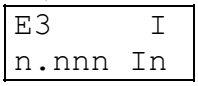
If no digital inputs were activated, the message NONE is displayed.

Q11 - Q12 - Q13 - MEMORIZED MEASURES ON EVENT

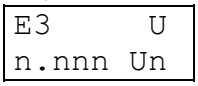
The values of the measures at the event are displayed (current, voltage and angle between the current and the voltage); the values are expressed as relative terms (In and Un).

Examples:

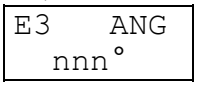
Q11



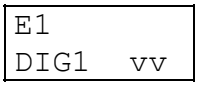
Q12

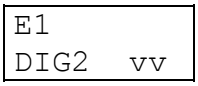


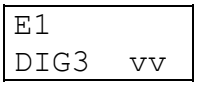
Q13



Q14 - Q15 - Q16 - DIGITAL INPUTS STATUS ON EVENT



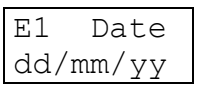


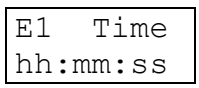


The status of the digital inputs at the event are displayed.

The parameter **vv** can assume the value HI or LO.

Q17 - Q18 - DATE AND TIME OF THE EVENT





The date and time of the event are showed

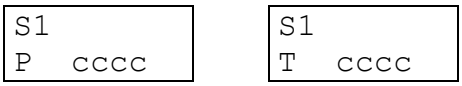
5.12 TRIPS COUNTERS (fig. 5)

In this section are displayed the total and partial counters of the output relay activation (on TRIP conditions) for each thresholds and the numbers of programming sessions with the date and time of the last confirmed programming session.

The total counters, the number of confirmed programming sessions and the date and time of the last confirmed programming session are not modifiable or resettable; the information related to the last programming session are used to control unauthorized access.

The partial counter can be modified following the standard set-up procedure for parameters as described at paragraph 4.2; the partial counters are immediately modified in the memory (the recorded values are immediately resetted without the need of the programming confirmation).

R1 ÷ R8 - TRIP COUNTERS

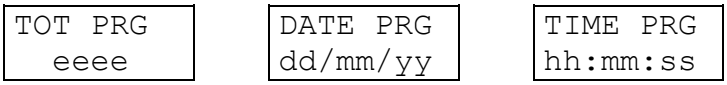


Display of the partial (P) and total (T) counters of the TRIP condition related to each threshold.

When the value exceed 9999 the counter starts again from 0000.

The counters are identified by the threshold name (S1, S2, S3 and SA); only the counter related to the active thresholds are shown (see selections to ref. C1).

R9 ÷ R11 - TOTAL PROGRAMMING SESSIONS AND DATE/TIME OF THE LAST PROGRAMMING SESSION



Display of the number of confirmed programming sessions (from the factory set-up) and the date and time of the last confirmed programming session.

6 INSTALLATION

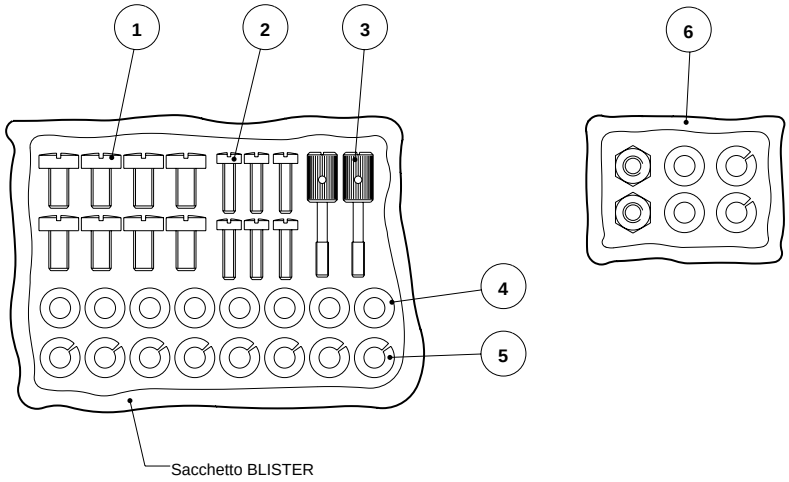
6.1 Supplied kit

RK VERSION - 19" rack installation (the proper rack is supplied by Seb)

- protection relay module IAD3N with rear socket
- transparent front panel for rack installation
- blister with items 1-2-3-4-5

CS VERSION - flush mounting installation

- protection relay module IAD3N with rear socket
- transparent front panel for rack flush mounting installation
- n° 2 brackets for flush mounting
- blister with items 1-2-3-4-5
- blister with item 6



1) n° 8 screws to fix wire terminals of current circuits
2) n° 4 screws to fix the relay rear socket on the 19" rack (or on the two brackets for flush mounting) and n° 2 screws to fix (optionally) the protection relay on the front of the 19" rack
3) n° 2 knobs to fix the transparent front panel
4) n° 8 washers to be used to fix current wire terminals
5) n° 8 growers to be used to fix current wire terminals
6) items to fix the brackets for flush mounting (only with CS version)

The knobs to fix the transparent front panel must be screwed through the panel the front panel itself; the operation will create a screw thread in the plastic material and the knobs will never be missed.

6.2 Cabling

Current circuits
It is suggested to terminate the current wirings using eyelet terminals.

Minimum suggested wire cross section: 2,5 mm^2

With reference to the insertion diagram in the next page, the currents measured by the protection relay have the following matching:

programmed nominal current **In = 5A** terminals A1 - A2
programmed nominal current **In = 1A** terminals B1 - B2

Voltage circuits
It is suggested to terminate the voltage wirings using plug terminals.

Minimum suggested wire cross section: 1,5 mm^2

With reference to the insertion diagram in the next page, the voltages measured by the protection relay have the following matching:

U	terminals 11 - 13	voltages with Un programmed from 110 to 400 V
	terminals 12 - 13	voltages with Un programmed from 0 to 100 V

Other circuits (output relays etc.)

It is suggested to terminate the wiring using plug terminals.

Minimum suggested wire cross section: 1,5 mm^2

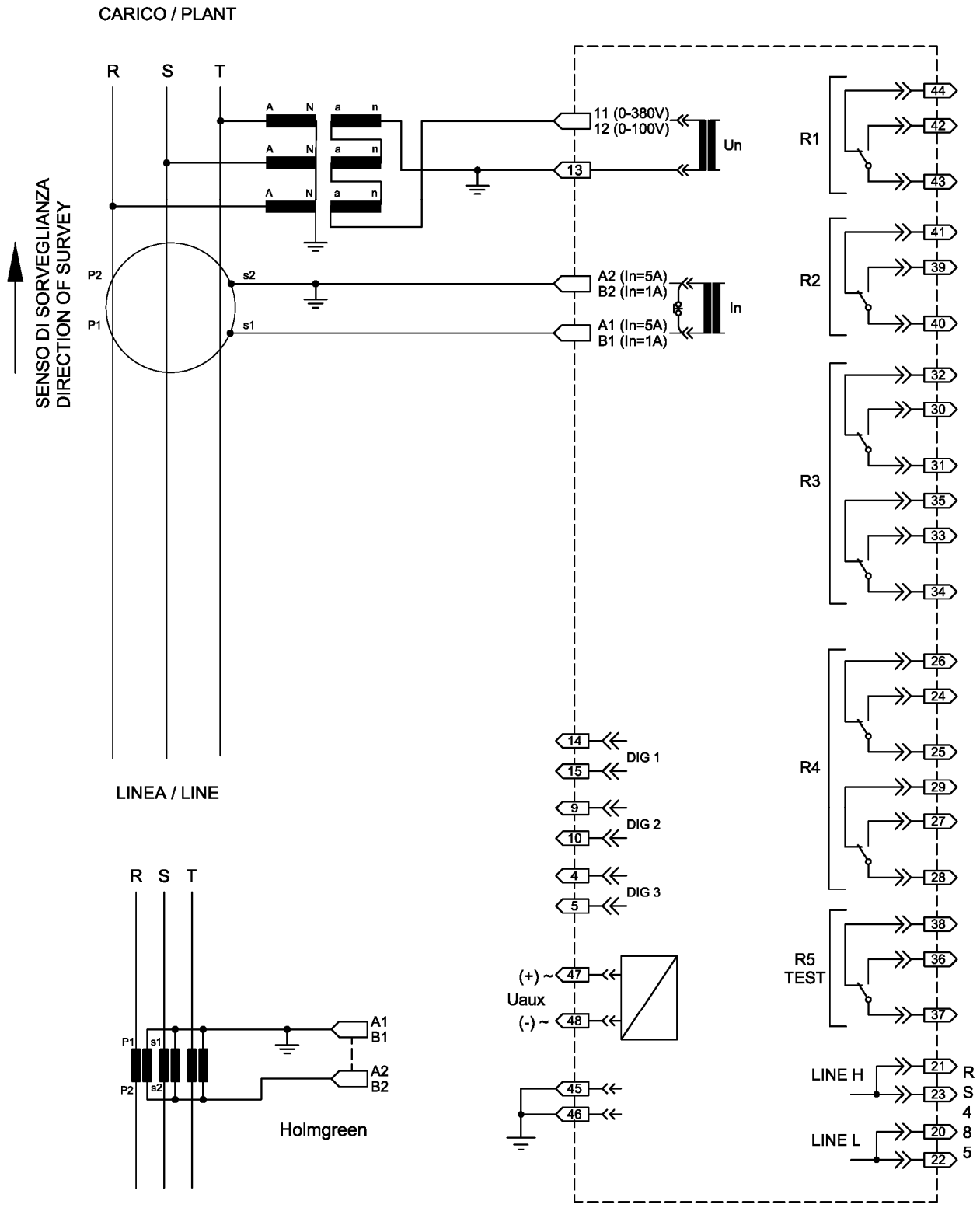


Figure 6 - Directional earth fault insertion

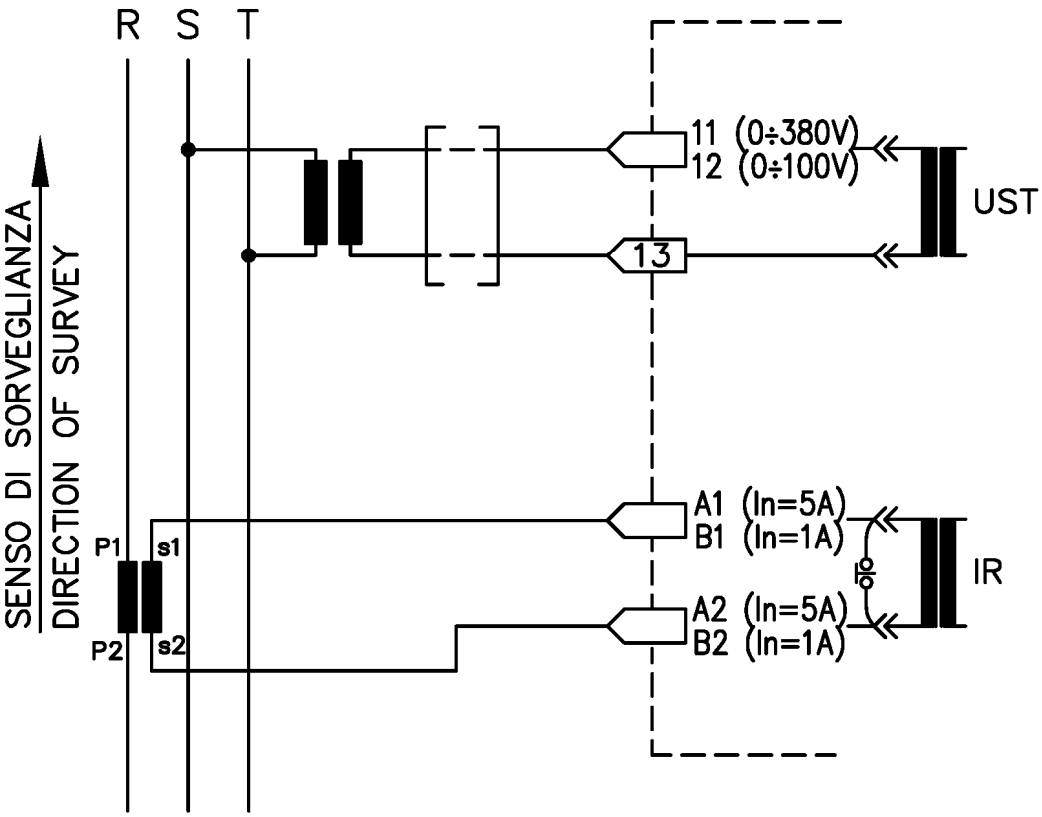


Figure 7

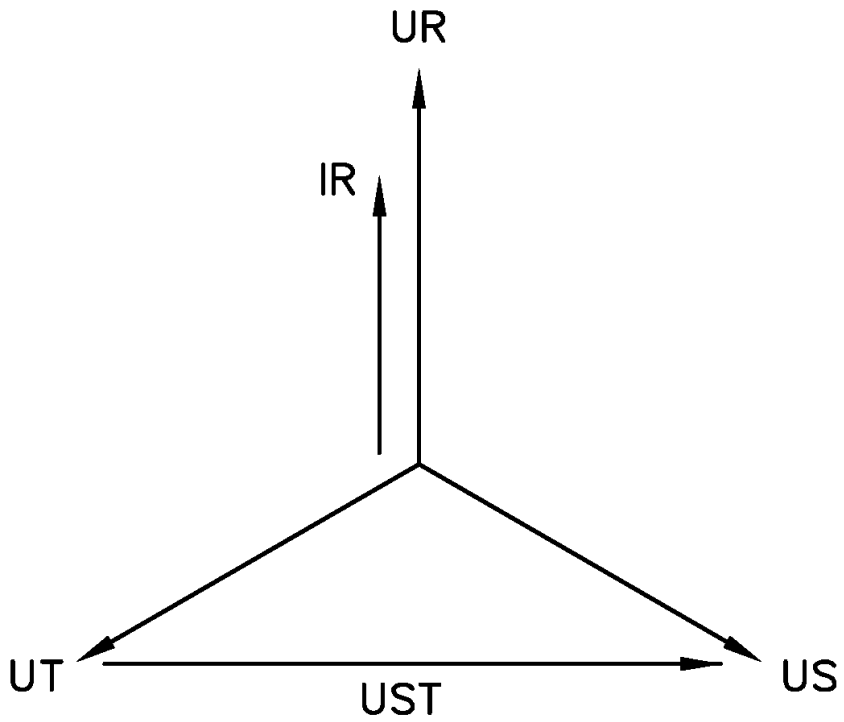
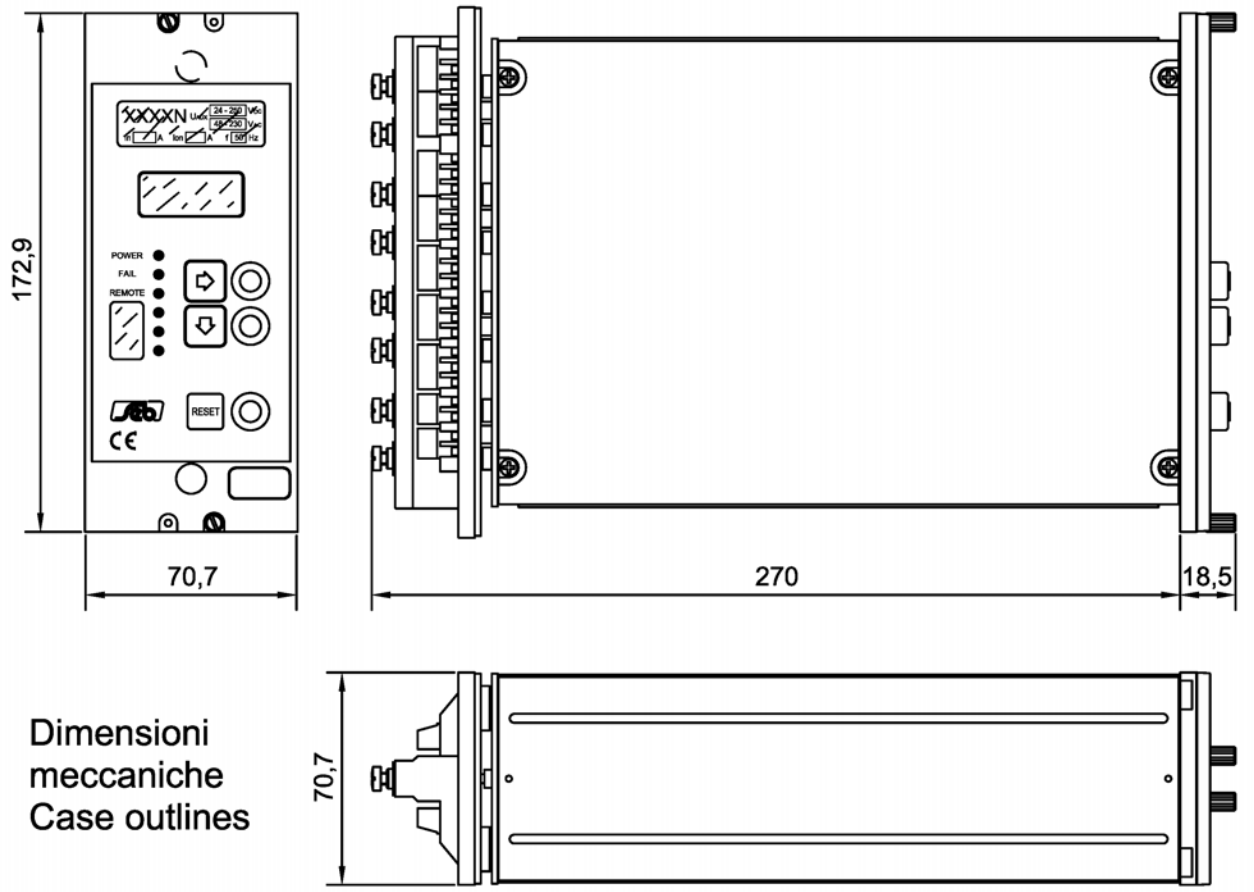
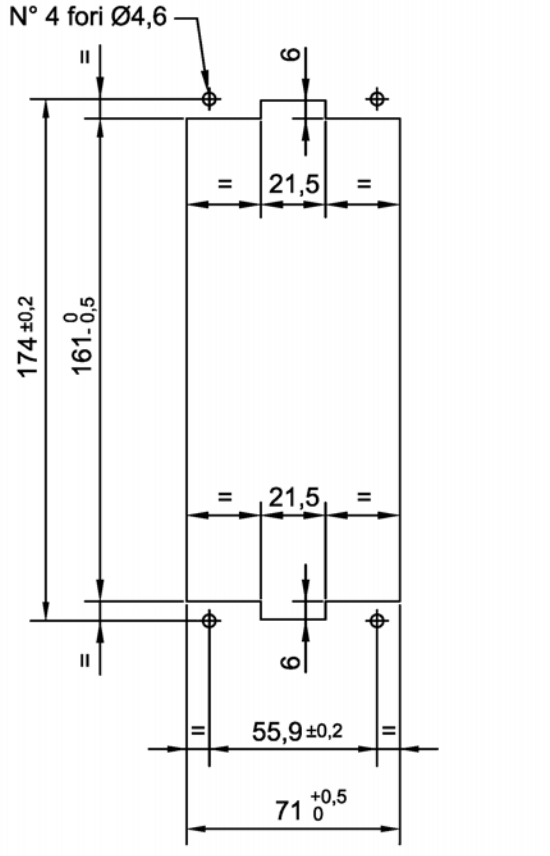


Figura 8

Directional power insertion



Dimensioni meccaniche
Case outlines



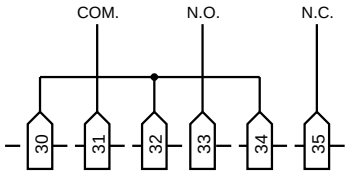
Dima montaggio da incasso
Flush mounting panel cut - out

Montaggio incassato / Flush mounting
Dimensioni pannello frontale trasparente :
Transparent front panel sizes :
208 x 89,5 mm.

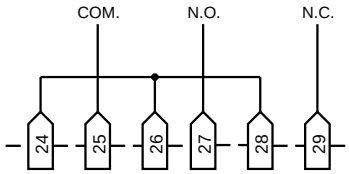
6.3 Relays R3 and R4 - Signaling / Command set-up

The protection relay is supplied with R3 and R4 relays configured as **SIGNALING RELAYS**, with 2 change-over output contacts with breaking capability equals to 0.2 A at 110 Vdc, L/R = 40 ms, 100000 operations.

Each R3 and R4 relay can be configured as **COMMAND RELAY** with 1 change-over output contact with breaking capability equals to 0.5 A at 110 Vdc, L/R = 40 ms, 100000 operations.
The new configuration is obtained with the following cabling:



R3



R4

6.4 RS485 serial communication port

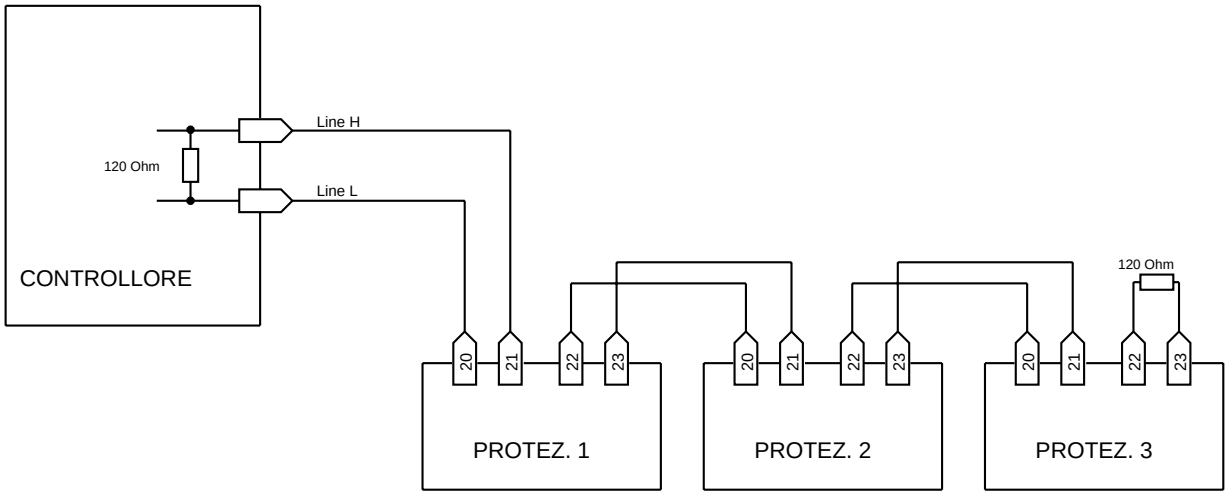
The digital protection relay PQR4N presents an insulated serial interface RS485 half-duplex that allow the multi-drop connection up to 31 protection units. There are available 2 selectable communication protocols (ref. B2 paragraph 5.3).

When the MODBUS communication protocol is selected, the transmission speed can be programmed between 300 to 9600 bauds (ref. B3, par. 5.3).

When the STANDARD Seb communication protocol is selected, the transmission speed is automatically selected between 300 to 9600 bauds and the protocol is ASCII-HEX.

It is suggested to use a shielded twisted pair AWG22; terminal 19 (not connected internally) can be used for shields connections.

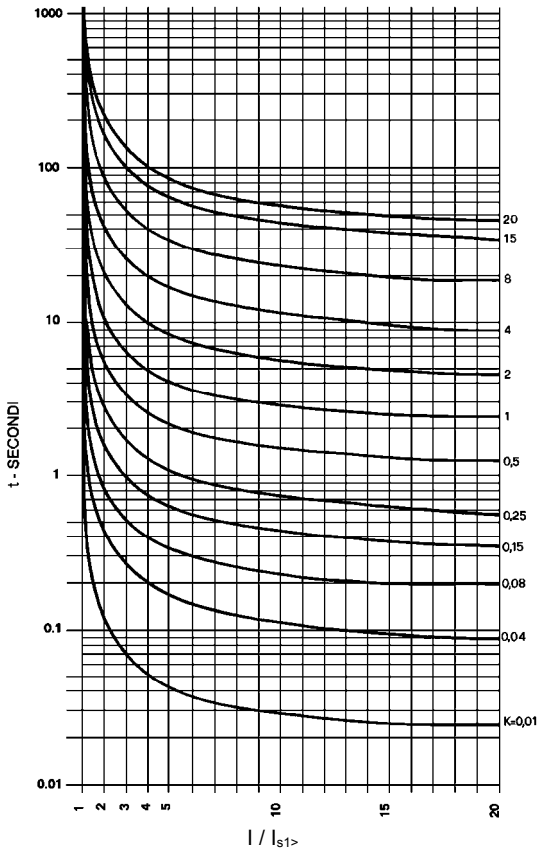
To integrate the protection relay in control systems, the documentation related to the protocol is freely available on request.



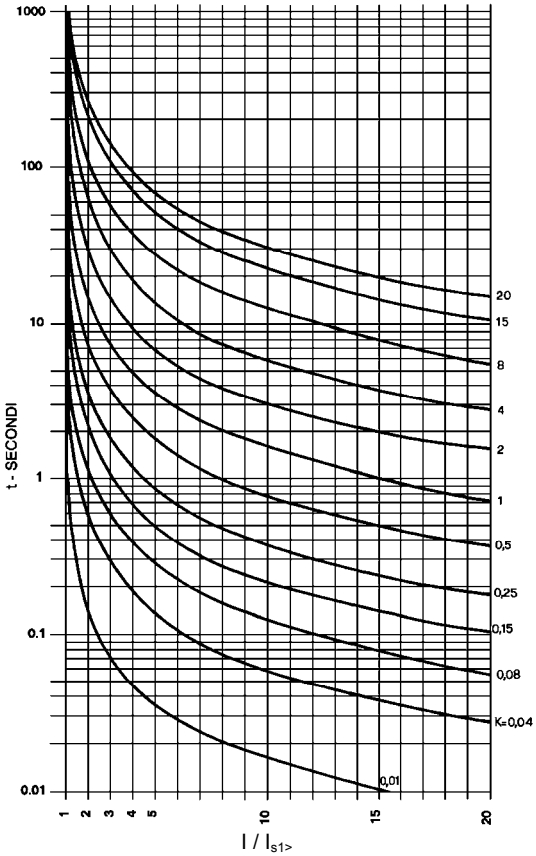
It is suggested to terminate the serial line with a resistance 120 Ω, 1/4 W.

7 TIME DEPENDENT CURVES

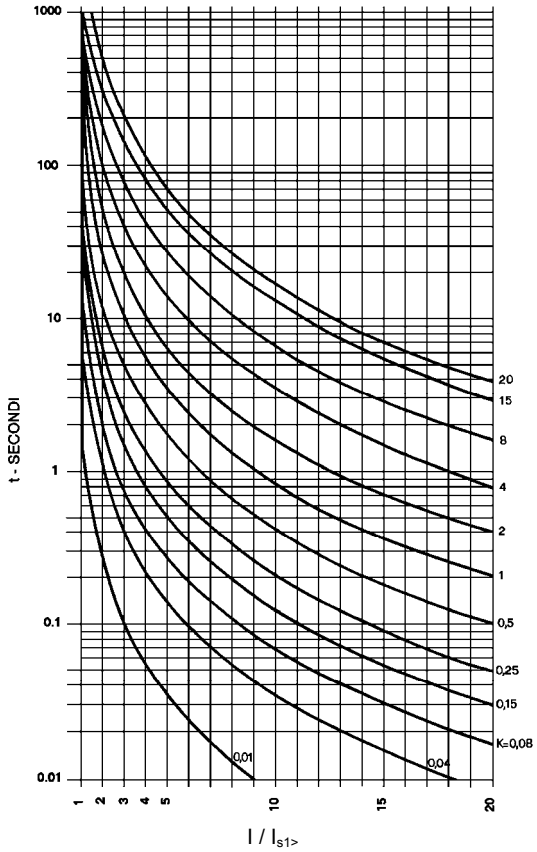
Curva - Curve A



Curva - Curve B



Curva - Curve C



Time dependent characteristic

$$t = \frac{Ki * K}{\left(\frac{I}{I_{s1>}}\right)^{\alpha} - 1} + 0.02s$$

Curve IEC 255-4	**A**	**B**	**C**
Ki	0.14	13.5	80
α	0.02	1	2

K	Parameter 0.01 ÷ 20.00 s
$I / I_{s1>}$	Ratio between the measured current and the threshold $I_{s1>}$

8 TECHNICAL CHARACTERISTICS

Measuring inputs

Rated phase current (In)	1 A or 5 A
Thermal withstand continuously	4 In
Thermal withstand for 1 s	100 In
Rated voltage (Un)	57,73 - 63,50 - 72,16 - 100 - 110 V
programmable	125 - 190 - 220 - 230 - 380 - 400 V
Thermal withstand continuously	2 Un
Thermal withstand for 1 s	2 Un
Rated frequency	50 / 60 Hz
Primary CT's current	1 - 18500 A
Primary VT's voltage	1 - 999999 V

Output contacts ratings

Number of relays (note 1)	4 + 1
Rated current	5 A
Rated voltage	250 V
Contact configuration	change over
Breaking capability (note 2)	
- tripping relays (R1, R2)	0.5 A
- signaling relays (R3, R4, R5) (note 3)	0.2 A
Mechanical life	> 10^6

Digital inputs

Number of inputs	3
External control voltage	as Uaux
Typical current (sink)	2 mA

Data transmission

Standard	RS-485 half duplex
Communication protocol	MOD-BUS ASCII
Transmission speed	300 - 9600 baud selectable
Optional	fibre optic module

Auxiliary supply

Range	24 ÷ 320 Vdc ± 20% 48 ÷ 230 Vac ± 20%
Frequency (Vac)	47 ÷ 63 Hz
Burdens (min/max)	5 / 10 W

Environmental conditions

Operation	- 10 / +60 °C
Transport and storage	- 25 / +80 °C
Relative humidity (without condensation)	< 95%
Protection degree for flush mounting	IP 52
(optional)	(IP 54)
Weight	2.5 kg

Note 1) The additional relay R5 is controlled by self-test program
Note 2) Breaking capability at 110 Vdc, L/R 40 ms, 100.000 operations

Note 3) The output contacts of R3 and R4 relays can be configured as signaling or tripping relays

9 TABLES

Table A Thresholds and time delays

THRESHOLDS		**DIRECTIONAL EARTH FAULT (ANSI 67N)**	**DIRECTIONAL POWER RELAY (ANSI 67-32)**
Is>	Setting	ON / OFF 0.005 ÷ 9.999 In	ON / OFF 0.01 ÷ 30.00 In
	Resolution	0.01 In	0.01 In
Us>	Setting	0.004 ÷ 1.200 Un	0.004 ÷ 1.200 Un
	Resolution	0.001 Un	0.001 Un
Characteristic angle	Setting	-180° ÷ +180°	-180° ÷ +180°
	Resolution	1°	1°
Sector width	Setting	+15° ÷ +180°	+15° ÷ +180°
	Resolution	1°	1°
Time Delays			
Definite Time	Setting	0.02 ÷ 99.99 s	0.02 ÷ 99.99 s
	Resolution	0.01 s	0.01 s
Dependent time	Characteristic curves (IEC 255-4)	A, B, C	A, B, C
	Characteristic constant Resolution	0.01 ÷ 20.00 s 0.01 s	0.01 ÷ 20.00 s 0.01 s
Additional delay		0.00 ÷ 99.99 s	0.00 ÷ 99.99 s
Drop-off ratio Is>, Us>		≥ 0.95	
Hysteresis of directional detection		≤ 3°	
Overshoot time		≤ 30 ms	
Output relays R1, R2, R3, R4		Programmable for each threshold START / TRIP and normally ON / OFF	

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