DIVISIONE ELETTRONICA E SISTEMI

ING4N

DIGITAL MULTIFUNCTION GENERATOR PROTECTION RELAY

USER MANUAL

P500D810 **July 2004**

INDEX

1 GENERAL CHARACTERISTICS

The protection relay ING4N is designed to protect generators; the user can select one of the functions listed in the table below.

Functions	ANSI	Measured currents
Phase overcurrent	50 - 51	I_A, I_B, I_C and Io
Earth-fault overcurrent	51N - 64S	
Negative sequence overcurrent	46	
Thermal overload	49	

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

THRESHOLDS - the following thresholds are available:

- 2 overcurrent thresholds (I>, I>>)
- 2 earth-fault overcurrent thresholds (Io>, Io>>)
- 2 negative sequence overcurrent thresholds (I2>, I2>>)
- 2 thermal overload thresholds (T°>, T°>>)

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

TRIP DELAYS - The thermal overload thresholds (ANSI 49) are time dependent only; the I>, Io> and I2> thresholds can be programmed as time definite or time dependent, whilst the remaining thresholds (I>>, Io>> and I2>>) are time definite only.

Each definite time threshold delay can be combined with an additional time delay (TA); 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 ING4N relay with cooperating protection relays.

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

OUTPUT RELAYS - the ING4N 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 at least one of the measured currents or parameters exceeds the programmed threshold value

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.

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

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 currents (primary values) or a computed parameters (over temperature etc.); all the measured currents 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 currents, 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 voltages and digital input status (see par. 5.10 - 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).

1.1 Description of the available functions

1.1.1 Negative Sequence Overcurrent (ANSI 46)

The protection relay measures the phase currents and from the current values computes the negative sequence currents **I2**; there are available 2 negative sequence overcurrent thresholds (**I2>** and **I2>>**).

The first threshold (**I2>**) can be programmed as:

- definite time
- dependent time (curves A, B and C as IEC 255-4, ref. par. 8)
- dependent time as curve D

The second threshold (**I2>>**) is definite time only.

The operating time as curve D is given by the following equation:

$$t = K * \left(\frac{Iref}{I2} \right)^2 \qquad \text{(s)}$$

where:

K programmable parameter 00.01÷99.99 s
Im reference current (0.5 ÷ 1.2 In)
I2 measured value of the negative sequence current

The time delay starts when the measured negative sequence current is greater than the threshold value **I2>**; when the measured negative sequence current goes below **I2>** threshold, the **elapsed time is decreased exponentially** with a programmable time constant **TC2** programmable from 1 to 99 seconds.

When the curve D is selected, a definite time delay **TLIM** related to **I2>** threshold is also available; **TLIM** is programmable from 100 to 9999 seconds.

When the 2-phase insertion is used, for the correct protection against negative sequence currents the ANSI 51N protection function must be programmed.

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

1.1.2 Thermal Overload (ANSI 49)

The ING4N protection relay performs the function of thermal overload protection under all the operating conditions by creating a mathematical model of the thermal behavior of the generator.

The positive sequence current (**I1**) and the negative sequence current (**I2**) of the generator are measured by the protection relay and combined to obtain an equivalent current **Ieq** used in the mathematical model to compute the thermal overload.

The equivalent current **Ieq** is computed using the following formula:

$$Ieq = \sqrt{I_1^2 + Ks * I_2^2} \qquad (1)$$

where **Ks** is a programmable coefficient from 0 to 10 used to modify the heating effect produced by the negative sequence current as its effect is much higher (due to eddy currents induced in the rotor at double frequency); for standard generators **Ks** = 6.

The protection relay computes the thermal overload of the generator and when the value exceeds one of the programmed thresholds (**T°>**, **T°>>**) the related output relays trip.

The tripping time (**t**) of the thermal overload function, according to IEC 255-8 and IEC 255-17 standards, is defined by the formula:

$$t = TC1 * \ln \frac{I_{eq}^2 - I_p^2}{I_{eq}^2 - I_b^2} \quad \text{(s)} \qquad (2)$$

where:

TC1 heating time constant (programmable)
Ieq computed equivalent current
Ip equivalent current before overload
Ib base current

Ib is programmable from **0.40** to **2.00 In** and it represents the equivalent current **Ieq** for which the relay will NOT OPERATE.

In paragraph 7 are shown the characteristic curves representing the operating time as function of different load currents (**Ip**) before the overload condition and when the overload current is constant.

Loss of auxiliary supply - whenever powered up the relay assumes the generator to be heated up to a level equals to the programmable **QTM0** value (programmable from 50% to 100% - default value 100 %).

1.1.3 Overcurrent Protection (ANSI 50 - 51)

There are available 2 phase overcurrent thresholds (I> and I>>).

The first phase overcurrent (I>) threshold can be programmed either definite time or dependent time in compliance with BS-142 and IEC 255-4 specifications; the other threshold (I>>) is definite time only.

Each definite time threshold delay can be combined with an additional timer controlled by the digital inputs. The trip of the relay is shown by LEDs and by a message on the display.

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

1.1.4 Earth-Fault Overcurrent (ANSI 51N - 64S)

There are available 2 earth-fault overcurrent thresholds (Io> and Io>>).

The first threshold (Io>) can be programmed either definite time or dependent time in compliance with BS-142 and IEC 255-4 specifications; the other threshold (Io>>) is definite time only.

Each definite time threshold delay can be combined with an additional timer controlled by the digital inputs. The trip of the relay is shown by LED’s and by a message on the display.

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

2 FRONT PANEL KEYS

The 5 push-buttons on the front panel allow to view 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 (rif. 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 Figures 1, 2, 3 and 4.
- 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 SIGNALINGS

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

I2> I2>> (red) ⊕ trip condition on I2> or I2>> thresholds (ANSI 46)

I> I>> Io> Io>> (red) ⊕ trip condition on I>, I>> (ANSI 50 - 51) or Io>, Io>> (ANSI 51N - 64S) thresholds

T°> T°>> (red) ⊕ trip condition on T°> or T°>> thresholds (ANSI 49)

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. 5.10).

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 1, 2, 3 and 4 at the following references:

B2 ÷ B7	relay address (RS485) and date/time
C1	relay insertion
D1 ÷ D5	nominal values, contrast etc
E1 ÷ E9	thresholds and time delays negative sequence overcurrent (ANSI 46)
F1 ÷ F6	thresholds and time delays phase overcurrent (ANSI 50-51)
G1 ÷ G7	thresholds and time delays earth-fault overcurrent (ANSI 51N - 64S)
H1 ÷ H7	thresholds and time delays thermal overload thresholds (ANSI 49)
L1 ÷ L10	output relays functions
M1 ÷ M3	digital input functions
T1 ÷ T16	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. 2, 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 LEDs

- 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. 1, ref. A1 - par. 5.1)

4.4 Test of output relays

When the output relays test is selected (Fig. 2, ref. L10) 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 1, 2, 3 and 4; the references A1, B1, B2 etc. identify specific displayed messages in the figures.

5.1 Standard display

A1 - STANDARD DISPLAY

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.

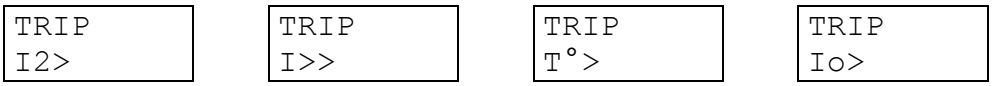
The displayed information is function of the protection relay status.

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 selected functions (ref. C1 - FUNCTION SELECTION).
- **Measured current and parameters** - the display shows one of the measured currents (I_A, I_B, I_C, Io) or computed ones (I2 - negative sequence current, Ieq - equivalent current) or the thermal overload value (QTM); the information to be visualized is selected by operator (ref. D4).

The voltage is visualized as primary value; if the selection of the voltage to be visualized refers to a voltage not measured (depending on FUCTION SELECTION) no values are presented.

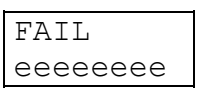
ON TRIP CONDITION
When a trip condition occurs the protection relay visualizes the TRIP message that includes the threshold related to the trip; the displayed messages are as the following:



The information of the trip, as well the glowing of the related LEDs, 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 is displayed:



The string eeeeeeee can be:

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

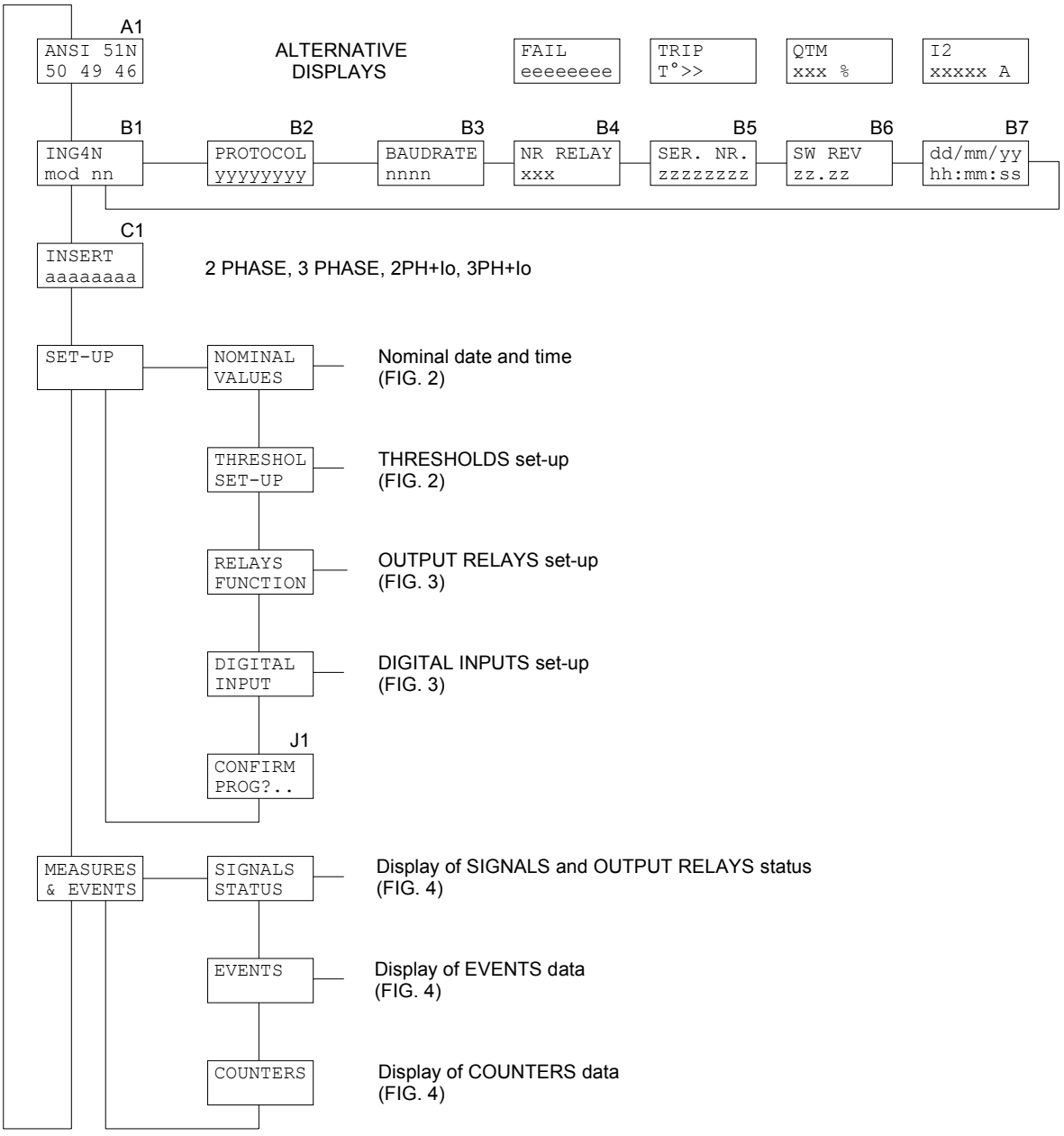


Figure 1

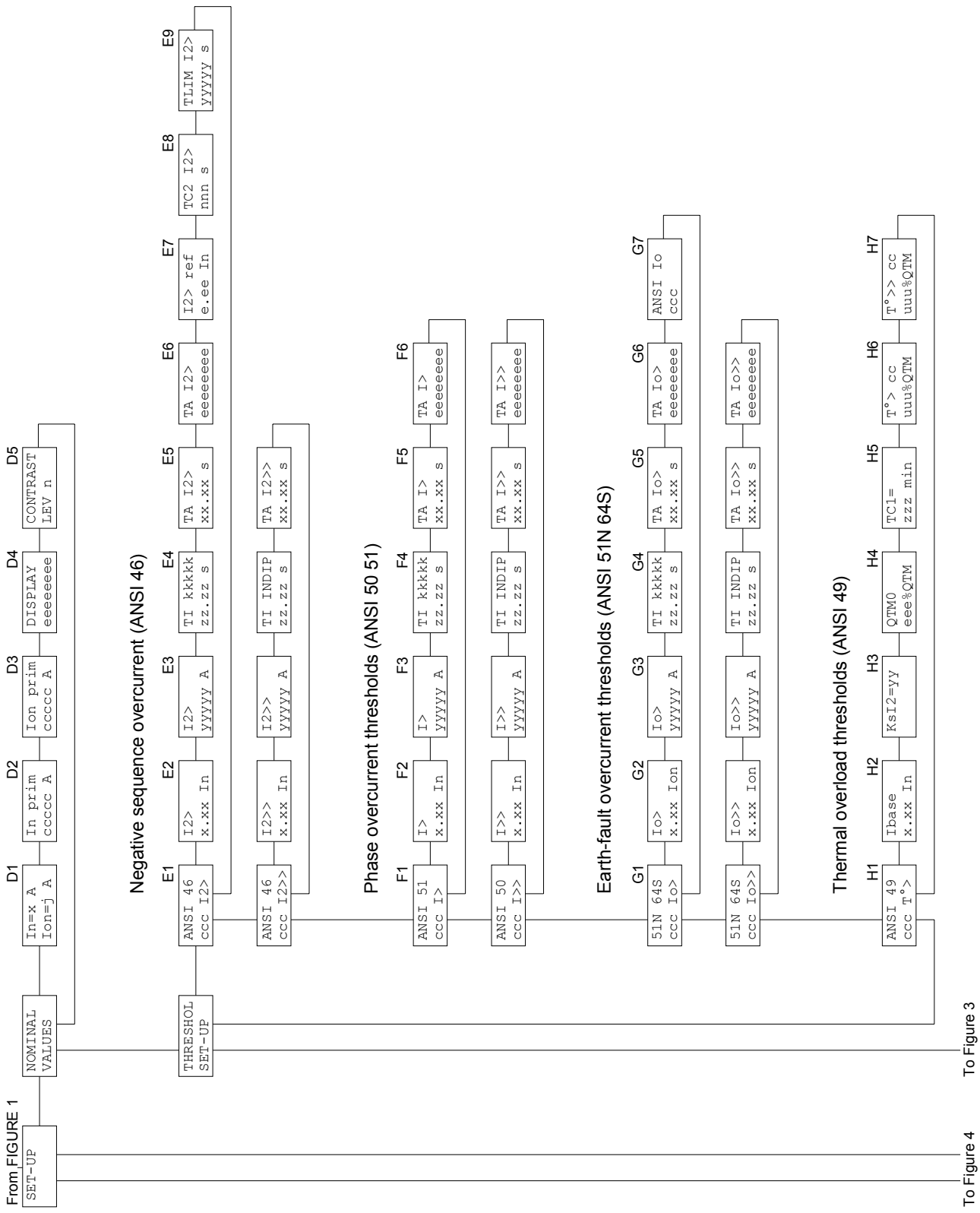

From FIGURE 1
SET-UP
NOMINAL VALUES
THRESHOL SET-UP
D1
In=x A
Ion=j A
D2
In prim
ccccc A
D3
Ion prim
ccccc A
D4
DISPLAY
eeeeeeee
D5
CONTRAST
LEV n
Negative sequence overcurrent (ANSI 46)
E1
ANSI 46
ccc I2>
E2
I2>
x.xx In
E3
I2>
yyyyy A
E4
TI kkkkk
zz.zz s
E5
TA I2>
xx.xx s
E6
TA I2>
eeeeeee
E7
I2> ref
e.ee In
E8
TC2 I2>
nnn s
E9
TLIM I2>
yyyyy s
ANSI 46
ccc I2>>
I2>>
x.xx In
I2>>
yyyyy A
TI INDIP
zz.zz s
TA I2>>
xx.xx s
Phase overcurrent thresholds (ANSI 50 51)
F1
ANSI 51
ccc I>
F2
I>
x.xx In
F3
I>
yyyyy A
F4
TI kkkkk
zz.zz s
F5
TA I>
xx.xx s
F6
TA I>
eeeeeee
ANSI 50
ccc I>>
I>>
x.xx In
I>>
yyyyy A
TI INDIP
zz.zz s
TA I>>
xx.xx s
TA I>>
eeeeeee
Earth-fault overcurrent thresholds (ANSI 51N 64S)
G1
51N 64S
ccc Io>
G2
Io>
x.xx Ion
G3
Io>
yyyyy A
G4
TI kkkkk
zz.zz s
G5
TA Io>
xx.xx s
G6
TA Io>
eeeeeee
G7
ANSI Io
ccc
51N 64S
ccc Io>>
Io>>
x.xx Ion
Io>>
yyyyy A
TI INDIP
zz.zz s
TA Io>>
xx.xx s
TA Io>>
eeeeeee
Thermal overload thresholds (ANSI 49)
H1
ANSI 49
ccc T°>
H2
Ibase
x.xx In
H3
KsI2=yy
H4
QTM0
eee%QTM
H5
TC1=
zzz min
H6
T°> cc
uuu%QTM
H7
T°>> cc
uuu%QTM
To Figure 3
To Figure 4

Figure 2

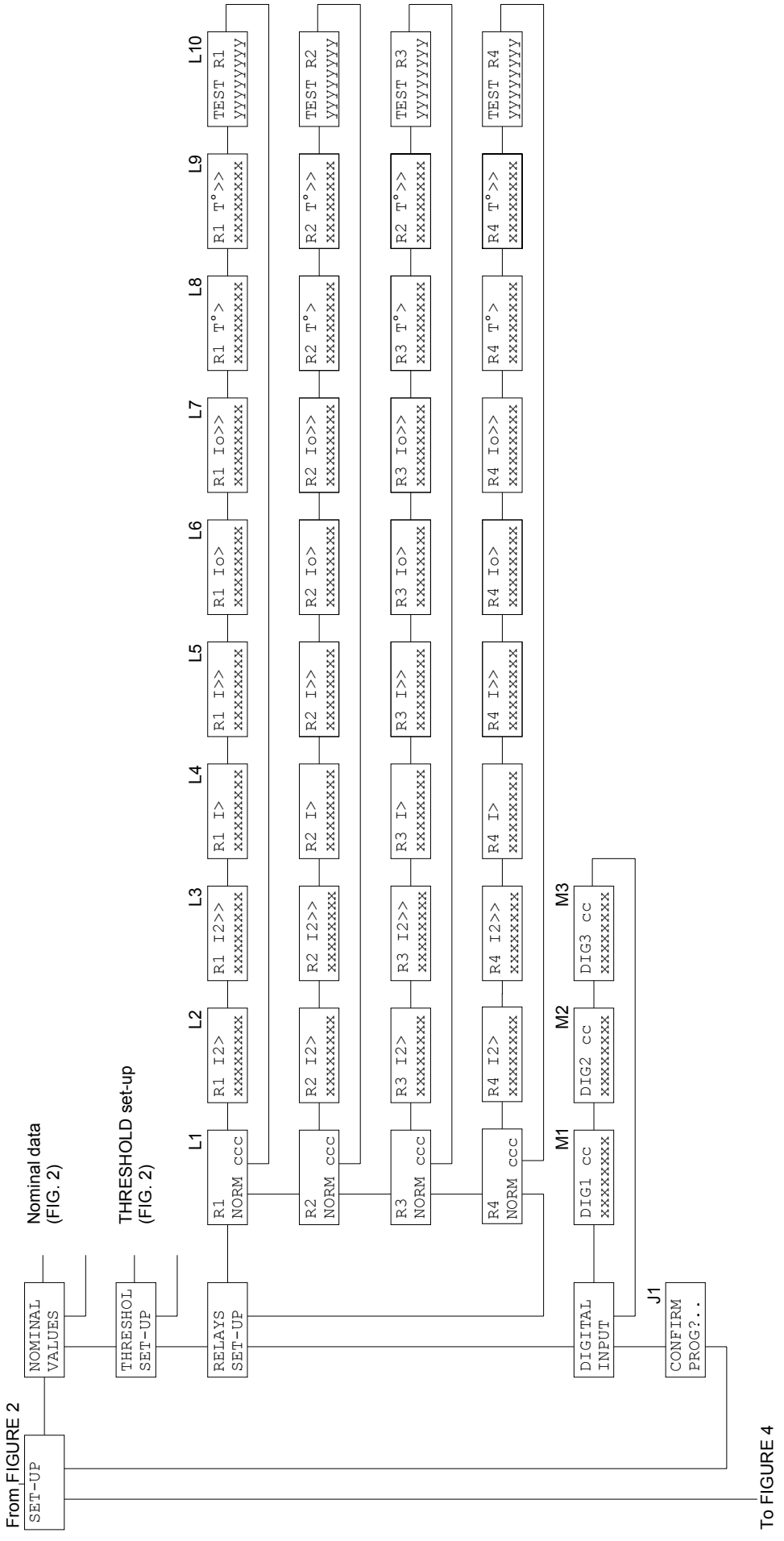

From FIGURE 2
SET-UP
NOMINAL VALUES
Nominal data (FIG. 2)
THRESHOL SET-UP
THRESHOLD set-up (FIG. 2)
RELAYS SET-UP
DIGITAL INPUT
J1
CONFIRM PROG?..
To FIGURE 4
L1
L2
L3
L4
L5
L6
L7
L8
L9
L10
M1
M2
M3
R1 NORM ccc
R1 I2> xxxxxxxxx
R1 I2>> xxxxxxxxx
R1 I> xxxxxxxxx
R1 I>> xxxxxxxxx
R1 Io> xxxxxxxxx
R1 Io>> xxxxxxxxx
R1 T°> xxxxxxxxx
R1 T°>> xxxxxxxxx
TEST R1 yyyyyyyy
R2 NORM ccc
R2 I2> xxxxxxxxx
R2 I2>> xxxxxxxxx
R2 I> xxxxxxxxx
R2 I>> xxxxxxxxx
R2 Io> xxxxxxxxx
R2 Io>> xxxxxxxxx
R2 T°> xxxxxxxxx
R2 T°>> xxxxxxxxx
TEST R2 yyyyyyyy
R3 NORM ccc
R3 I2> xxxxxxxxx
R3 I2>> xxxxxxxxx
R3 I> xxxxxxxxx
R3 I>> xxxxxxxxx
R3 Io> xxxxxxxxx
R3 Io>> xxxxxxxxx
R3 T°> xxxxxxxxx
R3 T°>> xxxxxxxxx
TEST R3 yyyyyyyy
R4 NORM ccc
R4 I2> xxxxxxxxx
R4 I2>> xxxxxxxxx
R4 I> xxxxxxxxx
R4 I>> xxxxxxxxx
R4 Io> xxxxxxxxx
R4 Io>> xxxxxxxxx
R4 T°> xxxxxxxxx
R4 T°>> xxxxxxxxx
TEST R4 yyyyyyyy
DIG1 cc xxxxxxxxx
DIG2 cc xxxxxxxxx
DIG3 cc xxxxxxxxx

Figure 3

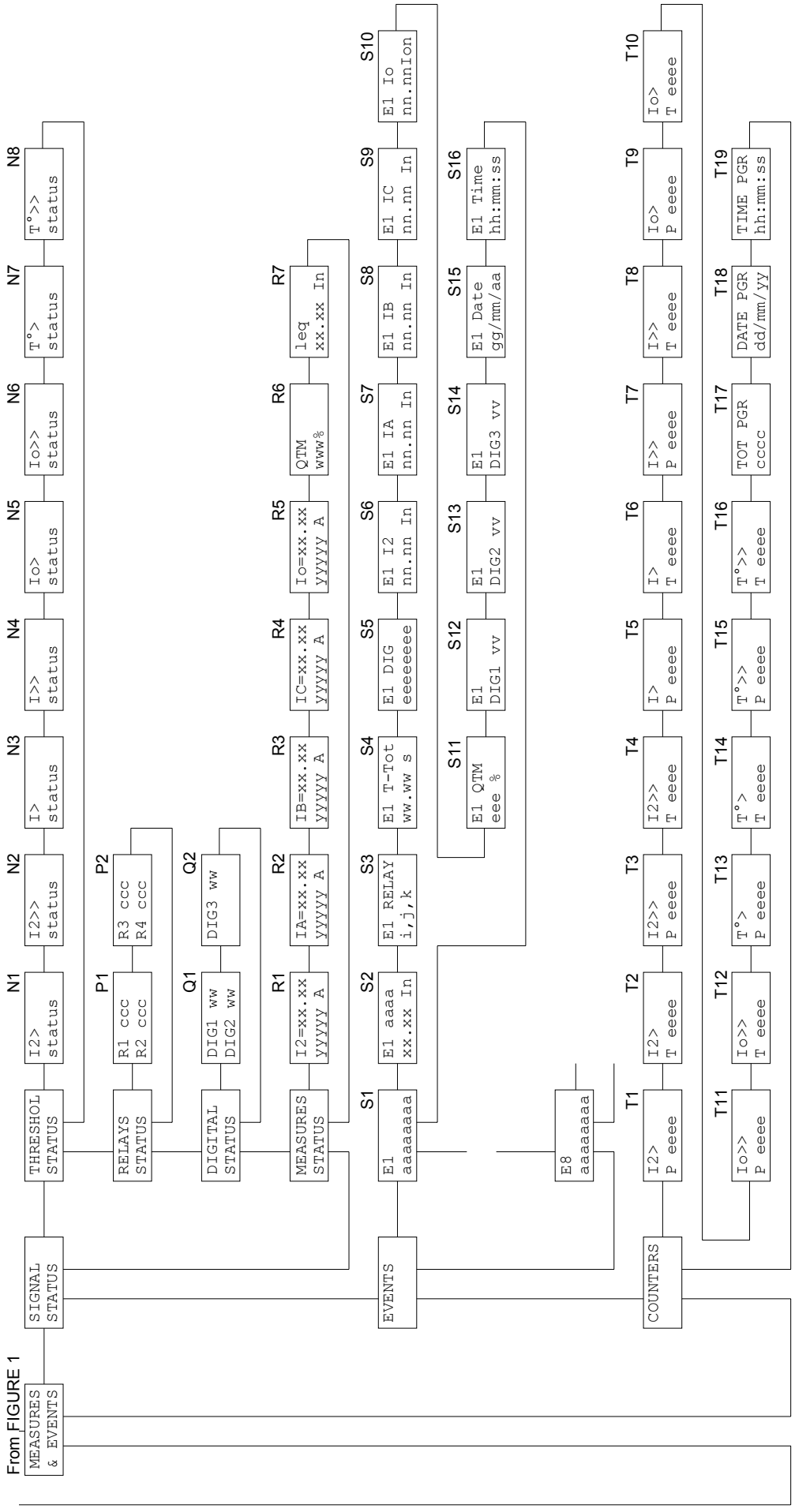

From FIGURE 1
MEASURES & EVENTS
SIGNAL STATUS
THRESHOL STATUS
RELAYS STATUS
DIGITAL STATUS
MEASURES STATUS
EVENTS
COUNTERS
E8 aaaaaaaa
N1 I2> status
N2 I2>> status
N3 I> status
N4 I>> status
N5 Io> status
N6 Io>> status
N7 T°> status
N8 T°>> status
P1 R1 ccc R2 ccc
P2 R3 ccc R4 ccc
Q1 DIG1 ww DIG2 ww
Q2 DIG3 ww
R1 I2=xx.xx yyyyy A
R2 IA=xx.xx yyyyy A
R3 IB=xx.xx yyyyy A
R4 IC=xx.xx yyyyy A
R5 Io=xx.xx yyyyy A
R6 QTM www%
R7 leq xx.xx In
S1 E1 aaaaaaaa
S2 E1 aaaa xx.xx In
S3 E1 RELAY i,j,k
S4 E1 T-Tot ww.ww s
S5 E1 DIG eeeeeeee
S6 E1 I2 nn.nn In
S7 E1 IA nn.nn In
S8 E1 IB nn.nn In
S9 E1 IC nn.nn In
S10 E1 Io nn.nnIon
S11 E1 QTM eee %
S12 E1 DIG1 vv
S13 E1 DIG2 vv
S14 E1 DIG3 vv
S15 E1 Date gg/mm/aa
S16 E1 Time hh:mm:ss
T1 I2> P eeee
T2 I2> T eeee
T3 I2>> P eeee
T4 I2>> T eeee
T5 I> P eeee
T6 I> T eeee
T7 I>> P eeee
T8 I>> T eeee
T9 Io> P eeee
T10 Io> T eeee
T11 Io>> P eeee
T12 Io>> T eeee
T13 T°> P eeee
T14 T°> T eeee
T15 T°>> P eeee
T16 T°>> T eeee
T17 TOT PGR cccc
T18 DATE PGR dd/mm/yy
T19 TIME PGR hh:mm:ss

Figure 4

5.3 Address and Time (fig. 1)

B1 - RELAY MODEL (not programmable)

```
ING4N
mod. A5
```

Models: A5 (nominal earth fault current = 5A)
A1 (nominal earth fault current = 1A)

The nominal phase current is programmable 1 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 Protection insertion (fig. 1)

C1 - INSERTION SELECTION (programmable)

```
INSERT.
xxxxxxxx
```

The insertion of the protection relay is selectable between the followings:

2 PHASE	Two phase insertion
3 PHASE	Three phase insertion
2 PH+Io	Two phase and earth insertion
3 PH+Io	Three phase and earth insertion

Examples:

```
INSERT.
2 PHASE
```

```
INSERT.
3 PH+Io
```

5.5 Nominal values set-up (fig. 2)

D1 - NOMINAL CURRENT SELECTION In (programmable)

```
In = x A
Ion= 1 A
```

```
In = x A
Ion= 5 A
```

In nominal phase current programmable 1 A or 5 A

Ion nominal earth current (defined by models - manufacturer set-up)

Ion = 5 A ING4N model A5
Ion = 1 A ING4N model A1

D2 - PRIMARY PHASE CURRENT (programmable)

```
In prim
xxxxx A
```

Primary phase current value of the installed phase CTs; the value is programmable from 0001 to 18500 A.

D3 - PRIMARY EARTH CURRENT (programmable)

```
Ion prim
xxxxx A
```

Primary current value of the installed earth CT; the value is programmable from 0001 to 18500 A.

NOTE: when Holmgreen insertion is used, select **Ion prim = In prim**.

D4 - 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 have been detected by the self-diagnosis module; the available selections are the following:

ANSI	displays of ANSI code
I2	display measured negative sequence current
IA	displays measured phase current IA
IB	displays measured phase current IC
IC	displays measured phase current IC
Io	displays measured earth current Io
Ieq	displays computed equivalent current (ref. paragraph 1.1.2 - formula 1, presented in terms of In)
QTM%	displays computed motor over temperature (0 ÷ 120 %)

The list of the selectable currents depends on the programmed INSERTION SELECTION (ref. C1); the current is displayed in primary values (the value depends on D2 and D3 set-ups).

Selection examples:

```
DISPLAY
ANSI
```

```
DISPLAY
I1
```

```
DISPLAY
QTM%
```

D5 - 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 Threshold and time delays set-up

5.6.1 Negative sequence overcurrent thresholds (fig. 2)

The information and set-ups related to threshold I2> in the following points are effective for the threshold I2>> (if not specifically written) just taking into consideration the change of the threshold identification.

E1

```
ANSI  46
ccc  I2>
```

E2

```
I2>
n.nn  In
```

E3

```
I2>
xxxxx A
```

E1 - ON / OFF NEGATIVE SEQUENCE OVERCURRENT THRESHOLD (programmable)

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

E2 - THRESHOLD LEVEL SET-UP (programmable)

nn.nn threshold level expressed in terms of In (0.05 ÷ 1.00)

E3 - THRESHOLD LEVEL IN PRIMARY VALUE (non programmable)

xxxxxx threshold level expressed in amperes (primary values)
NOT PROGRAMMABLE as function of ref. D2 set-up

E4 - TIME DELAY SET-UP (programmable)

```
TI eeeee
zz.zz  s
```

Set-up of time-delay to the activation (TRIP) of the programmed output relays when the measured current exceeds the threshold level.

Parameter TI eeeee: time delay characteristic

For **I2>** 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)
DIP=D	time delay as curve D - equation as formula paragraph 1.1.1

For the threshold **I2>>** the TI parameter is fixed as INDIP (definite time).

Parameter zz.zz:

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 8).

TI DIP=B 02.50 K	TI DIP=A 10.00 K	TI INDIP 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.

E5 - ADDITIONAL TIME DELAY SET-UP (programmable)

TA I2> xx.xx s

The selection is displayed only when a TIME DEFINITE characteristic has been selected (TI INDIP at ref. E4); when TIME DEPENDENT characteristic has been programmed, the selection will not be displayed.

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 time delay function (ref. M1, M2, M3 – 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.

E6 - DIGITAL INPUT ACTIVE ON THRESHOLD (not programmable)

TA I2> 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:

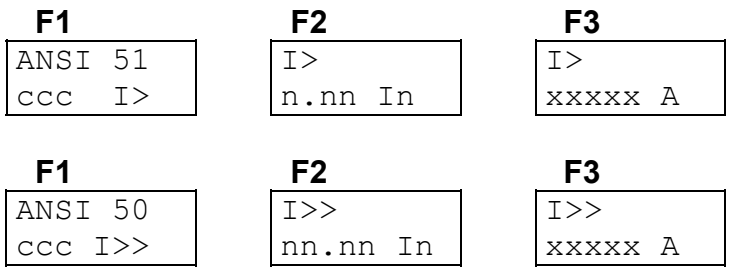
DISABLED	none of the digital inputs has been programmed to activate an additional time delay related to threshold I2> or I2>>
DIG1	digital input DIG1 activates the TA delay on threshold I2> or I2>>
DIG2	digital input DIG2 activates the TA delay on threshold I2> or I2>>
DIG3	digital input DIG3 activates the TA delay on threshold I2> or I2>>

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. M1, M2, M3 - paragraph 5.8).

5.6.2 Phase overcurrent thresholds ANSI 50 - 51 (fig. 2)



F1 - ON / OFF PHASE OVERCURRENT THRESHOLD (programmable)

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

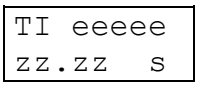
F2 - THRESHOLD LEVEL SET-UP (programmable)

n.nn threshold level I> expressed in terms of In (0.10 ÷ 5.00)
nn.nn threshold level I>> expressed in terms of In (0.10 ÷ 40.00)

F3 - THRESHOLD LEVEL IN PRIMARY VALUE (non programmable)

xxxxxx: threshold level expressed in Amperes (primary values) NOT PROGRAMMABLE as function of ref. D2 set-up

F4 - TIME DELAY SET-UP (programmable)



Set-up of time-delay to the activation (TRIP) of the programmed output relays when the measured current exceeds the threshold level.

Parameter TI eeeee: time delay characteristic

For **I>** 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 threshold **I>>** the TI parameter is fixed as INDIP (definite time).

Parameter zz.zz:

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 8).

TI DIP=B 02.50 K	TI DIP=A 10.00 K	TI INDIP 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.

F5 - ADDITIONAL TIME DELAY SET-UP (programmable)

TA I> xx.xx s

The selection is displayed only when a TIME DEFINITE characteristic has been selected (TI INDIP at ref. F4); when TIME DEPENDENT characteristic has been programmed, the selection will not be displayed.

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 time delay function (ref. M1, M2, M3 - 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.

F6 - DIGITAL INPUT ACTIVE ON THRESHOLD (not programmable)

TA I> 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 threshold I> or I>>
DIG1	digital input DIG1 activates the TA delay on threshold I> or I>>
DIG2	digital input DIG2 activates the TA delay on threshold I> or I>>
DIG3	digital input DIG3 activates the TA delay on threshold I> or I>>

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. M1, M2, M3 - paragraph 5.8).

5.6.3 Earth-fault overcurrent thresholds ANSI 51- 64S (fig. 2)

G1	G2	G3
ANSI 64S ccc Io>	Io> n.nn Ion	Io> xxxxx A

G1	G2	G3
ANSI 65S ccc Io>>	Io>> nn.nnIon	Io>> xxxxx A

G1 - ON / OFF EARTH-FAULT OVERCURRENT THRESHOLD (programmable)

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

G2 - THRESHOLD LEVEL SET-UP (programmable)

n.nn threshold level Io> expressed in terms of Ion (0.01 ÷ 2.00)
nn.nn threshold level Io>> expressed in terms of Ion (0.10 ÷ 10.00)

G3 - THRESHOLD LEVEL IN PRIMARY VALUE (non programmable)

xxxxxx threshold level expressed in Amperes (primary values) NON PROGRAMMABLE as function of ref. D3 set-up

G4 - TIME DELAY SET-UP (programmable)

TI eeeee zz.zz s

Set-up of time-delay to the activation (TRIP) of the programmed output relays when the measured current exceeds the threshold level.

Parameter TI eeeee: time delay characteristic

For I> 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 threshold **Io>>** the TI parameter is fixed as INDIP (definite time).

Parameter zz.zz:

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 8).

TI DIP=B 02.50 K	TI DIP=A 10.00 K	TI INDIP 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.

G5 - ADDITIONAL TIME DELAY SET-UP (programmable)

```
TA   Io>
xx.xx  s
```

The selection is displayed only when a TIME DEFINITE characteristic has been selected (TI INDIP at ref. G4); when TIME DEPENDENT characteristic has been programmed, the selection will not be displayed.

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 time delay function (ref. M1, M2, M3 - 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.

G6 - DIGITAL INPUT ACTIVE ON THRESHOLD (not programmable)

```
TA   Io>
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 threshold Io> or Io>>
DIG1	digital input DIG1 activates the TA delay on threshold Io> or Io>>
DIG2	digital input DIG2 activates the TA delay on threshold Io> or Io>>
DIG3	digital input DIG3 activates the TA delay on threshold Io> or Io>>

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. M1, M2, M3 - paragraph 5.8).

G7 - EARTH-FAULT THRESHOLDS ANSI CODE SELECTION (programmable)

```
ANSI  Io
ccc
```

ccc 51N - ANSI code 51N showed at ref. A1
64S - ANSI code 64S showed at ref. A1

It allows to select the ANSI code related to the earth-fault thresholds to be displayed by the protection relay.

5.6.4 Thermal overload thresholds ANSI 49 (fig. 2)

H1 - ON / OFF THERMAL OVERLOAD THRESHOLD (programmable)

```
ANSI  49
ccc  T°>
```

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

H2 - BASE CURRENT Ib (programmable)

```
I base
x.xx In
```

The base current **Ibase** represents the equivalent current Ieq for which the relays will NOT OPERATE (ref. paragraph 1.1.2 - formula 2).

x.xx current value expressed in terms of relative values (In)

Example:

```
I base
1.25 In
```

H3 - Ks COEFFICIENT (programmable)

```
KsI2=yy
```

Ks is a programmable coefficient used to modify the weight of the negative sequence current in the computing of the equivalent current Ieq (ref. paragraph 1.1.2 - formula 1).

yy programmable value from 0 to 10 (for standard motors **Ks** = 6)

Example:

```
KsI2= 06
```

H4 - INITIAL THERMAL OVERLOAD QTM0 (programmable)

```
QTM0
eee% QTM
```

Whenever powered up the relay assumes the generator to be heated up to a level equals to the programmable **QTM0** value.

The initial thermal overload is expressed in percentage of the allowed generator thermal overload **QTM**.

eee programmable value from 50% to 100% - default value 100 %

Example:

```
QTM0
050% QTM
```

H5 - GENERATOR HEATING TIME CONSTANT TC1 (programmable)

```
TC1 =
zzz  min
```

TC1 represents the generator heating time constant used to compute the operating time (TRIP condition) of the thermal overload thresholds (ref. paragraph 1.1.2 - formula 2). The heating constant is expressed in minutes.

zzz programmable value from 1 to 500 minutes

Example:

```
TC1 =
010  min
```

H6 - H7 - THERMAL OVERLOAD THRESHOLDS T°>, T°>> (programmable)

```
T°>   cc
uuu% QTM
```

```
T°>>  cc
uuu% QTM
```

Thermal overload thresholds T°>, T°>> programming; the two thresholds are independently programmable.

cc ON - enabled threshold
OF - disabled threshold (available but not active)

uuu thermal overload threshold values from 50% to 120% QTM (QTM - generator thermal capacity)

Example:

```
T°>  ON
103% QTM
```

```
T°>> OF
115% QTM
```

5.7 Output relays programming (fig. 2)

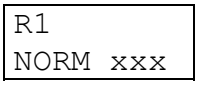
The session allows to program the activation of the output relays R1, R2, R3 or R4 on START or TRIP conditions for each threshold.

In the programming session are displayed only the active thresholds depending on selections in the THRESHOLD SET-UP paragraph (paragraph 5.6).

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

NOTE - the output relays related to the thermal overload thresholds (T°> and T°>>) do not have the START function.

L1 - OUTPUT RELAY R1 QUIESCENT STATUS (programmable)

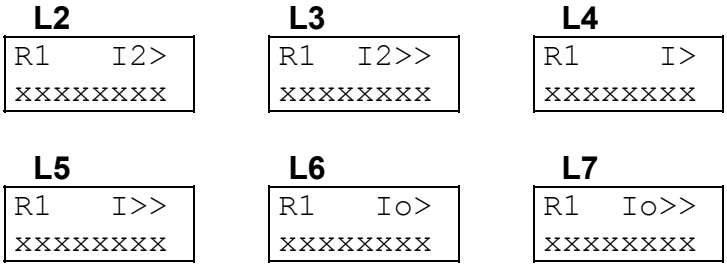


Programming of the R1 relay status when no START or TRIP conditions are activated (none of the measured currents exceed their thresholds).

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

Example:

L2 ÷ L7 - OUTPUT RELAY ACTIVATION ON THRESHOLDS I2>, I2>>, I>, I>>, Io>, Io>> (programmable)

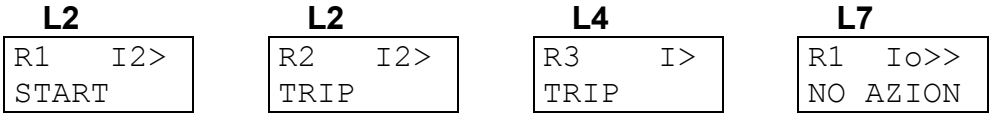


Programming of the R1 output relay activation (TRIP) on the I2>, I2>>, I>, I>>, Io> and Io>> thresholds.

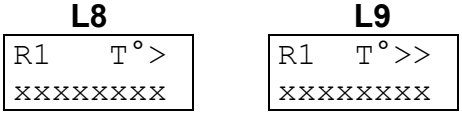
The parameter xxxxxxxx is selectable as the following:

START instantaneous output relay R1 activation when one of the measured currents exceeds the programmed threshold
TRIP output relay R1 activation when one of the measured currents exceeds the programmed threshold level for at least TI or TI+TA seconds
NONE no activation related to thresholds

Example:



L8 - L9 - OUTPUT RELAY ACTIVATION ON THRESHOLDS T°>, T°>> (programmable)



Programming of the R1 output relay activation (TRIP/NONE) on the thermal overload thresholds T°> and T°>>.

The parameter xxxxx is selectable as the following:

TRIP	output relay R1 activation when the time delay of the threshold expires (as curve IEC 255-8 and IEC 255-17)
NONE	no activations related to thresholds

Example:

L8

```
R1   T°>
TRIP
```

L9

```
R1  T°>>
NONE
```

L10 - TEST OF OUTPUT RELAY R1

```
TEST  R1
xxxxxxxx
```

See paragraph 4.4

5.8 Digital inputs function programming (fig. 2)

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

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

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

When function a) is programmed, a message is displayed at ref. E6, F6 and G6 in paragraph 5.6.

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.

M1 - DIGITAL INPUT DIG1 SET-UP (programmable)

```
DIG1  cc
xxxxxxxx
```

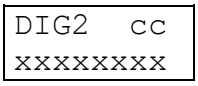
Programming of the function related to digital input channel 1 (DIG1).

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 threshold are presented):

NONE	no functions active related to digital input DIG1
TA I2>	additional time delay on the threshold I2>
TA I2>>	additional time delay on the threshold I2>>
TA I>	additional time delay on the threshold I>
TA I>>	additional time delay on the threshold I>>
TA Io>	additional time delay on the threshold Io>
TA Io>>	additional time delay on the threshold Io>>
TA ALL	additional time delay on all thresholds
OF I2>	threshold I2> disabled
OF I2>>	threshold I2>> disabled
OF I>	threshold I> disabled
OF I>>	threshold I>> disabled
OF Io>	threshold Io> disabled
OF Io>>	threshold Io>> disabled
OF T°>	threshold T°> disabled
OF T°>>	threshold T°>> disabled
OF ALL	all thresholds disabled
STATUS	activation of status function (see paragraph 1)

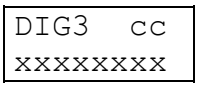
M2 - DIGITAL INPUT DIG2 SET-UP (programmable)



Programming of the function related to digital input channel 2 (DIG2); the selections available are the same as presented for DIG1 (ref. M1) plus the following:

MONITOR	activation of pilot wire monitor function.

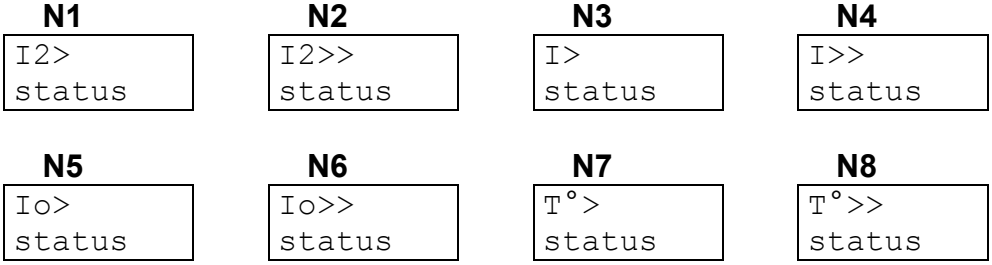
M3 - DIGITAL INPUT DIG3 SET-UP (programmable)



Programming of the function related to digital input channel 3 (DIG3); the selections available are the same as presented for DIG1 (ref. M1).

5.9 Parameter values visualization (fig. 3)

N1 - N2 - N3 - N4 - N5 - N6 - N7 - N8 - THRESHOLDS STATUS



The actual status of each threshold is displayed. For each threshold are displayed the threshold identification (I2>, I2>> 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, F1, G1, H1 - see par. 5.6)
OFF_DIG	threshold programmed active but momentary disabled by a digital input actual status (ref. M1, M2, M3 see par. 5.8).

Examples:

I2> ON	I2>> OFF	T°> ON	I> OFF_DIG

P1 - P2 - 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. L1).

Example:

P1

R1	ON
R2	OFF

P2

R3	OFF
R4	ON

Q1 - Q2 - 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)

Example:

Q1

DIG1	LO
DIG2	HI

Q2

DIG3	LO

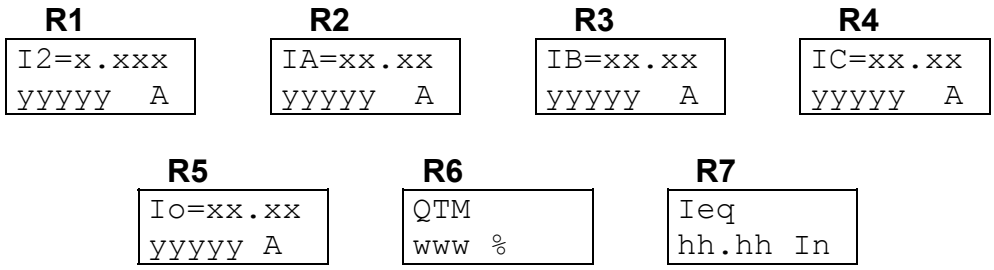
R1 - R2 - R3 - R4 - R5 - R6 - R7 - MEASUREMENT DISPLAY

The actual values of the measured currents and of the computed parameters are displayed; the parameters related to disabled thresholds are not displayed.

For each current the following information is displayed:

currents or parameters identification (I2, IA, IB, IC, Io, Ieq, QTM)

actual values expressed as In, Ion or %
actual primary value expressed as Amperes (only IA, IB, IC, I2 and Io)



xx.xx current values as In or Ion (from 00.00 to 50.00 In or from 00.00 to 10.00 Ion)

yyyyy actual primary value of the currents (expressed as Amperes)

hh.hh equivalent current value (from 00.00 to 99.99 In - computed as formula 1 - par. 1.1.2)

www thermal overload as % QTM (0 - 130 %)

5.10 Events (fig. 4)

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.

S1 - EVENT NUMBER

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
I2>	event on trip threshold I2> (ANSI 46)
I2>>	event on trip threshold I2>> (ANSI 46)
I>	event on trip threshold I> (ANSI 51)
I>>	event on trip threshold I>> (ANSI 50)
Io>	event on trip threshold Io> (ANSI 51N-64S)
Io>>	event on trip threshold Io>> (ANSI 51N-64S)
T°>	event on trip threshold T°> (ANSI 49)
T°>>	event on trip threshold T°>> (ANSI 49)
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.

S2 - TRIP THRESHOLD

It is shown the threshold that caused the TRIP condition and its value. This information is not presented on STATUS event.

Examples:

E1 T°>> 115% QTM	E1 I2> 0.50 In	E4 I> 1.30 In	E6 Io> 0.40 Ion

S3 - 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

S4 - TOTAL TIME DELAY ON TRIP

E1 T-Tot www.ww s

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

E1 T-Tot N/A

NOTE thresholds ANSI 49 (T°> and T°>>) do not have START condition, therefore T-tot is always presented as N/A

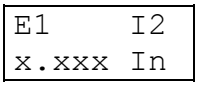
S5 - DIGITAL CHANNELS RELATED TO MEMORIZED EVENT

E1 DIG 1, 3

The list of the digital inputs related to the memorized event is displayed (STATUS function command or additional time TA enabled - rif. par. 5.8).

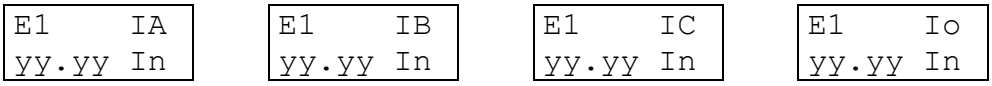
If no digital inputs were activated, the message NONE is displayed.

S6 - MEMORIZED NEGATIVE SEQUENCE CURRENT



The values of the negative sequence current at the event is displayed; the value is presented if at least one of the negative sequence current thresholds (I2> or I2>>) are enabled.

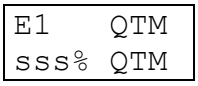
S7 - S8 - S9 - S10 - MEMORIZED MEASURED CURRENTS ON EVENT



The values of the measured currents at the event are displayed; the values are expressed as In and Ion terms.

There are presented only the currents measured coherently with the selection at ref. C1 – paragraph 5.4.

S11 - MEMORIZED THERMAL OVERLOAD



The values of the generator thermal overload at the event is displayed; the value is expressed as percentage (%) of the generator thermal capacity.

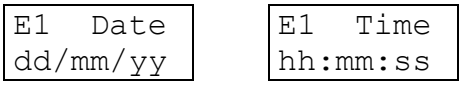
The value is presented if at least one of the thermal overload thresholds (T°> or T°>>) are enabled.

S12 - S13 - S14 - 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.

S15 - S16 - DATE AND TIME OF THE EVENT



The date and time of the event are showed

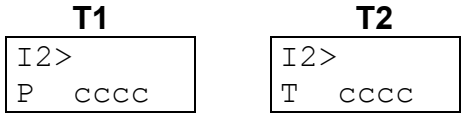
5.11 Trips Counters (fig. 4)

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).

T1 ÷ T16 - TRIP COUNTERS



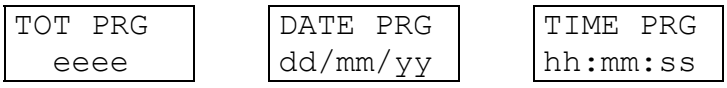
Display of the partial (P) and total (T) counters of the TRIP condition related to each threshold.

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

The counters are identified by the threshold name (I2>, I2>>, I>, I>>, Io>, Io>>, T°>, T°>>); there are presented only the counters related to the active thresholds.

The partial counters are modifiable in the range from 0000 to 9999 following the standard set-up procedure (paragraph 4.2).

T17 ÷ T19 - 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

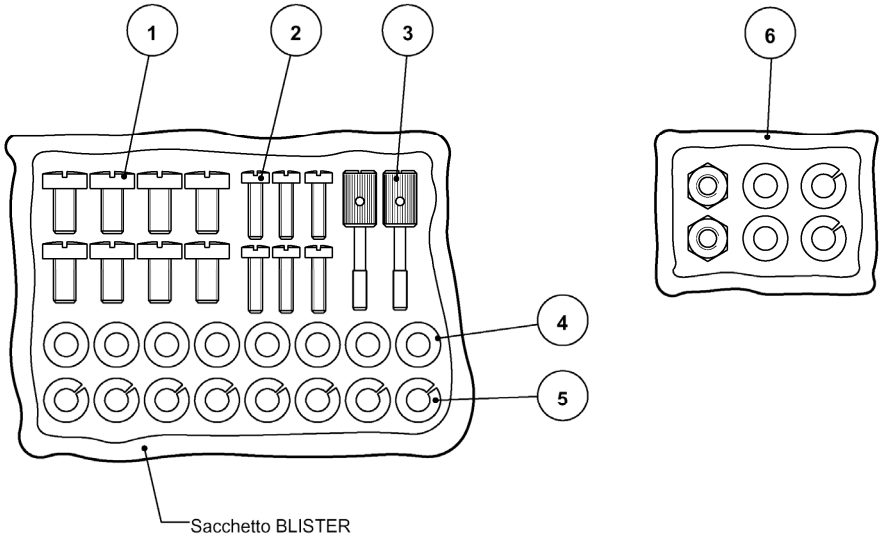
6.1 Supplied kit

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

- protection relay module ING4N 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 ING4N 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 wire terminals (current)
5) n° 8 growers to be used to fix wire terminals (current)
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 wiring using eyelet terminals.

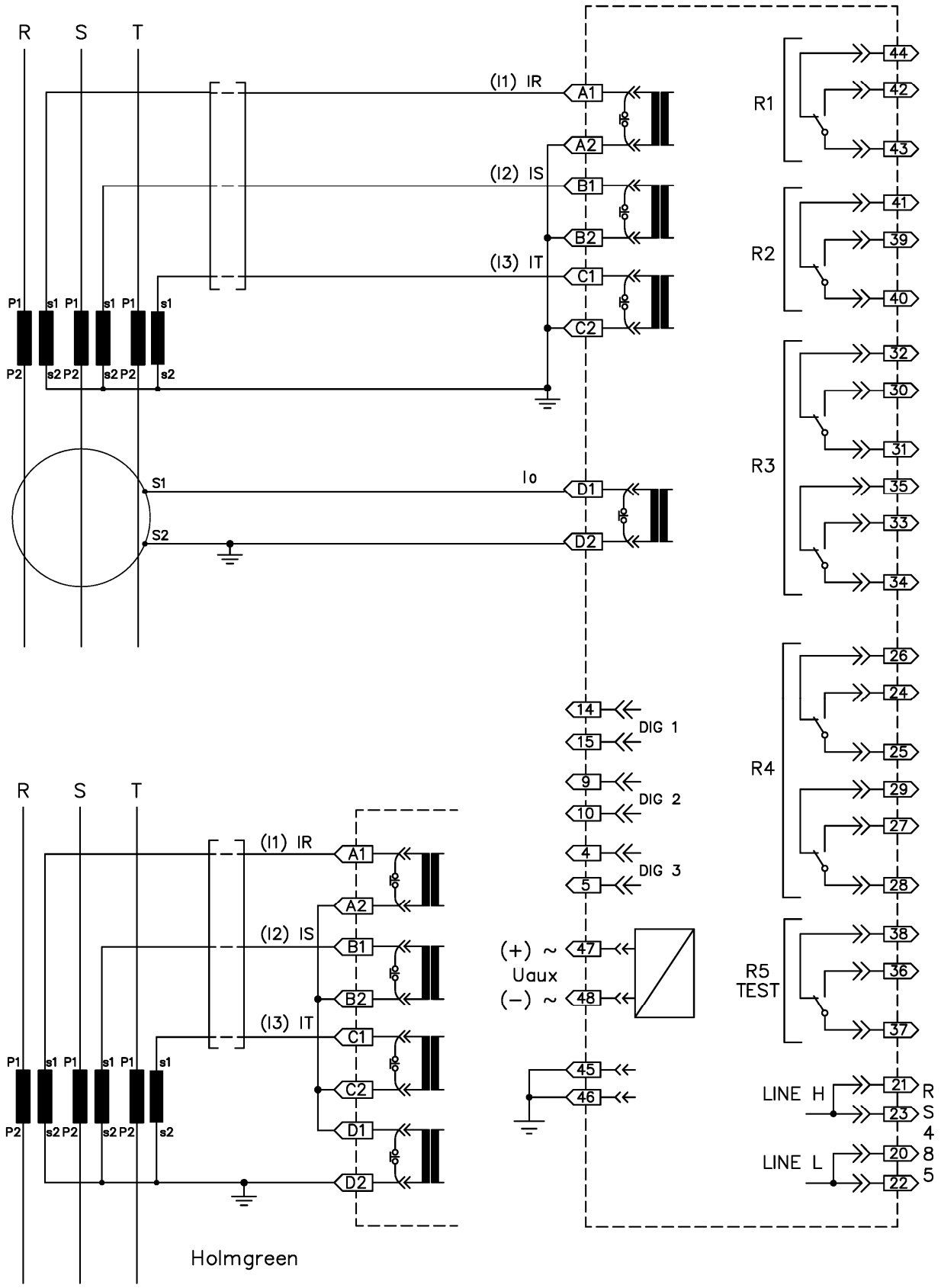
Minimum suggested wire cross section: 2,5 mm^2

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

I1	terminals A1 - A2
I2	terminals B1 - B2
I3	terminals C1 - C2
Io	terminals D1 - D2

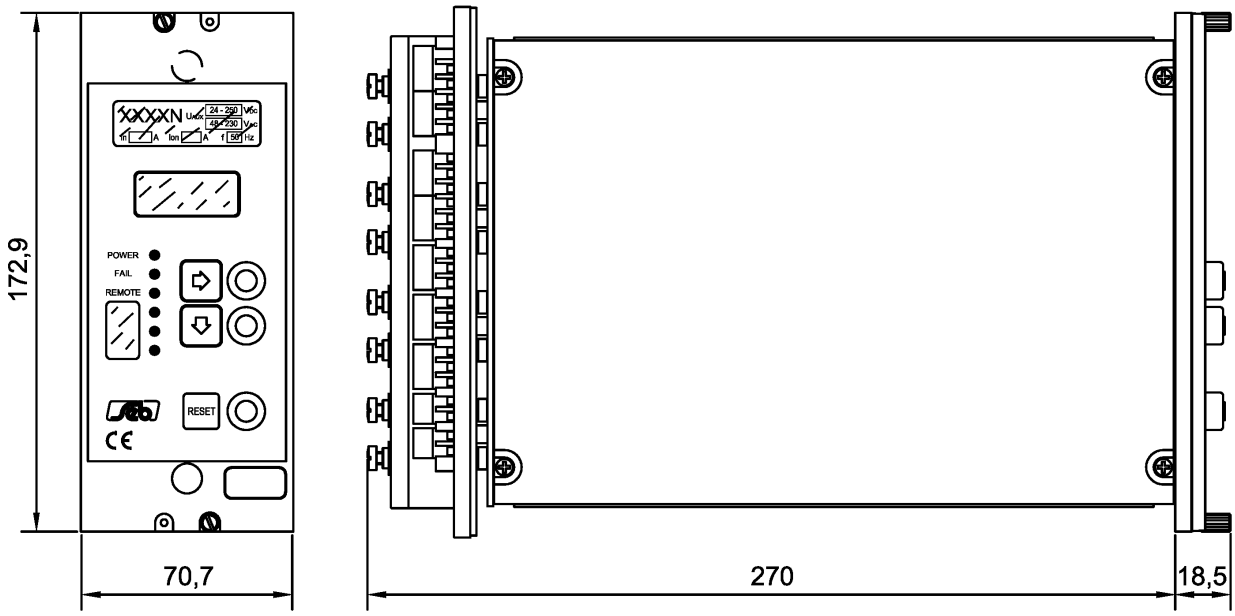
Other circuits (output relays etc.)
It is suggested to terminate the current wiring using plug terminals.

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

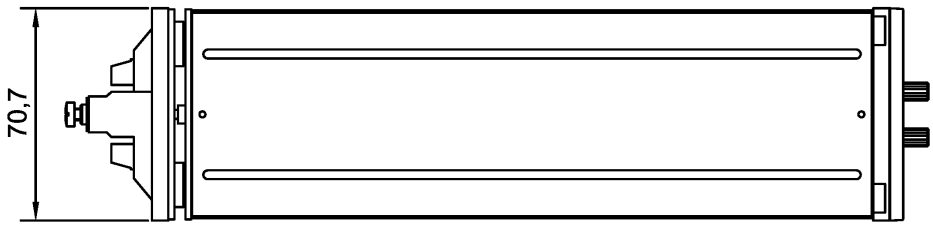


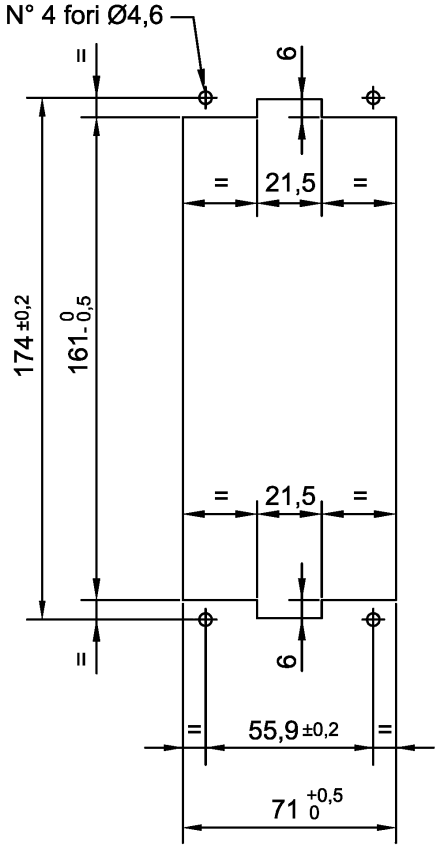
Insertion

Note: with bipolar insertion, do not connect I3 (C1 – C2)



Dimensioni meccaniche
Case outlines





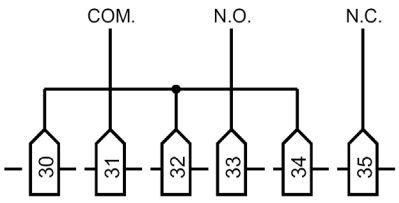
Dima montaggio da incasso
Flush mounting panel cut - out

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

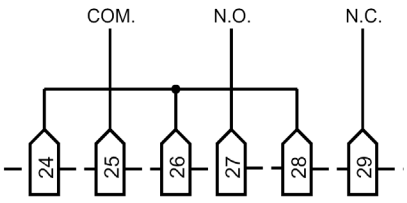
6.3 Relays R3 and R4 - Signaling / Command set-up

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

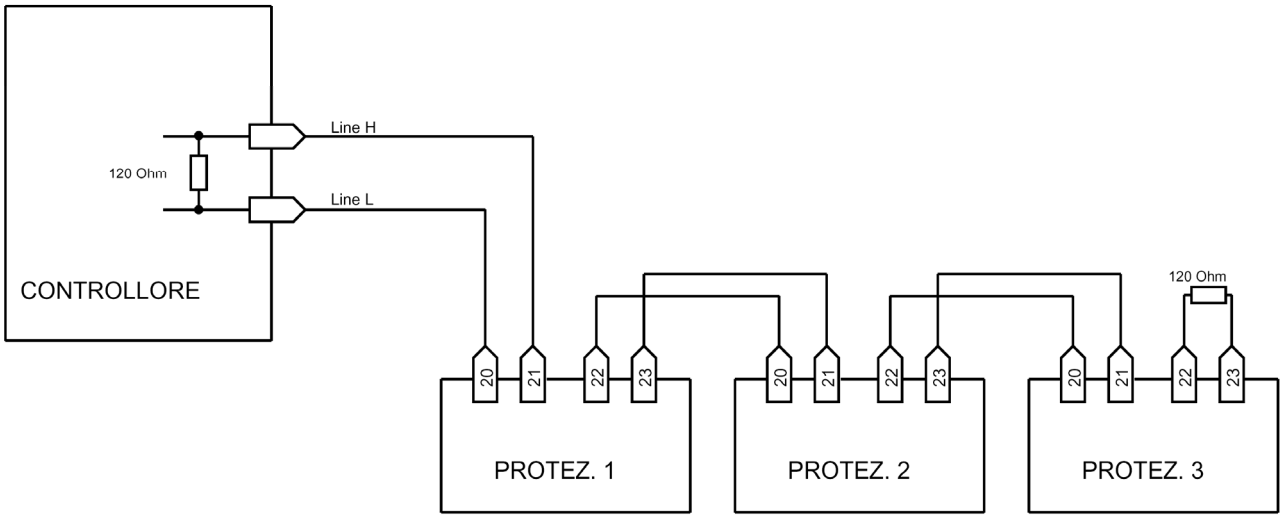
6.4 RS485 serial communication port

The digital protection relay ING4N 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).

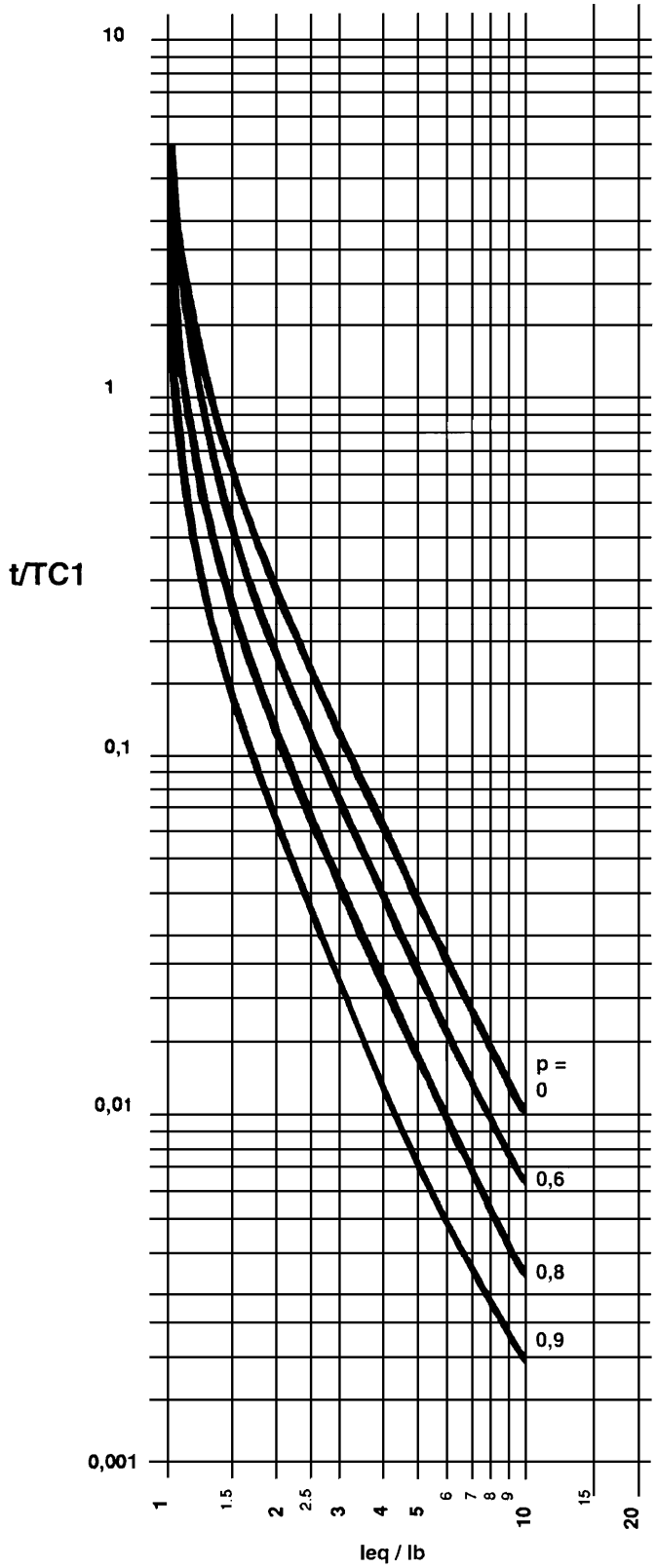
When the STANDARD Seb communication protocol is selected, the transmission speed is automatically selected between 300 to 9600 bauds and the protocol is ASCII-HEX.

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



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

7 THERMAL OVERLOAD CURVES - ANSI 49



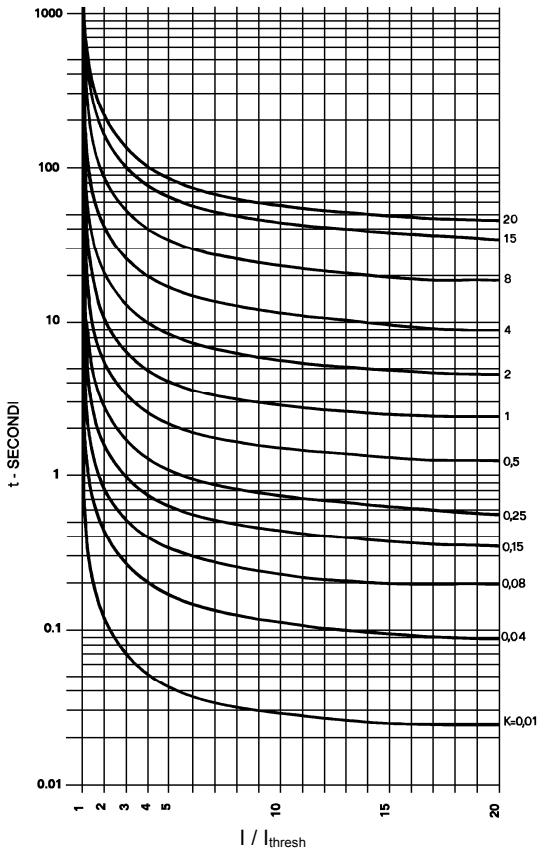
The curves refer to equation (2) and give the value **t/TC1**; the curves are expressed as function of:

- **Ieq/Ib** - ratio between the equivalent current computed as equation (1) and the selected base current (**Ib**).
- **p = Ip/Ib** - ratio between the current (Ip) before the overload and the selected base current (**Ib**).

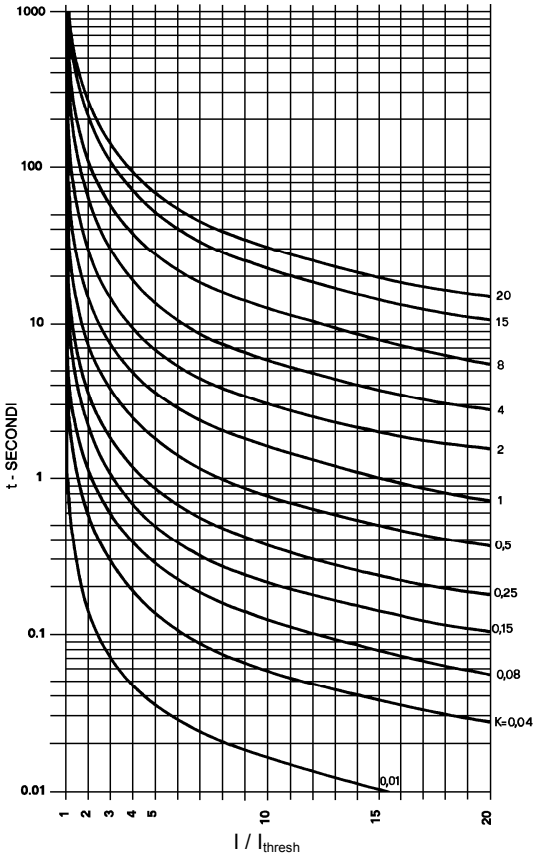
The operating time **t** is obtained multiplying the value **t/TC1** with the programmed heating constant **TC1**.

8 TIME DEPENDENT CURVES - IEC 255-4

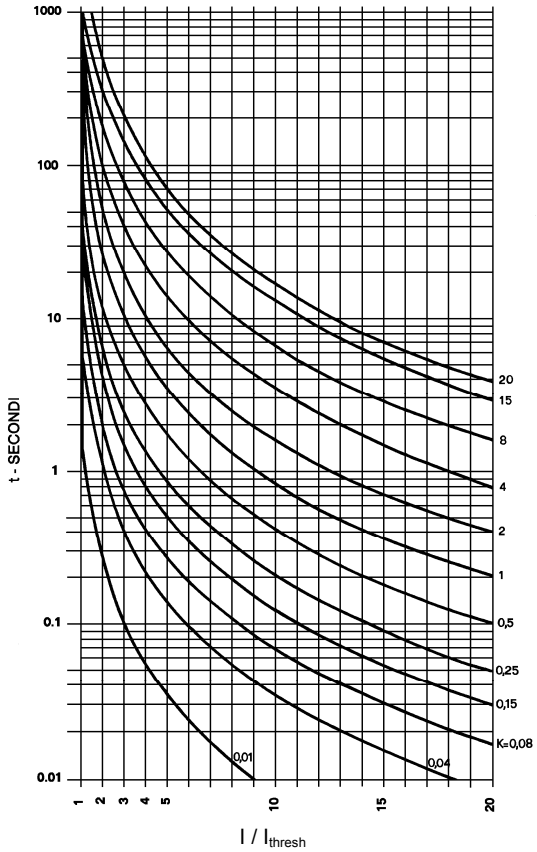
Curva - Curve A



Curva - Curve B



Curva - Curve C



Time dependent characteristic

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

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_{thresh}	Ratio between the greatest measured current and the threshold I>, Io> and I2

9 TECHNICAL CHARACTERISTICS

Measuring inputs	
Rated phase current (In)	1 A / 5 A programmable
Rated earth current (Ion)	1 A or 5 A
Thermal withstand continuously	4 In / Ion
Thermal withstand for 1 s	100 In / Ion
Rated frequency	50 / 60 Hz
Primary CT's current	1 - 18500 A
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 (optional)	IP 52 (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

10 TABLES

Table A Thresholds and time delays

ANSI	THRESHOLDS		Setting	Resolut.
50 - 51	I>	Phase overcurrent	0.10 ÷ 5.00 In	0.01 In
	I>>		0.10 ÷ 40.00 In	0.01 In
64S 51N	Io>	Earth fault overcurrent	0.01 ÷ 2.00 Ion	0.01 Ion
	Io>>		0.10 ÷ 10.00 Ion	0.01 Ion
46	I2>	Negative sequence overcurrent	0.05 ÷ 1.00 In	0.01 In
	I2>>		0.05 ÷ 1.00 In	0.01 In
	Im	Reference current (curve D)	0.50 ÷ 1.20 In	0.01 In
	TLIM	Maximum time delay	100 ÷ 9999 s	1 s
	TC2	Time constant for elapsed time decreasing (curve D)	1 ÷ 99 s	1 s
49	T°> T°>>	Thermal overload	50 ÷ 120 %	1 %
	Ib	Base current	0.40 ÷ 2.00 In	0.01 In
	Ks	Negative sequence current weight coefficient (Ieq computation)	0 ÷ 10	1
	QTM0	Initial thermal overload (at relay power-up)	50 ÷ 100 %	1 %
	TC1	Heating time constant	1 ÷ 500 min	1 min
Time delays			**Setting**	**Resolut.**
Definite time		All thresholds 50 - 51 - 64S - 51N - 46	0.02 ÷ 99.99 s	0.01 s
Dependent time (I>, Io>, I2>)		Characteristic curves (as IEC 255-4)	A, B, C	--
		Characteristic constant	0.01 ÷ 20.00 s	0.01 s
Dependent time (I2>)		Curve D	D	--
		Characteristic constant	0.01 ÷ 99.99 s	0.01 s
All thresholds definite time		Additional delay	0.00 ÷ 99.99 s	0.01 s

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