DIVISIONE ELETTRONICA E SISTEMI

IMT4N

DIGITAL MULTIFUNCTION MOTOR PROTECTION RELAY

USER MANUAL

P500D808 **April 2005**

INDEX

1 GENERAL CHARACTERISTICS

The protection relay IMT4N is designed to protect HV or MV motors; the user can select one of the functions listed in the table below.

Functions	ANSI	Measured currents
Thermal overload	49	I_A, I_B, I_C or I_A, I_B
Phase overcurrent	50	
Unbalanced load / loss of phase	46	
Locked rotor / excessive start-up time	51 R	
Undercurrent / loss of load	37	
Earth-fault overcurrent	51N	Io
Numbers of motor start-up limitation	66	not applicable

The wide range of the programmable heating time constant allows to use the relay for thermal protection of transformer and cable also.

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 following thresholds are available:

- 3 thermal overload thresholds
- overcurrent threshold for phase currents
- earth-fault overcurrent threshold
- unbalanced load / loss of phase threshold
- locked rotor / excessive motor start-up time
- undercurrent or loss of load threshold
- number of motor start-up limitation

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

TRIP DELAYS - The thermal overload thresholds (ANSI 49) and the unbalanced load threshold (ANSI 46) are time dependent, while the remaining thresholds are time independent.

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 IMT4N relay with cooperating protection relays.
The available settings for each timers are listed in Table A.

OUTPUT RELAYS - the IMT4N 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 current or parameter 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). For each relay is actionable the LATCH function; when programmed this function keeps the TRIP condition of the activated output relay until a RESET command on front panel or through digital input or serial interface is received (BISTABLE relays).

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
- motor start-up command sensor
- RESET of bistable output relays

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 current (primary values) or a computed parameter (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 currents 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.

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 Descriptions of the available functions

1.1.1 Thermal overload (ANSI 49)

The IMT4N 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 motor.

The positive sequence current (**I1**) and the negative sequence current (**I2**) of the motor 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 motors **Ks** = 6.

The protection relay computes the thermal overload of the motor and when the value exceeds one of the programmed thresholds (**T°>**, **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:

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

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.

After the trip condition the protection relay continues to compute the cooling of the motor using the cooling time constant **TC2** (programmable from **1** to **10** times the **TC1** value to compensate the absence of the forced cooling); when all the measured currents are lower than **0.05 In** the motor is considered stopped.

Thermal restart inhibition - it is available a thermal threshold **QTMinh;** it prevents motor start-up attempts (temporary latch of the output relays related to the thermal thresholds **T°>**, **T°>>**, **T°>>>**) until the computed thermal overload has decreased to a level below the programmed threshold.

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

1.1.2 Overcurrent protection (ANSI 50)

It is available a time definite overcurrent threshold programmable from 1.00 to 20.00 In.

1.1.3 Earth fault overcurrent (ANSI 51N)

It is available a time definite earth-fault overcurrent threshold programmable from 0.01 to 2.00 Ion.

1.1.4 Unbalanced load – Loss of Phase (ANSI 46)

Unbalanced conditions can be severe (loss-of-phase or phase reversal) or less severe (unbalanced load or voltages); for this reason is available a time dependent negative sequence current threshold according to IEC 255-4 standard.

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

1.1.5 Locked rotor – Excessive start-up time (ANSI 51R)

It is available a time definite overcurrent threshold programmable from 1.00 to 20.00 In to protect the motor against stalling condition.

The threshold is inhibited during the programmable starting time $\mathbf{t_{avv}}$; the timer starts when the running condition of the motor is picked-up (one of the currents exceeds the value 0.05 In).

1.1.6 Undercurrent – Loss of load protection (ANSI 37)

It is available a time definite undercurrent threshold programmable from 0.10 to 1.00 In to detect a sudden loss of the load.

1.1.7 Limitation of motor start-up (ANSI 66)

It is available a function that limits the **NAVV** number of motor start-up within a programmable period **TLIM**; it is possible to define a period **TBLK** during which the start-up of the motor is inhibited.

The start-up inhibition is obtained with a temporary latch of the output relays related to ANSI 66 function.

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. 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 SIGNALLING

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
T°> (red)	⊗	trip condition on T°>, T°>>, T°>>> thresholds (ANSI 49)
I> I>> Io> (red)	⊗	trip condition on I> (ANSI 51R), I>> (ANSI 50), Io> (ANSI 51N) thresholds
I2> I< N> (red)	⊗	trip condition on I2> (ANSI 46), I< (ANSI 37), limitation of motor start-up (ANSI 66) thresholds

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 ÷ E10	thresholds and time delays thermal overload (ANSI 49)
F1 ÷ F5	thresholds and time delays locked rotor (ANSI 51R)
G1 ÷ G4	thresholds and time delays phase overcurrent (ANSI 50)
H1 ÷ H4	thresholds and time delays earth-fault overcurrent (ANSI 51N)
L1 ÷ L3	thresholds and time delays unbalanced load / negative sequence overcurrent (ANSI 46)
M1 ÷ M4	Limitation of motor start-up function (ANSI 66)
N1 ÷ N4	thresholds and time delays undercurrent (ANSI 37)
P1 ÷ P12	output relays functions
Q1 ÷ Q3	digital input functions
Z1 ÷ Z18	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 buttons [ENTER], [+] 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).

NOTE: If the thermal restart inhibition threshold **QTMinh** is higher of one of the thermal overload thresholds (**T°>**, **T°>>**, **T°>>>**) the following message is showed:

```
Data
Error
```

and the new programmed set is not accepted; the value of the QTMinh threshold (ref. E7 - fig. 2) or the values of the lower overload thresholds (T°>, T°>>, T°>>> - ref. E8, E9, E10 fig. 2) must be modified.

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:

a) reset of glowing LED's

b) drop-off of tripped relays

c) reset of any parameter changed but not confirmed (parameters are shown as confirmed at the end of the last programming session)

d) 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. 3, ref. P12) 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 main selectable functions (49 - 51 - 46 - 37).

- **Measured current and parameters** - the display shows one of the measured currents (IA, IB, IC, Io) or computed ones (I2 - negative sequence current, Ieq - equivalent current) or the thermal overload value (QTM - presented as percentage); the information to be visualized is selected by operator (ref. D4).

The measured currents are visualized as primary value; if the selection of the current to be visualized refers to a current not measured (depending on FUNCTION 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:

TRIP T°>	TRIP I>>	TRIP I2>	TRIP Io>

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 is 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

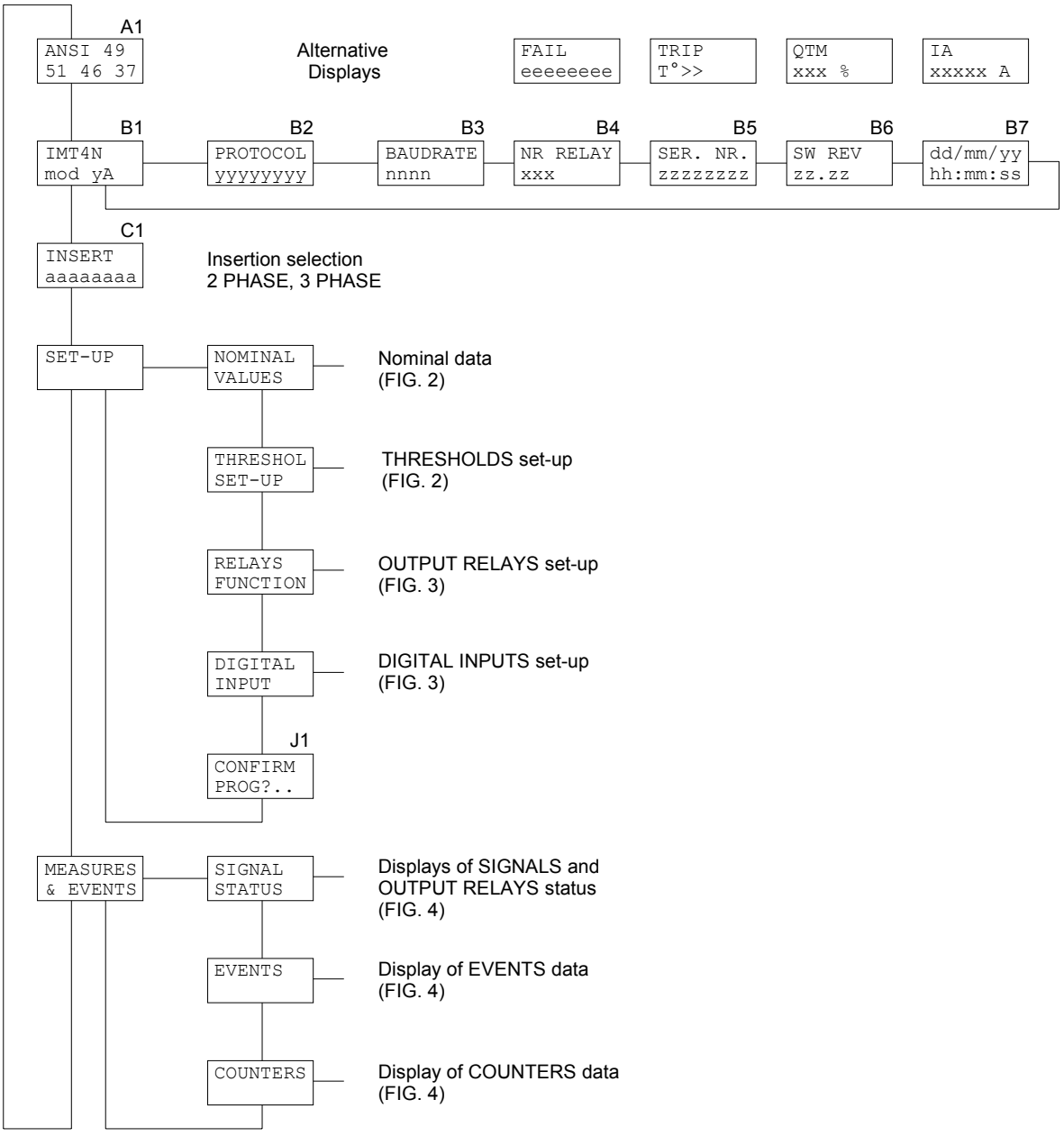


Figure 1

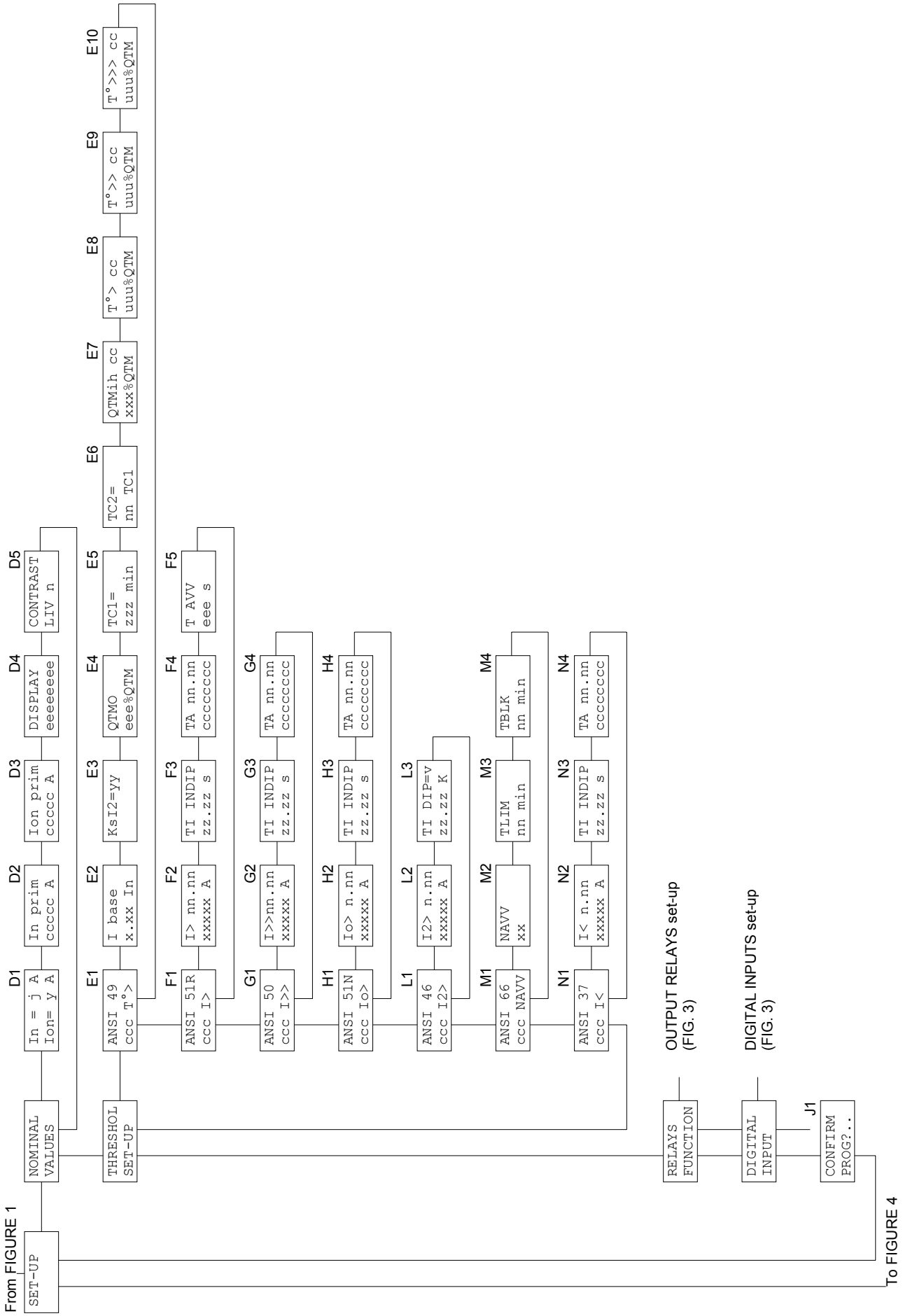

From FIGURE 1
SET-UP
NOMINAL VALUES
In = j A
Ion= y A
D1
In prim
ccccc A
D2
Ion prim
ccccc A
D3
DISPLAY
eeeeeeee
D4
CONTRAST
LIV n
D5
THRESHOL SET-UP
ANSI 49
ccc T°>
E1
I base
x.xx In
E2
KsI2=yy
E3
QTMO
eee%QTM
E4
TC1=
zzz min
E5
TC2=
nn TC1
E6
QTMih cc
xxx%QTM
E7
T°> cc
uuu%QTM
E8
T°>> cc
uuu%QTM
E9
T°>>> cc
uuu%QTM
E10
ANSI 51R
ccc I>
F1
I> nn.nn
xxxxx A
F2
TI INDIP
zz.zz s
F3
TA nn.nn
ccccccc
F4
T AVV
eee s
F5
ANSI 50
ccc I>>
G1
I>>nn.nn
xxxxx A
G2
TI INDIP
zz.zz s
G3
TA nn.nn
ccccccc
G4
ANSI 51N
ccc Io>
H1
Io> n.nn
xxxxx A
H2
TI INDIP
zz.zz s
H3
TA nn.nn
ccccccc
H4
ANSI 46
ccc I2>
L1
I2> n.nn
xxxxx A
L2
TI DIP=v
zz.zz K
L3
ANSI 66
ccc NAVV
M1
NAVV
xx
M2
TLIM
nn min
M3
TBLK
nn min
M4
ANSI 37
ccc I<
N1
I< n.nn
xxxxx A
N2
TI INDIP
zz.zz s
N3
TA nn.nn
ccccccc
N4
RELAYS FUNCTION
OUTPUT RELAYS set-up (FIG. 3)
DIGITAL INPUT
DIGITAL INPUTS set-up (FIG. 3)
J1
CONFIRM PROG?..
To FIGURE 4

Figure 2

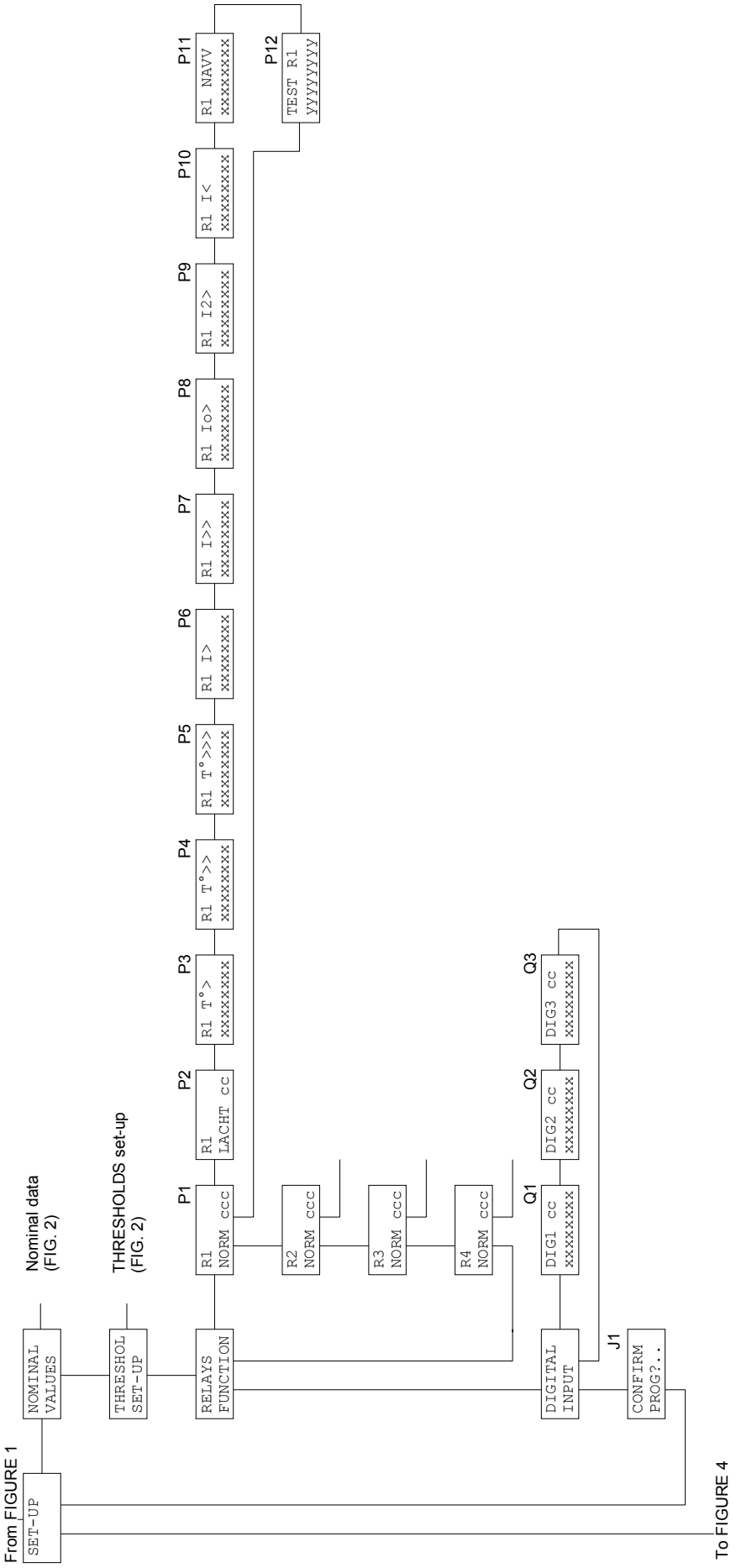

From FIGURE 1
SET-UP
NOMINAL VALUES
Nominal data (FIG. 2)
THRESHOL SET-UP
THRESHOLDS set-up (FIG. 2)
RELAYS FUNCTION
DIGITAL INPUT
J1
CONFIRM PROG?..
To FIGURE 4
P1
R1 NORM ccc
R2 NORM ccc
R3 NORM ccc
R4 NORM ccc
P2
R1 LACHT cc
P3
R1 T°>
xxxxxxxxx
P4
R1 T°>>
xxxxxxxxx
P5
R1 T°>>>
xxxxxxxxx
P6
R1 I>
xxxxxxxxx
P7
R1 I>>
xxxxxxxxx
P8
R1 Io>
xxxxxxxxx
P9
R1 I2>
xxxxxxxxx
P10
R1 I<
xxxxxxxxx
P11
R1 NAVV
xxxxxxxxx
P12
TEST R1
yyyyyyyy
Q1
DIG1 cc
xxxxxxxxx
Q2
DIG2 cc
xxxxxxxxx
Q3
DIG3 cc
xxxxxxxxx

Figure 3

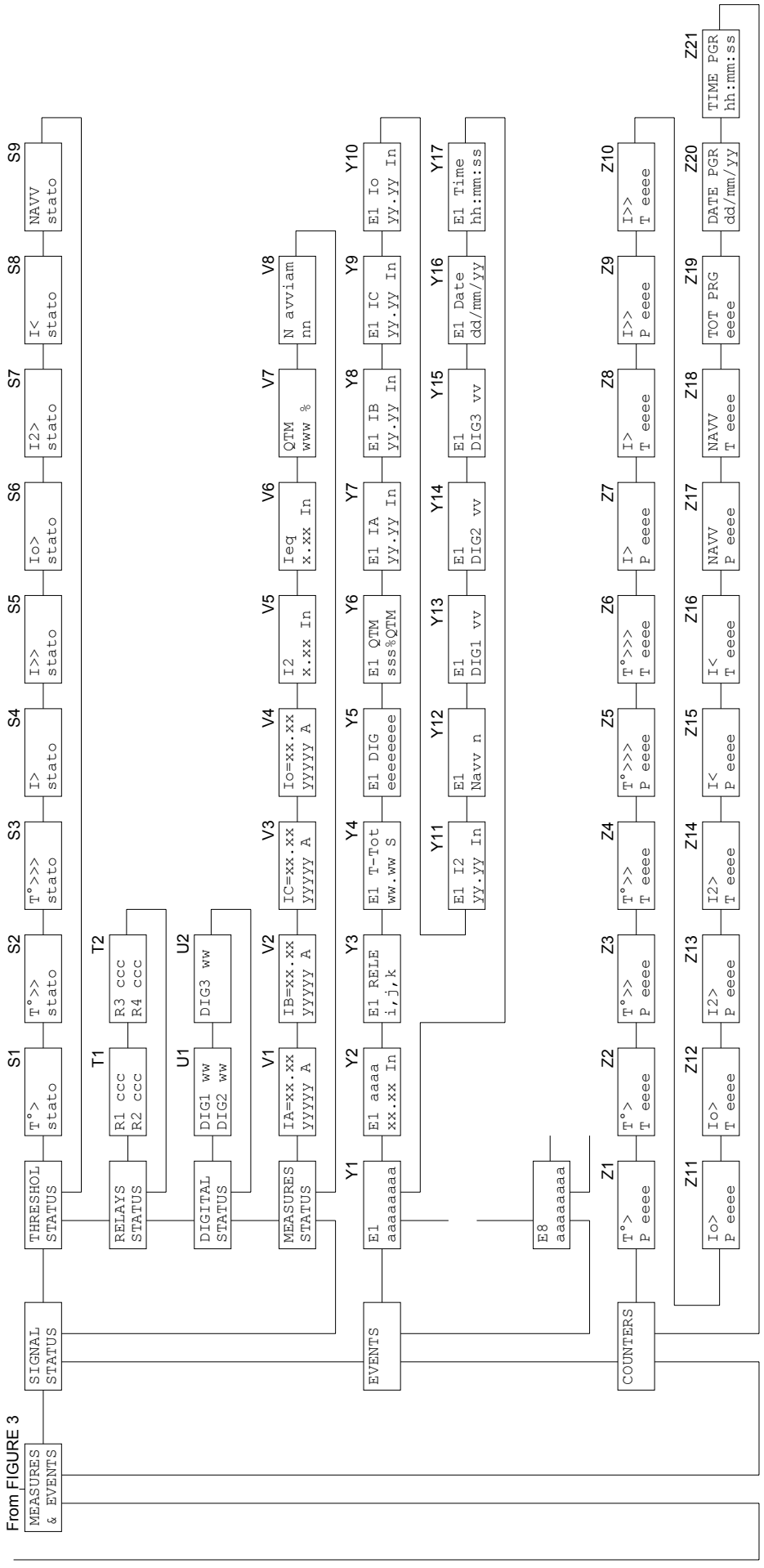

From FIGURE 3
MEASURES & EVENTS
SIGNAL STATUS
THRESHOL STATUS
RELAYS STATUS
DIGITAL STATUS
MEASURES STATUS
EVENTS
COUNTERS
S1 T°> stato
S2 T°>> stato
S3 T°>>> stato
S4 I> stato
S5 I>> stato
S6 Io> stato
S7 I2> stato
S8 I< stato
S9 NAVV stato
T1 R1 ccc R2 ccc
T2 R3 ccc R4 ccc
U1 DIG1 ww DIG2 ww
U2 DIG3 ww
V1 IA=xx.xx yyyyy A
V2 IB=xx.xx yyyyy A
V3 IC=xx.xx yyyyy A
V4 Io=xx.xx yyyyy A
V5 I2 x.xx In
V6 Ieq x.xx In
V7 QTM www %
V8 N avviam nn
Y1 E1 aaaaaaaa
Y2 E1 aaaa xx.xx In
Y3 E1 RELE i,j,k
Y4 E1 T-Tot ww.ww S
Y5 E1 DIG eeeeeeee
Y6 E1 QTM sss%QTM
Y7 E1 IA yy.yy In
Y8 E1 IB yy.yy In
Y9 E1 IC yy.yy In
Y10 E1 Io yy.yy In
Y11 E1 I2 yy.yy In
Y12 E1 Navv n
Y13 E1 DIG1 vv
Y14 E1 DIG2 vv
Y15 E1 DIG3 vv
Y16 E1 Date dd/mm/yy
Y17 E1 Time hh:mm:ss
E8 aaaaaaaa
Z1 T°> P eeee
Z2 T°> T eeee
Z3 T°>> P eeee
Z4 T°>> T eeee
Z5 T°>>> P eeee
Z6 T°>>> T eeee
Z7 I> P eeee
Z8 I> T eeee
Z9 I>> P eeee
Z10 I>> T eeee
Z11 Io> P eeee
Z12 Io> T eeee
Z13 I2> P eeee
Z14 I2> T eeee
Z15 I< P eeee
Z16 I< T eeee
Z17 NAVV P eeee
Z18 NAVV T eeee
Z19 TOT PRG eeee
Z20 DATE PGR dd/mm/yy
Z21 TIME PGR hh:mm:ss

Figure 4

5.3 Address and time (fig. 1)

B1 - RELAY MODEL (not programmable)

```
IMT4N
mod. A5
```

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

The nominal phase current is programmable 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 – B6 - RELAY SERIAL NUMBER and SOFTWARE REVISION (not programmable)

```
SER.  NR
0012345
```

```
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

Examples:

```
INSERT.
2 PHASE
```

```
INSERT.
3 PHASE
```

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 IMT4N model A5
Ion = 1 A IMT4N model A1

D2 - D3 - PRIMARY PHASE AND EARTH CURRENT (programmable)

```
In  prim
xxxxx A
```

```
Ion prim
xxxxx A
```

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

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
IA	displays measured phase current I1
IB	displays measured phase current I2
IC	displays measured phase current I3
Io	displays measured earth current Io
I2	displays negative sequence current (presented as In terms)
Ieq	displays computed equivalent current (ref. Paragraph 1.1.1 - 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 Thresholds and time delay set-up

5.6.1 Thermal overload thresholds (fig. 2)

E1 - ON / OFF THERMAL OVERLOAD THRESHOLD (programmable)

ANSI 49
ccc T°>

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

E2 - 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 1.1.1 - formula 2).

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

Example:

```
I base
1.25 In
```

E3 - 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 1.1.1 - formula 1).

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

Example:

```
KsI2= 06
```

E4 - INITIAL THERMAL OVERLOAD QTM0 (programmable)

```
QTM0
eee% QTM
```

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

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

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

Example:

```
QTM0
050% QTM
```

E5 - MOTOR HEATING TIME CONSTANT TC1 (programmable)

```
TC1 =
zzz  min
```

TC1 represents the motor heating time constant used to compute the operating time (TRIP condition) of the thermal overload thresholds (ref. paragraph 1.1.1 - formula 2). The heating constant is expressed in minutes.

zzz programmable value from 1 to 500 minutes

Example:

```
TC1 =
010  min
```

E6 - MOTOR COOLING TIME CONSTANT TC2 (programmable)

```
TC2 =
nn   TC2
```

TC2 represents the motor cooling time constant expressed in terms of 1 or more times the value of the motor heating time constant to take into consideration the absence of the forced cooling.

nn programmable value from 1 to 10 times TC1

NOTE when all the measured currents are less than 0.05 In the motor is considered stopped.

Example:

```
TC2 =
04  TC1
```

E7 - THERMAL OVERLOAD MOTOR RESTART INHIBITION (programmable)

```
QTMin cc
xxx% QTM
```

The thermal threshold QTMinh prevents motor start-up attempts (temporary latch of the output relays related to the thermal thresholds T°>, T°>>, T°>>>) until the computed thermal overload has decreased to a level below the programmed threshold.

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

eee programmable threshold value from 50% to 100% (default 100%)

Example:

```
QTMin cc
095% QTM
```

E8 - E9 - E10 - THERMAL OVERLOAD THRESHOLDS T°>, T°>>, T°>>> (programmable)

```
T°>   cc
uuu% QTM
```

```
T°>>  cc
uuu% QTM
```

```
T°>>> cc
uuu% QTM
```

Thermal overload thresholds T°>, T°>>, T°>>> programming; the three 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 - motor thermal capacity)

Example:

T°> ON 085% QTM	T°>> ON 103% QTM	T°>>> OF 115% QTM

5.6.2 Phase overcurrent - locked rotor ANSI 51R (fig. 2)

F1	F2	F3	F4	F5
ANSI 51R ccc I>	I> nn.nn xxxxxx A	TI INDIP zz.zz s	TA nn.nn cccccccc	T AVV eee s

F1 - ON / OFF THRESHOLD ANSI 51R (programmable)

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

F2 - THRESHOLD LEVEL SET-UP (programmable)

nn.nn threshold level expressed in terms of In (1.00 ÷ 20.00)

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

F3 - TIME DELAY SET-UP (programmable)

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

zz.zz: time delay value programmable from 00.02 to 99.99 seconds

F4 - ADDITIONAL TIME DELAY SET-UP (programmable)

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. Q1, Q2, Q3 – paragraph 5.8).

nn.nn: time delay value programmable from 00.02 to 99.99 seconds

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 parameter **eeeeeeee** shows the digital input programmed to activate the additional time delay TA on the threshold I>.

The parameter **eeeeeeee** is not programmable and 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 I>
DIG1 digital input DIG1 activates the TA delay on the threshold I>
DIG2 digital input DIG2 activates the TA delay on the threshold I>
DIG3 digital input DIG3 activates the TA delay on the threshold I>

More than one digital input channel can activate the same TA (es. DIG 1,3).

F5 - MOTOR START UP TIME (programmable)

T AVV
yyy s

During the motor start up time the ANSI 51R threshold (**I>**) is inhibited; the motor start up time is activated when the equivalent current **Ieq** exceeds the value **0.05 In**.

When the motor start up time expires the ANSI 51R threshold is activated.

yyy time delay value programmable from 1 to 999 seconds

Example:

F1	F2	F3	F4	F5
ANSI 51R ON I>	I> 03.20 00640 A	TI INDIP 05.00 s	TA 10.00 DIG1	T AVV 025 s

5.6.3 Phase overcurrent - short circuit ANSI 50 (fig. 2)

G1	G2	G3	G4
ANSI 50 ccc I>>	I>>nn.nn xxxxx A	TI INDIP zz.zz s	TA nn.nn eeeeeeee

G1 - ON / OFF THRESHOLD ANSI 50 (programmable)

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

G2 - THRESHOLD LEVEL SET-UP (programmable)

nn.nn threshold level expressed in terms of In (1.00 ÷ 20.00)

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

G3 - TIME DELAY SET-UP (programmable)

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

zz.zz time delay value programmable from 00.02 to 99.99 seconds

G4 - ADDITIONAL TIME DELAY SET-UP (programmable)

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. Q1, Q2, Q3 - paragraph 5.8).

nn.nn time delay value programmable from 00.02 to 99.99 seconds

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).

The parameter **eeeeeeee** shows the digital input programmed to activate the additional time delay TA on the threshold I>>.

The parameter **eeeeeeee** is not programmable and 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 I>>
DIG1	digital input DIG1 activates the TA delay on the threshold I>>
DIG2	digital input DIG2 activates the TA delay on the threshold I>>
DIG3	digital input DIG3 activates the TA delay on the threshold I>>

More than one digital input channel can activate the same TA (es. DIG 1,3).

Example:

G1	G2	G3	G4
ANSI 50 ON I>>	I>>10.00 02000 A	TI INDIP 00.80 s	TA 00.50 DIG2

5.6.4 Earth - fault overcurrent ANSI 51N (fig. 2)

H1	H2	H3	H4
ANSI 51N ccc Io>	Io> n.nn xxxxx A	TI INDIP zz.zz s	TA nn.nn eeeeeeee

H1 - ON / OFF THRESHOLD ANSI 51N (programmable)

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

H2 - THRESHOLD LEVEL SET-UP (programmable)

n.nn threshold level expressed in terms of Ion (0.01 ÷ 2.00)

xxxxxx: threshold level expressed in Amperes (primary values)
NOT PROGRAMMABLE as function of ref. **D3** set-up

H3 - TIME DELAY SET-UP (programmable)

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

zz.zz time delay value programmable from 00.02 to 99.99 seconds

H4 - ADDITIONAL TIME DELAY SET-UP (programmable)

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. Q1, Q2, Q3 - paragraph 5.8).

nn.nn time delay value programmable from 00.02 to 99.99 seconds

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)

The parameter **eeeeeeee** shows the digital input programmed to activate the additional time delay TA on the threshold Io>.

The parameter **eeeeeeee** is not programmable and 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 Io>
DIG1	digital input DIG1 activates the TA delay on the threshold Io>
DIG2	digital input DIG2 activates the TA delay on the threshold Io>
DIG3	digital input DIG3 activates the TA delay on the threshold Io>

More than one digital input channel can activate the same TA (es. DIG 1,3).

Example:

H1	H2	H3	H4
ANSI 51N ON Io>	Io> 0.30 00015 A	TI INDIP 02.00 s	TA 00.00 DISABLED

5.6.5 Negative sequence overcurrent ANSI 46 (fig. 2)

L1	L2	L3
ANSI 46 ccc I2>	I2> n.nn xxxxx A	TI DIP=v zz.zz K

L1 - ON / OFF THRESHOLD ANSI 46 (programmable)

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

L2 - THRESHOLD LEVEL SET-UP (programmable)

n.nn threshold level expressed in terms of In (0.10 ÷ 1.00)

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

L3 - TIME DELAY SET-UP (programmable)

Set-up of time-delay to the activation (TRIP) of the programmed output relays when the negative sequence current computed from the measured phase and earth currents exceeds the threshold level.

The parameter **v** can be programmed to value A, B or C.

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)

zz.zz value of the programmed parameter K used in the formulas related to curves A, B and C as showed in paragraph 8 (programmable from 0.01 to 20.00 s).

Example:

L1	L2	L3
ANSI 46 OF I2>	I2> 0.20 0020 A	TI DIP=B 04.00 K

5.6.6 Number of motor start-up limitation ANSI 66 (fig. 2)

M1	M2	M3	M4
ANSI 66 ccc NAVV	NAVV xx	TLIM nn min	TBLK nn min

M1 - ON / OFF THRESHOLD ANSI 66 (programmable)

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

NOTE: the function of the number of motor start-up limitation must use a digital input channel programmed to the function **CMDAVV** (see paragraph 5.8 - ref. Q1, Q2 and Q3) which must be connected to an auxiliary contact related to the motor switch-gear.

M2 - NUMBER OF MOTOR START-UP THRESHOLD (programmable)

xx threshold level expressed in terms of motor start-up (1 ÷ 20)

NAVV represents the maximum allowed number of motor start-up within the time period **TLIM**.

M3 - START-UP PERIOD (programmable)

nn time period expressed in minutes (1 ÷ 99)

TLIM defines the time period during which the maximum number **NAVV** of motor start-up is allowed.

M4 - START-UP INHIBITION PERIOD (programmable)

nn time period expressed in minutes (1 ÷ 99)

TBLK defines the time period during which no more motor start-up attempts are allowed.

The start-up inhibition is obtained with a temporary latch of the output relays related to ANSI 66 function.

Example:

M1	M2	M3	M4
ANSI 66 OFF NAVV	NAVV 04	TLIM 05 min	TBLK 10 min

5.6.7 Undercurrent - loss of load ANSI 37 (fig. 2)

N1	N2	N3	N4
ANSI 37 ccc I<	I< n.nn xxxxx A	TI INDIP zz.zz s	TA nn.nn eeeeeeee

N1 - ON / OFF THRESHOLD ANSI 37 (programmable)

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

N2 - THRESHOLD LEVEL SET-UP (programmable)

n.nn threshold level expressed in terms of In (0.10 ÷ 1.00)

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

N3 - TIME DELAY SET-UP (programmable)

Set-up of time-delay to the activation (TRIP) of the programmed output relays when one of the measured phase current is lower than the threshold level.

zz.zz time delay value programmable from 00.02 to 99.99 seconds

N4 - ADDITIONAL TIME DELAY SET-UP (programmable)

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. Q1, Q2, Q3 - paragraph 5.8).

nn.nn time delay value programmable from 00.02 to 99.99 seconds

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)

The parameter **eeeeeeee** shows the digital input programmed to activate the additional time delay TA on the threshold I<.

The parameter **eeeeeeee** is not programmable and 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 I<
DIG1	digital input DIG1 activates the TA delay on the threshold I<
DIG2	digital input DIG2 activates the TA delay on the threshold I<
DIG3	digital input DIG3 activates the TA delay on the threshold I<

More than one digital input channel can activate the same TA (es. DIG 1,3).

Example:

N1	**N2**	**N3**	**N4**
ANSI 37 ON I<	I< 0.50 00500 A	TI INDIP 05.00 s	TA 00.00 DISABLED

5.7 Output relays programming (fig. 3)

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°>, T°>> and T°>>>), the undercurrent threshold (I<) and the number of motor start-up limitation (NAVV) do not have the START function.

P1 - OUTPUT RELAY R1 QUIESCENT STATUS (programmable)

R1 NORM xxx

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:

R1 NORM OFF

P2 - LATCH OF THE OUTPUT RELAYS (programmable)

R1 LATCH cc

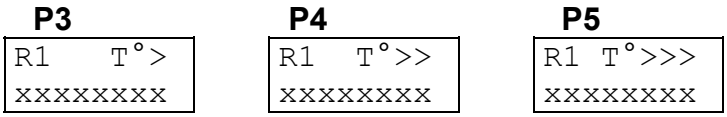
Programming of the LATCH function on the output relay R1 when the relay has been activated on a START or TRIP condition.

cc ON LATCH function enabled
OF LATCH function disabled

When the LATCH function has been activated the tripped relay will drop-off only when:

- RESET command on front panel
- RESET command from a specifically programmed digital input (ref. paragraph 5.8)
- RESET command through serial interface

P3 - P4 - P5 - OUTPUT RELAY ACTIVATION ON THERMAL OVERLOAD THRESHOLDS (T°>, T°>>, T°>>>) (programmable)

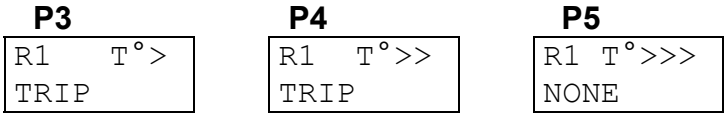


Programming of the R1 output relay activation (TRIP) on the thermal overload thresholds.

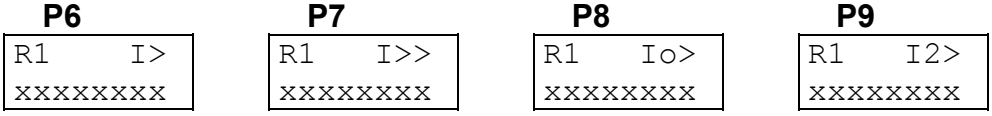
The parameter xxxxxxxx is selectable as the following:

TRIP R1 output relay activation on the thermal overload thresholds
NONE no activation related to thermal thresholds

Example:



P6 ÷ P9 - OUTPUT RELAY ACTIVATION ON THRESHOLDS I>, I>>, Io>, I2> (programmable)



Programming of the R1 output relay activation (START / TRIP / NONE) on the thresholds I>, I>>, Io> and I2>.

The parameter xxxxx is selectable as the following:

START R1 output relay instantaneous activation on I>, I>>, Io> and I2> thresholds
TRIP R1 output relay activation on I>, I>>, Io> and I2> thresholds
NONE no activation related to thresholds I>, I>>, Io> and I2>

Example:

P6	P7	P8	P9
R1 I> START	R1 I>> TRIP	R1 Io> TRIP	R1 I2> NONE

P10 - OUTPUT RELAY ACTIVATION ON THRESHOLD I< (programmable)

```
R1     I<
xxxxxxxx
```

Programming of the R1 output relay activation (TRIP / NONE) on the thresholds I<.

The parameter xxxxxxxx is selectable as the following:

TRIP	R1 output relay activation on the I< threshold
NONE	no activation related to I< threshold

P11 - OUTPUT RELAY ACTIVATION ON THRESHOLD NAVV (programmable)

```
R1   NAVV
xxxxxxxx
```

Programming of the R1 output relay activation (TRIP / NONE) on the threshold NAVV.

The parameter xxxxxxxx is selectable as the following:

TRIP	R1 output relay activation on the NAVV threshold
NONE:	no activation related to NAVV threshold

P12 - TEST OF OUTPUT RELAY R1

```
TEST  R1
xxxxxxxx
```

See paragraph 4.4

5.8 Digital inputs function programming (fig. 3)

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).

e) RESET output relay with active LATCH function

f) Motor start-up signal acquisition

When function a) is programmed, a message is displayed at ref. F4, G4, H4 and N4 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.

Q1 - 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 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 I<	additional time delay on the threshold I<
TA ALL	additional time delay on all thresholds
OF T°>	threshold T°> disabled
OF T°>>	threshold T°>> disabled
OF T°>>>	threshold T°>>> disabled
OF I>	threshold I> disabled
OF I>>	threshold I>> disabled
OF Io>	threshold Io> disabled
OF I2>	threshold I2> disabled
OF I<	threshold I< disabled
OF NAVV	threshold NAVV disabled
OF ALL	all thresholds disabled
STATUS	activation of status function (see paragraph 1.)
RST RELE	RESET output relay with active LATCH function
CMDAVV	motor start-up signal acquisition

Q2 - 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. Q1) plus the following:

MONITOR	activation of pilot wire monitor function.

Q3 - 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. Q1).

5.9 Parameter values visualization (fig. 4)

S1 - S2 - S3 - S4 - S5 - S6 - S7 - S8 - S9 - THRESHOLDS STATUS

S1	S2	S3	S4
T°> status	T°>> status	T°>>> status	I> status

S5	S6	S7	S8
I>> status	Io> status	I2> status	I< status

S9
NAVV status

The actual status of each threshold is displayed. For each threshold are displayed the threshold identification (I>, I>> 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, L1, M1, N1 - see par. 5.6)
OFF_DIG	threshold programmed active but momentary disabled by a digital input actual status (ref. Q1, Q2, Q3 see par. 5.8).

Examples:

T°> ON	T°>> OFF	T°>>> ON	I2> OFF_DIG

T1 - T2 - 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 - not activated)

NOTE that ON/OFF do not necessary mean energized or de-energized (see ref. P1).

Example:

T1

```
R1  ON
R2  OFF
```

T2

```
R3  OFF
R4  ON
```

U1 - U2 - 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:

U1

```
DIG1  LO
DIG2  HI
```

U2

```
DIG3  LO
```

V1 - V2 - V3 - V4 - V5 - V6 - V7 - V8 - 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 (IA, IB, IC, Io, I2, Ieq, QTM, N avviam)
- actual values expressed as In, Ion or %
- actual primary value expressed as Amperes (only IA, IB, IC and Io)

V1

```
IA=xx.xx
yyyyy  A
```

V2

```
IB=xx.xx
yyyyy  A
```

V3

```
IC=xx.xx
yyyyy  A
```

V4

```
Io=xx.xx
yyyyy  A
```

V5

```
I2
zz.zz In
```

V6

```
Ieq
hh.hh In
```

V7

```
QTM
www %
```

V8

```
N avviam
nn
```

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)

zz.zz: negative sequence current value (from 00.00 to 10.00 In)

hh.hh: equivalent current value (from 00.00 to 99.99 In - computed as formula 1 - par. 1.1.1)

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

nn: number of motor start-up in the last TLIM minutes (from 00 to 99)

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.

Y1 - 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	
T°>	event on trip threshold T°>	(ANSI 49)
T°>>	event on trip threshold T°>>	(ANSI 49)
T°>>>	event on trip threshold T°>>>	(ANSI 49)
I>	event on trip threshold I>	(ANSI 51R)
I>>	event on trip threshold I>>	(ANSI 50)
Io>	event on trip threshold Io>	(ANSI 51N)
I2>	event on trip threshold I2>	(ANSI 46)
I<	event on trip threshold I<	(ANSI 37)
NAVV	event on trip threshold NAVV	(ANSI 66)
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 display give more detailed information on the event.

Y2 - 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    I>
02.50 In
```

```
E4   I2>
0.35 In
```

```
E6  NAVV
08
```

Y3 - 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

Y4 - 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

Y5 - DIGITAL CHANNELS RELATED TO MEMORIZED EVENT

E1 DIG 1, 3, 4

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

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

Y6 - MEMORIZED MOTOR THERMAL OVERLOAD

E1 QTM Sss% QTM

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

Y7 - Y8 - Y9 - Y10 - MEMORIZED MEASURED CURRENTS ON EVENT

E1 IA yy.yy In	E1 IB yy.yy In	E1 IC yy.yy In	E1 Io yy.yy In

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.

Y11 - MEMORIZED NEGATIVE SEQUENCE CURRENT

```
E1     I2
xx.xx  In
```

The values of the negative sequence current at the event is displayed; the value is expressed as In terms.

Y12 - MEMORIZED NUMBER OF MOTOR START-UP

```
E1
Navv   nn
```

The values of the number of motor start-up in the last TLIM minutes before the event is displayed.

Y13 - Y14 - Y15 - DIGITAL INPUTS STATUS ON EVENT

```
E1
DIG1   vv
```

```
E1
DIG2   vv
```

```
E1
DIG3   vv
```

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

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

Y16 - Y17 - DATE AND TIME OF THE EVENT

```
E1  Date
dd/mm/yy
```

```
E1  Time
hh:mm:ss
```

The date and time of the event are showed

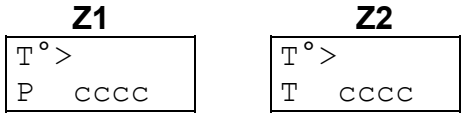
5.11 Trips counters (fig. 4)

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).

Z1 ÷ Z18 - TRIP COUNTERS



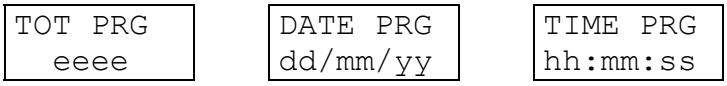
Display of the partial (P) and total (T) counters of the TRIP condition related to each threshold.

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

The counters are identified by the threshold name (T°>>, T°>>>, I>, I>>, Io>, I2>, NAVV); 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).

Z19 ÷ Z21 - 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

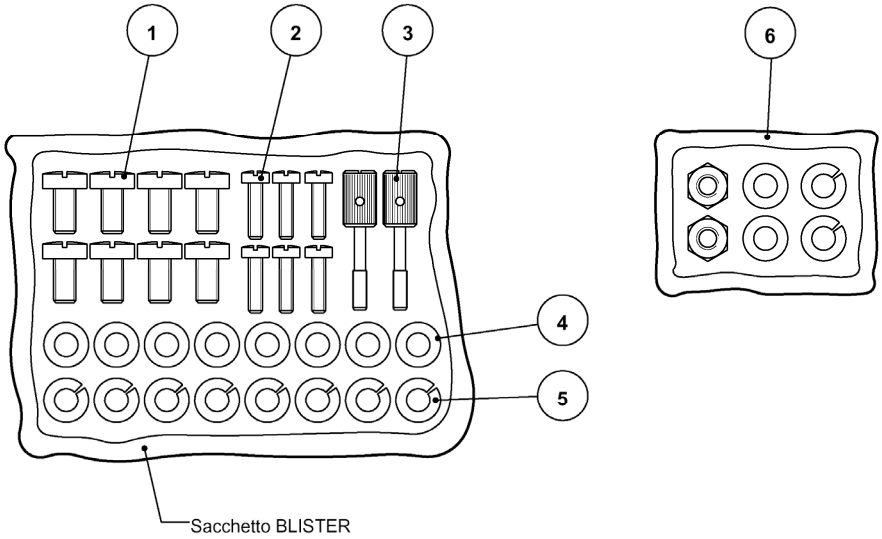
6.1 Supplied kit

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

- protection relay module IMT4N 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 IMT4N 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)
3) n° 2 screws to fix (optionally) the protection relay on the front of the 19" rack
4) n° 2 knobs to fix the transparent front panel
5) n° 8 washers to be used to fix wire terminals (current)
6) n° 8 growers to be used to fix wire terminals (current)

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

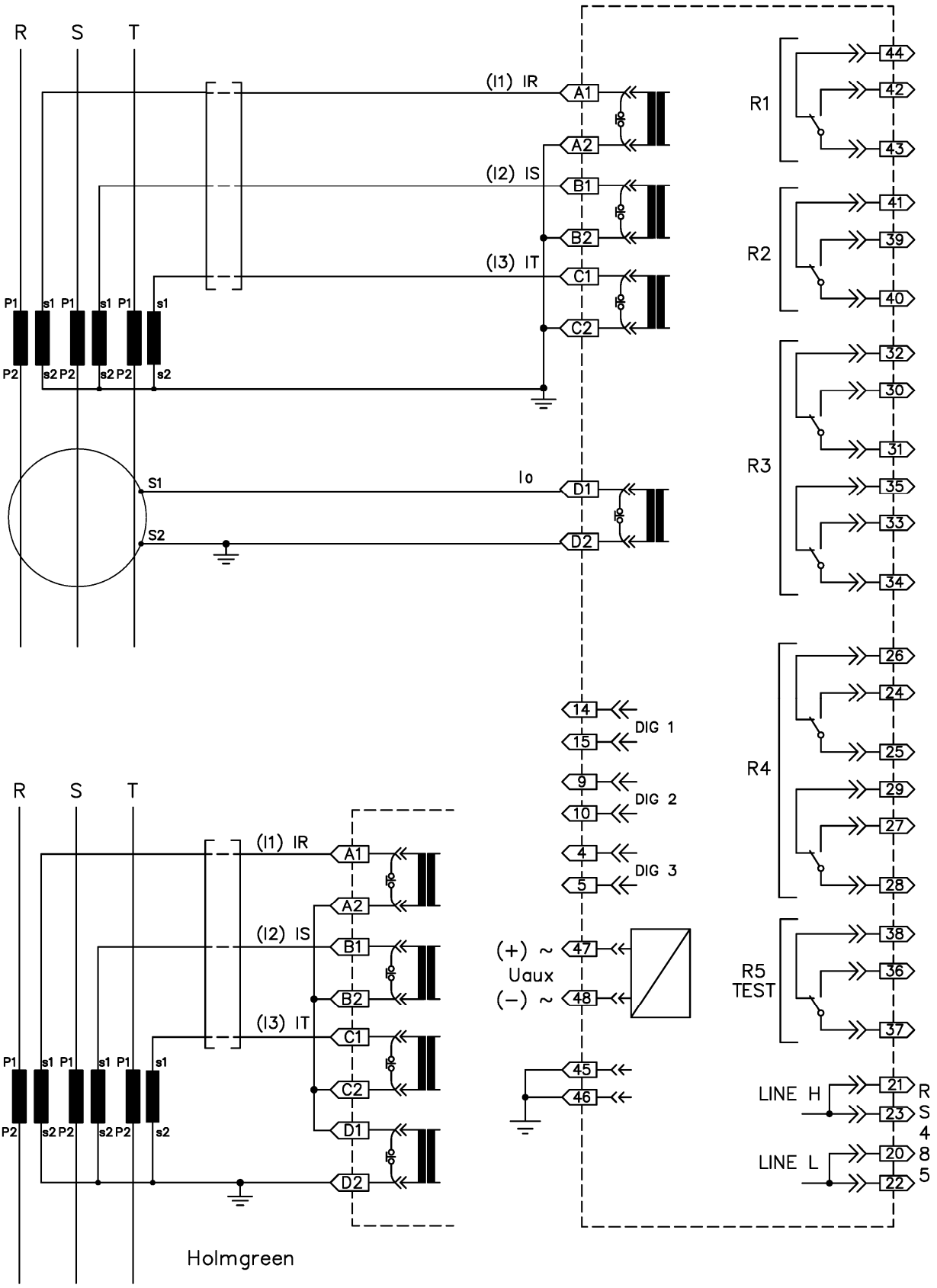
With reference to the insertion diagram in the next page, the currents measured by the protection relay have the following matching:

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

Other circuits (output relays etc.)

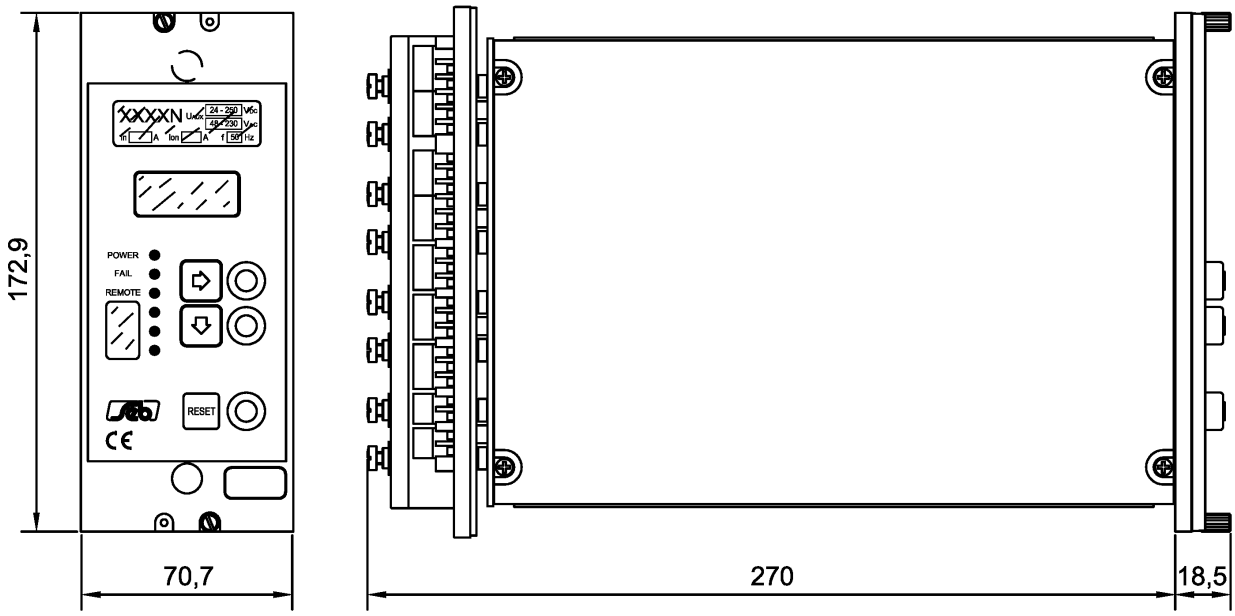
It is suggested to terminate the current wiring using plug terminals.

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

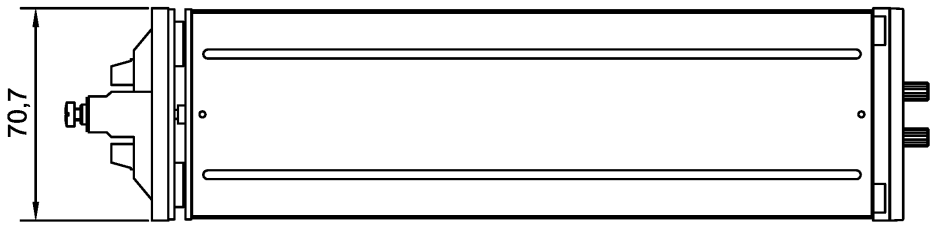


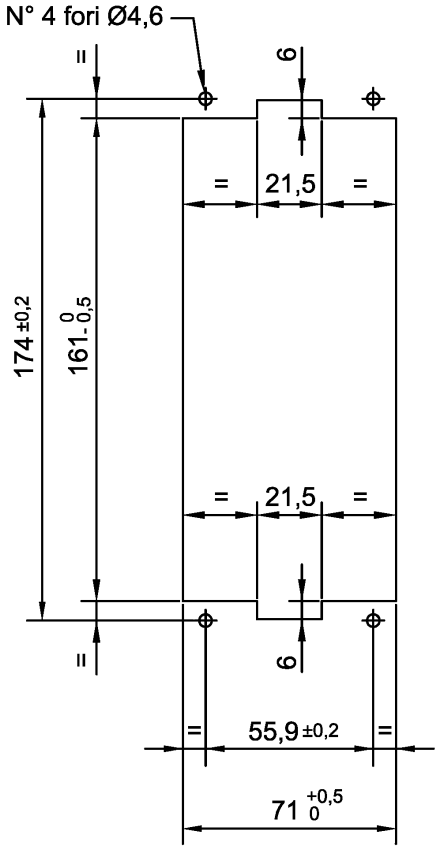
Insertion

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.

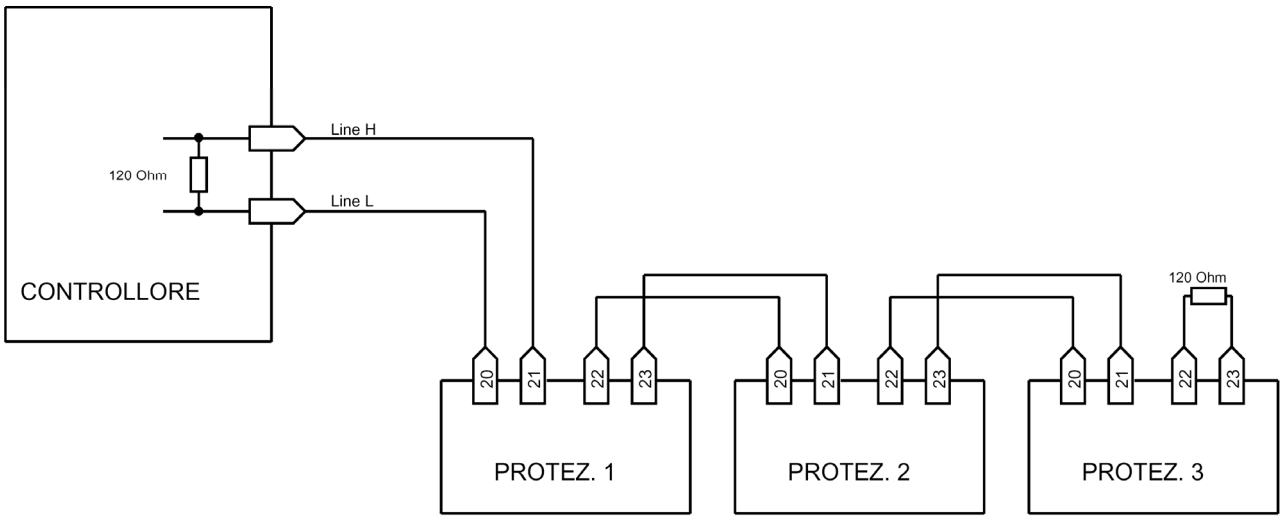
Each R3 and R4 relay can be configured as **COMMAND RELAY** with 1 change-over output contact with breaking capability equals to 0.5 A at 110 Vdc, L/R = 40 ms, 100000 operations.
The new configuration is obtained with the following cabling:

6.4 RS485 serial communication port

The digital protection relay IMT4N presents an insulated serial interface RS485 half-duplex that allow the multi-drop connection up to 31 protection units.

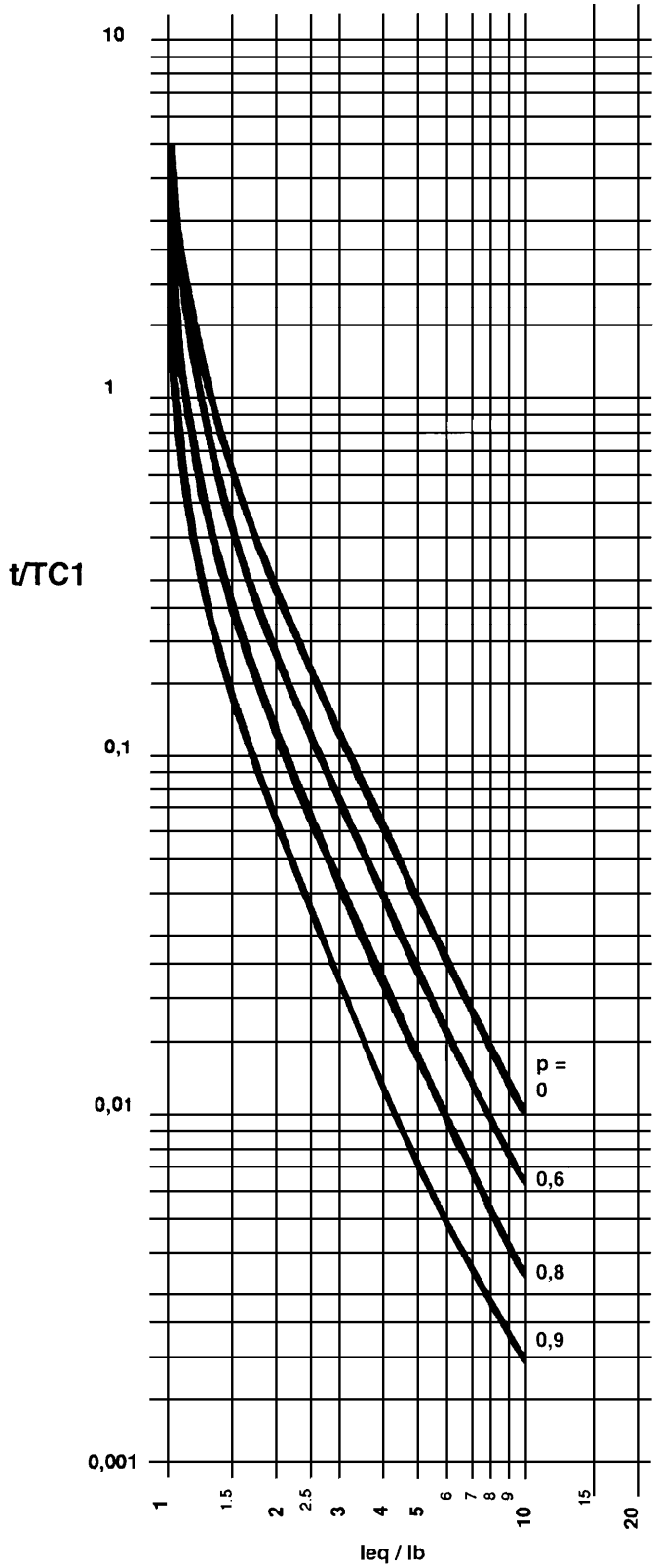
The transmission speed is automatically selected between 300 to 9600 bauds and the protocol is ASCII-HEX; the documentation related to the protocol is freely available on request.

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



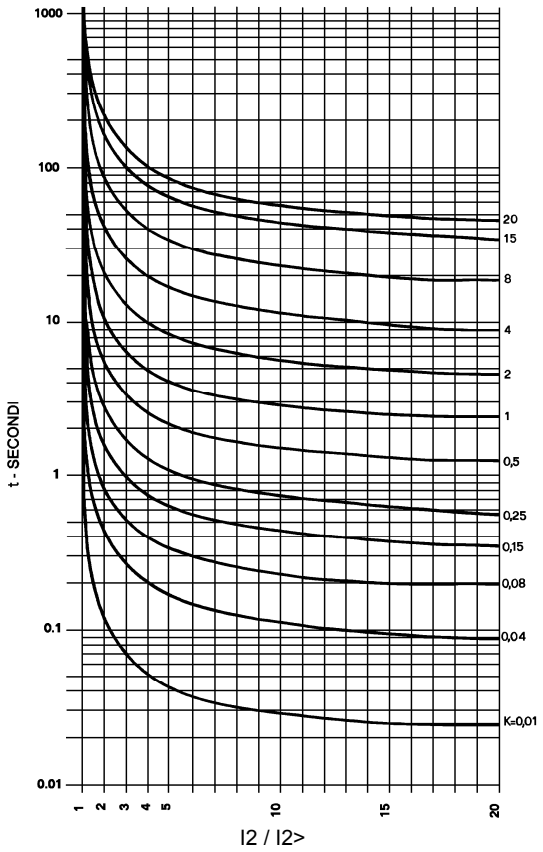
The curves refer to equation (2) and give the value **t/TC1**; the curves are expressed as function of:

- **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**).

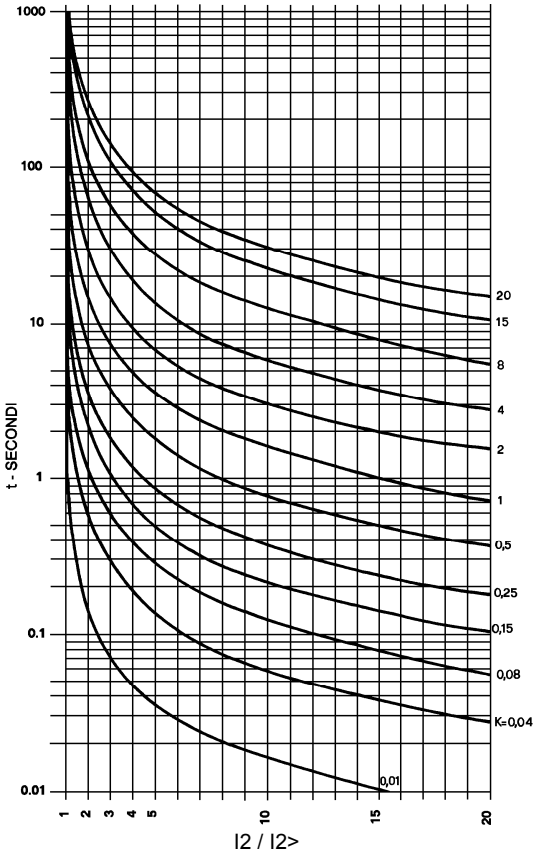
The operating time **t** is obtained multiplying the value **t/TC1** with the programmed heating constant **TC1**.

8 TIME DEPENDENT CURVES - ANSI 46

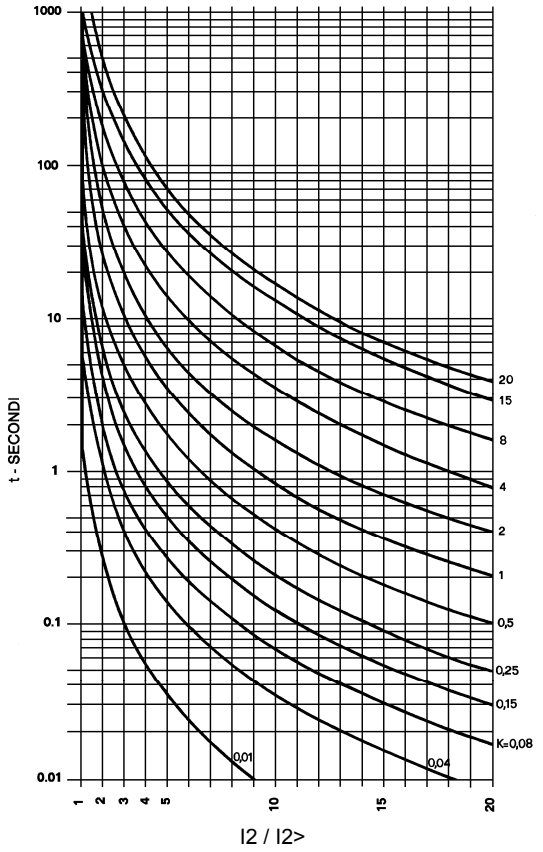
Curva - Curve A



Curva - Curve B



Curva - Curve C



ANSI 46
Unbalanced load

$$t = \frac{Ki * K}{\left(\frac{I2}{I2>}\right)^{\alpha} - 1} + 0.02s$$

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
I2 / I2>	Ratio between inverse sequence current (I2) and threshold I2>

9 TECHNICAL CHARACTERISTIC

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
- signalling 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	fiber 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 Settings

ANSI	THRESHOLDS		Setting	Resolution
49	T°> T°>> T°>>>	Thermal overload	ON / OFF 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 %
	QTMinh	Thermal overload restart inhibit	50 ÷ 100 % ON / OFF	1 %
	TC1	Heating time constant	1 ÷ 500 min	1 min
	TC2	Cooling time constant	1 ÷ 10 TC1	1 TC1
51N	Io>	Earth fault overcurrent	0.01 ÷ 2.00 Ion / OFF	0.01 Ion
		Time delay trip Io>	0.02 ÷ 99.99 s	0.01 s
51R	I>	Phase overcurrent (locked rotor)	1.00 ÷ 20.00 In / OFF	0.01 In
		Time delay trip I>	0.02 ÷ 99.99 s	0.01 s
	Tavv	Starting time (threshold I> disabled)	1 ÷ 999 s	1 s
50	I>>	Phase overcurrent (short circuit)	1.00 ÷ 20.00 In / OFF	0.01 In
		Time delay trip I>>	0.02 ÷ 99.99 s	0.01 s
46	I2>	Negative sequence overcurrent (unbalanced load)	0.10 ÷ 1.00 In / OFF	0.01 In
		Dependent time delay Characteristic curves as IEC 255-4	A, B, C	
		Characteristic constant	0.01 ÷ 20.00 s	0.01 s
37	I<	Undercurrent (loss of load)	0.1 ÷ 1.00 In / OFF	0.01 In
		Time delay trip I<	0.20 ÷ 99.99 s	0.01 s
66	NAVV	Max. number of starts	1 ÷ 20 / OFF	1
	TLIM	Start-up period	1÷ 99 min	1 min
	TBLK	Start-up inhibition time	1÷ 99 min	1 min
50 – 51N 51R - 37		Additional delay	0.00 ÷ 99.99 s	0.01 s

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