DIVISIONE ELETTRONICA E SISTEMI

HAR1N

FREQUENCY AND OVERFLUXING DIGITAL MULTIFUNCTION RELAY

USER MANUAL

P500D812 **August 2004**

INDEX

1 GENERAL CHARACTERISTICS

The protection relay HAR1N belongs to the SIGMA-N digital protection line and one or more of the functions listed below are activable:

Function	ANSI
Under – frequency	81
Over - frequency	81
Overfluxing	59 / 81
Max. frequency rate-of-change	dt / df
Max. voltage vector shift	$\Delta\Theta$

All the functions of the relay are fully programmable by the front panel keyboard or through the RS485 serial interface; 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:

- 2 under-frequency thresholds F<, F<<
- 2 over-frequency thresholds F>, F>>
- 2 overfluxing thresholds FL>, FL>>
- 2 max. frequency rate-of-change (module) thresholds DF>, DF>>
- 2 max. voltage vector shift thresholds +DA>, -DA>

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

A programmable undervoltage threshold is provided to inhibit the functions of the relay during the generator start-up; the threshold operates instantaneously without any time delays.

The functions of the protection relay are inhibited when the following conditions are presented:

- measured voltage lower then U< threshold
- measured frequency lower than 35 Hz or higher then 75 Hz

The undervoltage threshold **is always** active (0.2 Un minimum set-up)

TRIP DELAYS - all the thresholds, except the max. voltage vector shift (+DA> and -DA>) thresholds, have a programmable definite time delay TI; the time delay related to the threshold FL> can be programmed as definite time or dependent time in compliance with IEC 255-4 standard.

The definite time delay related to frequency and overflux thresholds can be combined with an additional time delay (TA); the additional time delay is added to time delay TI and its activation is controlled by the digital inputs.

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

OUTPUT RELAYS - the HAR1N 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 (the undervoltage threshold U< and the max. voltage vector shift thresholds present only the TRIP or no-activation conditions).

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).

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

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

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

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

DISPLAY OF MEASURES - the user can select the continuous display of a measured parameter such as frequency, flux (V/f) and voltage; 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 parameters, 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. 5.9 - 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 visualize the relay set-up but changes of parameters are disabled (ENTER and buttons disabled).

1.1 Under - and Over-frequency thresholds (ANSI 81)

Two under-frequency thresholds (F<, F<<) and two over-frequency thresholds (F>, F>>) are available and independently programmable. All the thresholds are definite time.

The under-frequency function, with the related frequency rate-of-change function, are specially suitable for the following applications:

- control of the frequency

- graded load-shedding in overloaded systems due to loss of generating units or mains failure

The operation of the frequency thresholds is based on the frequency measurement in the last NFILT periods; a frequency threshold goes in the START condition when the measured frequency exceeds the related threshold value for at least NFILT times to avoid unsuitable trips.

The threshold drops-off when the measurement of the frequency is “below” the threshold value in the last NFILT periods.

The value of the NFILT counter is independently programmable for each threshold.

The total activation time of the under and over-frequency thresholds will be:

NFILT periods + programmed time delay

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

1.2 Overfluxing thresholds (ANSI 59 / 81)

The overfluxing function protects the step-up transformers in generation plants by the effect of excessive flux density (proportional to the V/f ratio) that can cause damages due to the increase in the iron losses.

Two overfluxing thresholds (**FL>**, **FL>>**) are available and independently programmable; the time delay related to the threshold **FL>** can be programmed as definite time or dependent time in compliance with IEC 255-4 standard (ref. par. 7).

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

1.3 Max. frequency rate-of-change (df/dt) and max. voltage vector shift (ΔΘ)

The frequency rate-of-change and the voltage vector shift functions allow the rapid disconnection of the generator from local grid in case of mains failure, avoiding the risk at the resumption of the main grid (when auto-reclosing functions are provided on HV and MV lines of the main grid) of finding the generator in asynchronous phase position (with short-circuit type currents and risk of damages).

As the shortest reclosing period takes place in about 300 ms, the opening of the switch-gear should take place in less than 200 ms. To detect the mains failure condition within 100 ms the **df/dt** e ΔΘ functions are used as the monitoring of the frequency or voltage does not always allow to detect the condition within this time due to the typical evolution of the electrical parameters.

The typical operating time of the frequency rate-of-change thresholds (START conditions) are the following:

≤ 100 ms (70 ms typical) with thresholds greater than 1 Hz/s
≤ 300 ms (150 ms typical) with thresholds equal or lower then 1 Hz/s

The operating times are closed as above when the frequency rate-of-change is close to the programmed thresholds; for other conditions the operating time is substantially lower.

The maximum voltage vector shift thresholds are without time delays (about 80 ms from the vector shift event).

The protection relay does not operate when the voltage vector shift exceeds 45°.

There are available the following thresholds:

- independent frequency rate-of-change thresholds (DF>, DF>>)
- independent maximum voltage vector shift thresholds (+DA>, -DA>)

During the generator start-up, the frequency rate-of-change thresholds and the maximum voltage vector shift thresholds should be inhibited to avoid unsuitable trips of the protection relays; the inhibition can be obtained using external commands on digital inputs (see ref. G1, paragraph 5.7).

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

1.4 Undervoltage threshold (ANSI 27)

A programmable undervoltage threshold is available to inhibit the protection functions during the generator start-up.

An output relay can be activated (programmed) on the undervoltage threshold.

The functions of the protection relay are also inhibited when the measured frequency is lower than 35 Hz or higher then 75 Hz; the output relay programmed on the undervoltage threshold will TRIP on the above conditions related to frequency.

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

NOTE: the threshold is always active (minimum set-up value 0.2 Un).

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
F< F> (red)	⊗	trip condition on frequency thresholds F<, F<<, F> and F>> (ANSI 81)
DF DA (red)	⊗	trip condition on frequency rate-of-change (DF>, DF>>) and max. voltage vector shift (+DA>, -DA>) thresholds
FL> FL>> (red)	⊗	trip condition on overfluxing thresholds FL> and FL>>

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. 5.9).

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÷B5	relay address (RS485) and date/time
C1÷C5	nominal values, contrast etc.
D1F÷D6F	thresholds and time delays min. and max. frequency (ANSI 81)
D1M÷D5M	thresholds and time delays overfluxing (ANSI 59/81)
D1D÷D3D	thresholds and time delays frequency rate-of-change
D1S - D2S	thresholds and time delays voltage vector shift
D1U÷D3U	thresholds and time delays undervoltage (ANSI 27)
F1÷F14	output relays functions
G1÷G3	digital input functions
R1÷R20	partial trip counters reset

The programming sequence is the following:

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

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

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

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

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

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

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

4.2 How to modify a visualized parameter

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

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

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

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

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

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

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

increasing of the parameter

a) the digits are increased by 1 unit

b) the other parameters are presented following the selection list

3) PRESS [ENTER] to end parameter modification session

The modification session is ended and the parameter stops to blink

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

```
Data
Error
```

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

4.3 Reset

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

- reset of glowing LED's

- drop-off of tripped relays
- reset of any parameter changed but not confirmed (parameters are shown as confirmed at the end of the last programming session)
- display on STANDARD MODE (Fig. 1, ref. A1 - par. 5.1)

4.4 Test of output relays

When the output relays test is selected (Fig. 3, ref. F14) 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 VISUALISATION** 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 [⇨] o **[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 (81 - DF - DA - 59/81).

- **Measured parameters** - the display shows one of the measures (frequency, voltage or flux).

The measure is visualized as primary value.

NOTE - for the flux measurement only the secondary voltage of the VT is taken into consideration (programmed function ref. C1 - par. 5.2).

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 F>	TRIP FL>>	TRIP F<<	TRIP DF>

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

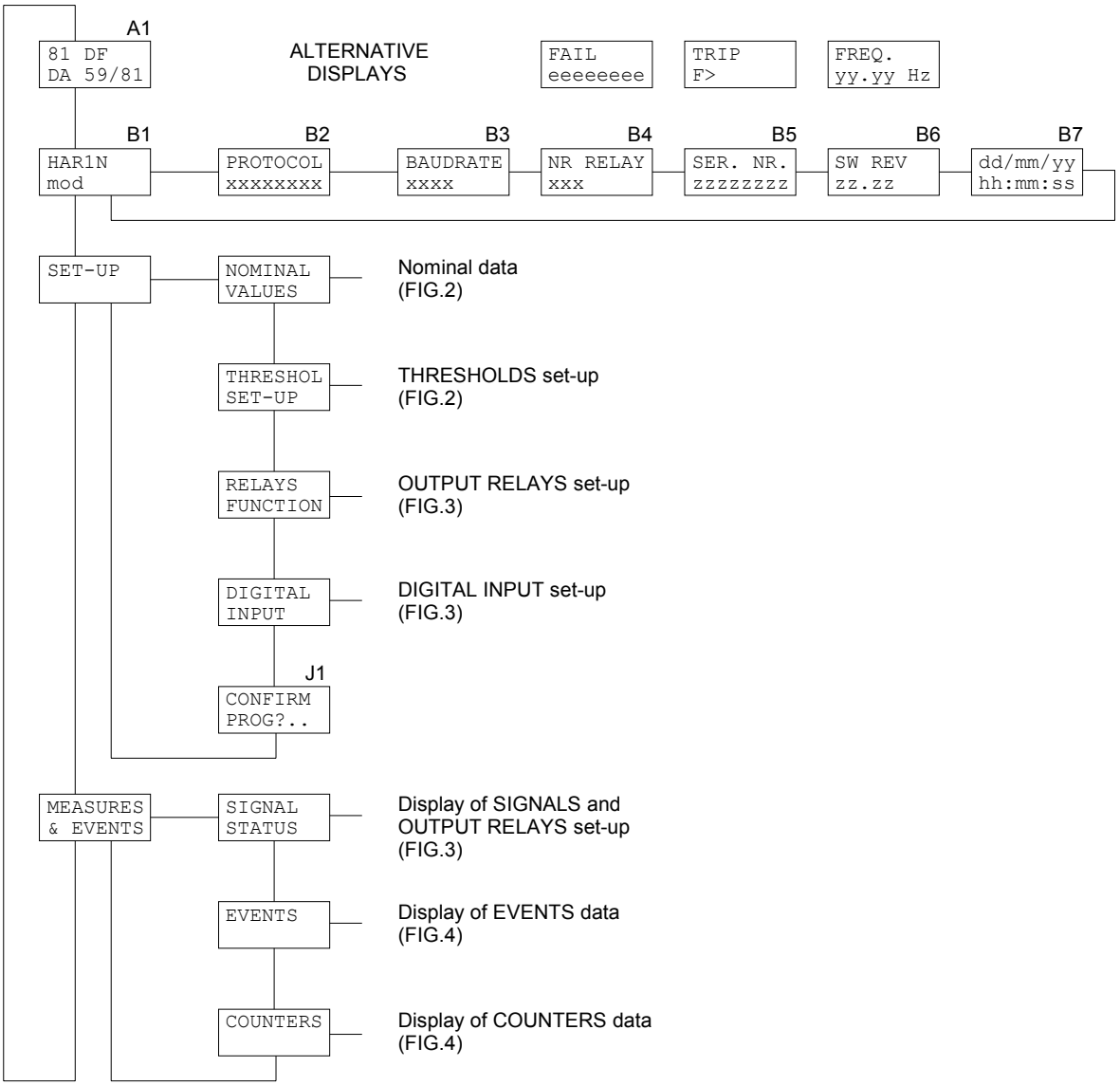


Figure 1

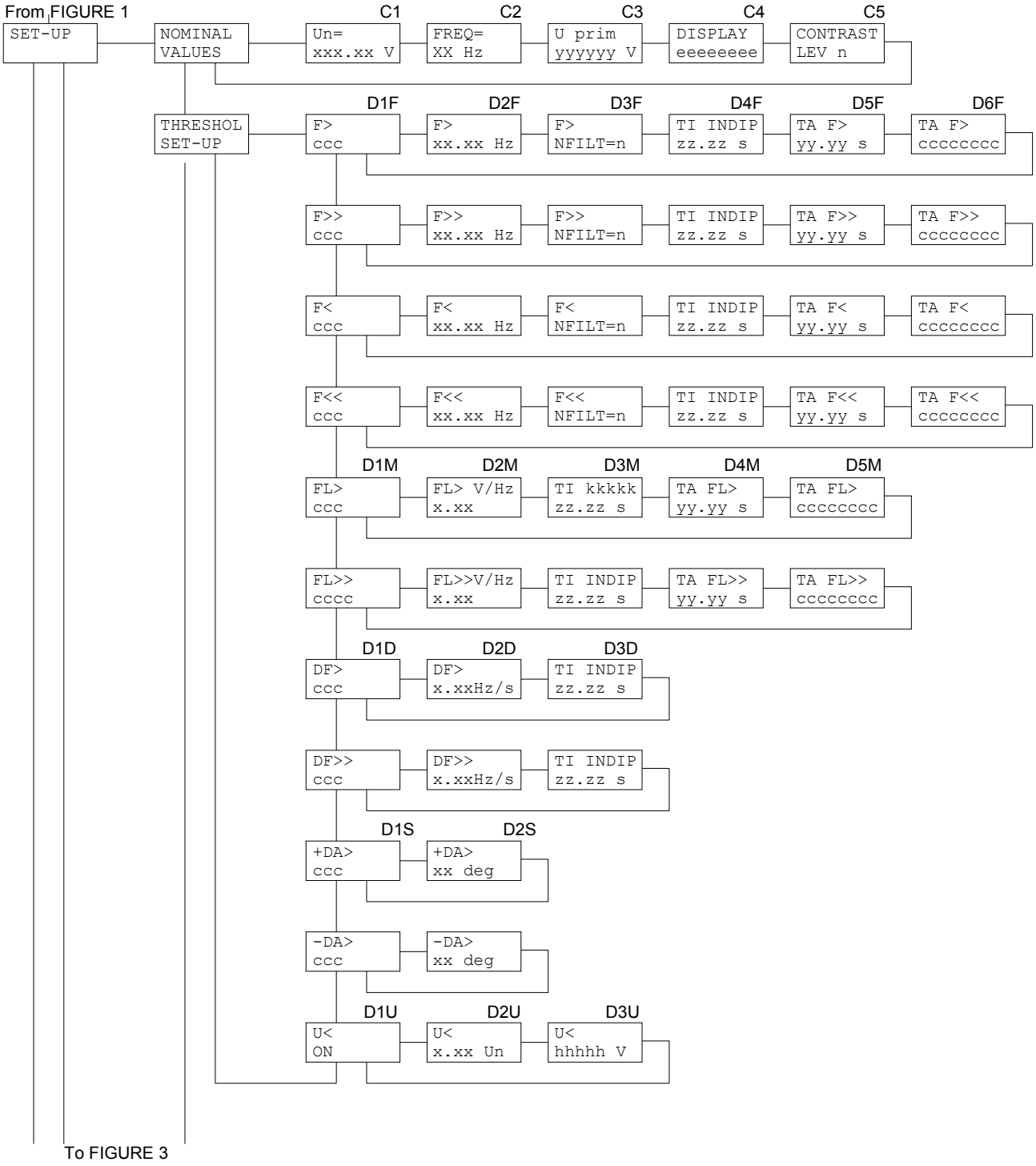

From FIGURE 1
SET-UP
NOMINAL VALUES
C1
Un= xxx.xx V
C2
FREQ= XX Hz
C3
U prim yyyyyy V
C4
DISPLAY eeeeeeee
C5
CONTRAST LEV n
THRESHOL SET-UP
D1F
F> ccc
D2F
F> xx.xx Hz
D3F
F> NFILT=n
D4F
TI INDIP zz.zz s
D5F
TA F> yy.yy s
D6F
TA F> cccccccc
F>> ccc
F>> xx.xx Hz
F>> NFILT=n
TI INDIP zz.zz s
TA F>> yy.yy s
TA F>> cccccccc
F< ccc
F< xx.xx Hz
F< NFILT=n
TI INDIP zz.zz s
TA F< yy.yy s
TA F< cccccccc
F<< ccc
F<< xx.xx Hz
F<< NFILT=n
TI INDIP zz.zz s
TA F<< yy.yy s
TA F<< cccccccc
D1M
FL> ccc
D2M
FL> V/Hz x.xx
D3M
TI kkkkk zz.zz s
D4M
TA FL> yy.yy s
D5M
TA FL> cccccccc
FL>> cccc
FL>>V/Hz x.xx
TI INDIP zz.zz s
TA FL>> yy.yy s
TA FL>> cccccccc
D1D
DF> ccc
D2D
DF> x.xxHz/s
D3D
TI INDIP zz.zz s
DF>> ccc
DF>> x.xxHz/s
TI INDIP zz.zz s
D1S
+DA> ccc
D2S
+DA> xx deg
-DA> ccc
-DA> xx deg
D1U
U< ON
D2U
U< x.xx Un
D3U
U< hhhhh V
To FIGURE 3

Figure 2

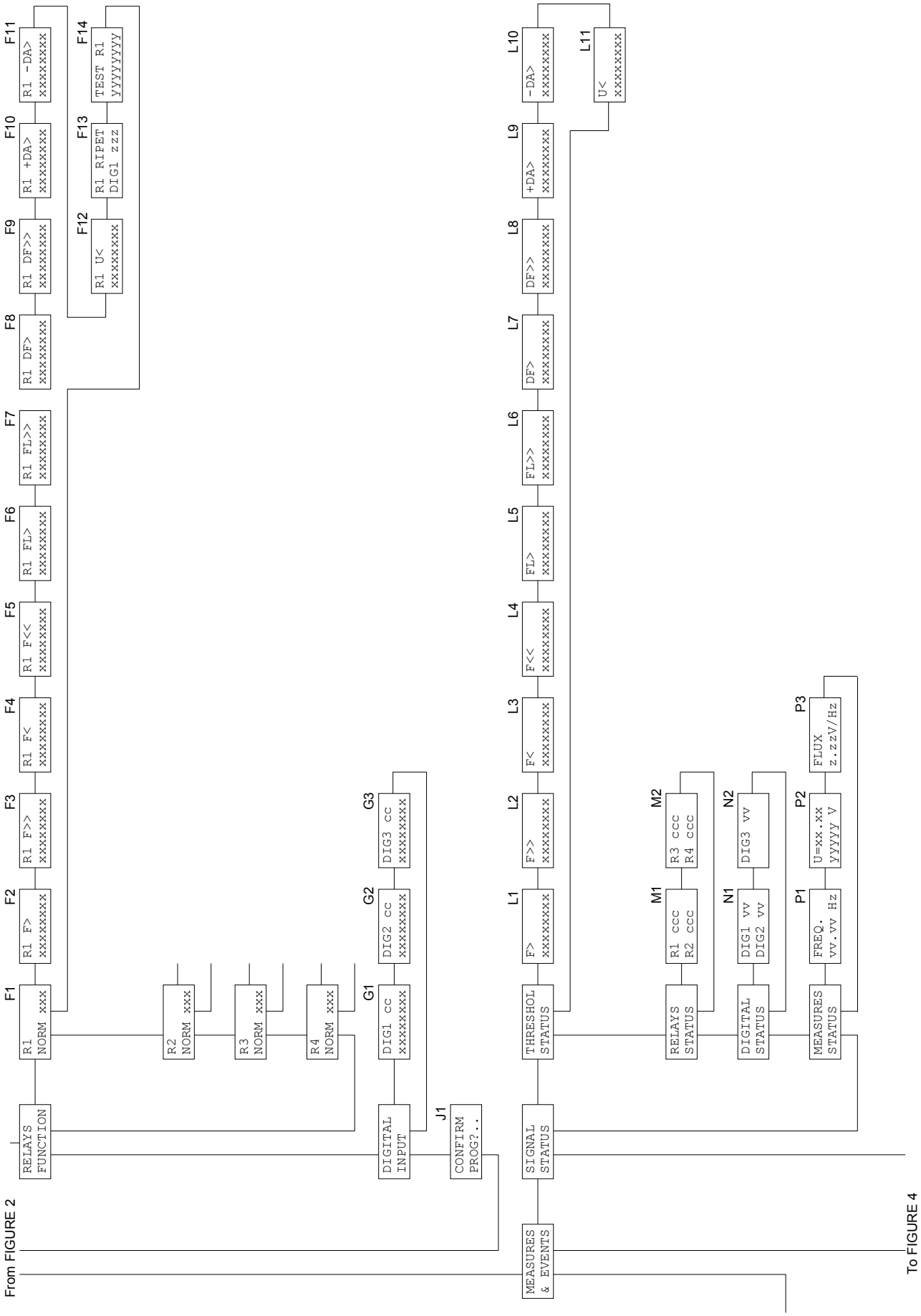

From FIGURE 2
To FIGURE 4
MEASURES & EVENTS
RELAYS FUNCTION
SIGNAL STATUS
DIGITAL INPUT
CONFIRM PROG?..
THRESHOL STATUS
RELAYS STATUS
DIGITAL STATUS
MEASURES STATUS
R1 NORM xxx
R2 NORM xxx
R3 NORM xxx
R4 NORM xxx
R1 F> xxxxxxxx
R1 F>> xxxxxxxx
R1 F< xxxxxxxx
R1 F<< xxxxxxxx
R1 FL> xxxxxxxx
R1 FL>> xxxxxxxx
R1 DF> xxxxxxxx
R1 DF>> xxxxxxxx
R1 U< xxxxxxxx
R1 RIPET DIG1 zzz
TEST R1 yyyyyyyy
R1 +DA> xxxxxxxx
R1 -DA> xxxxxxxx
DIG1 cc xxxxxxxx
DIG2 cc xxxxxxxx
DIG3 cc xxxxxxxx
F> xxxxxxxx
F>> xxxxxxxx
F< xxxxxxxx
F<< xxxxxxxx
FL> xxxxxxxx
FL>> xxxxxxxx
DF> xxxxxxxx
DF>> xxxxxxxx
U< xxxxxxxx
+DA> xxxxxxxx
-DA> xxxxxxxx
R1 ccc R2 ccc
R3 ccc R4 ccc
DIG1 vv DIG2 vv
DIG3 vv
FREQ. vv.vv Hz
U=xx.xx yyyyy V
FLUX z.zzV/Hz
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
F13
F14
G1
G2
G3
J1
L1
L2
L3
L4
L5
L6
L7
L8
L9
L10
L11
M1
M2
N1
N2
P1
P2
P3

Figure 3

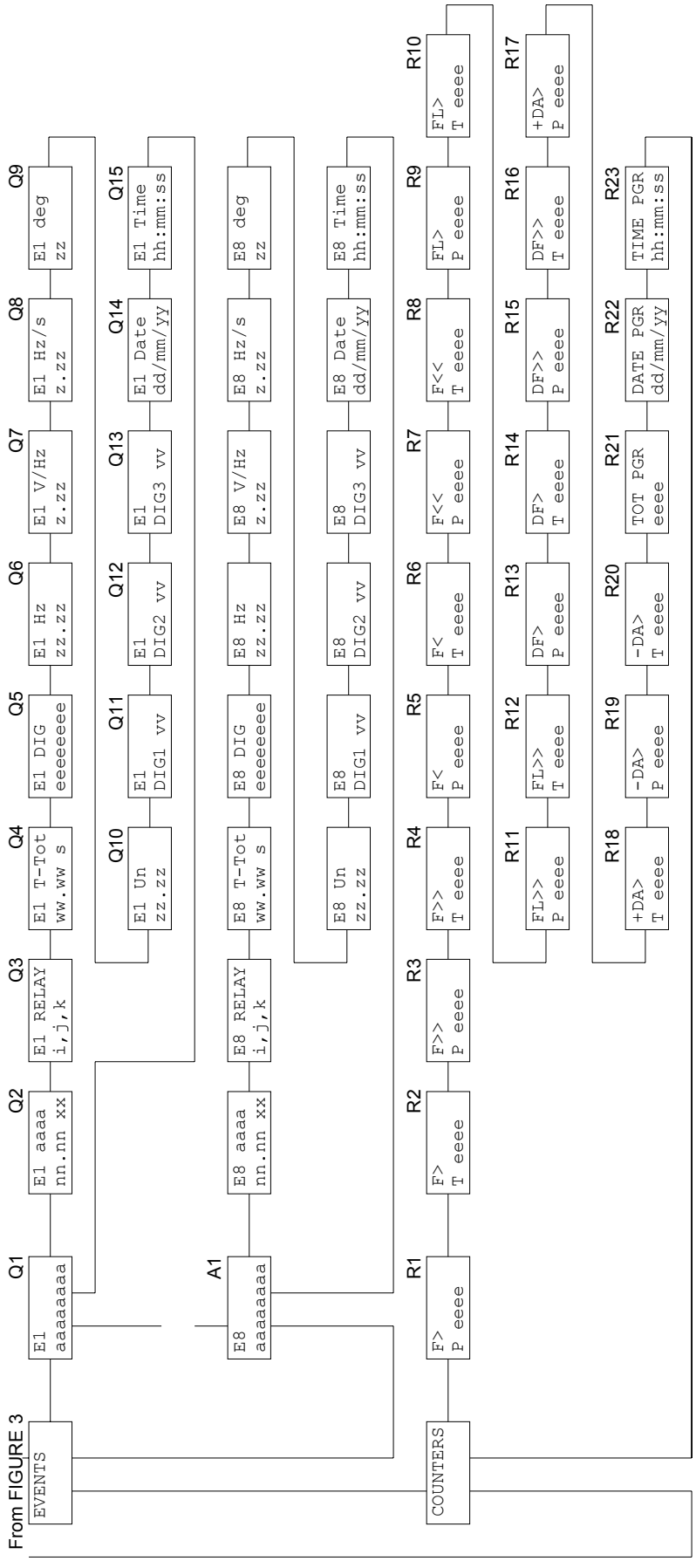

From FIGURE 3
EVENTS
COUNTERS
Q1
E1 aaaaaaaa
Q2
E1 aaaa nn.nn xx
Q3
E1 RELAY i,j,k
Q4
E1 T-Tot ww.ww s
Q5
E1 DIG eeeeeeee
Q6
E1 Hz zz.zz
Q7
E1 V/Hz z.zz
Q8
E1 Hz/s z.zz
Q9
E1 deg zz
Q10
E1 Un zz.zz
Q11
E1 DIG1 vv
Q12
E1 DIG2 vv
Q13
E1 DIG3 vv
Q14
E1 Date dd/mm/yy
Q15
E1 Time hh:mm:ss
A1
E8 aaaaaaaa
E8 aaaa nn.nn xx
E8 RELAY i,j,k
E8 T-Tot ww.ww s
E8 DIG eeeeeeee
E8 Hz zz.zz
E8 V/Hz z.zz
E8 Hz/s z.zz
E8 deg zz
E8 Un zz.zz
E8 DIG1 vv
E8 DIG2 vv
E8 DIG3 vv
E8 Date dd/mm/yy
E8 Time hh:mm:ss
R1
F> P eeee
R2
F> T eeee
R3
F>> P eeee
R4
F>> T eeee
R5
F< P eeee
R6
F< T eeee
R7
F<< P eeee
R8
F<< T eeee
R9
FL> P eeee
R10
FL> T eeee
R11
FL>> P eeee
R12
FL>> T eeee
R13
DF> P eeee
R14
DF> T eeee
R15
DF>> P eeee
R16
DF>> T eeee
R17
+DA> P eeee
R18
+DA> T eeee
R19
-DA> P eeee
R20
-DA> T eeee
R21
TOT PGR eeee
R22
DATE PGR dd/mm/yy
R23
TIME PGR hh:mm:ss

Figure 4

5.3 Address and Time (fig. 1)

B1 - RELAY MODEL (not programmable)

```
HAR1N
mod. T1
```

B2 - B3 - 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 Nominal values selection (fig. 1)

C1 - NOMINAL LINE VOLTAGE SELECTION - Un (programmable)

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

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

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

C2 - NOMINAL FREQUENCY SELECTION (programmable)

```
FREQ =
xx  Hz
```

The nominal frequency value is selectable between the followings:

50 - 60

C3 - PRIMARY VTs LINE VOLTAGE (programmable)

```
U prim
xxxxxx V
```

Primary voltage value of the installed line VTs; the value is programmable from 000001 to 999999 V.

C4 - 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
FREQ	displays measured frequency

FLUX	displays measured flux
U	displays measured voltage

The voltage is displayed in primary values (the value depends on C3 set-ups).

Selection examples:

DISPLAY ANSI	DISPLAY FREQ	DISPLAY U

C5 - 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.

5.5 Thresholds and time delays set-up

5.5.1 Under and over-frequency thresholds (fig. 2)

The information and set-ups related to threshold F> in the following points are effective for all the thresholds F>>, F< and F<< just taking into consideration the change of the threshold identification.

D1F - ON / OFF THRESHOLD (programmable)

F> ccc

F> threshold identification (F>, F>>, F<, F<<)

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

D2F - THRESHOLD LEVEL SET-UP (programmable)

F> nn.nn Hz

nn.nn: threshold level expressed in Hz

The available settings for the thresholds are listed in Table A.

Examples:

F> 50.50 Hz	F>> 51.50 Hz	F< 49.30 Hz

D3F - NFILT COUNTER SET-UP (programmable)

Programming of the number of periods NFILT used by the frequency thresholds (START condition and drop-off - see par. 1.1).

```
F>
NFILT= n
```

n filter value programmable from 2 to 9 periods

The frequency threshold goes in the START condition when the measured frequency exceeds the related threshold value for at least NFILT times to avoid unsuitable trips. The threshold drops-off when the measurement of the frequency is “below” the threshold value in the least NFILT periods.

The value of the NFILT counter is independently programmable for each threshold.

D4F - TIME DELAY SET-UP (programmable)

```
TI INDIP
xx.xx s
```

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

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

Example:

```
TI INDIP
02.50 s
```

D5F - ADDITIONAL TIME DELAY SET-UP (programmable)

```
TA F>
xx.xx s
```

The additional time delay TA is programmable from 00.00 to 99.99 seconds; please note that at least one of the digital inputs should be programmed to activate time delay function (ref. G1, G2, G3 – paragraph 5.7).

D6F - DIGITAL INPUT ACTIVE ON THRESHOLD (not programmable)

```
TA F>
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 F>

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

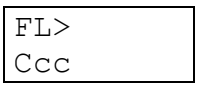
More than one digital input can activate the same additional time delay (e.g. DIG 1,3).

Please note that to activate the additional time delay at least one of the digital inputs should be programmed (ref. G1, G2, G3 - paragraph 5.7).

5.5.2 Overfluxing thresholds (fig. 2)

The information and set-ups related to threshold FL> in the following points are effective for the threshold FL>> just taking into consideration the change of the threshold identification.

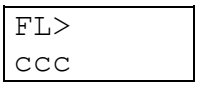
D1M - ON / OFF THRESHOLD (programmable)



FL> threshold identification (FL>, FL>>)

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

D2M - THRESHOLD LEVEL SET-UP (programmable)

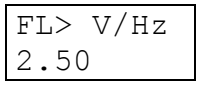


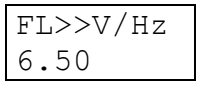
n.nn threshold level expressed in V/Hz

Please note that the flux value is computed using the secondary VT's voltage (ref. C1 - par. 5.4).

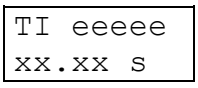
The available settings for the thresholds are listed in Table A.

Examples:





D3M - TIME DELAY SET-UP (programmable)



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

Parameter TI eeeee: time delay characteristic

For FL> threshold the time delay can be selected between one of the following:

INDIP	independent 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 FL>> threshold the TI parameter is fixed as INDIP (independent time).

Parameter xx.xx:

Time independent - time delay (seconds) to activate the programmed output relays: the output relay trips when the measured voltage exceeds the threshold level for at least xx.xx seconds (programmable from 00.02 to 99.99 s).

Time dependent - value of the parameter K (see formulas paragraph 1.2).

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.

D4M - ADDITIONAL TIME DELAY SET-UP (programmable)

The selection is displayed only when a TIME INDEPENDENT characteristic has been selected (TI INDIP at ref. D4M); when TIME DEPENDENT characteristic has been programmed, the selection will not be displayed.

TA FL> xx.xx s

The additional time delay TA is programmable from 00.00 to 99.99 seconds; please note that at least one of the digital inputs should be programmed to activate time delay function (ref. G1, G2, G3 - paragraph 5.7).

D5M - DIGITAL INPUT ACTIVE ON THRESHOLD (not programmable)

TA FL> eeeeeee

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

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

Please note that to activate the additional time delay at least one of the digital inputs should be programmed (ref. G1, G2, G3 - paragraph 5.7).

5.5.3 Frequency rate-of-change thresholds (fig. 2)

The information and set-ups related to threshold DF> in the following points are effective for the threshold DF>> just taking into consideration the change of the threshold identification.

D1D - ON / OFF THRESHOLD (programmable)

```
DF>
ccc
```

DF> threshold identification (DF>, DF>>)

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

D2D - THRESHOLD LEVEL SET-UP (programmable)

```
DF>
n.nnHz/s
```

n.nn threshold level expressed in Hz/s

The available settings for the thresholds are listed in Table A.

Examples:

```
DF>
1.00Hz/s
```

```
DF>>
5.50Hz/s
```

D3D - TIME DELAY SET-UP (programmable)

```
TI INDIP
xx.xx s
```

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.

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

Example:

```
TI INDIP
02.50 s
```

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

5.5.4 Voltage vector shift thresholds (fig. 2)

The information and set-ups related to threshold +DA> in the following points are effective for the threshold -DA> just taking into consideration the change of the threshold identification.

D1S - ON / OFF THRESHOLD (programmable)

```
+DA>
ccc
```

+DA> threshold identification (+DA>, -DA>)

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

D2S - THRESHOLD LEVEL SET-UP (programmable)

```
+DA>
nn deg
```

nn threshold level expressed in degree

The available settings for the thresholds are listed in Table A.

The maximum voltage vector shift thresholds are without time delays (about 80 ms from the vector shift event).

The protection relay does not operate when the voltage vector shift exceeds 45°.

5.5.5 Undervoltage threshold (fig. 2)

For the functions related to the undervoltage threshold (protection relay functions inhibition) please refer to paragraph 1.4.

D1U - ON / OFF THRESHOLD (programmable)

```
U<
ccc
```

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

D2U - D3U - THRESHOLD LEVEL SET-UP (programmable)

D2U

```
U<
n.nn Un
```

D3U

```
U<
xxxxxx V
```

n.nn: threshold level expressed in Un

xxxxxx: threshold level expressed in Volts (primary values)

The available settings for the thresholds are listed in Table A.

The undervoltage threshold operates without time delays.

5.6 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 status for each threshold.

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

F1 - OUTPUT RELAY R1 QUIESCENT STATUS (programmable)

```
R1
NORM xxx
```

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

F2 - OUTPUT RELAY ACTIVATION ON THRESHOLD F> (programmable)

```
R1 F>
xxxxxxxx
```

Programming of the R1 output relay activation (START or TRIP) on the over-frequency F> threshold.

The parameter xxxxxxxx is selectable as the following:

START R1 output relay activation on the over-frequency threshold
TRIP R1 output relay activation on the over-frequency threshold
NONE no activation related to the over-frequency threshold

F3 ÷ F12 - OUTPUT RELAY ACTIVATION ON THRESHOLDS STATUS F>>, F<, F<<, FL>, FL>>, DF>, DF>>, +DA>, -DA>, U< (programmable)

Examples:

F5

```
R1 F<<
xxxxxxxx
```

F8

```
R1 DF>
xxxxxxxx
```

F12

```
R1 U<
xxxxxxxx
```

Programming of the R1 output relay activation (NONE, START, TRIP) on the thresholds status (as threshold F> - ref. F2).

NOTE the output relays related to the thresholds +DA>, -DA> and U< do not have the START function.

F13 - OUTPUT RELAY ACTIVATION ON DIGITAL INPUT STATUS (programmable)

Please note that this function is normally used only for special applications, where the protection relay HAR1N is supplied by Seb integrated in protection panels.

```
R1 RIPET
DIG3 zzz
```

Activation of the R1 output relay function to copy the digital input DIG3 status (DIG3 HI - R1 ON, DIG3 LO - R1 - OFF).

The parameter zzz is selectable as the following:

ON	function enabled
OFF	function disabled

F14 - TEST OF OUTPUT RELAY R1

```
TEST R1
xxxxxxxx
```

See paragraph 4.4

5.7 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) R1 output relay activation on DIG3 status (DIG3 only)

When function a) is programmed, a message is displayed at ref. D6F and D5M in paragraph 5.5.

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

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

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

G1 - DIGITAL INPUT DIG1 SET-UP (programmable)

```
DIG1 cc
xxxxxxxx
```

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

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

Parameter xxxxxxx: programming of the function related to digital input DIG1; the following functions are selectable (only the active threshold are presented):

NONE	no functions active related to digital input DIG1
TA F>	additional time delay on the threshold F>
TA F>>	additional time delay on the threshold F>>
TA F<	additional time delay on the threshold F<
TA F<<	additional time delay on the threshold F<<
TA FL>	additional time delay on the threshold FL>
TA FL>>	additional time delay on the threshold FL>>
TA ALL	additional time delay on all thresholds
OF F>	threshold F> disabled
OF F>>	threshold F>> disabled
OF F<	threshold F< disabled
OF F<<	threshold F<< disabled
OF FL>	threshold FL> disabled
OF FL>>	threshold FL>> disabled
OF DF>	threshold DF> disabled
OF DF>>	threshold DF>> disabled
OF +DA>	threshold +DA> disabled
OF -DA>	threshold -DA> disabled
OF ALL	all thresholds disabled
STATUS	activation of status function (see paragraph 1.)

G2 - DIGITAL INPUT DIG2 SET-UP (programmable)

```
DIG2 cc
xxxxxxxx
```

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

MONITOR	activation of pilot wire monitor function.

G3 - DIGITAL INPUT DIG3 SET-UP (programmable)

```
DIG3 cc
xxxxxxxx
```

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

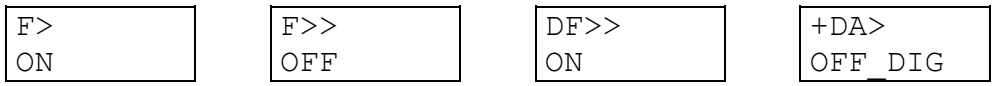
5.8 Parameter values visualization (fig. 3)

L1 ÷ L11 - THRESHOLDS STATUS

The actual status of each threshold is displayed. For each threshold are displayed the threshold identification (F>, F>> etc.) and the threshold status; the status can show one of the following values:

ON	active threshold
OFF	disabled threshold (programmed OFF at ref. D1 - par. 5.5)
OFF_DIG	threshold programmed active but momentary disabled by a digital input actual status (ref. G1, G2, G3 see par. 5.7).

Examples:



NOTE The threshold U< is always active (ON).

M1 - M2 OUTPUT RELAY STATUS

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

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

Note that ON/OFF do not necessary mean energized or de-energized (see ref. F1).

N1 - N2 DIGITAL INPUT STATUS

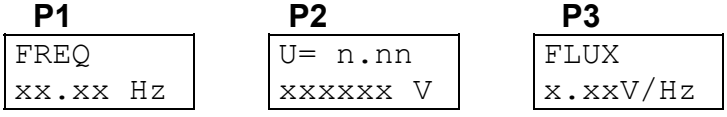
The actual status of each digital input is displayed.

For each digital input the following information is presented:

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

P1 - P2 - P3 MEASUREMENT DISPLAY

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



When a parameter is not measurable it is displayed in terms of " * ".

Example - the measured frequency is lower than 35 Hz (all the functions of the protection are inhibited).

P1	P2	P3
FREQ < 35 Hz	U= *.** ****** V	FLUX *.**V/Hz

Example - the measured voltage is lower than 5 V (es. 0.05 Un at Un=100 V - all the functions of the protection are inhibited).

P1	P2	P3
FREQ **.** Hz	U= *.** ****** V	FLUX *.**V/Hz

5.9 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.

Q1 - EVENT NUMBER

E1 cccccccc

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

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

NONE	no event memorized
F>	event on trip threshold F>
F>>	event on trip threshold F>>
F<	event on trip threshold F<
F<<	event on trip threshold F<<
FL>	event on trip threshold FL>
FL>>	event on trip threshold FL>>
DF>	event on trip threshold DF>
DF>>	event on trip threshold DF>>
+DA>	event on trip threshold +DA>
- DA>	event on trip threshold - DA>
U<	event on trip threshold U<
STATUS	information recorded on external command
POWER ON	switch-on of the protection relay (auxiliary power)

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

Q2 - TRIP THRESHOLD

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

Examples:

E4 U<	E2 FL>>	E5 DF>>	E1 F>
0.50 Un	2.50V/Hz	1.05Hz/s	50.05 Hz

Q3 - ACTIVATED OUTPUT RELAYS

E1 RELAY
nnnnnnn

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

Examples:

E1 RELAY	E3 RELAY
1,3,4	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

Q4 - 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 overflux 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

Q5 - 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. 5.7).

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

Q6 - Q7 - Q8 - Q9 - Q10 - MEMORIZED MEASURES ON EVENT

Q6	Q7	Q8	Q9	Q10
E1 Hz yy.yy	E1 V/Hz y.yy	E1 Hz/s y.yy	E1 deg yy	E1 Un y.yy

The values of the measured parameters at the event are displayed.

The measurement of the voltage vector shift (Q9) is displayed only for events related to the thresholds +DA> and -DA>; on the same events the value of frequency rate-of-change is not presented (Q8).

For more information please refer to paragraph 5.8.

If the frequency rate-of-change exceeds the value ±30 Hz/s the values >+30.00 Hz/s or <-30.00 Hz/s are presented.

Q11 - Q12 - Q13 - 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.

Q14 - Q15 - 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

5.10 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).

R1 ÷ R20 - TRIP COUNTERS

R1	R2
F> P cccc	F> T cccc

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 (F>, F>>, F<, F<<: etc.); 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).

R21 ÷ R23 TOTAL PROGRAMMING SESSIONS AND DATE/TIME OF THE LAST PROGRAMMING SESSION

TOT PRG	DATE PRG	TIME PRG
eeee	dd/mm/yy	hh:mm:ss

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

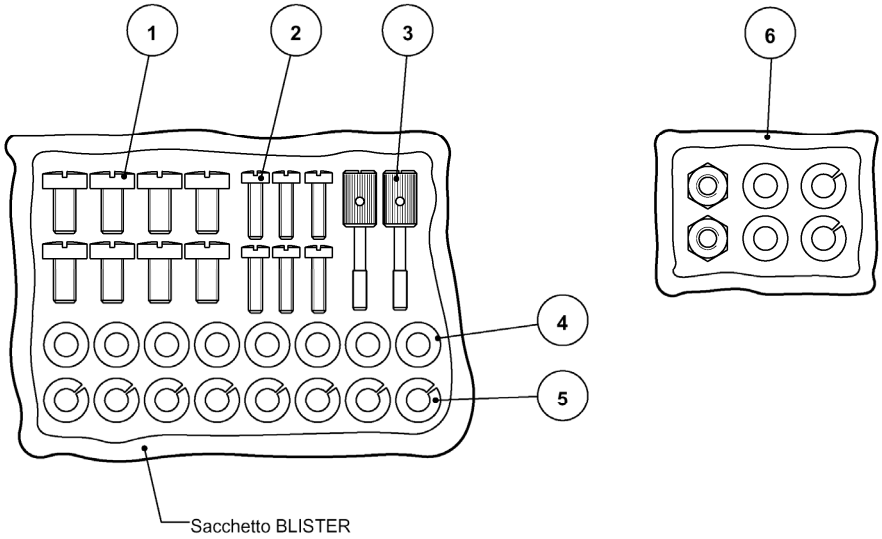
6.1 Supplied kit

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

- protection relay module HAR1N 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 HAR1N 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 (not used)
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 - not used)
5) n° 8 growers to be used to fix wire terminals (current - not used)
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.

NOTE: The items related to current inputs are the standard supplied items with all SIGMA N protection relays but for the HAR1N model they are not used.

6.2 Cabling

Voltage circuits

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

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

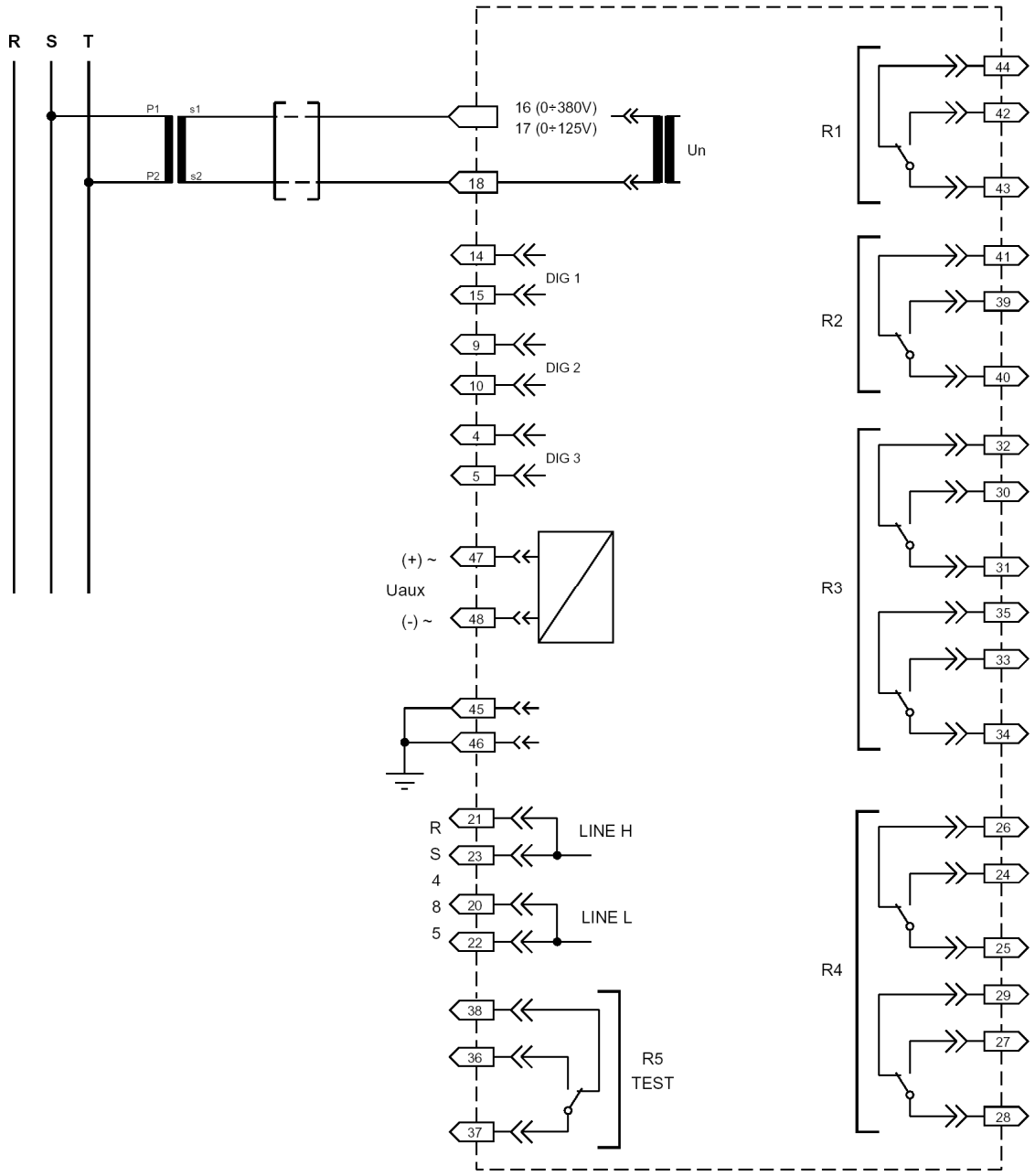
With reference to the insertion diagram in the next page, the voltages measured by the protection relay have the following matching:

U1	terminals 16 - 18	voltages with Un programmed from 190 to 380 V
	terminals 17 - 18	voltages with Un programmed from 0 to 125 V

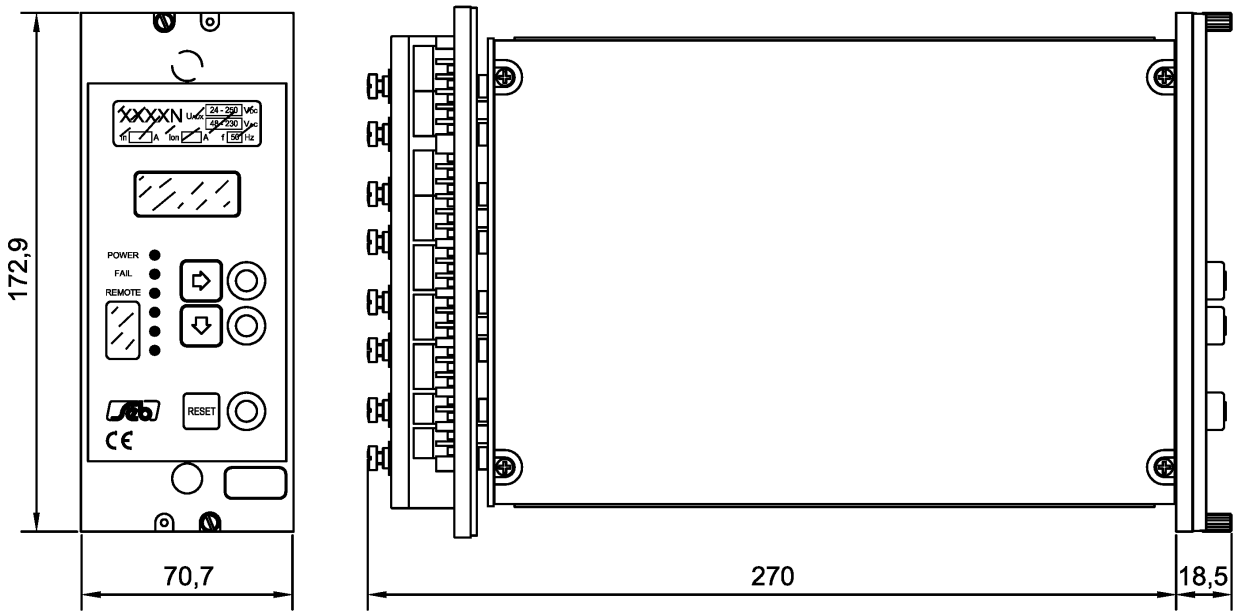
Other circuits (output relays etc.)

It is suggested to terminate the wiring using plug terminals.

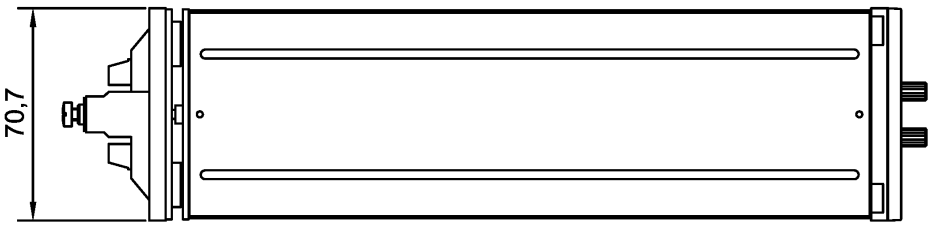
Minimum suggested wire cross section: 1,5 mm^2

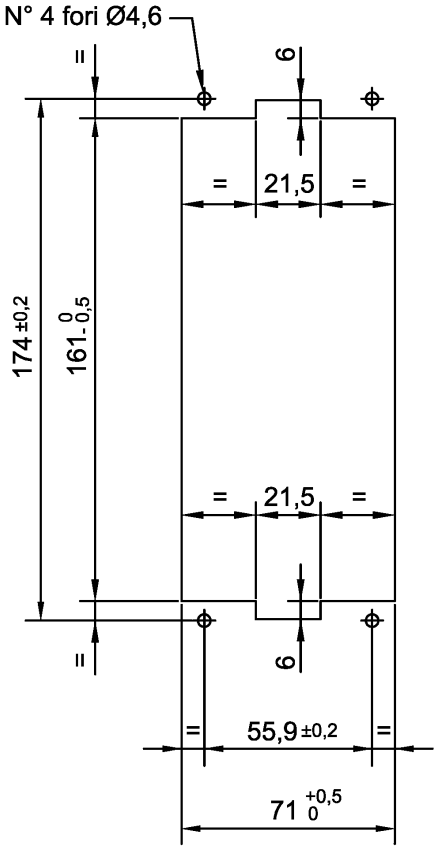


HAR1N insertion



Dimensioni meccaniche
Case outlines





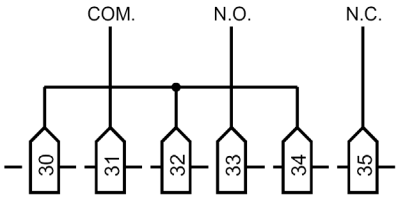
Dima montaggio da incasso
Flush mounting panel cut - out

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

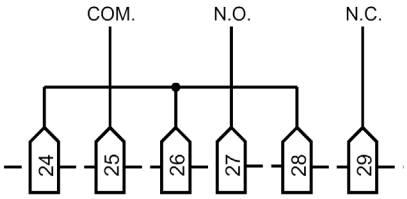
6.3 Relays R3 and R4 - Signaling / Command set-up

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

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



R3



R4

6.4 RS485 serial communication port

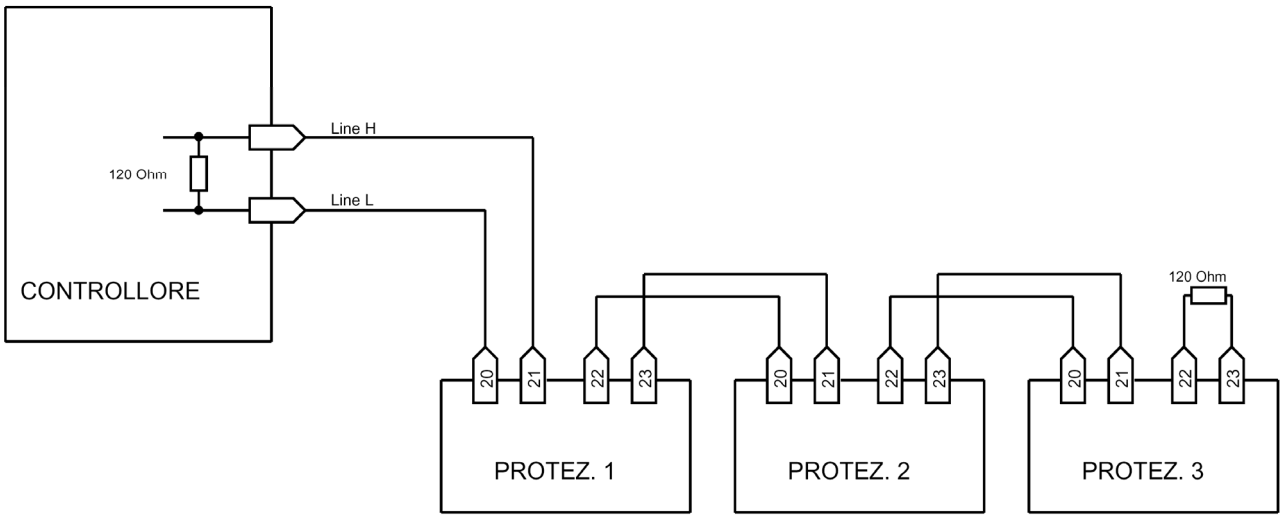
The digital protection relay HAR1N presents an insulated serial interface RS485 half-duplex that allow the multi-drop connection up to 31 protection units. There are available 2 selectable communication protocols (ref. B2 paragraph 5.3).

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

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

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

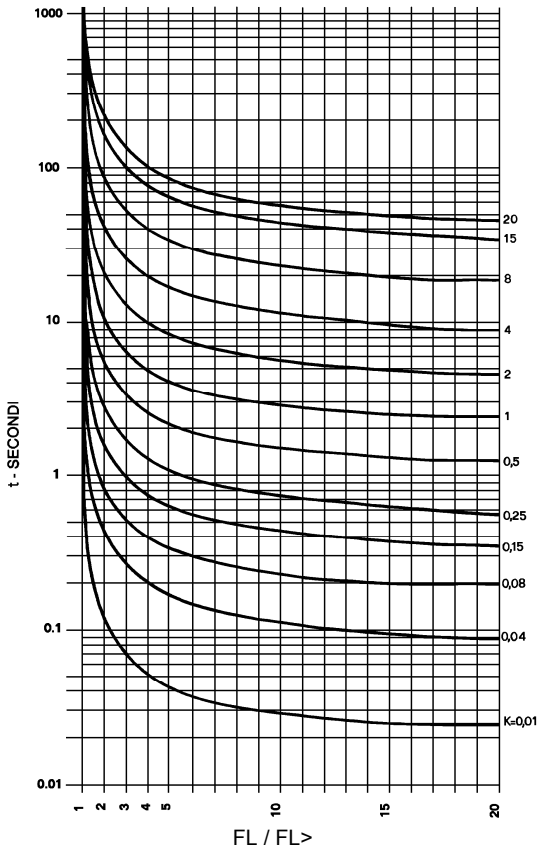
To integrate the protection relay in control systems, the documentation related to the protocol is freely available on request.



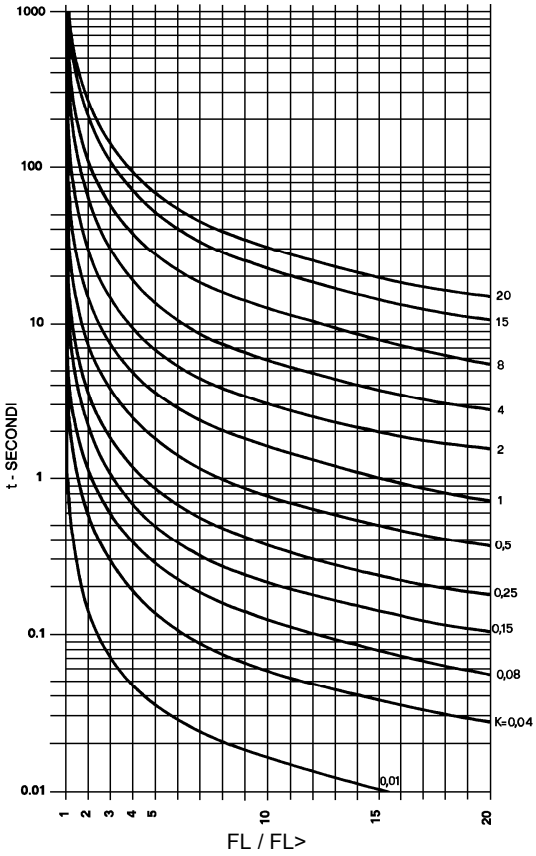
It is suggested to terminate the serial line with a resistance 120 Ω, 1/4 W.

7 TIME DEPENDENT CURVES - IEC 255-4

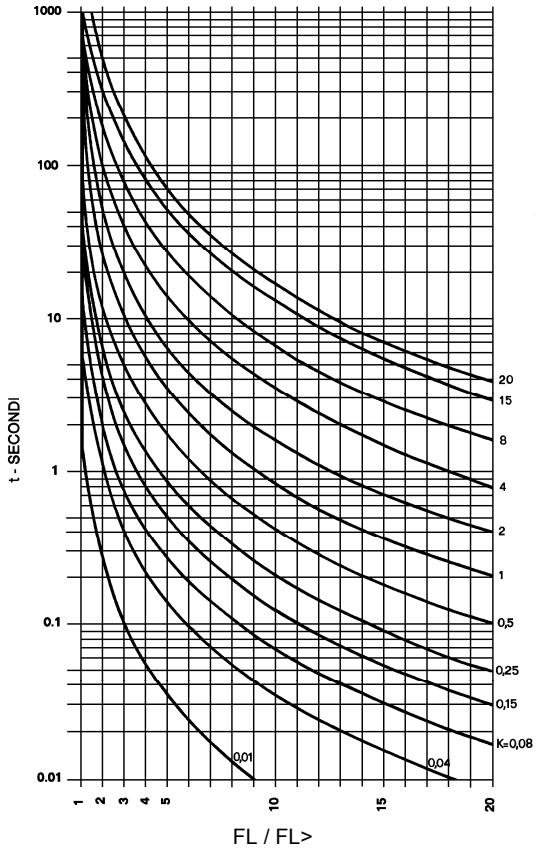
Curva - Curve A



Curva - Curve B



Curva - Curve C



Time dependent characteristic

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

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
FL/FL>	Ratio between the measured V/f and the threshold FL>

8 TECHNICAL DATA

Measuring inputs

Rated voltage (Un) programmable	57.73 - 63.50 - 72.16 - 100 - 110 V 125 - 190 - 220 - 230 - 380 - 400 V
Thermal withstand continuously	2 Un
Thermal withstand for 1 s	2 Un
Rated frequency	50 / 60 Hz
Primary VT's voltage	1 - 999999 V
Burden referred to rated value	0.3 VA/phase
Frequency measurement range	35 ÷ 75 Hz

Output contact 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 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

Operating	- 10 / +60 °C
Transport and storage	- 25 / +80 °C
Relative humidity (without condensation)	< 95%
Protection degree for flush mounting (optional)	IP 52 (IP54)
Weight	2.5 kg

Note 1) The additional relay R5 is controlled by self-test program

Note 2) Breaking capability at 110 Vdc, L/R 40 ms, 100.000 operations

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

9 TABLE

Table A Settings

ANSI	THRESHOLDS	Settings	Resolut.
81	Over-frequency (F>, F>>)	40.00 ÷ 70.00 Hz	0.01 Hz
	Under-frequency (F<, F<<)	40.00 ÷ 70.00 Hz	0.01 Hz
	NFILT - number of cycles (Note 1)	2 ÷ 9 n	1 n
59/81	Overfluxing (FL>, FL>>)	0.50 ÷ 9.00 V/Hz	0.01 V/Hz
df/dt	Frequency rate-of-change (DF>, DF>>)	0.10 ÷ 9.95 Hz/s	0.05 Hz/s
ΔΘ	Voltage vector shift (+DA>, -DA>) (Note 2)	2° ÷ 30°	1°
27	U< Under-voltage threshold to relay inhibition (Note 2)	0.20 ÷ 1.00 Un	0.01 Un
Delays		**Settings**	**Resolut.**
Definite time	All thresholds (excepted ΔΘ = 0.04 s)	0.02 ÷ 99.99 s	0.01 s
Dependent time (FL>)	Characteristic curves (as IEC 255-4)	A, B, C	--
	Characteristic constant	0.01 ÷ 20 s	0.01 s
All definite time thresholds	Additional delay	0.00 ÷ 99.99 s	0.01 s

NOTE 1) the operating time of ANSI 81 thresholds = NFILT periods + programmed definite time

NOTE 2) TRIP only condition

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