DIVISIONE ELETTRONICA E SISTEMI

PQR4N

DIGITAL MULTIFUNCTION GENERATOR PROTECTION RELAY FOR LOSS OF EXCITATION, ANTIMOTORING AND ROTOR EARTH FAULT

USER MANUAL

P500D816 **June 2005**

INDEX

1 GENERAL CHARACTERISTICS

The PQR4N protection relay performs functions as generator protection relay against loss of excitation (or underexcitation conditions), antimotoring (reverse power) and against rotor earth faults. The user can select one or more of the functions listed in the table below:

Function	ANSI
Loss of excitation	40
Antimotoring (reverse power)	32
Rotor earth fault	64R

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 loss of excitation (underexcitation) thresholds
- 2 active power thresholds (max. or minimum)
- 2 reactive power thresholds (max. or minimum)
- 2 rotor insulation resistance thresholds

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

A programmable undervoltage threshold is provided to inhibit the functions related to loss of excitation (ANSI 40) and antimotoring (ANSI 32) during the generator start-up; the threshold operates instantaneously without any time delays.

TRIP DELAYS - each threshold have a programmable definite time delay TI; for each threshold it is available 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 PQR4N 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< presents only the TRIP or no-activation conditions).

START — instantaneous activation of the output relay when at least one of the measured 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:

- measured line current
- measured line voltage
- single-phase active power
- single-phase reactive power
- rotor insulation resistance

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. 5.10 - EVENTS). The recorded information allows an analysis of trip causes in co-operative protection relays systems.

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

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

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

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

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

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

1.1 Under excitation - loss of excitation (ANSI 40)

The PQR4N relay performs functions as protection relay against loss of excitation or underexcitation condition as when the generator operates in this conditions for considerable periods danger arises due to overheating or mechanical damages.

The operating characteristic of the relay is a straight line on the P-Q diagram as figure 1.

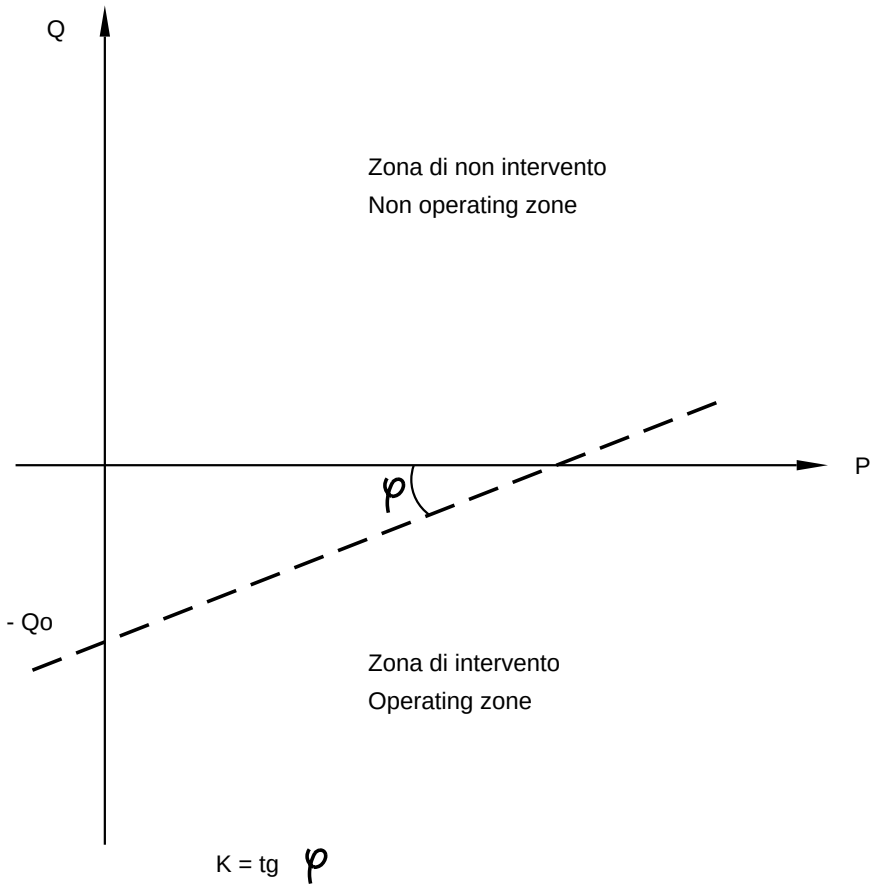


Figure 1

The straight line is defined by the slope **K** and by the intersection (**-Qo**) with the semi-axis of the deliverable capacitive reactive power at P = 0. The equation of the straight line which determines on P-Q diagram the operating and non-operating zones is the following:

$$Q = K * P - Qo$$

where **K** is the tangent of the angle φ between the straight line and the active power axis P.

The **K** and **Qo** parameters are programmable.

The straight line is programmed to copy, within some margins of safety, the capability curve of the generator; if the generator is equipped with an underexcitation limiting device the protection relay must operate after the limiting device (P-Q characteristic and time delay).

The PQR4N protection relay provides 2 independent thresholds (2 straight line on P-Q diagram) to define an operating characteristic which better approximates the capability curves of the generators.

The insertion diagram is presented in figure 5; the PQR4N relay is a single-phase relay therefore it can be used in system assumed to be balanced. The active (**P**) and reactive (**Q**) measured powers are single phase powers.

Current and voltage have to be applied according to the following table:

Current	Phase-Neutral Voltage	Phase-Phase Voltage
I_R	U_R	U_{R-T}
I_S	U_S	U_{S-R}
I_T	U_T	U_{T-S}

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

NOTE: an undervoltage programmable threshold (ref. 1.4) is always active and it inhibits thresholds, related to the ANSI 32 and ANSI 40 functions.

1.2 Antimotoring - reverse power (ANSI 32)

The PQR4N protection relay performs the function of antimotoring protection to avoid the generator to work as a motor.

There are also available reactive power thresholds; the thresholds are straight lines on the P-Q diagram, parallel with axis.

The insertion diagram is presented in figure 5; the PQR4N relay is a single-phase relay therefore it can be used in system assumed to be balanced. The active (**P**) and reactive (**Q**) measured powers are single phase powers.

There are available the following thresholds defined as apparent power An (An = Un * In)

- 2 active power thresholds (P1 and P2)
- 2 reactive power thresholds (Q1 and Q2)

Each threshold can be programmed in terms of **GREATER THAN** or **LOWER THAN** and the sign of the power.

(e.g. antimotoring gas turbine: P1< -0.015 An)

A programmable undervoltage threshold (**U<**) is available to inhibit the relay functions during the start-up of the generators (the threshold inhibits the ANSI 40 and ANSI 32 functions).

With reference to figure 5, the positive active power flows from the generator to the grid and the positive reactive power is inductive and flows from the generator to the grid.

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

NOTE: an undervoltage programmable threshold (ref. 1.4) is always active and it inhibits thresholds, related to the ANSI 32 and ANSI 40 functions.

1.3 Rotor earth fault (ANSI 64R)

The PQR4N relay performs the function of protection relay against rotor earth faults; the relay operates on the a.c. voltage injection principle on the rotor circuits.

When the protection relay PQR4N must perform ANSI 64R protection function an additional rotor injection unit **GAR** must be installed to inject between the rotor circuit and the earth an a.c. signal derived from an auxiliary a.c. voltage.

When a rotor earth fault occurs an a.c. current flows through earth and the PQR4N relay measures the resistive component of the current (in phase with the a.c. voltage on the rotor circuit) to detect the fault condition without influences due to rotor capacities.

Two minimum insulation resistance thresholds are available and programmable in ohm (**R1<**, **R2<**).

The resistance measurement is done when the a.c. voltage on the rotor circuit is greater than 10 V ac. If the measured voltage is less than 10 V only the current module measurement will be taken into consideration:

- current module $\geq$ 50 mA - trip threshold **R<< (if enabled)**
- current module < 50 mA - ANSI 64R function inhibition (loss of V a.c. supply)

as when the voltage is very low (less than 10 V) the resistance measurement will be less accurate.

In the second case it is possible to program an output relay to signal the condition (loss of V a.c. supply of the **GAR** module).

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

NOTE: an undervoltage threshold is always active (10 V fixed) and it inhibits the thresholds R1< and R2< whilst the R<< must be enabled by the user.

1.4 Undervoltage threshold (ANSI 27)

A programmable undervoltage threshold is always available to inhibit the protection functions related to ANSI 32 and ANSI 40 during the generator start-up.

An output relay can be activated (programmed) on the undervoltage threshold. The available settings for each threshold are listed in Table A.

The undervoltage inhibition threshold is always active when enabled at least one of the function ANSI 32 or ANSI 40; the threshold operates instantaneously without any time delays.

2 FRONT PANEL KEYS

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

right arrow

down arrow

programming session activation or parameter confirmation

change or increment of the selected parameter

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

VISUALIZATION OF PARAMETERS

- all visualizations are circular and they can be displayed using the two arrow push-buttons.
- the structure of the visualizations and their contents are showed in Figures 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 SIGNALLINGS

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
ANSI 40 (red)	⊕	trip condition on loss of excitation or under excitation thresholds
ANSI 32 (red)	⊕	trip condition on antimotoring or reverse power thresholds
ANSI 64R (red)	⊕	trip condition on rotor earth fault 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 2, 3 and 4 at the following references:

B2÷B6	relay protocol, address (RS485) and date/time
C1÷C5	nominal values, contrast etc.
D1D÷D6D	thresholds and time delays loss of excitation (ANSI 40)
D1P÷D5P	thresholds and time delays reverse power (ANSI 32)
D1U - D2U	thresholds and time delays undervoltage threshold
D1R÷D5R	thresholds and time delays rotor earth fault R1< and R2<
D1C÷D4C	thresholds and time delays rotor earth fault R<<
E1÷E12	output relays functions
G1÷G3	digital input functions
R1÷R18	partial trip counters reset

The programming sequence is the following:

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

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

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

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

5) **CONFIRM** the new protection relay set-up at the visualization CONFIRM PROG? (Fig. 2, ref. J1) within 5 minutes depressing the push-buttons [ENTER] and ⊞ up to visualize **YES** and [ENTER] again to confirm.

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

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

4.2 How to modify a visualized parameter

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

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

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

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

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

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

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

increasing of the parameter

a) the digits are increased by 1 unit

b) the other parameters are presented following the selection list

3) PRESS [ENTER] to end parameter modification session

The modification session is ended and the parameter stops to blink

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

```
Data
Error
```

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

4.3 Reset

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

- reset of glowing LEDs

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

4.4 Test of output relays

When the output relays test is selected (Fig. 3, ref. E13) 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 2, 3 and 4; the references A1, B1, B2 etc. identify specific displayed messages in the figures.

5.1 Standard display (fig. 2)

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 FUCTIONING
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 enabled functions.

- **Measured parameters** - the display shows one of the measures (line current or voltage) or a computed parameter (active power, reactive power, rotor insulation resistance).

The measure is visualized as primary value excepted powers that will be visualized in nominal value terms.

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

TRIP S1	TRIP P1	TRIP R1<	TRIP R<<

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

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

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

FAIL eeeeeeee

The string eeeeeeee can be:

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

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

5.2 Visualization structure

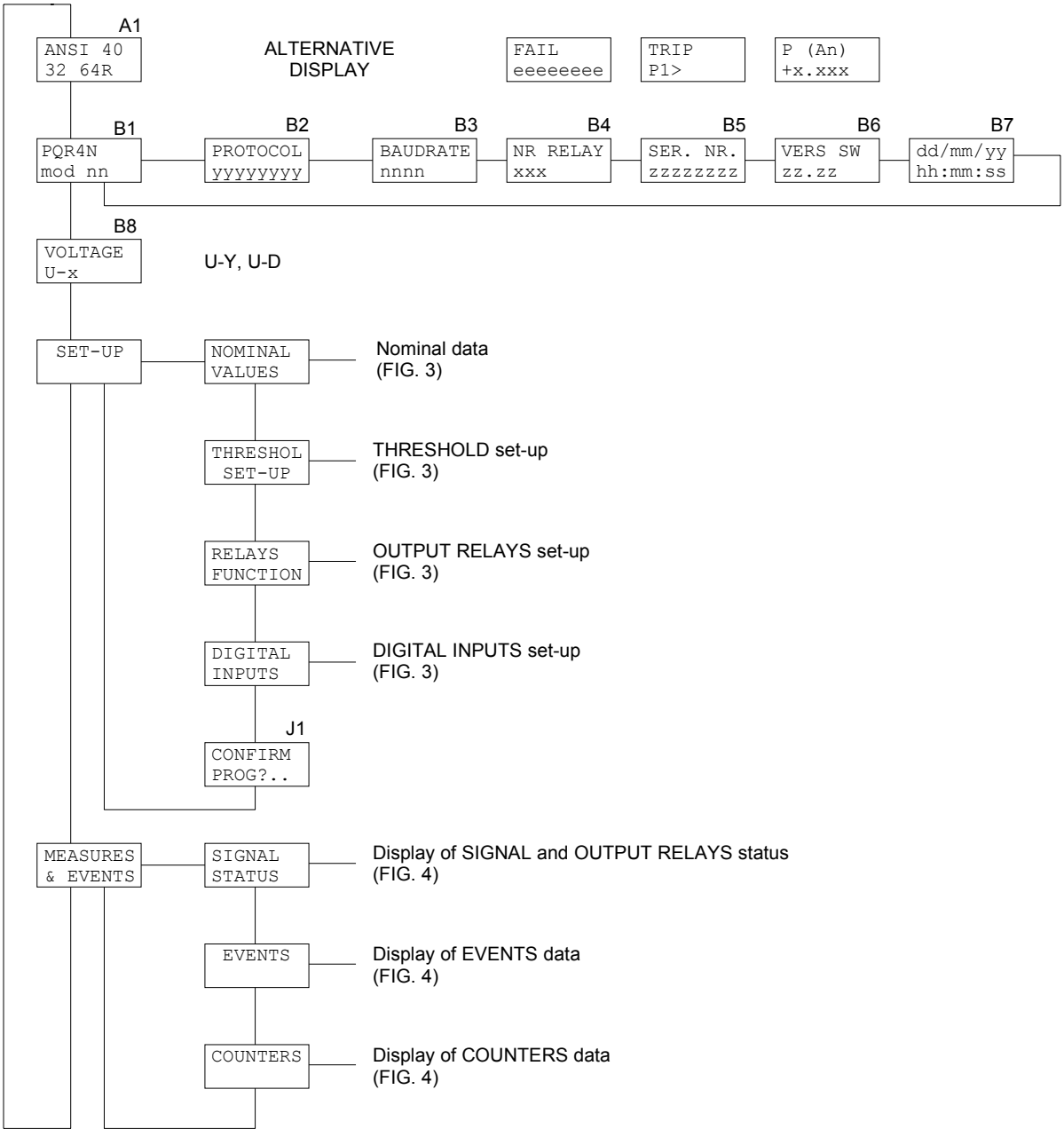


Figure 2

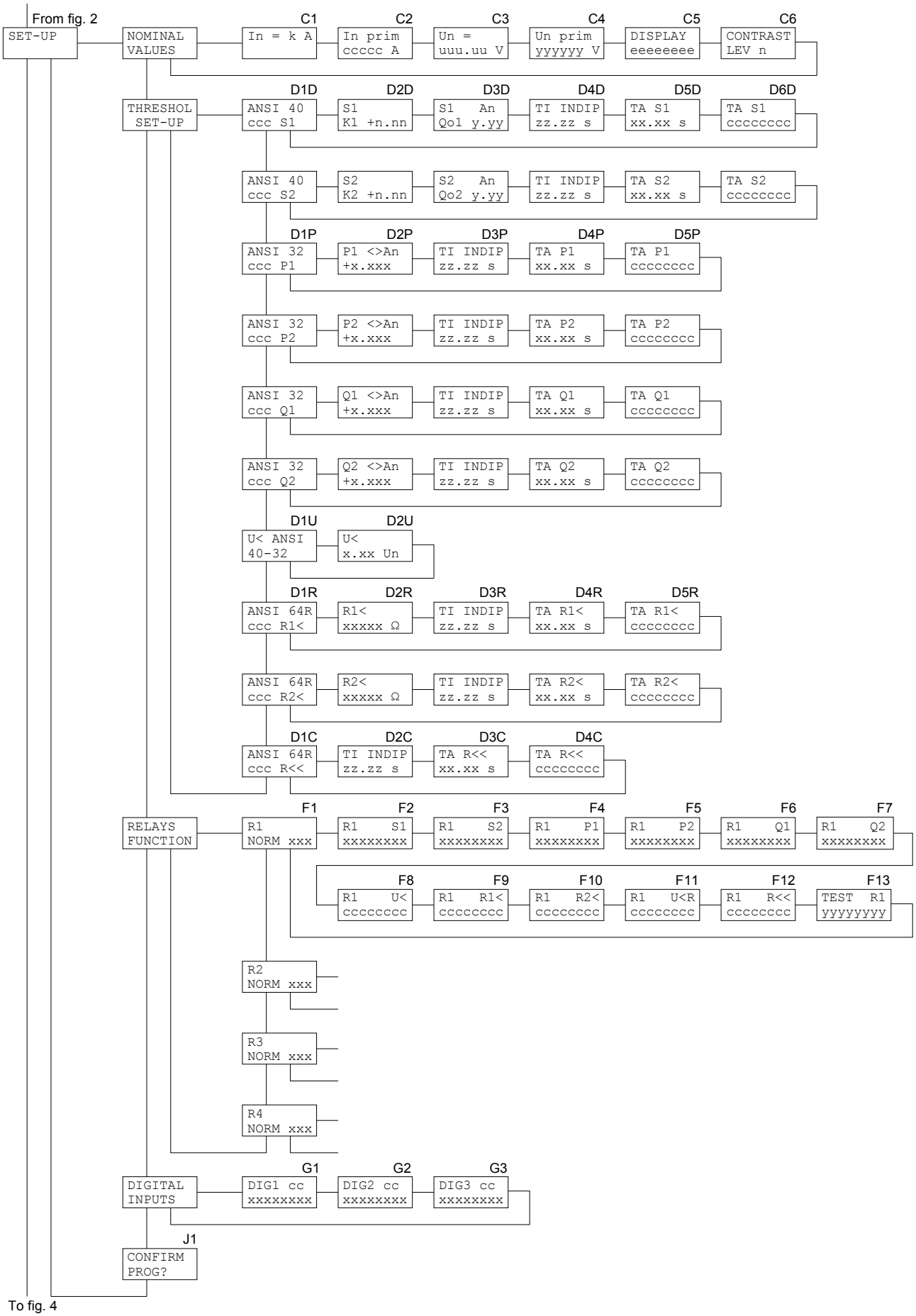

From fig. 2
SET-UP
NOMINAL VALUES
C1
In = k A
C2
In prim cccccc A
C3
Un = uuu.uu V
C4
Un prim yyyyyy V
C5
DISPLAY eeeeeeee
C6
CONTRAST LEV n
THRESHOL SET-UP
D1D
ANSI 40 ccc S1
D2D
S1 K1 +n.nn
D3D
S1 An Qo1 y.yy
D4D
TI INDIP zz.zz s
D5D
TA S1 xx.xx s
D6D
TA S1 cccccccc
ANSI 40 ccc S2
S2 K2 +n.nn
S2 An Qo2 y.yy
TI INDIP zz.zz s
TA S2 xx.xx s
TA S2 cccccccc
D1P
ANSI 32 ccc P1
D2P
P1 <>An +x.xxx
D3P
TI INDIP zz.zz s
D4P
TA P1 xx.xx s
D5P
TA P1 cccccccc
ANSI 32 ccc P2
P2 <>An +x.xxx
TI INDIP zz.zz s
TA P2 xx.xx s
TA P2 cccccccc
ANSI 32 ccc Q1
Q1 <>An +x.xxx
TI INDIP zz.zz s
TA Q1 xx.xx s
TA Q1 cccccccc
ANSI 32 ccc Q2
Q2 <>An +x.xxx
TI INDIP zz.zz s
TA Q2 xx.xx s
TA Q2 cccccccc
D1U
U< ANSI 40-32
D2U
U< x.xx Un
D1R
ANSI 64R ccc R1<
D2R
R1< xxxxx Ω
D3R
TI INDIP zz.zz s
D4R
TA R1< xx.xx s
D5R
TA R1< cccccccc
ANSI 64R ccc R2<
R2< xxxxx Ω
TI INDIP zz.zz s
TA R2< xx.xx s
TA R2< cccccccc
D1C
ANSI 64R ccc R<<
D2C
TI INDIP zz.zz s
D3C
TA R<< xx.xx s
D4C
TA R<< cccccccc
RELAYS FUNCTION
F1
R1 NORM xxx
F2
R1 S1 xxxxxxxx
F3
R1 S2 xxxxxxxx
F4
R1 P1 xxxxxxxx
F5
R1 P2 xxxxxxxx
F6
R1 Q1 xxxxxxxx
F7
R1 Q2 xxxxxxxx
F8
R1 U< cccccccc
F9
R1 R1< cccccccc
F10
R1 R2< cccccccc
F11
R1 U<R cccccccc
F12
R1 R<< cccccccc
F13
TEST R1 yyyyyyyy
R2 NORM xxx
R3 NORM xxx
R4 NORM xxx
DIGITAL INPUTS
G1
DIG1 cc xxxxxxxx
G2
DIG2 cc xxxxxxxx
G3
DIG3 cc xxxxxxxx
J1
CONFIRM PROG?
To fig. 4

Figure 3

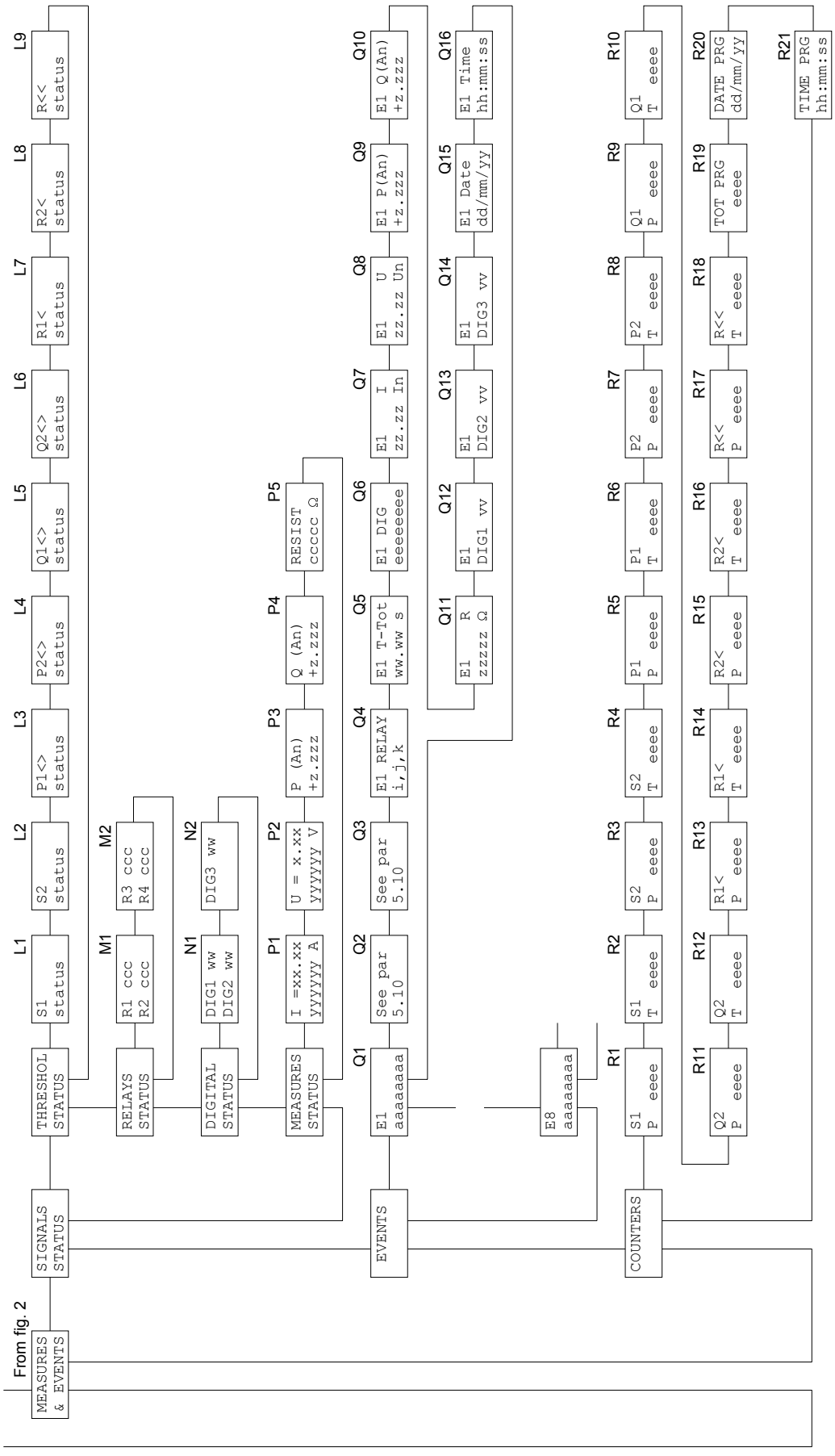

From fig. 2
MEASURES & EVENTS
SIGNALS STATUS
EVENTS
COUNTERS
THRESHOL STATUS
RELAYS STATUS
DIGITAL STATUS
MEASURES STATUS
E1 aaaaaaaa
E8 aaaaaaaa
S1 P eeee
L1 S1 status
L2 S2 status
L3 P1<> status
L4 P2<> status
L5 Q1<> status
L6 Q2<> status
L7 R1< status
L8 R2< status
L9 R<< status
M1 R1 ccc R2 ccc
M2 R3 ccc R4 ccc
N1 DIG1 ww DIG2 ww
N2 DIG3 ww
P1 I =xx.xx yyyyyy A
P2 U = x.xx yyyyyy V
P3 P (An) +z.zzz
P4 Q (An) +z.zzz
P5 RESIST ccccc Ω
Q1 E1 aaaaaaaa
Q2 See par 5.10
Q3 See par 5.10
Q4 E1 RELAY i,j,k
Q5 E1 T-Tot ww.ww s
Q6 E1 DIG eeeeeee
Q7 E1 I zz.zz In
Q8 E1 U zz.zz Un
Q9 E1 P(An) +z.zzz
Q10 E1 Q(An) +z.zzz
Q11 E1 R zzzzz Ω
Q12 E1 DIG1 vv
Q13 E1 DIG2 vv
Q14 E1 DIG3 vv
Q15 E1 Date dd/mm/yy
Q16 E1 Time hh:mm:ss
R1 S1 P eeee
R2 S1 T eeee
R3 S2 P eeee
R4 S2 T eeee
R5 P1 P eeee
R6 P1 T eeee
R7 P2 P eeee
R8 P2 T eeee
R9 Q1 P eeee
R10 Q1 T eeee
R11 Q2 P eeee
R12 Q2 T eeee
R13 R1< P eeee
R14 R1< T eeee
R15 R2< P eeee
R16 R2< T eeee
R17 R<< P eeee
R18 R<< T eeee
R19 TOT PRG eeee
R20 DATE PRG dd/mm/yy
R21 TIME PRG hh:mm:ss

Figure 4

5.3 Address and time (fig. 2)

B1 - RELAY MODEL (not programmable)

```
PQR4N
mod. XX
```

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

B2 - COMMUNICATION PROTOCOL (programmable)

B2

```
PROTOCOL
xxxxxxxx
```

The communication protocol is programmable between the followings:

STANDARD	ASCII SEB protocol
MODBUS	Modbus protocol (SLAVE)

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

B3

```
BAUDRATE
xxxx
```

The xxxx parameter is selectable between the followings:

300 - 600 - 1200 - 2400 - 4800 - 9600

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

B4 - ADDRESS (programmable)

```
NR RELAY
001
```

Programmable address from 001 to 255.

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

B5 - RELAY SERIAL NUMBER (not programmable)

```
SER. NR.
0012345
```

B6 - SOFTWARE REVISION LEVEL (not programmable)

```
SW REV
zz.zz
```

B7 - TIME/DATE (programmable)

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

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

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

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

5.4 Insertion Selection (fig. 2)

B8 - INSERTION SELECTION - ANSI 40-32 (programmable)

It is possible to select the protection relay insertion related to the voltage measurement for the ANSI 40 and ANSI 32 functions:

B8

```
VOLTAGE
xxx
```

The following selection are available:

U-D phase-phase voltage
U-Y phase-neutral voltage

5.5 Nominal values set-up (fig. 3)

C1 - NOMINAL CURRENT SELECTION In (not programmable)

```
In = jA
```

In: nominal phase current
(not programmable - see ref. B1)

C2 - PRIMARY PHASE CURRENT (programmable)

```
In prim
xxxxx A
```

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

C3 - NOMINAL LINE VOLTAGE SELECTION - Un (programmable)

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

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

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

C4 - PRIMARY VT LINE VOLTAGE (programmable)

```
U prim
xxxxxx V
```

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

C5 - 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
CURRENT	displays measured line current
VOLTAGE	displays measured line voltage
P ACTIVE	displays measured single-phase active power
Q REACT	displays measured single-phase reactive power
RESIST	displays measured resistance

The current and the voltage is displayed in primary values (the value depends on C2 and C4 set-ups)

The powers are displayed as nominal values referred to An (An= Un In, apparent nominal power)

Selection examples:

```
DISPLAY
ANSI
```

```
DISPLAY
P ACTIVE
```

```
DISPLAY
RESIST
```

C6 - DISPLAY CONTRAST LEVEL (programmable)

```
CONTRAST
LEV x
```

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

5.6 Threshold and time delays set-up (fig. 3)

5.6.1 Loss of excitation - under excitation thresholds

The information and set-ups related to threshold S1 in the following points are effective for the threshold S2 just taking into consideration the change of the threshold identification.

D1D - ON / OFF THRESHOLD (programmable)

```
ANSI 40
ccc S1
```

S1 threshold identification (S1, S2)

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

D2D - SET-UP PARAMETER K (programmable)

```
S1
K1 +n.nn
```

±n.nn value of the parameter (tangent of the angle φ)

Programming of the parameter K of the equation at paragraph 1.1.

The parameter is programmable from -2.00 to +2.00 with resolution 0.01. To select the sign or the parameter use the down arrow.

Examples:

```
S1
K1 -0.50
```

```
S2
K2 +1.50
```

D3D - SET-UP PARAMETER Qo (programmable)

```
S1 An
Qo1 y.yy
```

y.yy value of the parameter

Programming of the parameter Qo of the equation at paragraph 1.1; the parameter is expressed in terms of nominal apparent **single-phase** power An (An = Un * In) of the current and voltage transformer.

The parameter is programmable from 0.00 to 2.00 An with resolution 0.01 An.

Examples:

```
S1 An
Qo1 1.34
```

```
S2 An
Qo2 1.50
```

D4D - 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
```

D5D - ADDITIONAL TIME DELAY SET-UP (programmable)

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

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

D6D - DIGITAL INPUT ACTIVE ON THRESHOLD (not programmable)

```
TA S1
eeeeeeee
```

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

The parameter eeeeeeee can show one of the following values:

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

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

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

5.6.2 Reverse power - antimotoring thresholds (ANSI 32)

The information and set-ups related to threshold P1 in the following points are effective for the thresholds P2, Q1 and Q2 just taking into consideration the change of the threshold identification.

D1P - ON / OFF THRESHOLD (programmable)

```
ANSI 32
ccc P1
```

P1 threshold identification (P1, P2, Q1, Q2)

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

D2P - THRESHOLD LEVEL SET-UP (programmable)

```
P1 <> An
±x.xxx
```

±x.xxx threshold level expressed in SINGLE-PHASE apparent power An (An = Un * In of the current and voltage transformer)

The sign of the power value defines the position of the threshold in the P-Q diagram.

< > sign of the disequation - it shows if the power which determines the trip is placed in the right side (> - positive increasing powers) or in the left side (< - negative increasing powers) of the straight line on the P-Q diagram.

To select the sign or the parameter use the down arrow. The available settings for each threshold are listed in Table A.

Example:

```
P1 < An
-0.015
```

Threshold of active power less than -0.015 An (maximum reverse active power), therefore the relay trips with increasing negative powers sign <) when the measured power exceeds the threshold value -0.015 An (e.g. -0.020 An).

D3P - 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
```

D4P - ADDITIONAL TIME DELAY SET-UP (programmable)

```
TA P1
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 5.8).

D5P - DIGITAL INPUT ACTIVE ON THRESHOLD (not programmable)

```
TA P1
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 P1
DIG1	digital input DIG1 activates the TA delay on threshold P1
DIG2	digital input DIG2 activates the TA delay on threshold P1
DIG3	digital input DIG3 activates the TA delay on threshold P1

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

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

5.6.3 Undervoltage threshold

For the functional characteristics of the undervoltage threshold (protection functions inhibition) please refer to paragraph 1.4.

D1U - D2U - THRESHOLD LEVEL SET-UP (programmable)

D1U

```
U< ANSI
40 - 32
```

D2U

```
U<
x.xx Un
```

x.xx threshold level expressed as Un (programmable)

The available settings of the threshold are listed in Table A.

The undervoltage inhibition threshold is always active when enabled at least one of the function ANSI 32 or ANSI 40; the threshold operates instantaneously without any time delays.

5.6.4 Rotor earth fault thresholds (ANSI 64R)

The information and set-ups related to threshold R1< in the following points are effective for the threshold R2< just taking into consideration the change of the threshold identification.

D1R - ON / OFF THRESHOLD (programmable)

```
ANSI 64R
ccc R1<
```

R1< threshold identification (R1<, R2<)

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

D2R - THRESHOLD LEVEL SET-UP (programmable)

```
R1<
xxxxx Ω
```

xxxxx threshold level expressed in Ohm

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

Example:

```
R1<
02500 Ω
```

D3R - 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
```

D4R - ADDITIONAL TIME DELAY SET-UP (programmable)

```
TA   R1<
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 5.8)

D5R - DIGITAL INPUT ACTIVE ON THRESHOLD (not programmable)

```
TA R1<
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 R1<
DIG1	digital input DIG1 activates the TA delay on threshold R1<
DIG2	digital input DIG2 activates the TA delay on threshold R1<
DIG3	digital input DIG3 activates the TA delay on threshold R1<

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

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

5.6.5 Rotor earth fault threshold R<< (ANSI 64R)

D1C - ON / OF THRESHOLD (programmable)

```
ANSI 64R
ccc R<<
```

R<< threshold identification

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

This threshold is not active when the measured voltage on the rotor circuit is greater than 10 Vca. When the measured voltage is lower than 10 V the thresholds will be automatically activated and only the module of the measured current is taken into consideration with the two following actions:

- current module ≥ 50 mA - TRIP threshold **R<< (if enabled)**
- current module < 50 mA - ANSI 64R function inhibition (loss of voltage V c.a. or fault in the GAR module)

D2C - 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
```

D3C - ADDITIONAL TIME DELAY SET-UP (programmable)

```
TA R<<
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 5.8)

D4C - DIGITAL INPUT ACTIVE ON THRESHOLD (not programmable)

```
TA R<<
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 R<<
DIG1	digital input DIG1 activates the TA delay on threshold R<<
DIG2	digital input DIG2 activates the TA delay on threshold R<<
DIG3	digital input DIG3 activates the TA delay on threshold R<<

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

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

5.7 Output relays programming (fig. 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 S1 (programmable)

```
R1 S1
xxxxxxxx
```

Programming of the R1 output relay activation (START or TRIP) on the S1 threshold.

The parameter xxxxxxxx is selectable as the following:

START	R1 output relay activation on the S1 threshold
TRIP	R1 output relay activation on the S1 threshold
NONE	no activations related to the S1 threshold

F3 ÷ F12 - OUTPUT RELAY ACTIVATION ON THRESHOLDS STATUS S2, P1, P2, Q1, Q2, R1<, R2<, R<<, U<R (programmable)

Examples:

```
R1 U<
xxxxxxxx
```

```
R1 Q2
xxxxxxxx
```

```
R1 R2<
xxxxxxxx
```

Programming of the R1 output relay activation (NONE, START, TRIP) on the thresholds status.

NOTE: the output relays related to the threshold U<R do not have the START function.

F13 - 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).

When function a) is programmed, a message is displayed at ref. D6D, D5P, D5R and D5R 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.

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 S1	additional time delay on the threshold S1
TA S2	additional time delay on the threshold S2
TA P1	additional time delay on the threshold P1
TA P2	additional time delay on the threshold P2
TA Q1	additional time delay on the threshold Q1
TA Q2	additional time delay on the threshold Q2
TA R1<	additional time delay on the threshold R1<
TA R2<	additional time delay on the threshold R2<
TA R<<	additional time delay on the threshold R<<
TA ALL	additional time delay on all thresholds
OF S1	threshold S1 disabled
OF S2	threshold S2 disabled
OF P1	threshold P1 disabled
OF P2	threshold P2 disabled
OF Q1	threshold Q1 disabled
OF Q2	threshold Q2 disabled
OF R1<	threshold R1< disabled
OF R2<	threshold R2< disabled
OF R<<	threshold R<< disabled
OF ALL	all thresholds disabled
STATUS	activation of status function (see paragraph 1)

G2 - DIGITAL INPUT DIG2 SET-UP (programmable)

```
DIG2 cc
xxxxxxxx
```

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

MONITOR activation of pilot wire monitor function.

G3 - DIGITAL INPUT DIG3 SET-UP (programmable)

```
DIG3 cc
xxxxxxxx
```

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

5.9 Parameter values visualization (fig. 4)

L1 ÷ L9 - THRESHOLDS STATUS

The actual status of each threshold is displayed. For each threshold are displayed the threshold identification (S1, R1< 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. 5.6)
OFF_DIG	threshold programmed active but momentary disabled by a digital input actual status (ref. G1, G2, G3 see par. 5.8)

Examples:

```
S1
ON
```

```
P1<
OFF
```

```
P2>
ON
```

```
R1<
OFF_DIG
```

NOTE: The threshold U< is always active (ON), therefore it will not be presented.

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 - P4 - P5 - MEASUREMENT DISPLAY

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

P1	P2	P3	P4	P5
I=xx.xx yyyyy A	U= xx.xx yyyyyy V	P (An) ± x.xxx	Q (An) ± x.xxx	RESIST ccccc Ω

When the resistance is greater than 40 kΩ it will displayed the following:

```
RESIST
>40000 Ω
```

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.

Q1 - EVENT NUMBER

```
E1
cccccccc
```

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

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

NONE	no event memorized
S1	event on trip threshold S1
S2	event on trip threshold S2
P1	event on trip threshold P1
P2	event on trip threshold P2
Q1	event on trip threshold Q1
Q2	event on trip threshold Q2
R1<	event on trip threshold R1<
R2<	event on trip threshold R2<
R<<	event on trip threshold R<<
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 - Q3 - DISPLAY OF THE PARAMETERS RELATED TO THE TRIP THRESHOLD

Trip thresholds S1 or S2 - ANSI 40

Q2	Q3
E1 S1 K1 +1.30	E1 S1 Qo1 0.85

See ref. D2D and D3D, paragraph 5.6.1

Trip thresholds P1, P2, Q1 o Q2 - ANSI 32 (Q2 only)

Q2

```
E1 P1<
-0.015
```

See ref. D2P paragraph 5.6.2

Trip thresholds R1< or R2< - ANSI 64R (Q2 only)

Q2

```
E1 R2<
03000 Ω
```

See ref. D2R paragraph 5.6.4

Trip thresholds R<< - ANSI 64R (Q2 only)

When the measured current is greater than 50 mA and the measured voltage lower than 10 Vac:

Q2

```
E1 R<<
200 Ω
```

When the measured current is lower than or equal to 50 mA and the measured voltage lower than 10 Vac:

Q2

```
E1 U<R
10 Volt
```

Q4 - ACTIVATED OUTPUT RELAYS

```
E1 RELAY
nnnnnnn
```

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

Examples:

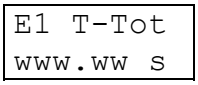
```
E1 RELAY
1,3,4
```

```
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:

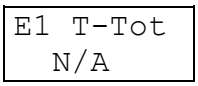
```
E1 RELAY
NONE
```

Q5 - TOTAL TIME DELAY TO TRIP

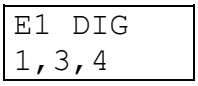


It is shown the total delay to the TRIP of the output relays from the detection of a measured parameter which exceed the related threshold value; when additional delays are activated, the change of the status of the digital input that controls the additional delay during the delay itself could bring 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.



Q6 - DIGITAL CHANNELS RELATED TO MEMORIZED EVENT

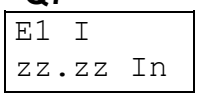


The list of the digital inputs related to the memorized event is displayed (STATUS function command or additional time TA enabled - rif. E4 par. 5.8).

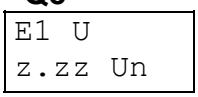
If no digital inputs were activated, the message **NONE** is displayed.

Q7 - Q8 - Q9 - Q10 - Q11 - MEMORIZED MEASURES ON EVENT

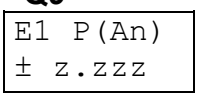
Q7



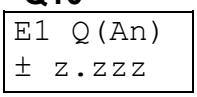
Q8



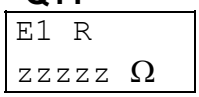
Q9



Q10



Q11

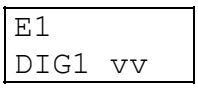


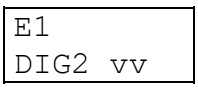
The values of the measured parameters at the event are displayed.

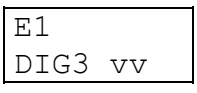
The current and the voltage are presented in terms of relative units (In or Un) and the single-phase active and reactive powers are presented in terms single-phase nominal apparent power An (Un * In of the installed CT and VT).

The resistance is expressed in Ohm.

Q12 - Q13 - Q14 - DIGITAL INPUTS STATUS ON EVENT







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

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

Q15 - Q16 - DATE AND TIME OF THE EVENT

E1 Date	E1 Time
dd/mm/yy	hh:mm:ss

The date and time of the event are showed

5.11 Trip 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 ÷ R18 - TRIP COUNTERS

R1	R2
S1	S2
P 0035	T 0084

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

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

The counters are identified by the threshold name (S1, S2, P1, P2, Q1, Q2, R1<, R2<, R<<); 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).

R19 ÷ R21 - 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

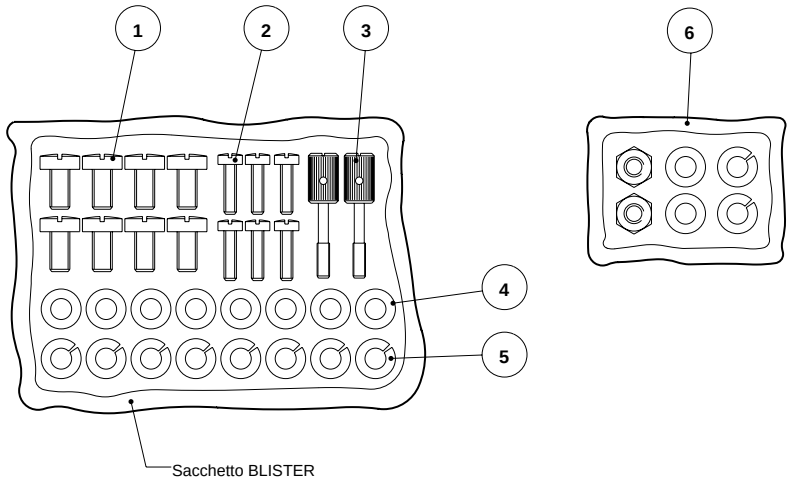
6.1 Supplied kit

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

- protection relay module UAR4N 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 PQR4N with rear socket
- transparent front panel for rack flush mounting installation
- n° 2 brackets for flush mounting
- blister with items 1-2-3-4-5
- blister with item 6



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

The knobs to fix the transparent front panel must be screwed through the front panel itself; the operation will create a screw thread in the plastic material to prevent knob missing.

NOTE The items related to current inputs are the standard supplied items with all SIGMA-N protection relays but for the PQR4N model they are partially 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 1 - 3	voltages with Un programmed from 190 to 380 V
	terminals 2 - 3	voltages with Un programmed from 0 to 125V
UR	terminals 17 - 18	voltage from GAR module

Other circuits(output relays etc.)

It is suggested to terminate the wiring using plug terminals.

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

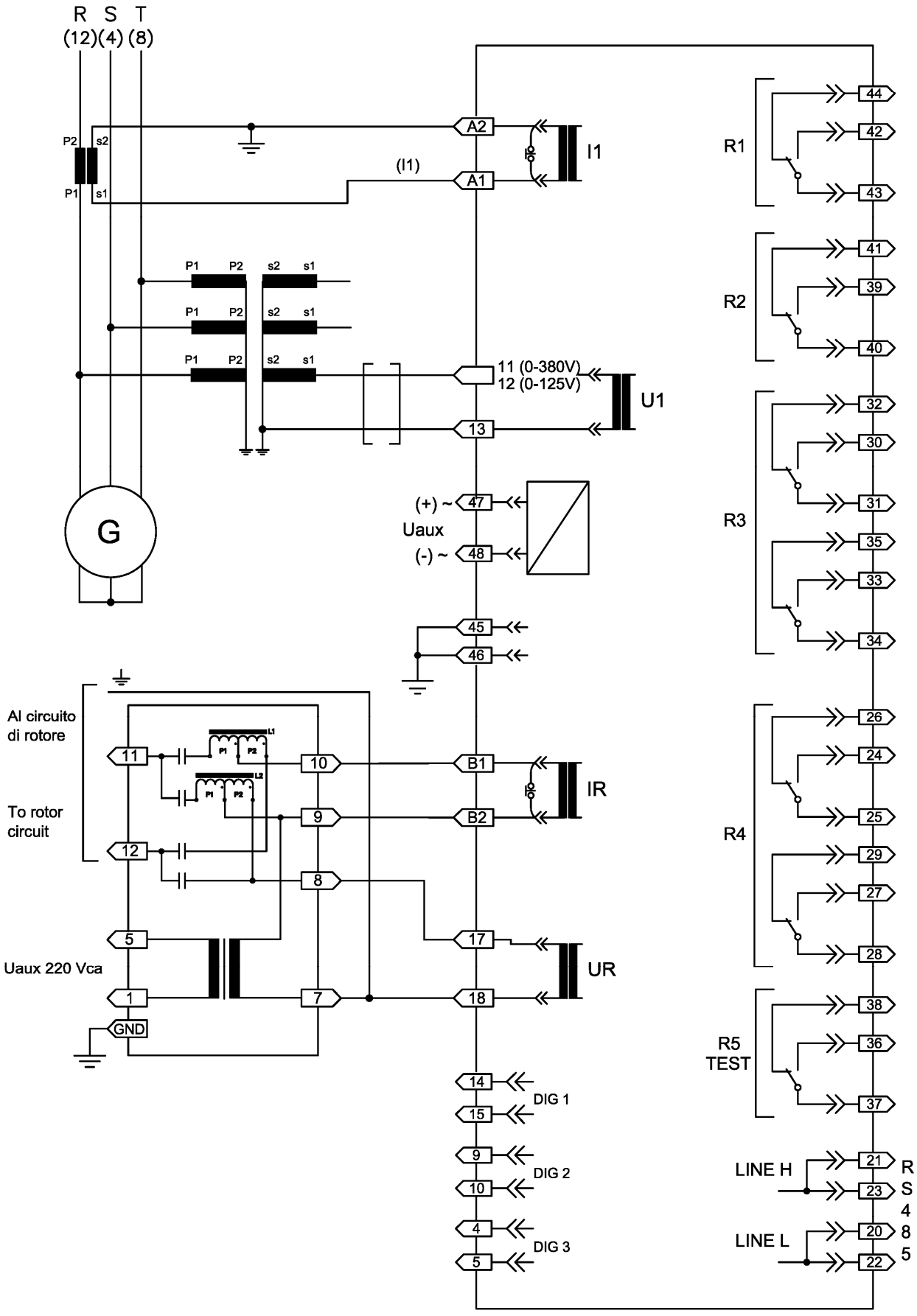
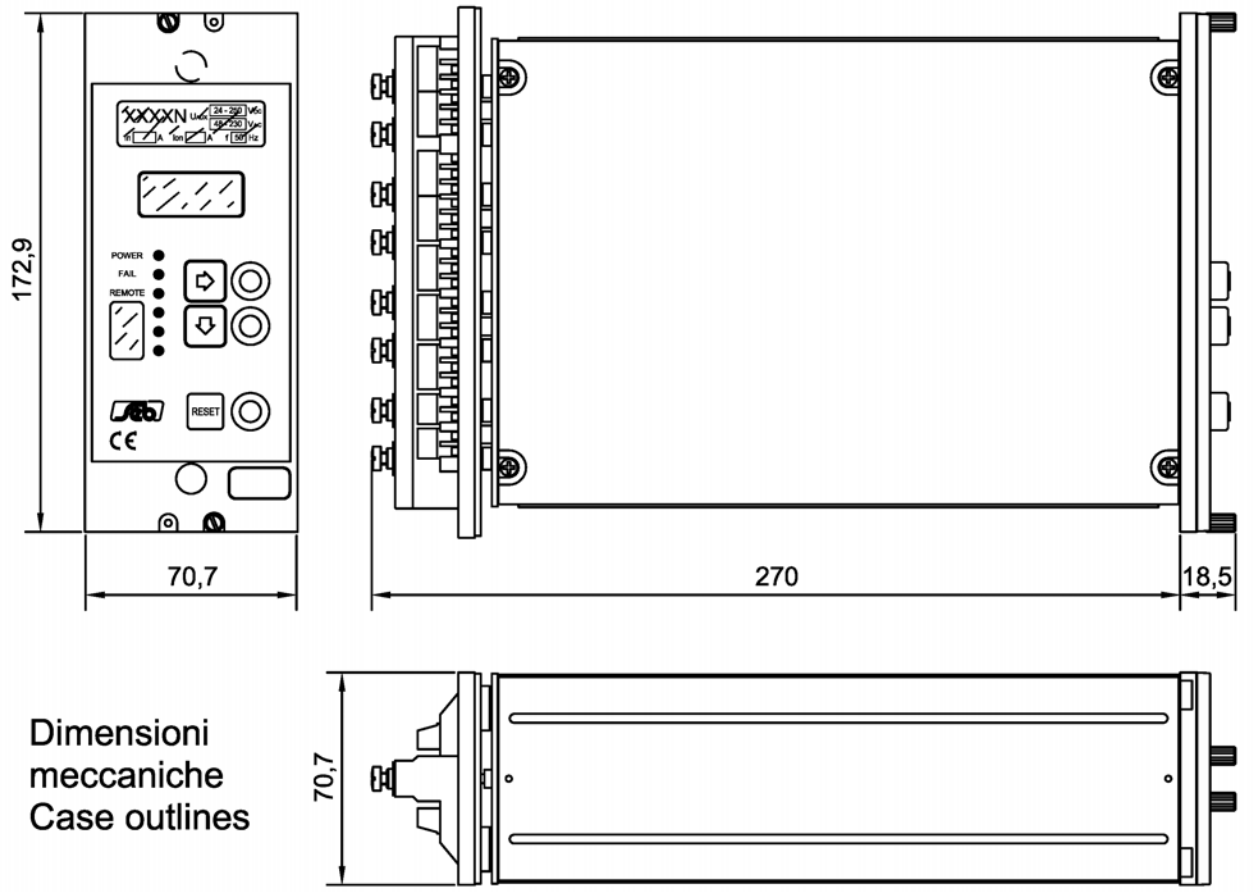
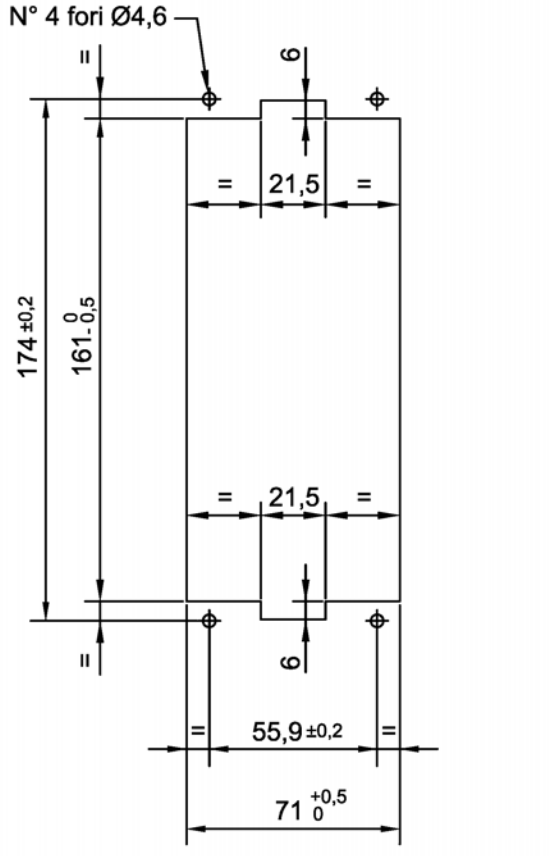


Figure 5 - PQR4N INSERTION



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:

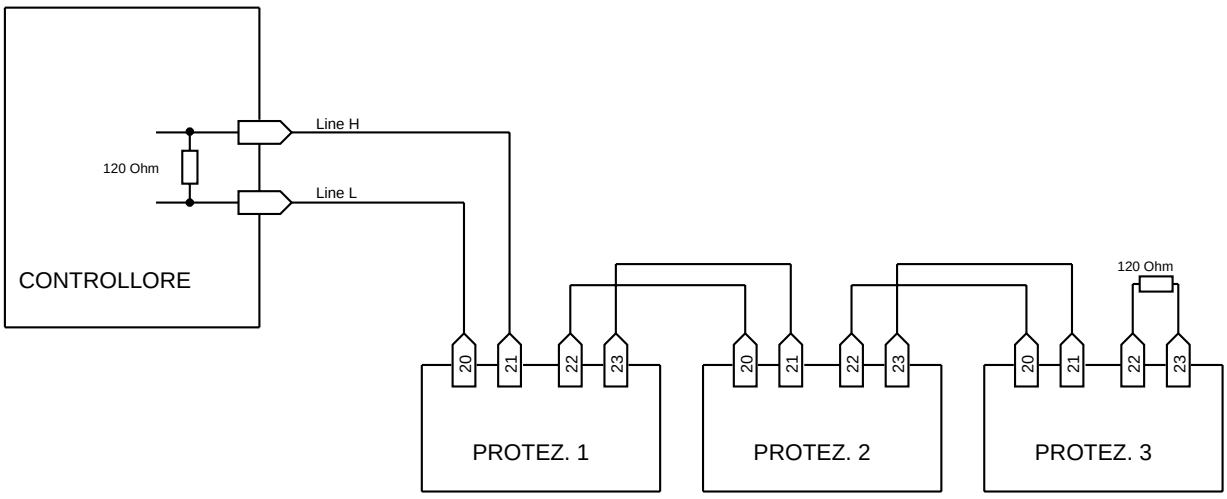
6.4 RS485 serial communication port

The digital protection relay PQR4N presents an insulated serial interface RS485 half-duplex that allow the multi-drop connection up to 31 protection units.

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; the documentation related to the protocol is freely available on request.

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

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 TECHNICAL CHARACTERISTICS

Measuring inputs (ANSI 40-32)

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

Output contacts ratings

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

Digital inputs

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

Data transmission

Standard	RS485 half duplex
Communication protocol	MOD-BUS ASCII
Transmission speed	300 - 9600 baud selectable
Optional	fibre optic module

Auxiliary supply

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

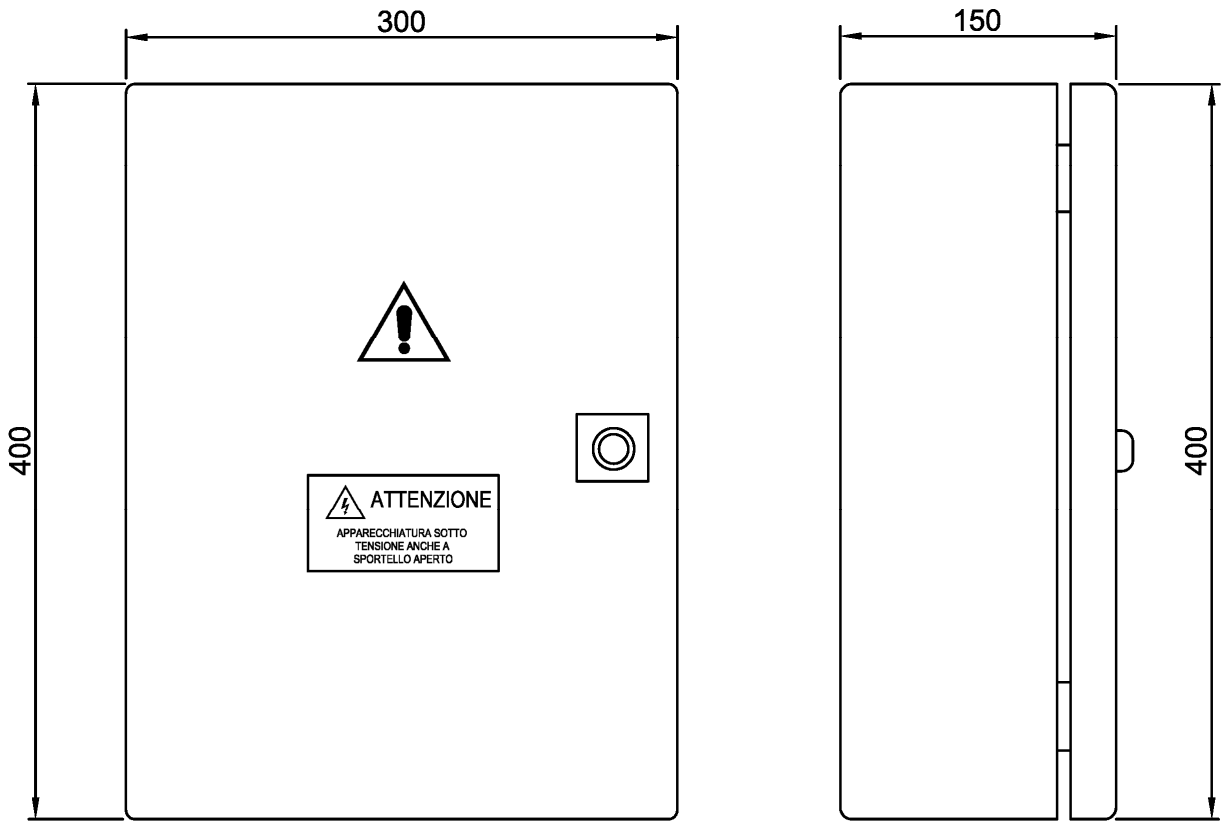
Environmental conditions

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

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

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

8 ROTOR VOLTAGE INJECTION UNIT



Case outlines - Fig. 6

8.1 GAR module Technical characteristics

Auxiliary supply	
Range	220 Vac ± 20%
Frequency (Vac)	47 / 63 Hz
Burdens (max)	50 VA
Environmental conditions	
Operation	- 10 / +60 °C
Transport and storage	- 25 / +80 °C
Relative humidity (without condensation)	< 95%
Protection degree	To be installed in a cabinet
Weight	8 kg
Mounting	wall mounting

9 TABLES

Table A: Settings

ANSI	THRESHOLDS		Settings	Resolution
40	**K1, K2**	Tangent angle φ (see fig. 1)	-2.00 ÷ +2.00	0.01
	Qo1, Qo2	Parameter Qo - fig. 1	0.00 ÷ 2.00 An	0.01 An
32	**P1, P2**	Active power thresholds (Note 1)	-1.500 ÷ 1.500 An	0.005 An
	Q1, Q2	Reactive power threshold (Note 1)	-1.500 ÷ 1.500 An	0.005 An
32 - 40	**U<**	Undervoltage inhibition threshold	0.20 ÷ 1.20 Un	0.01 Un
64R	**R1<, R2<**	Minimum resistance insulation threshold	200 ÷ 40000 Ω	10 Ω
	U<R	Undervoltage threshold ANSI 64R	10 V	
		Trip R<<	if I ≥ 50 mA	
		Inhibition ANSI 64R	if I < 50 mA	
DELAYS				
Definite delay		All threshold (ANSI 40 - 32 - 64R)	0.02 ÷ 99.99 s	0.01 s
Additional delay		All thresholds	0.00 ÷ 99.99 s	0.01 s
OTHER PARAMETERS				
Drop-off ratio			≥ 0.95 (max thresholds) or ≤ 1.05 (min thresholds)	

Note 1: The sign of the disequation < or > is programmable for each threshold

SEB DIVISIONE ELETTRONICA E SISTEMI - UFFICIO COMMERCIALE
Via Segantini, 5 - 20825 BARLASSINA (MB) - **tel.** +39 0362 5669.1 - **fax** +39 0362 556622
web: www.seb-barlassina.it
mail to: servizio-clienti@seb-barlassina.it