DIVISIONE ELETTRONICA E SISTEMI

CU90N

VOLTAGE REGULATING UNIT
VOLTAGE EQUALIZING UNIT

USER MANUAL

P500D818 **August 2004**

INDEX

1 GENERAL CHARACTERISTICS

The CU90N unit belongs to SIGMA-N digital protection line and it performs functions as voltage regulating unit for transformers equipped with tap changer or voltage equalizing unit for generator paralleling (jointly with the SCK4N unit it performs function as automatic synchronizing and coupler device).

The user can select one of the functional modes listed below:

Functions	ANSI
Voltage regulating unit for tap changer control	90
Voltage equalizer unit for automatic synchronizing of generators	25A

All the functions of the unit 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.

OPERATING MODES - the CU90N unit manages the following functional modes:

- voltage regulating unit for transformers equipped with tap changer
- voltage equalizer for generator paralleling

The two operating modes are independent and only one at the same time can be selected

The User Manual is divided into two separate sections, one for each mode, as the programming data is different for each operating mode.

THRESHOLDS – when the operating mode **VOLTAGE REGULATING** is active, the following voltage and current thresholds are available:

- undervoltage threshold U<
- overvoltage threshold U>
- maximum compensation current Ia>
- overload threshold I>
- overcurrent threshold (short circuit) I>>
- current unbalance alarm threshold Id>

The **I>>** and **Id>** thresholds can be used to disable the regulating operations.

When the operating mode **VOLTAGE EQUALIZING** is active there are **ONLY AVAILABLE** an undervoltage threshold (**U<**) and an overvoltage threshold (**U>**) to disable the equalizing function.

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

OUTPUT RELAYS – there are available 4 output relays (R1, R2, R3, R4); the output relays can be programmed to issue raise (**AUM**) or lower (**DIM**) commands; the commands can be issued as:

- definite time
- dependent time (as function of the voltage difference)
- continue commands

The output relays can also be programmed for alarm tripping on the following conditions:

- undervoltage **U<** or overvoltage **U>**
- overcurrent threshold **I>>**
- unbalanced currents thresholds **Id>**
- reverse power (the regulating operations remain enabled)
- regulating function disabled (for any cause)
- condition $|B| \geq 1$ (voltage regulation or equalization in progress)

The output relays activation related to the thresholds I>, I>>, Id> and to the reverse power condition detection are available only with the **VOLTAGE REGULATOR** (ANSI 90) operation mode.

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.

With the VOLTAGE REGULATOR operating mode partial and total counters of the issued commands are available (under normal operation and under overload operation).

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

- on/off voltage regulating or equalizing function
- tap changer position (VOLTAGE REGULATOR mode)
- selection of alternative parameters set (Vp2 and Z2) for voltage regulation
- recording of measures on external event
- pilot wire fault monitoring (only digital input DIG2)

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

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

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

DISPLAY OF MEASURES - the user can select the continuous display of a measured parameter such as:

- measured voltage
- measured voltage difference

- measured line current (only VOLTAGE REGULATION mode)

EVENTS - information related to the last 8 events such as external anomaly detection, alarm on thresholds I>> or Id>, external command (STATUS) or POWER ON condition are recorded in the EEPROM memory.

Information includes the event code, the activated relays (if any), the measured parameters, the digital input status, the main set-up data and the 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 CU90N unit.

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 unit functions are suspended to avoid unsuitable tripping.

STATUS FUNCTION - when the STATUS function is activated by one of the digital input (when programmed) the CU90N unit memorizes information related to measured parameters and digital input status (see par. 6.9 and 7.9 - EVENTS). The recorded information allows an analysis of the installation parameters when an external event is detected (e.g. trip of protection relays, circuit breaker open etc.).

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 unit 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 unit set-up but changes of parameters are disabled (ENTER and ⊞ buttons disabled).

1.1 Voltage REGULATION mode (ANSI 90)

The description of the displayed information for the VOLTAGE REGULATION operation mode is shown in paragraph 6 figure 1, 2 and 3.

The CU90N voltage regulating unit is used to control the secondary voltage of a transformer equipped with on-load tap changer (insertion - fig. 6 and 7).

The CU90N unit delivers commands to the tap charger when the controlled voltage **Va** (input transducer **U3**) differs from the programmed reference voltage value **Vp** more than a programmed quantity.

This voltage difference, called degree of insensibility α, must be programmed taking into consideration the value of the steps of the changer.

If the regulated value is the voltage at the end of a transmission line, the CU90N unit can compensate the line voltage drop using the “CURRENT COMPENSATION“ function.

In paragraph 9 is presented an example of parameter set-up with current compensation function.

Regulation algorithm
The condition which determines the issue of commands to the changer is the following:

$$|B| \geq 1$$

where

$$B = \frac{(Va - Vp - Z * Ia * Vp)}{\alpha * Vp}$$

Vp programmed reference voltage (Un)
Va measured voltage (Un)
Z current compensation coefficient
Ia measured current - input I1 (In)
α insensibility degree (%)

The issue of commands will continue as long as the module of **B** is higher than 0.7; an output relay can be activated to signal the regulating process in progress (selection |B| > - ref. F10, paragraph 6.6)

The type of the issued command is function of the B sign:

B > 0 LOWER command (DIM)
B < 0 RAISE command (AUM)

Two set-up values are available (**Vp1, Z1** and **Vp2, Z2**) and selectable by an external command (digital input) to take into consideration two different configuration of the installation.

The maximum allowed value for the compensation current **Ia** can be defined (threshold **Ia>**); when the measured current exceeds the **Ia>** threshold the compensation algorithm will consider **Ia = Ia>**.

When a command **AUM** or **DIM** is issued the related counters (partial and total) are increased; there are also available counters related to the command issue under normal condition (CMNOR) and counters related to command issue under overload condition (CMSVR), where overload condition is detected when the flowing current is higher than I> threshold.

Command timing
The duration **TCOM** of the **AUM / DIM** commands is programmable (definite time) to match the characteristics of the tap changer.

The time delay between two commands can be programmed as:

definite time TI

inverse time $T = \frac{K}{|B|}$

exponential time $T = K * 2^{(1-|B|)}$

continue (the command will be issued until $|B| > 0.7$)

The definite time selection is preferable when step-down transformers in cascade are equipped with tap changer.

When dependent time functions are used, it is available a programmable minimum time delay **To** between the issue of two consecutive commands.

Operation disabling
The voltage regulation operations can be disabled by:

- external command (digital input)
- detection of anomaly condition such as:
  - under or over voltage (**U<**, **U>**)
  - overcurrent (threshold **I>>**)
  - tap changer signals inconsistency
  - command inconsistency
  - reverse power flowing in the controlled transformer

The disabling causes are programmable (except **U<** and **U>** always active).

Tap changer signals inconsistency
The voltage regulation function can be disabled when the CU90N unit verifies more than one of the digital inputs programmed to detect the tap changer position are active (signals **ESTRPOS, ESTRNEG, INTER**), where:

ESTRPOS	highest position (positive)
ESTRNEG	lowest position (negative)
INTER	intermediate position

The check of the status (and the disable condition of the voltage regulation function) is performed only if the specific blocking function has been enabled in the programming section.

Command inconsistency
The voltage regulation function can be disabled when the CU90N unit verifies that one of the digital inputs programmed to detect the extreme tap changer position (signals **ESTRPOS** and **ESTRNEG**) is active in the following condition:

$|B| \geq 1$, $B>0$ (command DIM issue), active digital input ESTRPOS

$|B| \geq 1$, $B<0$ (command AUM issue), active digital input ESTRNEG

The check of the status (and the disable condition of the voltage regulation function) is performed only if the specific blocking function has been enabled in the programming section.

Reverse power
The voltage regulation function can be disabled when the CU90N unit verifies the reverse power flow in the controlled transformer (power flowing from the MV side of the transformer); the regulation function can be disabled if the measured angle between the current **Ia** (transducer **I1**) and the voltage **Va** (transducer **U3**) in the angular sector:

$\Phi a \pm 90°$ (where **Φa** is programmable from -180° to +180°)

The disable condition of the voltage regulation function is performed only if the specific blocking function has been enabled in the programming section; if the blocking function has not been programmed, when the reverse power condition is detected, the CU90N unit will operate considering the parameter **Z = 0**.

Unbalanced load alarm
It is available the **2TRAFO** insertion mode (see insertion fig. 7) to allow the management of 2 parallel operating transformers (with the same electrical characteristics and tap changer). The two transformers can be managed with the same CU90N regulating unit.

With reference to figure 7, the CU90N unit controls the two transformers TR1 and TR2, reading the currents flowing in TR1 and TR2.

The AUM/DIM commands are delivered to both transformers (the control inputs of the two tap changer must be connected in parallel), taking into consideration for the regulating algorithm the current flowing in TR1.

The CU90N unit verifies that the difference between the current flowing in TR2 and TR1 will be lower then the programmable threshold **Id>**.

The current threshold **Id>** defines the maximum allowed vector difference between the current **Ia** flowing in TR1 (**I1** input) and the current **I2** flowing in TR2 (**I2** input).

The threshold **Id>** can be programmed to activate an output relay for alarm signaling (with related programmable time delay to activation).

1.2 Voltage EQUALIZING mode (ANSI 25A)

The CU90N unit is used to equalize the generator voltage to the grid voltage for automatic paralleling of generators (see insertion fig. 8).

The CU90N unit delivers commands to generator voltage regulation unit when the measured voltage **Va** (generator side - transducer **U3**) differs from the measured voltage **Vl** (network side - transducer **U4**) more than a define value.

The degree of insensibility α must be programmed depending on the regulator characteristics.

Regulation algorithm
The condition which determines the issue of commands to the changer is the following:

$$|B| \geq 1$$

where

$$B = \frac{Va - Vl}{\alpha * Vl}$$

Vl measured voltage – network side (Un)
Va measured voltage – generator side (Un)
α insensibility degree (%)

The issue of commands will continue as long as the module of **B** is higher than 0.7; an output relay can be activated to signal the regulating process in progress (selection $|B|$ > - ref. F7, paragraph 7.6)

The type of the issued command is function of the B sign:

B > 0 LOWER command issue (**DIM**)

B < 0 RAISE command issue (**AUM**)

Command timing
The duration **TCOM** of the **AUM / DIM** commands is programmable (definite time) to match the characteristics of the voltage regulator of the generator.

The time delay **between two commands** can be programmed as:

definite time TI

inverse time $T = \frac{K}{|B|}$

exponential time $T = K * 2^{(1-|B|)}$

continue (the command will be issued until $|B| > 0.7$)

When dependent time functions are used, it is available a programmable minimum time delay **To** between the issue of two consecutive commands.

Blocking functions
The voltage equalizing function can be blocked by:

- external command (digital input)
- detection of under or over voltage condition (**U<**, **U>**) on network side (**Vl**)

The blocking functions related to voltage thresholds are always active.

2 FRONT PANEL KEYS

The 5 push-buttons on the front panel allow to visualize all the parameters and to modify the CU90N unit set-up.

right arrow

down arrow

programming session activation or parameter confirmation

change or increment of the selected parameter

reset of the CU90N unit (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 Figures 1, 2, 3, 4 and 5.
- when the sealable transparent front panel is installed only the arrow push-buttons and the RESET push-button are accessible to prevent unauthorized modification of the unit set-up.

MODIFICATION OF PARAMETERS

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

3 FRONT PANEL LED SIGNALING

POWER (green)	⊗	auxiliary supply available
FAIL (red)	⊗	fault condition detected by SELF-DIAGNOSIS software or by PILOT WIRE FAULT MONITORING function
REMOTE (red)	⊗	communication session active on RS485 port
COM (red)	⊗	regulation or equalizing in progress (B module ≥ 1)
AN EXT (red)	⊗	external anomaly condition detected
BLK (red)	⊗	regulation or equalizing operations disabled

4 PROGRAMMING AND TEST

The CU90N unit is easily programmable following the instructions in the next paragraphs:

- HOW TO PROGRAM THE UNIT
- HOW TO MODIFY A VISUALIZED PARAMETER

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

4.1 How to program the unit

The programmable parameters are showed in Figures 1, 2, 3, 4 and 5 at the following references:

B2÷B7	unit protocol, address (RS485) and date/time
C1, C2	functional mode selection and insertion
D1÷D6	nominal values, contrast etc.
E1÷E8	functional parameters, thresholds and enabling
F1÷F11	output relays functions
G1÷G3	digital input functions
R1÷R4	partial counters reset (REGULATING mode only)

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 unit set-up

5) **CONFIRM** the new unit set-up at the visualization CONFIRM PROG? (Fig. 1, ref. J1) within 5 minutes depressing the push-buttons [**ENTER**] and ⊕ up to visualize **YES** and [**ENTER**] again to confirm.

NOTE: The unit will continue 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 set-up.

If the new set-up is not confirmed within 5 minutes from the last pressed push-button, the unit visualizes again the previous set-up (the parameters set-up that the unit 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 unit 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. 2, ref. F11 and Fig. 4, ref. F8) it is possible to command an output relay (one at the time) to trip from the current status allowing functional tests on electrical plants.

The output relays are activated with the following sequence:

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

```
TEST R1
OFF
```

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

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

```
TEST R1
ON
```

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

The relay will stay on the new condition until:

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

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

5 DISPLAY AND PROGRAMMING

The contents and the structure of the displayed messages are shown in figures 1, 2, 3, 4 and 5; the references A1, B1, B2 etc. identify specific displayed messages in the figures.

The figure 1 (main menu) is applicable for all operation modes, whilst the remaining figures are applicable as following:

Figure 2 and 3	**VOLTAGE REGULATING MODE**	paragraph 6
Figure 4 and 5	**VOLTAGE EQUALIZING MODE**	paragraph 7

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 unit status.

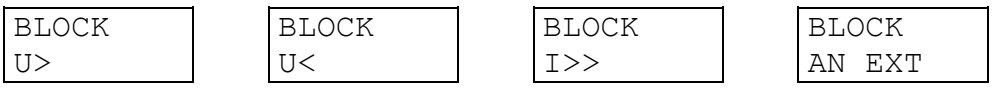
NORMAL OPERATIONS
During this state the following information can be visualized (as defined by set-up):

- **Unit function (ANSI code)** - the display shows the ANSI codes of the enabled functions (see ref. C1).

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

The measure is visualized as primary values; when the selected measure is not managed by the operating mode (incoherent selection) no values will be presented.

TEMPORARY BLOCKED REGULATION or EQUALIZING OPERATIONS
When the temporary block condition of the regulation or equalizing function occurs, the following messages will be presented:



BLOCK U>	disabled for overvoltage condition (always active)
BLOCK U<	disabled for undervoltage condition (always active)
BLOCK I>>	disabled for overcurrent condition (if function enabled)
BLOCK AN EXT	disabled for external anomaly detection (if function enabled)
BLOCK INV ALIM	disabled for reverse power condition (if function enabled)

For the blocking function programming (function ON / OFF) please refer to paragraph 6.5 (only for the VOLTAGE REGULATION mode).

The message of the blocking cause will be shown as long as the blocking condition is present.

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 unit and contact SEB post sales service

5.2 Visualization structure

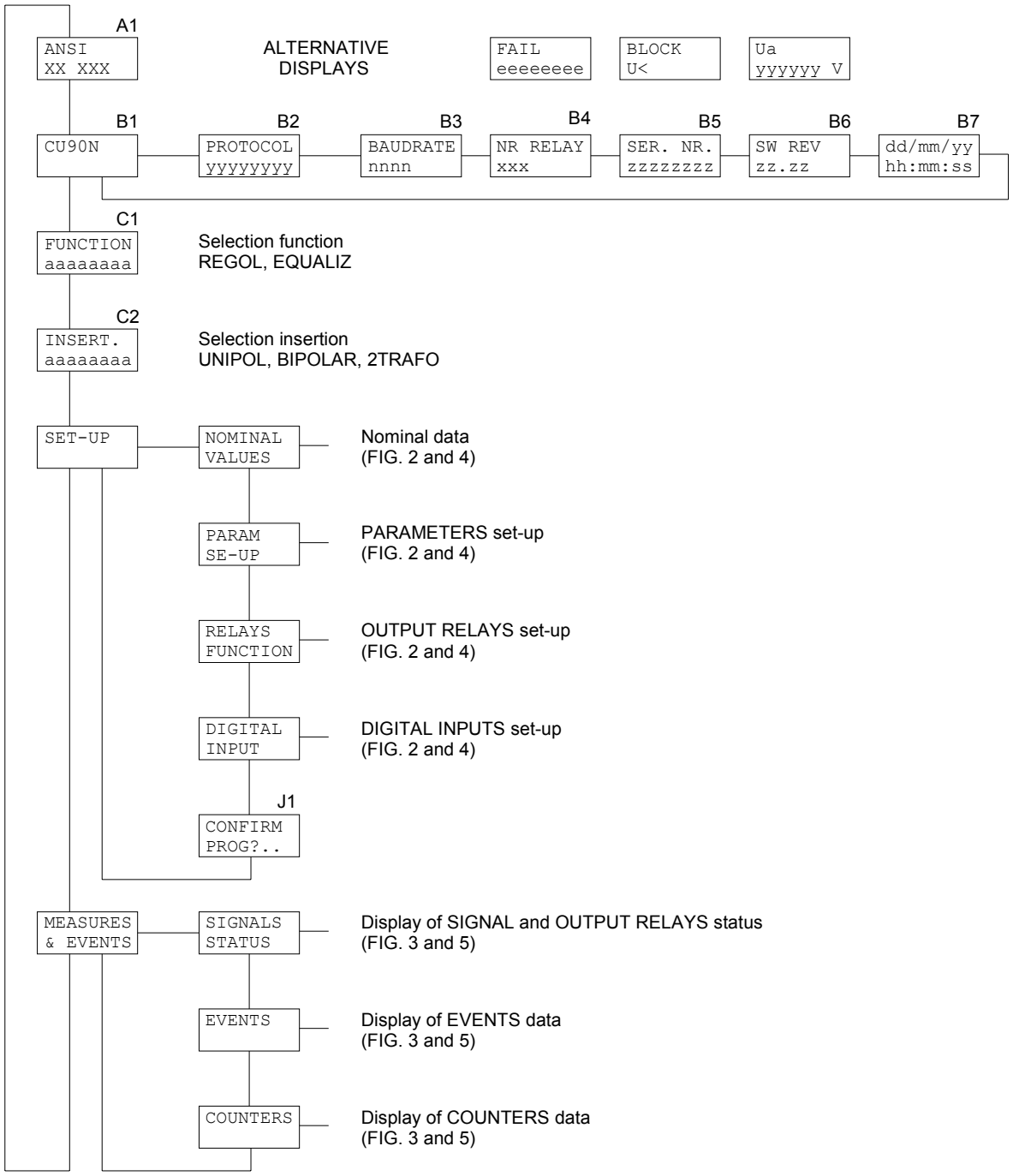


Figure 1

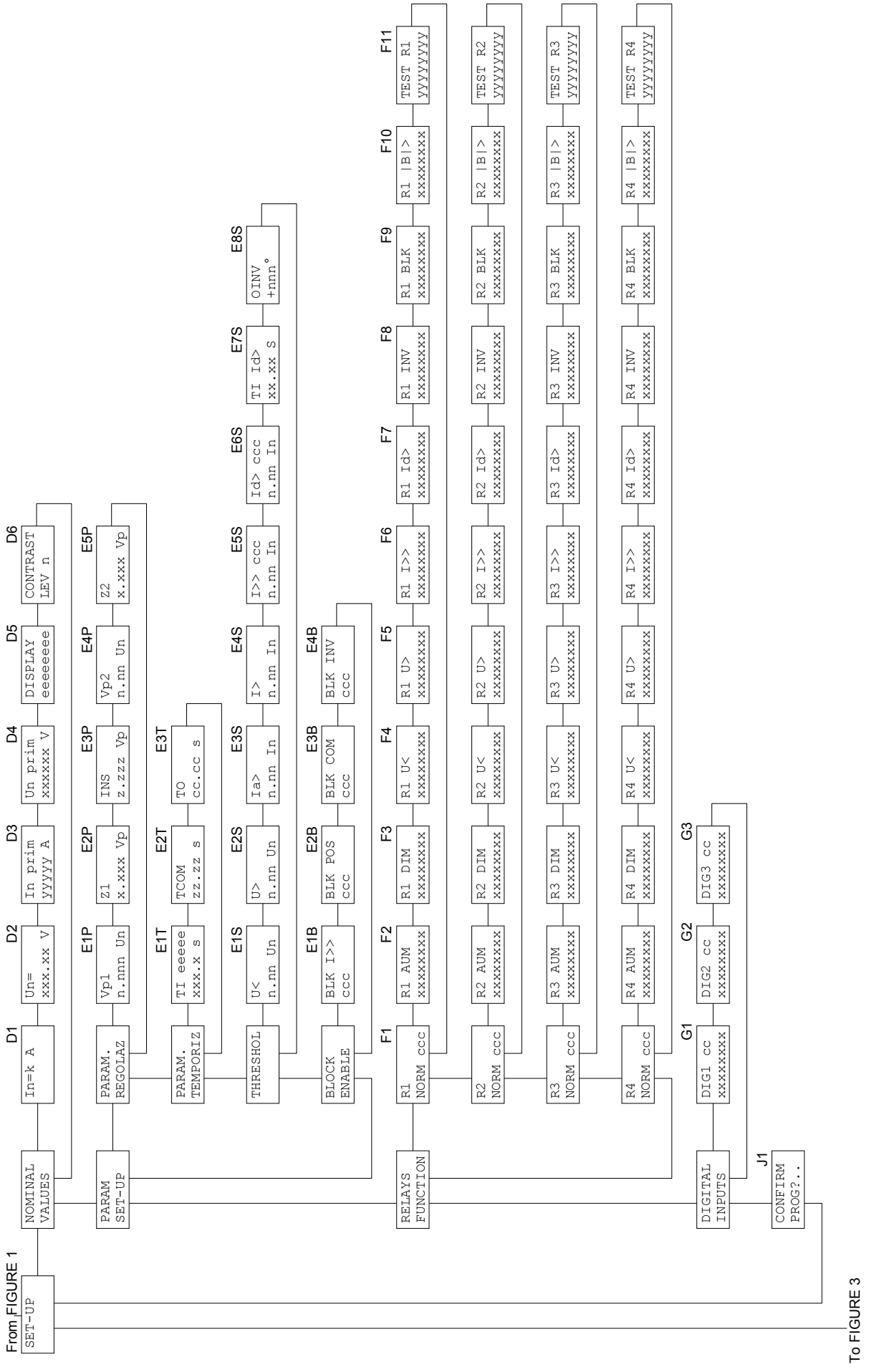

From FIGURE 1
SET-UP
NOMINAL VALUES
PARAM SET-UP
RELAYS FUNCTION
DIGITAL INPUTS
J1
CONFIRM PROG?..
To FIGURE 3
D1
In=k A
D2
Un= xxx.xx V
D3
In prim yyyyy A
D4
Un prim xxxxxx V
D5
DISPLAY eeeeeeee
D6
CONTRAST LEV n
PARAM. REGOLAZ
E1P
Vp1 n.nnn Un
E2P
Z1 x.xxx Vp
E3P
INS z.zzz Vp
E4P
Vp2 n.nn Un
E5P
Z2 x.xxx Vp
PARAM. TEMPORIZ
E1T
TI eeeee xxx.x s
E2T
TCOM zz.zz s
E3T
TO cc.cc s
THRESHOL
E1S
U< n.nn Un
E2S
U> n.nn Un
E3S
Ia> n.nn In
E4S
I> n.nn In
E5S
I>> ccc n.nn In
E6S
Id> ccc n.nn In
E7S
TI Id> xx.xx s
E8S
OINV +nnn°
BLOCK ENABLE
E1B
BLK I>> ccc
E2B
BLK POS ccc
E3B
BLK COM ccc
E4B
BLK INV ccc
F1
R1 NORM ccc
F2
R1 AUM xxxxxxxx
F3
R1 DIM xxxxxxxx
F4
R1 U< xxxxxxxx
F5
R1 U> xxxxxxxx
F6
R1 I>> xxxxxxxx
F7
R1 Id> xxxxxxxx
F8
R1 INV xxxxxxxx
F9
R1 BLK xxxxxxxx
F10
R1 |B|> xxxxxxxx
F11
TEST R1 yyyyyyyy
R2 NORM ccc
R2 AUM xxxxxxxx
R2 DIM xxxxxxxx
R2 U< xxxxxxxx
R2 U> xxxxxxxx
R2 I>> xxxxxxxx
R2 Id> xxxxxxxx
R2 INV xxxxxxxx
R2 BLK xxxxxxxx
R2 |B|> xxxxxxxx
TEST R2 yyyyyyyy
R3 NORM ccc
R3 AUM xxxxxxxx
R3 DIM xxxxxxxx
R3 U< xxxxxxxx
R3 U> xxxxxxxx
R3 I>> xxxxxxxx
R3 Id> xxxxxxxx
R3 INV xxxxxxxx
R3 BLK xxxxxxxx
R3 |B|> xxxxxxxx
TEST R3 yyyyyyyy
R4 NORM ccc
R4 AUM xxxxxxxx
R4 DIM xxxxxxxx
R4 U< xxxxxxxx
R4 U> xxxxxxxx
R4 I>> xxxxxxxx
R4 Id> xxxxxxxx
R4 INV xxxxxxxx
R4 BLK xxxxxxxx
R4 |B|> xxxxxxxx
TEST R4 yyyyyyyy
G1
DIG1 cc xxxxxxxx
G2
DIG2 cc xxxxxxxx
G3
DIG3 cc xxxxxxxx

Figure 2

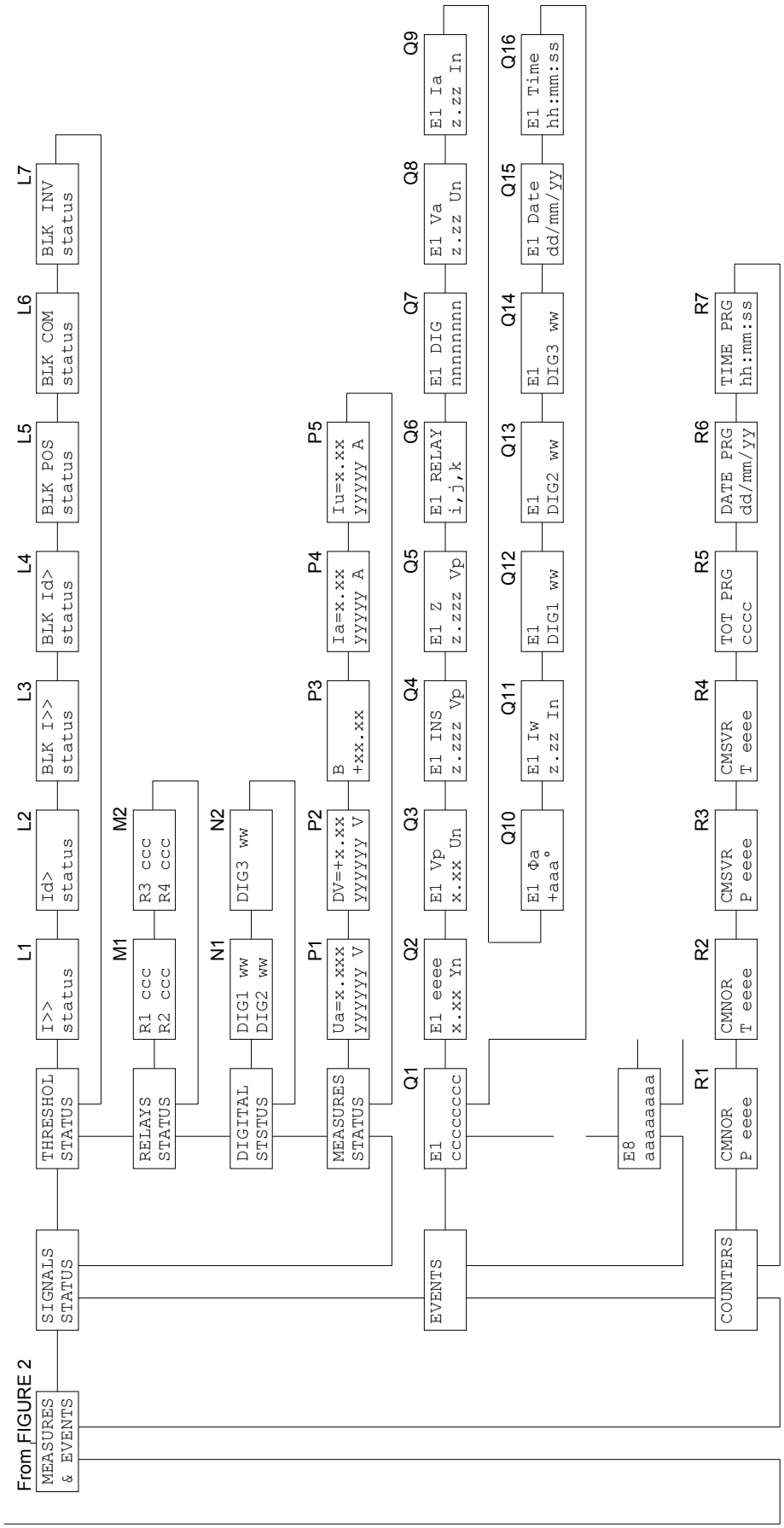

From FIGURE 2
MEASURES & EVENTS
SIGNALS STATUS
THRESHOL STATUS
I>> status
Id> status
BLK I>> status
BLK Id> status
BLK POS status
BLK COM status
BLK INV status
RELAYS STATUS
R1 ccc R2 ccc
R3 ccc R4 ccc
DIGITAL STSTUS
DIG1 ww DIG2 ww
DIG3 ww
MEASURES STATUS
Ua=x.xxx yyyyyy V
DV=+x.xx yyyyyy V
B +xx.xx
Ia=x.xx yyyyy A
Iu=x.xx yyyyy A
EVENTS
E1 cccccccc
E1 eeee x.xx Yn
E1 Vp x.xx Un
E1 INS z.zzz Vp
E1 z z.zzz Vp
E1 RELAY i,j,k
E1 DIG nnnnnnnn
E1 Va z.zz Un
E1 Ia z.zz In
E8 aaaaaaaa
E1 Φa +aaa°
E1 Iw z.zz In
E1 DIG1 ww
E1 DIG2 ww
E1 DIG3 ww
E1 Date dd/mm/yy
E1 Time hh:mm:ss
COUNTERS
CMNOR P eeee
CMNOR T eeee
CMSVR P eeee
CMSVR T eeee
TOT PRG cccc
DATE PRG dd/mm/yy
TIME PRG hh:mm:ss
L1
L2
L3
L4
L5
L6
L7
M1
M2
N1
N2
P1
P2
P3
P4
P5
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q15
Q16
R1
R2
R3
R4
R5
R6
R7

Figure 3

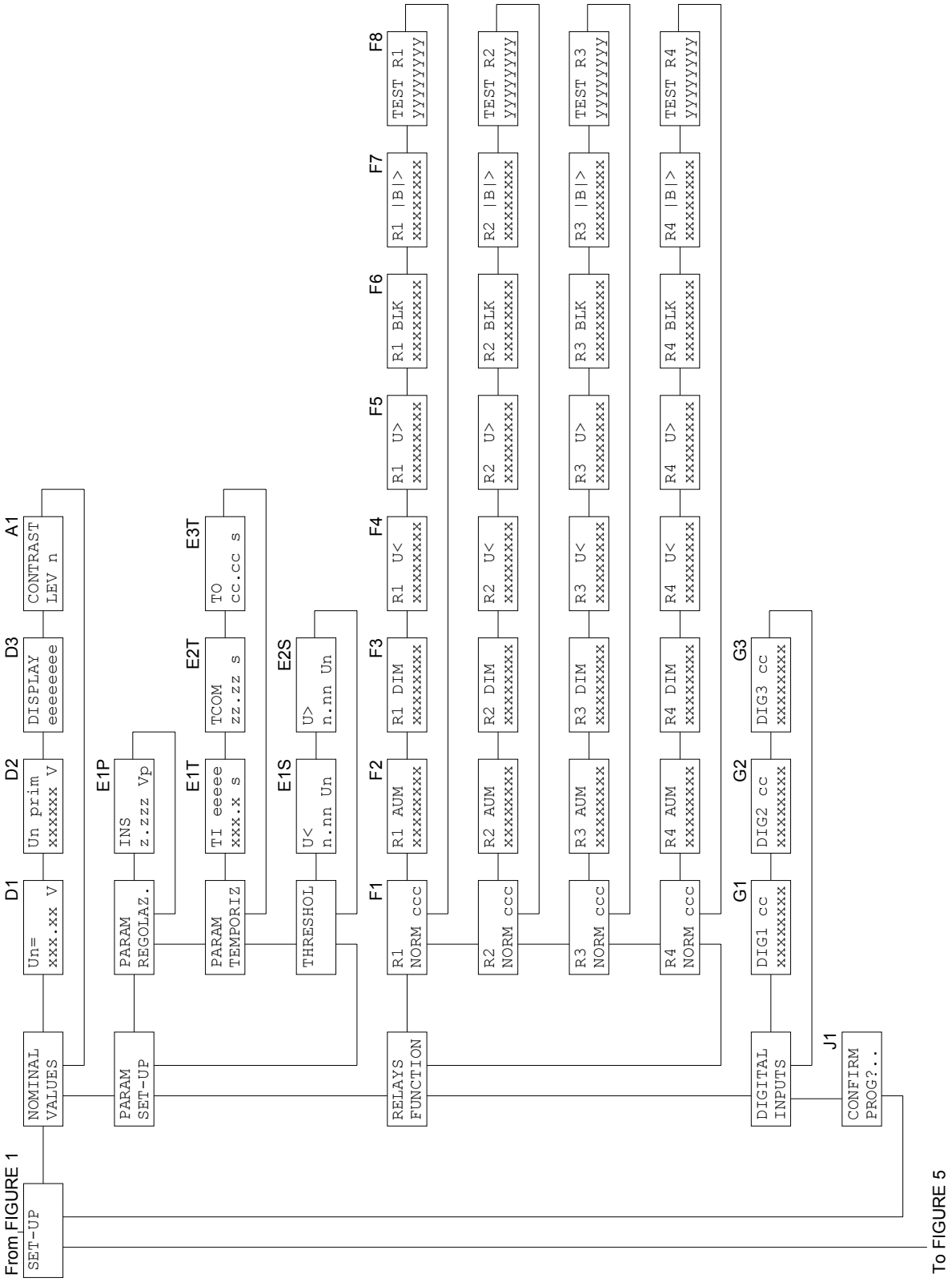

From FIGURE 1
SET-UP
NOMINAL VALUES
PARAM SET-UP
RELAYS FUNCTION
DIGITAL INPUTS
CONFIRM PROG?..
J1
D1
Un= xxx.xx V
D2
Un prim xxxxxx V
D3
DISPLAY eeeeeeee
A1
CONTRAST LEV n
E1P
INS z.zzz Vp
PARAM REGOLAZ.
E1T
TI eeee xxx.x s
PARAM TEMPORIZ
E2T
TCOM zz.zz s
E3T
TO cc.cc s
E1S
U< n.nn Un
THRESHOL
E2S
U> n.nn Un
F1
R1 NORM ccc
R2 NORM ccc
R3 NORM ccc
R4 NORM ccc
F2
R1 AUM xxxxxxxx
R2 AUM xxxxxxxx
R3 AUM xxxxxxxx
R4 AUM xxxxxxxx
F3
R1 DIM xxxxxxxx
R2 DIM xxxxxxxx
R3 DIM xxxxxxxx
R4 DIM xxxxxxxx
F4
R1 U< xxxxxxxx
R2 U< xxxxxxxx
R3 U< xxxxxxxx
R4 U< xxxxxxxx
F5
R1 U> xxxxxxxx
R2 U> xxxxxxxx
R3 U> xxxxxxxx
R4 U> xxxxxxxx
F6
R1 BLK xxxxxxxx
R2 BLK xxxxxxxx
R3 BLK xxxxxxxx
R4 BLK xxxxxxxx
F7
R1 |B|> xxxxxxxx
R2 |B|> xxxxxxxx
R3 |B|> xxxxxxxx
R4 |B|> xxxxxxxx
F8
TEST R1 yyyyyyyy
TEST R2 yyyyyyyy
TEST R3 yyyyyyyy
TEST R4 yyyyyyyy
G1
DIG1 cc xxxxxxxx
G2
DIG2 cc xxxxxxxx
G3
DIG3 cc xxxxxxxx
To FIGURE 5

Figure 4

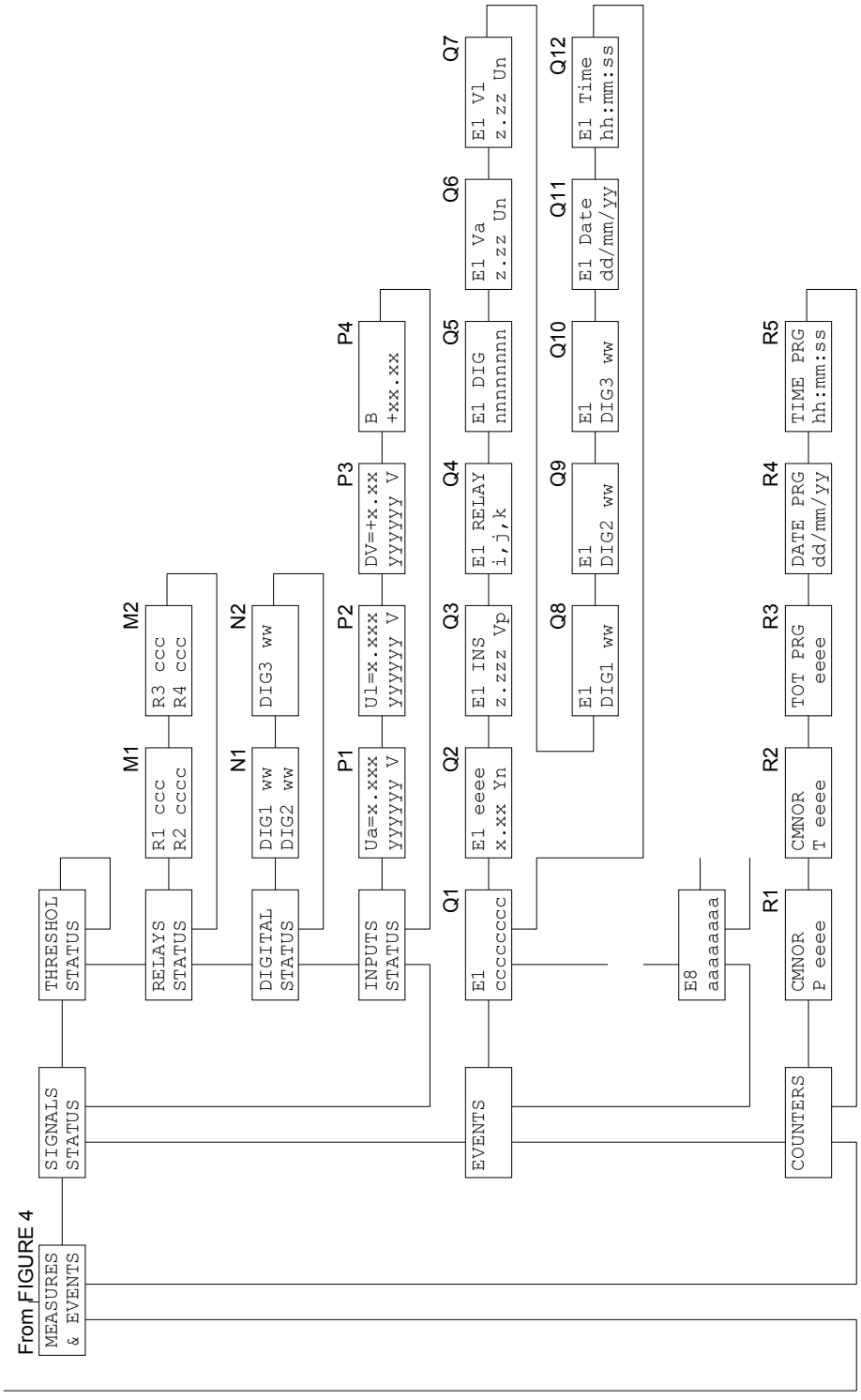


Figure 5

5.3 Address and time (fig. 1)

B1 - UNIT MODEL (not programmable)

CU90N

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 CU90N unit.

B4 - ADDRESS (programmable)

```
NR RELAY
001
```

Programmable address from 001 to 255.

The number is used on RS485 port to address the CU90N unit when other CU90N units or SIGMA-N 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 Operating mode selection and insertion (fig. 1)

C1 - OPERATING MODE SELECTION (programmable)

```
FUNCTION
xxxxxxxx
```

The following operating mode are available:

Operating mode	SELECTION	ANSI
Voltage regulating unit for tap changer control	REGOL	90
Voltage equalizer unit for automatic synchronizing of generators	EQUALIZ	25A

Examples:

C1

```
FUNCTION
REGOL
```

C1

```
FUNCTION
EQUALIZ
```

C2 - INSERTION SELECTION (programmable)

The selection is presented ONLY FOR VOLTAGE REGULATION operating mode

```
INSERZ
xxxxxxxx
```

The available selections are the followings:

Insertion	SELECTION
Voltage regulation with only one measured current	UNIPOL
Voltage regulation with TWO measured current	BIPOL
Voltage regulation with TWO PARALLEL OPERATING TRANSFORMERS (the threshold current unbalance **Id>** will be available)	2TRAFO

6 VOLTAGE REGULATING MODE - PARAMETERS SET-UP

6.1 Nominal values set-up (fig. 2)

D1 - NOMINAL CURRENT SELECTION In (programmable)

```
In = jA
```

In nominal phase current programmable 1 A or 5 A

D2 - 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

D3 - PRIMARY PHASE CURRENT (programmable)

```
In prim
xxxx  A
```

Primary phase current value of the installed phase CT; the value is programmable from 0001 to 9999 A.

D4 - PRIMARY LINE VOLTAGE (programmable)

```
Un prim
xxxxxx V
```

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

D5 - STANDARD DISPLAY SELECTION (programmable)

```
DISPLAY
eeeeeeee
```

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

NORMALE	displays ANSI 90
Ia	displays the measured line current (I1 transducer)
Va	displays the measured line voltage (U3 transducer)
Vp	displays the programmed line voltage

DV displays the computed voltage difference $DV = (Va - Vp - Z * Ia * Vp)$, ref. paragraph 1.1

Examples:

DISPLAY NORMALE	DISPLAY Ia	DISPLAY DV

D6 - DISPLAY CONTRAST LEVEL (programmable)

CONTRAST LEV x

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

6.2 Voltage regulation - parameters set-up (fig. 2)

The information refers to the set-up of the parameters related to the voltage regulation mode; for the meaning of the parameters, please refer to paragraph 1.1

E1P - REFERENCE VOLTAGE SET-UP (programmable)

Vp1 n.nnn Un

Set-up of the reference voltage (first set of parameters - Vp1 and Z1)

Vp1 programmable 0.800 ÷ 1.200 Un, resolution 0.010 Un

Example:

Vp1 1.050 Un

E2P - CURRENT COMPENSATION COEFFICIENT (programmable)

Z1 x.xxx Vp

Set-up of the current compensation coefficient (first set of parameters - Vp1 and Z1)

Z1 programmable 0.000 ÷ 0.600 Vp, resolution 0.002 Vp

Example:

Z1 0.152 Vp

When Z1 = 0.000 the voltage regulation is not influenced by the current flowing in the transformer.

E3P - SET-UP INSENSITIVITY DEGREE α (programmable)

```
INS
n.nnn Vp
```

Set-up of the insensitivity parameter (as function of the regulation steps available – see paragraph 1.1)

INS programmable 0.008 ÷ 0.030 Vp, resolution 0.002 Vp

Example:

```
INS
0.020 Vp
```

E4P - PROGRAMMING OF THE 2nd SET OF PARAMETERS (programmable)

```
Vp2
n.nnn Un
```

```
Z2
x.xxx Vp
```

Set-up of the reference voltage and of the current compensation coefficient related to the second set of parameters (Vp2 and Z2)

Vp2 programmable 0.800 ÷ 1.200 Un, resolution 0.010 Un

Z2 programmable 0.000 ÷ 0.600 Vp, resolution 0.002 Vp

Example:

```
Vp2
1.100 Un
```

```
Z2
0.098 Vp
```

6.3 Regulation time delay programming (fig. 2)

Note: the time delays refer to the issue of the commands **AUM** and **DIM**

E1T - TIME DELAY BETWEEN TWO COMMANDS (programmable)

```
TI eeeee
xxx.x s
```

Programming of the time delay between two consecutive commands.

Parameter TI **eeeee**: time delay characteristic

INDIP	independent time delay
DIP-I	inverse time delay
DIP-E	exponential time delay
CONT	continuous command

Formulas of the time delays are described in paragraph 1.1

Parameter xx.xx:

Time independent - time delay (seconds) between the issue of two consecutive commands (programmable from 000.1 to 999.9 s, resolution 1 s)

Time dependent – (DIP-I and DIP-E) value of the parameter K (see formulas paragraph 1.1) programmable from 1 to 200 s, resolution 1 s.

Continue command – not applicable (no influences - fixed to 0.0 s)

Examples:

TI DIP=I 002.0 K	TI CONT 000.0 S	TI INDIP 003.2 S

E2T - COMMAND LENGTH (programmable)

TCOM xx.xx s

Set-up of the command length (commands AUM and DIM); the programming is not presented when selected TI = CONT at reference E1T.

xx.xx programmable 00.10 ÷ 99.99 s, resolution 0.01 s

Example:

TCOM 05.00 s

E3T - MINIMUM TIME DELAY BETWEEN TWO CONSECUTIVE COMMANDS (programmable)

To xx.xx s

Set-up of the minimum time delay between the issue of two consecutive commands; the set-up is present only with dependent time delays (selection DIP-I and DIP-E at reference E1T).

xx.xx programmable 00.10 ÷ 99.99 s, resolution 0.01 s

Example:

To 10.00 s

6.4 Thresholds set-up (fig. 2)

E1S - UNDERVOLTAGE THRESHOLD SET-UP (programmable)

U< n.nn Un

n.nn threshold value expressed as Un, programmable 0.70 ÷ 1.10 Un, resolution 0.01 Un

When the measured voltage exceeds the threshold value **U<** the regulation function will be temporary disabled (command AUM/DIM issue disabled); the threshold is **always active**.

Example:

```
U<
0.80 Un
```

E2S - OVERVOLTAGE THRESHOLD SET-UP (programmable)

```
U>
n.nn Un
```

n.nn threshold value expressed as Un, programmable 0.90 ÷ 1.50 Un, resolution 0.01 Un

When the measured voltage exceeds the threshold value **U>** the regulation function will be temporary disabled (command AUM/DIM issue disabled); the threshold is **always active**.

E3S - MAXIMUM COMPENSATION CURRENT THRESHOLD (programmable)

```
Ia>
n.nn In
```

n.nn threshold value expressed as In, programmable 0.10 ÷ 9.99 In, resolution 0.01 In

When the measured current **Ia** (transducer I1) exceeds the threshold value, the regulation algorithm (see formula in paragraph 1.1) utilizes a current value equals to **Ia>**, independently from the effective current value.

The threshold is **always active**.

Example:

```
Ia>
1.20 In
```

E4S - OVERLOAD CONDITION THRESHOLD (programmable)

```
I>
n.nn In
```

n.nn threshold value expressed as In, programmable 0.10 ÷ 9.99 In, resolution 0.01 In

When the measured current **Ia** (transducer I1) exceeds the threshold value **I>**, the CU90N unit considers the AUM or DIM commands issued under overload conditions (the issued command counter **CMSVR** will be increased instead of the counter **CMNOR**).

The threshold is **always active**.

E5S - OVERCURRENT THRESHOLD (programmable)

```
I>> ccc
n.nn In
```

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

n.nn threshold value expressed as In, programmable 0.10 ÷ 9.99 In, resolution 0.01 In

When the measured current (transducer **I1**) exceeds the threshold value **I>>** the regulation function will be temporary disabled (command AUM/DIM issue disabled); on the front panel the LED named BLK will glow and a message will be displayed.

E6S - UNBALANCED CURRENT THRESHOLD (programmable)

The set-up is presented only if the 2TRAFO insertion has been selected at reference C2. The threshold defines the **maximum vectorial difference** between the currents flowing in the two transformers; the threshold represents the module of the current difference vector.

```
Id> ccc
n.nn In
```

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

n.nn threshold value expressed as In, programmable 0.10 ÷ 9.99 In, resolution 0.01 In

To signal the unbalanced condition (alarm) an output relay can be activated by the threshold.

Example:

```
Id> ON
0.20 In
```

E7S - UNBALANCED CONDITION TIME DELAY (programmable)

```
TI Id>
xx.xx s
```

Set-up of the time delay related to the unbalanced condition threshold **Id>** (to activate the output relay for alarm signaling).

xx.xx time delay programmable 00.02 ÷ 99.99 seconds

Example:

```
TI Id>
20.00 s
```

E8S - REVERSE POWER ANGLE (programmable)

```
ΦINV
±nnn°
```

Set-up of the angular sector which defines the condition of reverse power (power flowing from the MV side of the transformer); the angular sector is defined as:

ΦINV ± 90° (where **ΦINV** programmable -180° ÷ +180°, resolution 1°)

The measured angle is between the current **Ia** (transducer I1) and the voltage **Va** (transducer U3).

Example:

ΦINV +60°

The issue of AUM/DIM commands will be temporary disabled, if programmed, when the vector of the current **Ia** is **within** the angular sector +150° / -30°; the measured voltage **Va** is used as a reference.

Note: the angle are considered positive when the current vector lags (referred to the voltage vector).

6.5 Operation disabling on external causes (fig. 2)

The regulating operation of the CU90N unit can be disabled on external anomalies or commands (ref. paragraph 1)

NOTE: to allow the operation disabling due to **tap changer signals inconsistency**, 3 digital input must be programmed for the functions ESTRPOS, ESTRNEG and INTER - see paragraph 6.7

To allow the operation disabling due to command inconsistency, 2 digital input must be programmed for the functions ESTRPOS and ESTRNEG - see paragraph 6.7

E1B - OVERCURRENT (programmable)

BLK I>> ccc

ccc ON enabled function when the current overcame the I>> threshold
OFF disabled function (available but not active)

E2B - TAP CHANGER SIGNALS INCONSISTENCY (programmable)

BLK POS ccc

ccc ON enabled function when tap changer signals are inconsistent
OFF disabled function (available but not active)

E3B - COMMAND INCONSISTENCY (programmable)

BLK COM ccc

ccc ON enabled function when command signals are inconsistent
OFF disabled function (available but not active)

E4B - REVERSE POWER (programmable)

```
BLK INV
ccc
```

ccc ON enabled function when reverse power is detected
OFF disabled function (available but not active)

6.6 Output relays programming (fig. 2)

The session allows to program the activation of the output relays R1, R2, R3 or R4 on:

- **AUM** and **DIM** commands
- alarm signaling for overvoltage and undervoltage condition (**U>, U<)**
- alarm signaling for overcurrent condition (**I>>)**
- alarm signaling for current unbalance condition (**Id>**)
- alarm signaling for reverse power (even without disabling of the regulation operation)
- regulation operation disabled (for any cause)
- signaling of the condition |B| ≥ 1 (regulation in progress)

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 quiescent status

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

F2 - F3 - OUTPUT RELAY ACTIVATION FOR COMMANDS AUM E DIM (programmable)

F2

```
R1 AUM
xxxxxxxx
```

F3

```
R1 DIM
xxxxxxxx
```

Output relay R1 programmed to issue the AUM or DIM command (the same relay cannot be programmed for both functions).

The parameter xxxxxxxx is selectable as the following:

ON R1 output relay activation to issue the command
NONE no activation

F4 ÷ F7 - OUTPUT RELAY ACTIVATION ON THRESHOLDS STATUS U<, U>, I>>, Id> (programmable)

F4	F5	F6	F7
U< xxxxxxx	U> xxxxxxx	I>> xxxxxxx	Id> xxxxxxx

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

The parameter xxxxxxxx is selectable as the following:

ON	R1 output relay activation on the threshold
NONE	no activation

Examples:

R1 U< ON	R1 U> ON	R1 Id> NO AZION

NOTE: the selection F7 is presented only if the insertion 2TRAFO has been selected at reference C2 – par. 5.4

F8 - OUTPUT RELAY ACTIVATION ON REVERSE POWER (programmable)

R1 INV xxxxxxx

Programming of the R1 output relay activation (NONE, ON) on the detection of the reverse power condition (ref. paragraph 1.1).

The parameter xxxxxxxx is selectable as the following:

ON	R1 output relay activation on the reverse power condition
NONE	no activation

F9 - OUTPUT RELAY ACTIVATION WHEN REGULATION OPERATIONS ARE DISABLED (programmable)

R1 BLK xxxxxxx

Programming of the R1 output relay activation (NONE, ON) when the regulation operations are disabled for any of the programmed causes (ref. E1B - E4B - paragraph 6.5)
The parameter xxxxxxxx is selectable as the following:

ON	R1 output relay activation when operations are disabled
NONE	no activation

F10 - OUTPUT RELAY ACTIVATION WHEN REGULATION OPERATIONS ARE IN PROGRESS (programmable)

```
R1 |B|>
xxxxxxx
```

Programming of the R1 output relay activation (NONE, ON) when the regulation operations are in progress (condition $|B| \geq 1$ - ref. paragraph 1.1)

The parameter xxxxxxx is selectable as the following:

ON	R1 output relay activation when operations are in progress
NONE	no activation

Example:

```
R1 |B|>
ON
```

F11 - TEST OF OUTPUT RELAY R1

```
TEST R1
xxxxxxxx
```

See paragraph 4.4

6.7 Digital input function programming (fig. 2)

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

- on/off voltage regulating function
- tap changer highest position
- tap changer lowest position
- tap changer intermediate position
- selection of alternative parameters set (Vp2 and Z2) for voltage regulation
- recording of measures on external event (STATUS - ref. par. 1)
- pilot wire fault monitoring (only digital input DIG2)

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: function related to digital input DIG1

The following functions are selectable (one of them):

NONE	no functions active related to digital input DIG1
BLK EST	disabling of the regulation operations on external command
SET2 ON	use of parameters Vp2 and Z2 for regulation
ESTRPOS	tap changer highest position
ESTRNEG	tap changer lowest position
INTER	tap changer intermediate position
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).

6.8 Parameter values visualization (fig. 3)

L1 - L2 - THRESHOLDS STATUS

The actual status of the **I>>** and **Id>** thresholds is displayed. The **Id>** threshold status is displayed only if insertion 2TRAFO has been selected at reference C2 – par. 5.4

For each threshold the status can show one of the following values:

ON	active threshold
OFF	disabled threshold (programmed OFF)

Examples:

L1	L2
I>>	Id>
ON	OFF

L3 - L4 - L5 - L6 - L7 - STATUS OF THE BLOCKING CAUSES

The programmed status of each condition which will cause the disabling of the regulation operations.

ON	condition programmed enabled

OFF condition programmed disabled

Examples:

BLK I>>	BLK Id>	BLK POS	BLK COM	BLK INV
ON	OFF	ON	OFF	OFF

The BLK Id> display is presented only if the 2TRAFO insertion has been selected - ref. C2, paragraph 5.4).

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 - P6 - MEASUREMENTS DISPLAY

The actual values of the measured and computed parameters are displayed; the parameters related to disabled measurements are not displayed (as function of the insertion programmed at ref. C2, paragraph 5.4)

P1

Ua=x.xxx
yyyyyy V

P2

DV=±x.xx
yyyyyy V

Measured voltage (Ua) and computed voltage difference DV, where:

$$DV = (Va - Vp - Z * Ia * Vp)$$ ref. paragraph 1.1

P3

B
± xx.xx

Parameter B (ref. paragraph 1.1)

P4	P5
Ia= x.xx yyyyy A	Iu= x.xx yyyyy A

P4 - Measured current **Ia** (transducer I1)

P5 - Measured current **I2** (transducer I2 - insertion BIPOL) or computed current **Id** (module of the vectorial difference between the currents **Ia** and **I2** - only 2TRAFO insertion - ref. C2, paragraph 5.4)

6.9 Events (fig. 3)

On the display are shown the memorized information related to the following events:

- operations disabled due to external anomaly (ref. paragraph 1.1)
- alarm for threshold Id> (insertion 2TRAFO)
- alarm for threshold I>> (insertion BIPOL)
- external command (STATUS)
- POWER ON

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
BLK U<	regulation operations disabled on threshold U<
BLK U>	regulation operations disabled on threshold U>
BLK I>>	regulation operations disabled on threshold I>>
BLK POS	regulation operations disabled on tap changer position inconsistency
BLK COM	regulation operations disabled on command inconsistency
BLK INV	regulation operations disabled on reverse power detection
I>>	alarm on threshold I>> (insertion BIPOL)
Id>	alarm on threshold Id> (insertion 2TRAFO)
STATUS	information recorded on external command
POWER ON	switch-on of the unit (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 - THRESHOLD IDENTIFICATION

E1 eeee x.xx Yn

Not shown for STATUS event

It is shown the threshold that caused the operation disabling (if programmed - ref. paragraph 6.5) or the alarm signaling (if programmed - ref. paragraph 6.6) This information is not presented on STATUS event.

E2 I>> 2.50 In	E5 U> 1.25 Un	E8 Id> 0.60 In

Q3 - Q4 - Q5 - PARAMETER SET-UP

It is shown the parameters related to the regulation function (voltage reference - Vp, insensitivity degree - INS, current compensation coefficient - Z).

E1 Vp 0.98 Un	E1 INS 0.040 Vp	E1 Z 0.200 Vp

Q6 - ACTIVATED OUTPUT RELAYS

E1 RELAY nnnnnnn

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

Examples:

E1 RELAY 1,3,4	E3 RELAY 1,4

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

E1 RELAY NONE

Q7 - 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).

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

Q8 - Q9 - Q10 - Q11 - MEASURED CURRENTS AND VOLTAGES ON EVENT

Q8	Q9	Q10	Q11
E1 Va y.yy Un	E1 Ia y.yy In	E1 Φa +aaa°	E1 Iw y.yy In

The values of the measured voltage, currents and the angle between the current and the voltage at the event are displayed; the values are expressed as Un, In and degree.

There are presented only the currents measured coherently with the insertion selection at ref. C2 - paragraph 5.4

The current **Iw** represent the current **I2** (transducer I2 - insertion BIPOL) or **Id** (module of the vectorial difference between **Ia** and **I2** - insertion 2TRAFO).

Q12 - Q13 - Q14 - 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.

Q15 - Q16 - 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

6.10 Counters (fig. 3)

In this section are displayed the total and partial counters of the command issued to the tap changer 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 - R2 - COUNTERS FOR COMMAND UNDER NORMAL CONDITIONS

R1	**R2**
CMNOR P cccc	CMNOR T cccc

Display of the partial (P) and total (T) counters of the command to the tap changer issued under normal condition (current **Ia** lower then the threshold **I>**).

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

R3 - R4 - COUNTERS FOR COMMAND UNDER OVERLOAD CONDITIONS

R3

```
CMSVR
P cccc
```

R4

```
CMSVR
T cccc
```

Display of the partial (P) and total (T) counters of the command to the tap changer issued under overload condition (current **Ia** higher then the threshold **I>**).

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

R5 ÷ R7 - TOTAL PROGRAMMING SESSIONS AND DATE/TIME OF THE LAST PROGRAMMING SESSION

```
TOT PRG
eeee
```

```
DATE PRG
dd/mm/yy
```

```
TIME PRG
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.

7 VOLTAGE EQUALIZING MODE - PARAMETERS SET-UP

7.1 Nominal values set-up (fig. 4)

D1 - 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

D2 - PRIMARY LINE VOLTAGE (programmable)

```
Un prim
xxxxxx V
```

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

D3 - STANDARD DISPLAY SELECTION (programmable)

```
DISPLAY
eeeeeeee
```

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

NORMALE	displays ANSI 25A
Va	displays the measured voltage - generator (U3 transducer)
Vl	displays the measured voltage - network (U4 transducer)
DV	displays the voltage difference (Va - Vl)

Examples:

```
DISPLAY
NORMALE
```

```
DISPLAY
Va
```

```
DISPLAY
DV
```

D4 - 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.

7.2 Voltage equalizing - parameters set-up (fig. 4)

The information refers to the set-up of the parameters related to the voltage equalizing mode; for the meaning of the parameters, please refer to paragraph 1.2

E1P - SET-UP INSENSITIVITY DEGREE α (programmable)

```
INS
n.nnn Vl
```

Set-up of the insensitivity parameter (as function of the voltage regulation system of the generator – see paragraph 1.2).

INS programmable 0.008 ÷ 0.030 Vp, resolution 0.002 Vp

Example:

```
INS
0.020 Vl
```

7.3 Equalizing time delay programming (fig. 4)

Note: the time delays refer to the issue of the commands **AUM** and **DIM**

E1T - TIME DELAY BETWEEN TWO COMMANDS (programmable)

```
TI eeeee
xxx.x s
```

Programming of the time delay between two consecutive commands.

Parameter TI eeeee: time delay characteristic

INDIP	independent time delay
DIP-I	inverse time delay
DIP-E	exponential time delay
CONT	continuous command

Formulas of the time delays are described in paragraph 1.2

Parameter xx.xx:

Time independent - time delay (seconds) between the issue of two consecutive commands (programmable from 000.1 to 999.9 s, resolution 1 s).

Time dependent – (DIP-I and DIP-E) value of the parameter K (see formulas paragraph 1.1) programmable from 1 to 200 s, resolution 1 s.

Continue command – not applicable (no influences – fixed to 0.0 s)

Examples:

```
TI DIP=I
002.0 K
```

```
TI CONT
000.0 s
```

```
TI INDIP
003.2 s
```

E2T - COMMAND LENGTH (programmable)

```
TCOM
xx.xx s
```

Set-up of the command length (commands AUM and DIM); the programming is not presented when selected TI = CONT at reference E1T.

xx.xx programmable 00.10 ÷ 99.99 s, resolution 0.01 s

Example:

```
TCOM
05.00 s
```

E3T - MINIMUM TIME DELAY BETWEEN TWO CONSECUTIVE COMMANDS (programmable)

```
To
xx.xx s
```

Set-up of the minimum time delay between the issue of two consecutive commands; the set-up is present only with dependent time delays (selection DIP-I and DIP-E at reference E1T).

xx.xx programmable 00.10 ÷ 99.99 s, resolution 0.01 s

Example:

```
To
10.00 s
```

7.4 Thresholds set-up (fig. 4)

E1S - UNDERVOLTAGE THRESHOLD SET-UP (programmable)

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

n.nn threshold value expressed as Un, programmable 0.70 ÷ 1.10 Un, resolution 0.01 Un

When the measured voltage exceeds the threshold value **U<** the equalizing function will be temporary disabled (command AUM/DIM issue disabled); the threshold is **always active**.

Example:

```
U<
0.80 Un
```

E2S - OVERVOLTAGE THRESHOLD SET-UP (programmable)

```
U>
n.nn Un
```

n.nn threshold value expressed as Un, programmable 0.90 ÷ 1.50 Un, resolution 0.01 Un

When the measured voltage exceeds the threshold value **U>** the equalizing function will be temporary disabled (command AUM/DIM issue disabled); the threshold is **always active.**

7.5 Operation disabling on external causes

This functionality is only used when the CU90N unit is operating as voltage regulator – ANSI 90.

7.6 Output relays programming (fig. 4)

The session allows to program the activation of the output relays R1, R2, R3 or R4 on:

- **AUM** and **DIM** commands
- alarm signaling for overvoltage and undervoltage condition (**U>**, **U<**)
- equalizing operations disabled (for any cause)
- signaling of the condition |B| ≥ 1 (equalizing in progress)

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 quiescent status

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

F2 - F3 - OUTPUT RELAY ACTIVATION FOR COMMANDS AUM E DIM (programmable)

F2

```
R1 AUM
xxxxxxxx
```

F3

```
R1 DIM
xxxxxxxx
```

Output relay R1 programmed to issue the AUM or DIM command (the same relay cannot be programmed for both functions).

The parameter xxxxxxxx is selectable as the following:

ON R1 output relay activation to issue the command
NONE no activation

F4 - F5 - OUTPUT RELAY ACTIVATION ON THRESHOLDS STATUS U< AND U> (programmable)

F4	F5
U< xxxxxxx	U> xxxxxxx

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

The parameter xxxxxxxx is selectable as the following:

ON	R1 output relay activation on the threshold
NONE	no activation

Examples:

R1 U< ON	R1 U> NO AZION

F6 - OUTPUT RELAY ACTIVATION WHEN EQUALIZING OPERATIONS ARE DISABLED (programmable)

R1 BLK xxxxxxx

Programming of the R1 output relay activation (NONE, ON) when the regulation operations are disabled for under or overvoltage condition or from an external command.

The parameter xxxxxxxx is selectable as the following:

ON	R1 output relay activation when operations are disabled
NONE	no activation

F7 - OUTPUT RELAY ACTIVATION WHEN EQUALIZATION OPERATIONS ARE IN PROGRESS (programmable)

R1 |B|> xxxxxxx

Programming of the R1 output relay activation (NONE, ON) when the equalization operations are in progress (condition |B| ≥1 - ref. paragraph 1.2)

The parameter xxxxxxxx is selectable as the following:

ON	R1 output relay activation when operations are in progress
NONE	no activation

Example:

R1 |B|> ON

F8 - TEST OF OUTPUT RELAY R1

```
TEST  R1
xxxxxxxx
```

See paragraph 4.4

7.7 Digital input function programming (fig. 4)

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

- on/off voltage equalizing function
- recording of measures on external event (STATUS – ref. par. 1)
- pilot wire fault monitoring (only digital input DIG2)

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: function related to digital input DIG1

The following functions are selectable (one of them):

NONE	no functions active related to digital input DIG1
BLK EST	disabling of the equalizing operations on external command
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).

7.8 Parameter values visualization (fig. 5)

THRESHOLDS STATUS

Programmable thresholds are used when the CU90N unit is operating as voltage regulator - ANSI 90 (**U<** and **U>** threshold are always active).

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 - MEASUREMENTS DISPLAY

The actual values of the measured and computed parameters are displayed.

P1

```
Ua=x.xxx
yyyyyy V
```

P2

```
Ul=x.xxx
yyyyyy V
```

P3

```
DV=±x.xx
yyyyyy V
```

Measured voltage - generator side (Ua), measured voltage - network side (Ul) and computed voltage difference DV, where DV = (Va - Vp).

P4

```
B
± xx.xx
```

When Vl = 0, the computed values of DV and B are considered not meaningful, therefore the message ∗∗∗ will be displayed at P3 and P4.

7.9 Events (fig. 5)

On the display are shown the memorized information related to the following events :

- operations disabled due to external anomaly (ref. paragraph 1.2)
- external command (STATUS)
- POWER ON

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
BLK U<	regulation operations disabled on threshold U<
BLK U>	regulation operations disabled on threshold U>
STATUS	information recorded on external command
POWER ON	switch-on of the unit (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 - THRESHOLD IDENTIFICATION

```
E1  eeee
x.xx Yn
```

Not shown for STATUS event

It is shown the threshold that caused the operation disabling.

```
E2   U<
0.70  Un
```

```
E5    U>
1.25  Un
```

Q3 - PARAMETER SET-UP

It is shown the parameter INS (insensitivity) related to the equalizing function.

```
E1   INS
0.040 Vp
```

Q4 - ACTIVATED OUTPUT RELAYS

```
E1 RELAY
nnnnnnn
```

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

Examples:

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

```
E3 RELAY
1,4
```

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

```
E1 RELAY
NONE
```

Q5 - DIGITAL CHANNELS RELATED TO MEMORIZED EVENT

```
E1 DIG
1, 3
```

The list of the digital inputs related to the memorized event is displayed (STATUS function command).

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

Q6 - Q7 - MEASURED VOLTAGES ON EVENT

```
E1    Va
y.yy  Un
```

```
E1    Vl
y.yy  Un
```

The values of the measured voltages at the event are displayed; the values are expressed as Un.

Q8 - Q9 - Q10 - 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.

Q11 - Q12 - 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.

7.10 Counters (fig. 5)

In this section are displayed the total and partial counters of the command issued to the voltage control unit of the generator and the numbers of programming sessions with the date and time of the last confirmed programming session.

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 - R2 - COUNTERS OF ISSUED COMMANDS

R1

```
CMNOR
P  cccc
```

R2

```
CMNOR
T  cccc
```

Display of the partial (P) and total (T) counters of the issued commands to the voltage regulator of the generator. When the value exceed 9999 the counter starts again from 0000.

R3 ÷ R5 - TOTAL PROGRAMMING SESSIONS AND DATE/TIME OF THE LAST PROGRAMMING SESSION

```
TOT PRG
  eeee
```

```
DATE PRG
dd/mm/yy
```

```
TIME PRG
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.

8 INSTALLATION

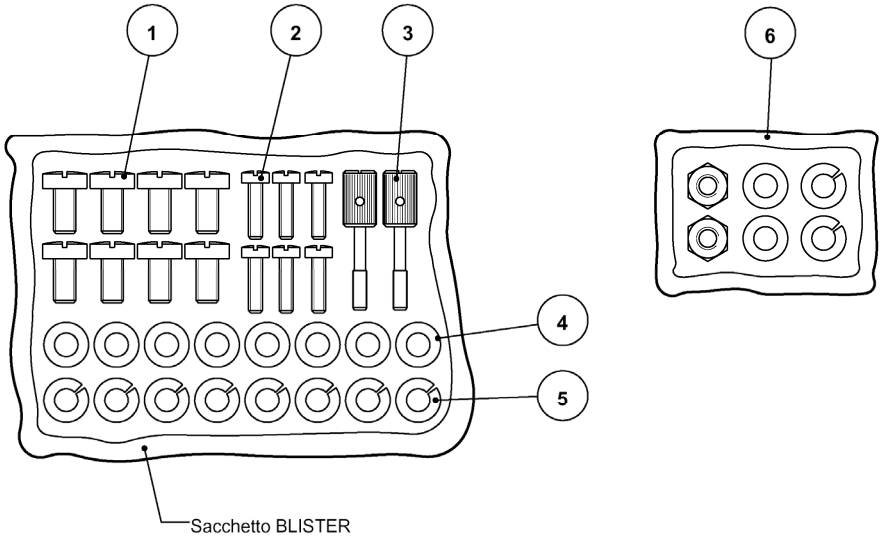
8.1 Supplied kit

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

- electronic unit CU90N with rear socket
- transparent front panel for rack installation
- blister with items 1-2-3-4-5

CS VERSION - flush mounting installation

- electronic unit CU90N 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) n° 2 screws to fix (optionally) the protection relay on the front of the 19" rack
3) n° 2 knobs to fix the transparent front panel
4) n° 8 washers to be used to fix wire terminals (current)
5) n° 8 growers to be used to fix wire terminals (current)
6) items to fix the brackets for flush mounting (only with CS version)

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

NOTE: The items related to current inputs are the standard supplied items with all SIGMA-N protection relays but for the CU90N unit when operating as VOLTAGE EQUALIZER (ANSI 25A) they are not used.

8.2 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:

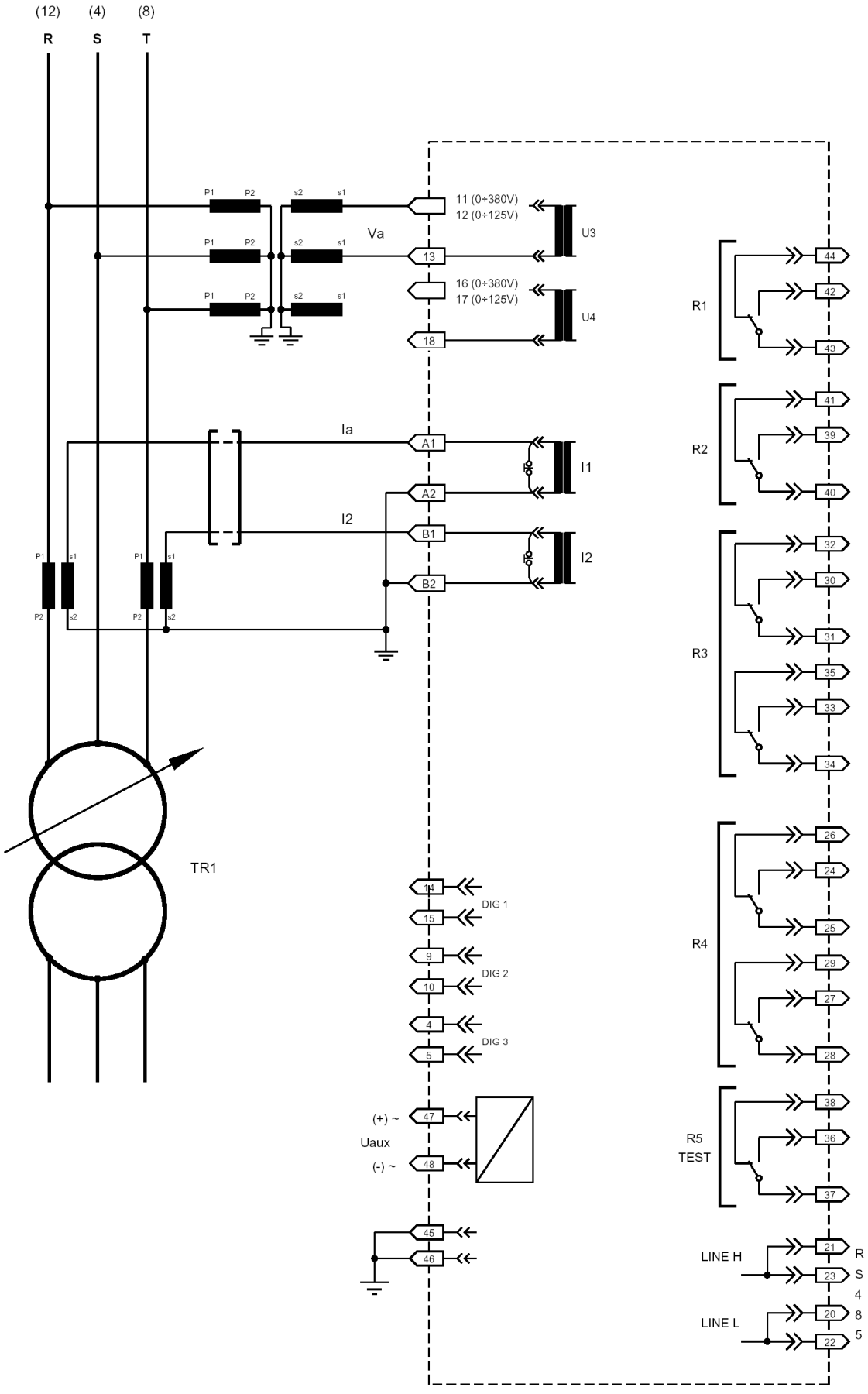
Va	terminals 1 - 3	voltages with Un programmed from 190 to 380 V
	terminals 2 - 3	voltages with Un programmed from 0 to 125 V
Vl	terminals 16 - 18	voltages with Un programmed from 190 to 380 V
	terminals 17 - 18	voltages with Un programmed from 0 to 125 V

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

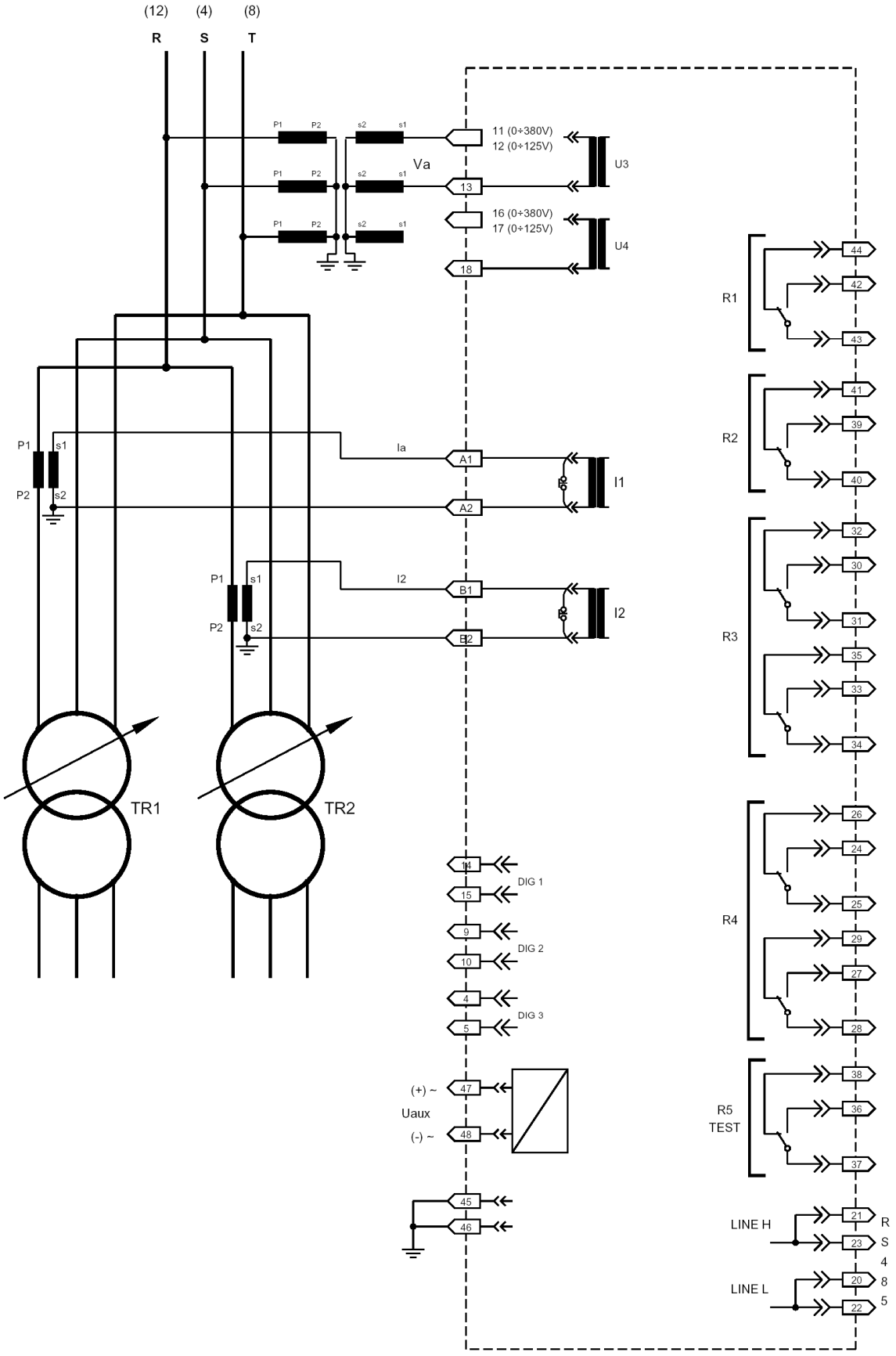
Minimum suggested wire cross section: 2,5 mm^2

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

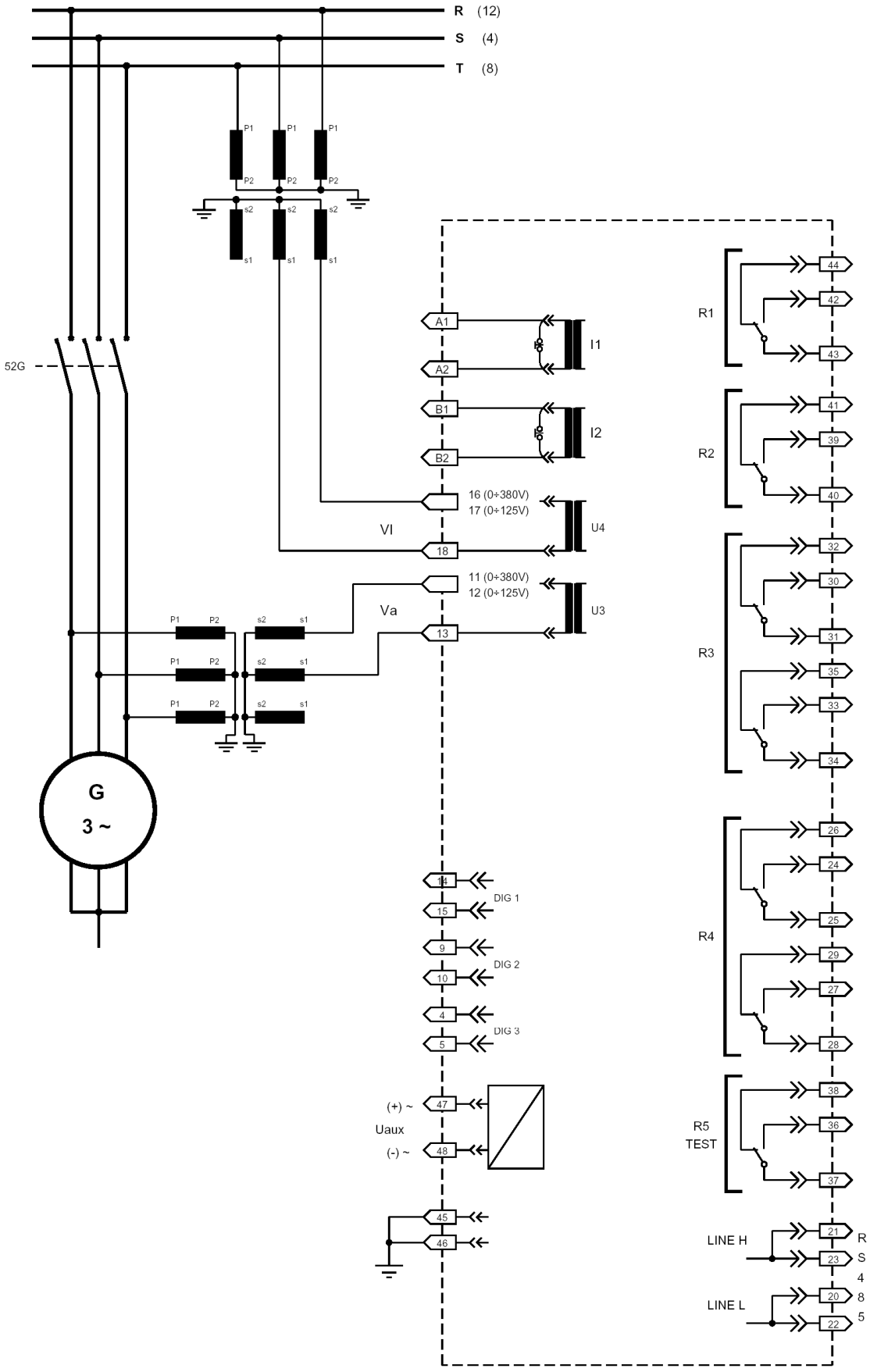
current **Ia**	terminals A1 - A2
current **I2**	terminals B1 - B2



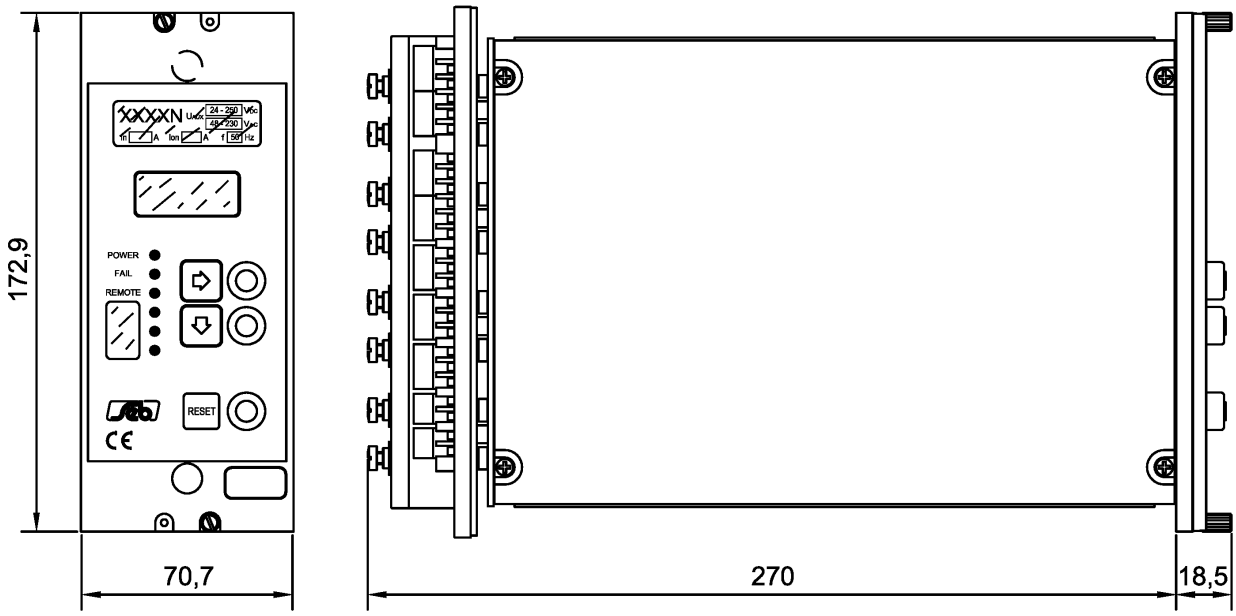
VOLTAGE REGULATOR - (ANSI 90) - Fig. 6



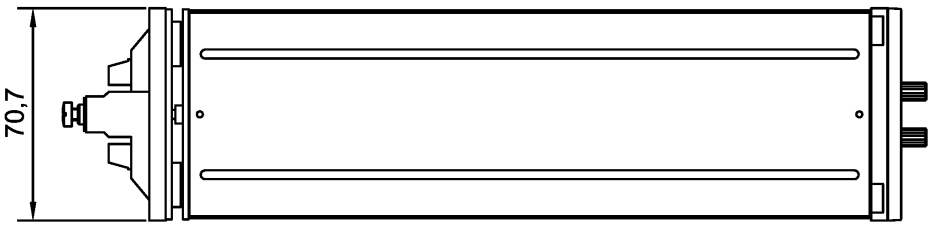
VOLTAGE REGULATOR (ANSI 90) - 2 TRANFORMERS insertion - Fig. 7

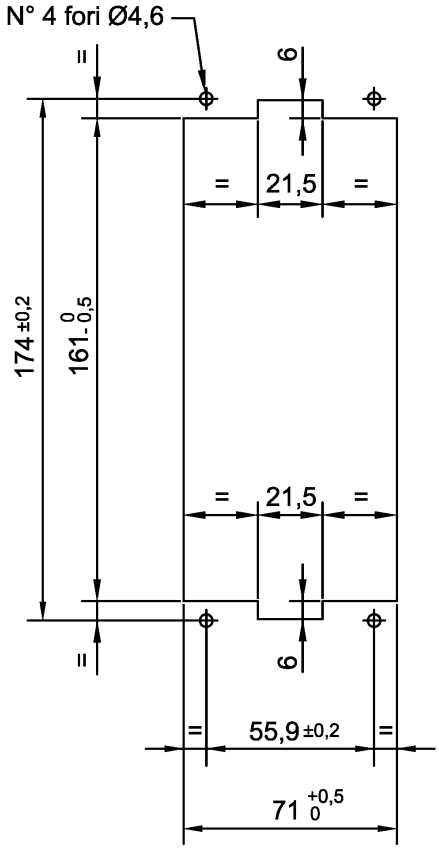


VOLTAGE EQUALIZING - (ANSI 25A)- Fig. 8



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.

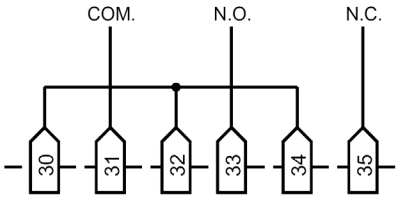
Other circuits (output relays etc.)
It is suggested to terminate the current wiring using plug terminals.

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

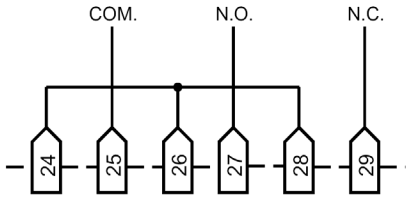
8.3 Relays R3 and R4 - Signaling / Command set-up

The CU90N unit 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

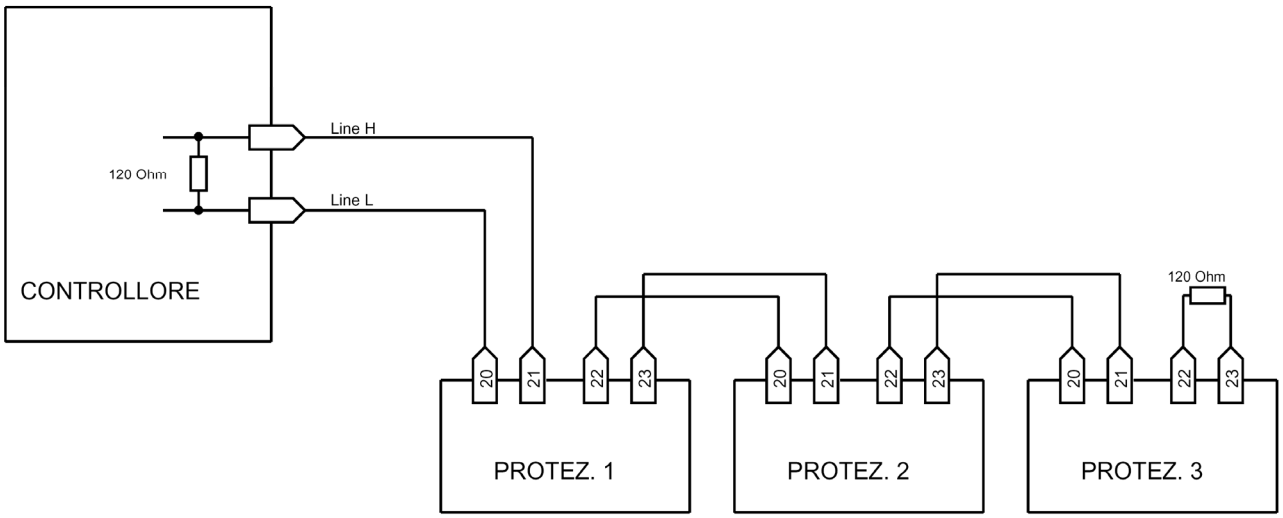
8.4 RS485 serial communication port

The CU90N unit 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 STANDARD SEB communication protocol is selected, the transmission speed is automatically selected between 300 to 9600 bauds and the protocol is ASCII-HEX.

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.

9 SET-UP EXAMPLE FOR VOLTAGE REGULATOR

As a general example, the set-up of a CU90N unit operating as voltage regulating unit will be presented in the following.

The installation is represented by a HV/MV transformer equipped with tap changer, with the following characteristics:

- Primary nominal voltage 150 kV
- Secondary nominal voltage 20 kV
- Nominal power 25 MVA
- Secondary nominal current 722 A
- VT's on the secondary side 20/ √3 / 0.1/√3 kV
- Ct's on the secondary side 1000 / 5 A
- On-load tap changer range ± 5 % (step 1 %)

The insertion diagram of the CU90N unit is presented in fig. 6

When the HV/MV transformer is working at the nominal condition the current measured by the CU90N unit will be 0.72 In (where In = 5A)

Comments on the set-up

Reference voltage - the reference voltage will be the nominal voltage, therefore **Vp** = 1 Un (where Un = 100 V as the phase-to-phase voltage will be measured)

Current compensation coefficient Z – it is supposed, from information on the 20 kV distribution network, that when the HV/MV transformer delivers the nominal current it is necessary to have a secondary voltage at the transformer equals to 103% of the nominal voltage in order to guarantee the nominal voltage condition in the worst point of the network.
Therefore the **current compensation coefficient Z** (at the nominal current of the HV/MV transformer, equals to 0.72 In of the CU90N) have to be programmed to 0.03/0.72 = 0.042 Vp.

Insensitivity degree - the on-load tap changer regulation step is equals to 1% of the nominal voltage; the insensitivity degree should have to be programmed:

greater than 0.6 times the tap changer step

lower than 3.3 times the tap changer step

therefore we could choose a insensitivity degree equals to 1.6 % (0.016 Vp).

Maximum current compensation value Ia> - normally this current threshold is programmed equals to the nominal current of the transformer, therefore **Ia>** = 0.72 In

Overload condition threshold I> - normally this current threshold is programmed 1.2 times the nominal current of the transformer, therefore **I>** = 0.86 In

Overcurrent threshold I>> - normally this current threshold is programmed 1.3 times the nominal current of the transformer, therefore **I>** = 0.94 In

The time delay between two commands is chosen **exponential** with a minimum time delay between two commands of 5 seconds and command length of 1.5 seconds.

In this example the digital input of the CU90N unit will be used for the acquisition of the tap changer position in order to disable the regulation function for changer position inconsistency.

Protocol	STANDARD
Nr relay	001
Serial number	(non programmable)
SW rev.	(non programmable)
Date (dd/mm/yy)	actual date
Time (hh:mm:ss)	actual time
Function	REGOL
Insertion	BIPOL
Nominal current (ref. CT's secondary side)	5 A
Nominal voltage (ref. VT's secondary side)	100 V
Nominal current (ref. CT's primary side)	1000 A
Nominal voltage (ref. VT's primary side)	20000 V
Display	NORMAL
Contrast	8
Reference voltage Vp1	1 Un
Current compensation coefficient Z1	0.042 Vp
Reference voltage Vp2	1 Un (*)
Current compensation coefficient Z2	0.042 Vp (*)
Insensitivity degree INS	0.016 Vp
Time delay curve (TI)	DIP = E
Time delay parameter TI (K)	60 s
Command length (TCOM)	1.5 s
Minimum time delay between 2 commands (To)	5 s
Undervoltage threshold U<	0.9 Un
Overvoltage threshold U>	1.2 Un
Maximum compensation current threshold Ia>	0.72 In
Overload condition threshold I>	0.86 In
Overcurrent threshold (function disabled) I>>	0.94 In
Reverse power angle ΦINV	-150°
Unbalanced current threshold Id>	0.1 In (*)
Time delay Id> (TI Id>)	5 s (*)
Overcurrent disabling BLK I>>	ON
Tap changer signal inconsistency disabling BLK POS	ON
Command inconsistency disabling BLK COM	ON

Reverse power disabling BLK INV	ON
Function relay R1	AUM (Norm OFF)
Function relay R2	DIM (Norm OFF)
Function relay R3	|B|> (Norm OFF)
Function relay R4	BLK (Norm OFF)
DIG1	ESTR POS (Active status HI)
DIG2	INTER (Active status HI)
DIG3	ESTR NEG (Active status HI)
Counters	All resetted

(*) This set-up parameters have no influences on the operations of the CU90N unit with this set-up and application.

10 TECHNICAL CHARACTERISTICS

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 phase current (In)	1 A or 5 A
Thermal withstand continuously	4 In
Thermal withstand for 1 s	100 In
Rated frequency	50 / 60 Hz
Primary CT's current	1 - 9999 A
Primary VT's voltage	1 - 999999 V

Output contacts ratings

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

Digital inputs

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

Data transmission

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

Auxiliary supply

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

Environmental conditions

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

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

Note 2) Breaking capability at 110 Vdc, L/R 40 ms, 100.000 operations
Note 3) The output contacts of R3 and R4 relays can be configured as signaling or tripping relays

11 TABLES

Table A REGULATION MODE parameters

	Parameter / Threshold	Setting	Resolution
Vp1, Vp2	Voltage reference	0.80 ÷ 1.20 Un	0.01 Un
Z1, Z2	Current compensation coefficient	0.000 ÷ 0.600 Vp	0.002 Vp
INS (α)	Insensitivity degree	0.008 ÷ 0.030 Vp	0.002 Vp
Ia>	Max. current compensation value	0.10 ÷ 9.99 In	0.01 In
I>	Overload condition threshold (command issue under overload conditions)	0.10 ÷ 9.99 In	0.01 In
I>>	Overcurrent threshold (regulation function disabling)	0.10 ÷ 9.99 In	0.01 In
ΦINV	Reverse power angle	-180° ÷ +180°	1°
Id>	Unbalanced current alarm threshold (2TRAFO)	0.10 ÷ 9.99 In	0.01 In
	Functional enable thresholds		
U>	Overvoltage threshold	0.90 ÷ 1.50 Un	0.01 Un
U<	Undervoltage threshold	0.70 ÷ 1.10 Un	0.01 Un
	Time delay		
TCOM	AUM/DIM commands length	0.10 ÷ 99.99 s	0.01 s
	Time delay selection	INDIP, INV, EXP, CONT	----
TI	Time delay between two commands (time definite)	0.1 ÷ 999.9 s	0.1 s
To	Minimum time delay between two commands (time dependent)	0.10 ÷ 99.99 s	0.01 s
K	Characteristic constant (dependent time)	1 ÷ 200 s	1 s
TI Id>	Time delay threshold Id>	0.02 ÷ 99.99 s	0.01 s

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