VEGA 76

User's Manual

CE

HT ITALIA

Release EN 2.00 - 08/06/2004

Contents:

1. PRECAUTIONS AND SAFETY MEASURES

1.1. GENERAL

This instrument has been designed in compliance with Standard EN 61010.

CAUTION

For your own safety and to avoid damaging the instrument follow the procedures described in this instruction manual and read carefully all notes preceded by this symbol ⚠.

When taking measurements:

- avoid doing that in humid or wet places - make sure that humidity is within the limits indicated in section “environmental conditions”.
- avoid doing that in rooms where explosive gas, combustible gas, steam or excessive dust is present.
- keep you insulated from the object under test.
- do not touch exposed metal parts such as test lead ends, sockets, fixing objects, circuits etc.
- avoid doing that if you notice anomalous conditions such as breakages, deformations, fractures, leakages of battery liquid, blind display etc.

The following symbols are used:

CAUTION - refer to the instruction manual - an improper use may damage the instrument or its components

HIGH VOLTAGE: risk of electrical shocks

1.2. PRELIMINARY INSTRUCTIONS

- This instrument has been designed for use in environments of pollution degree 2.
- It can be used for **voltage and current** measurements on installations of overvoltage category III 600V~ phase to phase / 300V~ phase to earth or CATII 350V phase to earth up to (and no more than) 2000 meters altitude.
- You are recommended to respect the usual safety regulations aimed at protecting you against dangerous currents and protecting the instrument against improper use.
- Only the original accessories supplied along with the instrument guarantee compliance with the safety Standards in force. They must be in a good conditions and, if necessary, replaced with identical ones.
- Do not test nor connect to any circuit exceeding the specified overload protection.
- Do not take measurements under environmental conditions exceeding the limits indicated in this manual.
- Before connecting cables, test probes, crocodiles and clamps to the installation to be tested make sure that the rotary selector is positioned on the right function.

1.3. DURING USE

CAUTION

An improper use may damage the instrument and/or its components or injure the operator.

- When the instrument is connected to the circuit under test do not touch any unused terminal.
- When measuring current, other currents located near the leads may affect the measuring accuracy.
- When measuring current, always position the wire in the very middle of the jaws in order to obtain the highest accuracy.
- A measured value remains constant if the "**HOLD**" function is active. Should you notice that the measured value remains unchanged, disable the "**HOLD**" function.

1.4. AFTER USE

- After use, turn off the instrument by pressing ON/OFF for a few seconds.
- If you expect not to use the instrument for a long time please keep to the storage instructions described at paragraph 3.4.

2. GENERAL DESCRIPTION

2.1. INTRODUCTION

VEGA 76 represents a new approach to the world of electrical measurements. Computer assisted instruments like this permit an easy and fast analysis of a huge quantity of data.

2.2. FUNCTIONS

The instrument can:

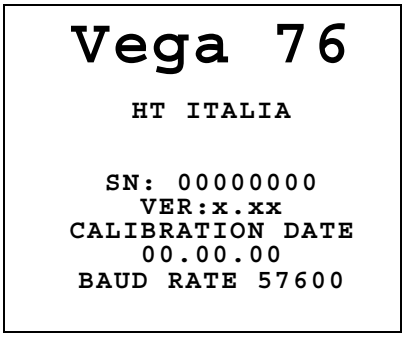
- **display in real time** the electrical parameters of single phase and three-phase systems (with and without neutral wire)
- **perform** a harmonic analysis of voltages and currents
- **perform a direct energy measurement** (without storing data).
- **memorize** (by pressing SAVE) the sampled values of the parameters present at the instrument's input by generating a "Smp" record inside the memory. **It's possible to analyze memorized data ONLY by transferring them to a PC.**
- **record simultaneously** (by pressing START after a proper setting): RMS values of voltages, currents, corresponding harmonics, active, reactive and apparent powers, power factors and cosφ, active, reactive and apparent energies, voltage anomalies (voltage sags and surges) with 10ms resolution. **It's possible to analyze recorded data ONLY by transferring them to a PC.**

CAUTION

Please note the difference between **memorize** and **record**. These terms will be used repeatedly in this manual. Please focus on their definitions and distinctions.

2.3. INITIAL SCREEN

When turning on the instrument by pressing ON/OFF, this screen will appear for a few seconds:



Here you can see:

- serial number of the instrument (SN.:)
- firmware software release (VER.:)
- calibration date (CALIBRATION:)
- transmission speed through serial I/O (Baud Rate)

3. PREPARING THE INSTRUMENT

3.1. PRELIMINARY CHECK

This instrument was checked both mechanically and electrically prior to shipment. All possible cares and precautions were taken to let you receive the instrument in perfect conditions. Notwithstanding we suggest you to check it rapidly (eventual damages may have occurred during transport – if so please contact the local distributor from whom you bought the item).
Make sure that all standard accessories mentioned in paragraph 13.3 are included.
Should you have to return back the instrument for any reason please follow the instructions mentioned in paragraph 17.

3.2. POWER SUPPLY

The instrument can be powered by batteries (refer to paragraph 13.1.11 for details on model, no. and battery life) and by an external power supply (refer to paragraph 13.3.1 for details on the model) supplied with the instrument as a standard accessory. When batteries are low, a low battery indication is displayed.
To replace/insert batteries follow the instructions indicated in paragraph 12.2.

CAUTION

For recordings use ALWAYS the external power supply (although the instrument allows the operator to perform a recording using internal batteries).

The instrument applies sophisticated algorithms to prolong the battery life. Particularly:

- it automatically switches off the backlight after 5 seconds.
- If the instrument is displaying in real time (and the external power supply is not connected), after about 5 minutes from the last pressure on keys or selector rotation the instrument automatically turns off ("AUTOPOWER OFF" procedure).
- If the instrument is recording or is measuring energy (and the external power supply is not connected), after about 5 minutes from the last pressure on keys or selector rotation the instrument starts a special procedure to save batteries ("ECONOMY MODE"): the instrument keeps recording but the display is turned off.

3.3. CALIBRATION

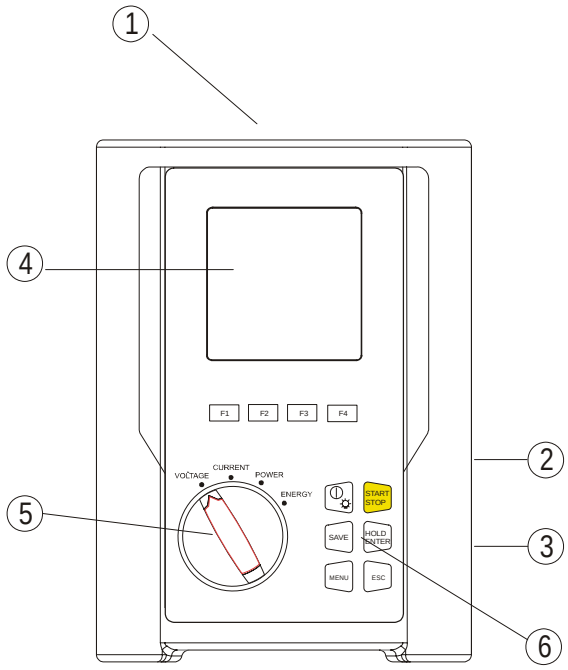
The instrument complies with the technical specifications contained in this manual and such compliance is guaranteed for 1 year. Annual recalibration is recommended.

3.4. STORAGE

After a period of storage in extreme environmental conditions exceeding the limits mentioned in paragraph 13.2 let the instrument resume normal measuring conditions before using it.

4. HOW TO OPERATE

4.1. INSTRUMENT - DESCRIPTION



Legend:

1. Inputs for voltage and current
2. RS232 serial output
3. Plug for external power supply
4. Display
5. Selector switch
6. Keyboard

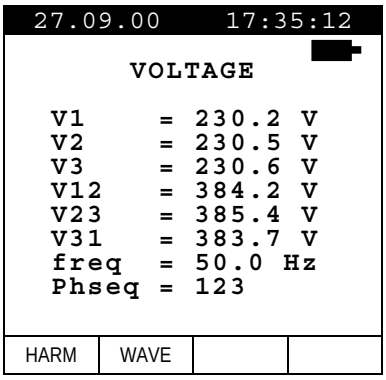
4.2. KEYBOARD - DESCRIPTION

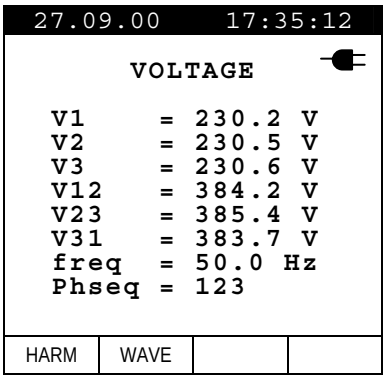
The following keys are available.

- ☞ **ON/OFF**: turning on – turning off / Backlight ON (automatic switching off after 5 sec.)
- ☞ **F1**, **F2**, **F3**, **F4**: multifunction keys. The various functions are deducible from the symbols shown on the bottom of the display.
- ☞ **MENU**: by pressing **MENU** it's possible to check and modify the recording parameters.
- ☞ **ESC**: to leave a menu or a sub-menu.
- ☞ **ENTER/HOLD**: double function key:
  - ✓ **ENTER**: to confirm the settings made
  - ✓ **HOLD**: to block the value updating in real time on all screens. This function is disabled when recording or measuring energy. When this function is active it's not possible to record or take energy measurements.
- ☞ **SAVE**: to save a record of "Smp" type (see paragraph 5.4) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- ☞ **START/STOP**: to start/stop manually a recording (see chapter 7).

4.3. DISPLAY - DESCRIPTION

The display is a graphic module with a resolution of128 x 128 pixels (16384 pixels overall). Each pixel has a dimension of 0.5mm x 0.5mm, the visible area is a square of 73mm x 73mm.
The first line of the display shows date and time. If not correct, you can set the exact ones according to the procedure described at paragraph 5.1.2.
On the top right corner of the display you can always see a battery indicator and, if the external power supply is connected, the corresponding symbol.





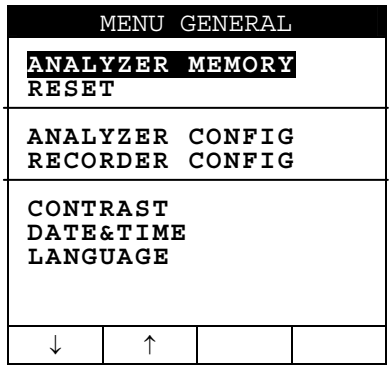
These symbols will be omitted in the following illustrations.

4.4. BACKLIGHT FUNCTION

When the instrument is turned on, press **ON** briefly to activate the backlight. The backlight automatically turns off after 5 seconds. If batteries are too low the instrument automatically disables the backlight function. A repeated use of the backlight function affects the battery life.

5. MENU GENERAL

By pressing **MENU** the following screen will be displayed:



It's not possible to enter the **MENU** during a recording or a Real Time Energy measurement.

5.1. INITIAL SETTINGS

5.1.1. How to adjust the contrast

By pressing the multifunction keys **F1** and **F2** position the cursor on **CONTRAST** and confirm it by pressing **ENTER**.
By pressing the multifunction keys **F3** and **F4**, adjust the contrast (higher values correspond to a higher contrast, lower values correspond to a lower contrast). Press **ENTER** to SAVE the change or press **ESC** to quit the modification.
This setting will remain unchanged also after turning off the instrument.

5.1.2. How to set date and time

By pressing the multifunction keys **F1** and **F2** position the cursor on **DATE&TIME** and confirm by pressing **ENTER**.
By pressing the multifunction keys **F1** and **F2** position the cursor on the Date format (**FORMAT**) and by pressing the **F3** or **F4** keys select one of the following Date formats:

DD.MM.YY (2 digits for day, 2 digits for Month, 2 digits for Year)
or
MM.DD.YY (2 digits for Month, 2 digits for Day, 2 digits for Year)

By pressing the multifunction keys **F1** and **F2** position the cursor on the value to be modified and change the value by pressing **F3** and **F4**.

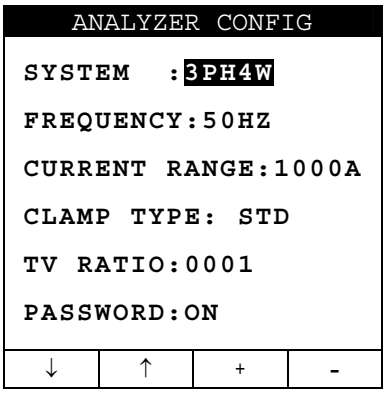
The time is expressed as **hh:mm** (2 digits for hours, 2 digits for minutes) on a 24-hours basis.
Press **ENTER** to SAVE the change or press **ESC** to quit the modification.
This setting will remain unchanged also after turning off the instrument.

5.1.3. How to set the language

By pressing the multifunction keys **F1** and **F2** position the cursor on **LANGUAGE** (EN) or **LINGUA** (IT) and confirm by pressing **ENTER**.
By pressing the multifunction keys **F1** and **F2** position the cursor on the desired language and press **ENTER** to SAVE the change or **ESC** to quit the modification.
This setting will remain unchanged also after turning off the instrument.

5.2. BASIC SETTING: ANALYZER CONFIG

By selecting **ANALYZER CONFIG** and pressing **ENTER**, the following screen will be displayed:



This page of settings can be confirmed by pressing **ENTER** or cancelled by pressing **ESC**.

5.2.1. How to set the type of electrical system under test

This parameter permits to select the type of electrical system under test among the following configurations:

- **SINGLE: single-phase system**
- **3PH3W: 3-wire system** (three-phase system without neutral) (see paragraph 16.3.2)
- **3PH4W: 4-wire system** (three-phase system with neutral)

The connections to the instrument inputs will have to be in accordance with the type of system selected.
Position the cursor on the corresponding word by pressing the multifunction keys **F1** and **F2** and set the desired value by pressing the multifunction keys **F3** and **F4**.

5.2.2. How to set the fundamental frequency

Position the cursor on the corresponding word by pressing the multifunction keys **F1** and **F2** and select the network frequency between the possible values **50Hz** and **60Hz** by pressing the multifunction keys **F3** and **F4**. This parameter is important ONLY if the input voltage is not sufficient to recognize the frequency value (for example, only current clamps are connected). In this case the instrument generates an internal synchronism equal to the value of the set frequency.

5.2.3. How to set the current range

The value of this parameter **must be always equal to the full scale of the current clamps** used to take the measurement. In case multi-scale clamps are used, the value of this parameter must be equal to the scale selected on the clamps.
Set the desired value by pressing the multifunction keys **F3** and **F4**.

5.2.4. How to set the type of clamp

The value of this parameter **must be always equal to the type of clamp being used.**
Three types of clamps are available:

- STD: standard clamps or current transformers
- FlexINT: flexible clamps without integrator
- FlexEXT: flexible clamps with integrator

Set the desired value by pressing the multifunction keys **F3** and **F4**.

CAUTION

If FlexINT is chosen, the current range can be set only at 1000A or 3000A.

5.2.5. How to set the value of the transformer voltage ratio (TV RATIO)

The instrument can be also interfaced with step-down transformers of the equipment under test: it can display the value of the voltages present on the primary winding of these transformers. To do this it will be necessary to set the value of the transformers' windings ratio from 2:1 to 3000:1. The default is set at 1:1 for measurements of none transformer systems.
Select "TV RATIO" in the ANALYZER CONFIG menu. Set the desired value by pressing the multifunction keys **F3** and **F4**.

5.2.6. How to enable/disable the password

The instrument is provided with a protective routine to avoid the risk of being disturbed or interrupted during a recording or an energy measurement. Once a recording or a direct energy measurement has been started (with the option "PASSWORD" enabled), after about 3 minutes from the last pressure on keys or selector rotation it won't be possible to press START/STOP to stop the recording, "PASSWORD" will be displayed and it will be necessary to insert the password.
In order to insert the password (which is not changeable), press the multifunction keys in the following sequence (within 10 seconds):

F1, **F4**, **F3**, **F2**

If you wait more than 10 seconds the display will return to the meter mode and the instrument will continue recording. If you insert a wrong password the message "Password error" will be displayed under "PASSWORD". After a few seconds the display will return to meter mode and the instrument will continue recording. In order to enable/disable this option the correct password must be entered. The display will return to meter mode and START/STOP will have to be pressed again to stop the recording. You will then need to re-enter the "ANALYZER CONFIG" menu and scroll up or down to the item "PASSWORD: ON" by pressing the multifunction keys **F1** and **F2.** Then turn off the password by pressing the multifunction keys **F3** and **F4**.

5.3. BASIC SETTING: RECORDER CONFIG

This option permits to check and eventually modify the recording parameters and the selected parameters (up to a maximum of 64). The calculation of the selected values is not affected by the selector's position. If the number of selected values exceeds 64 the message "too many param" will be displayed. The MENU mode is divided into 4 separate sub-pages:

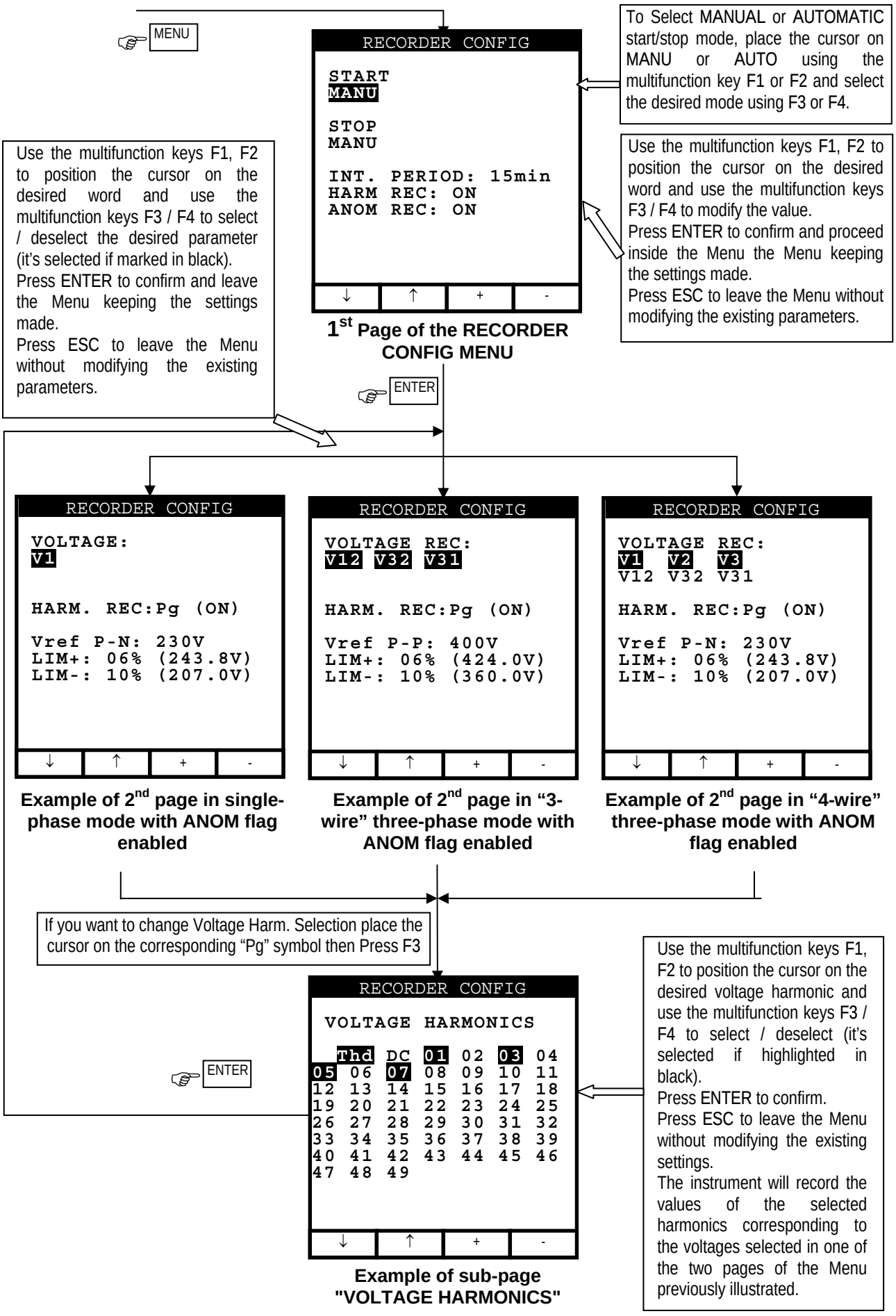
- ✓ 1st page: This page permits to set the START/ STOP mode (AUTO or MANUAL), the START and STOP time if AUTO mode is selected, the Integration Period value, the Enabling/Disabling of Voltage Anomalies detection, the Enabling/Disabling of Harmonics detection. Press **ENTER** to confirm the settings and pass to the following page.
  Press **ESC** to leave the Menu without modifying the existing parameters.

- ✓ 2nd page: This page is dedicated to the settings related to the **VOLTAGE** recording.
  Press **ENTER** to confirm the settings and pass to the following page.
  Press **ESC** to leave this page without modifying the existing parameters.
  From this page you can enter the sub-page "Harmonics" which permits to select the voltage harmonics to be recorded.
  Press **ENTER** to confirm the settings and leave the "Menu Harmonics".
  Press **ESC** to leave the "Menu Harmonics" without modifying the existing parameters.

- ✓ 3rd page: This page is dedicated to the settings related to the **CURRENT** recording.
  Press **ENTER** to confirm the settings and pass to the following page.
  Press **ESC** to leave this page without modifying the existing parameters.
  From this page you can enter the sub-page "Harmonics" which permits to select the current harmonics to be recorded.
  Press **ENTER** to confirm the settings and leave the "Menu Harmonics".
  Press **ESC** to leave the "Menu Harmonics" without modifying the existing parameters.

- ✓ 4th page: Menu composed of two sub-pages dedicated to the selection of the **POWERS and ENERGIES** to be recorded. From this page you can enter the sub-page "POWER" and "ENERGY" which permits to select the parameters to be recorded.
  By selecting the active powers for the recording, the corresponding active energies will be automatically selected.
  By selecting the reactive powers for the recording, the corresponding reactive energies will be selected.
  Press **ENTER** to confirm the settings.
  Press **ESC** to leave the "Menu" without modifying the existing parameters.

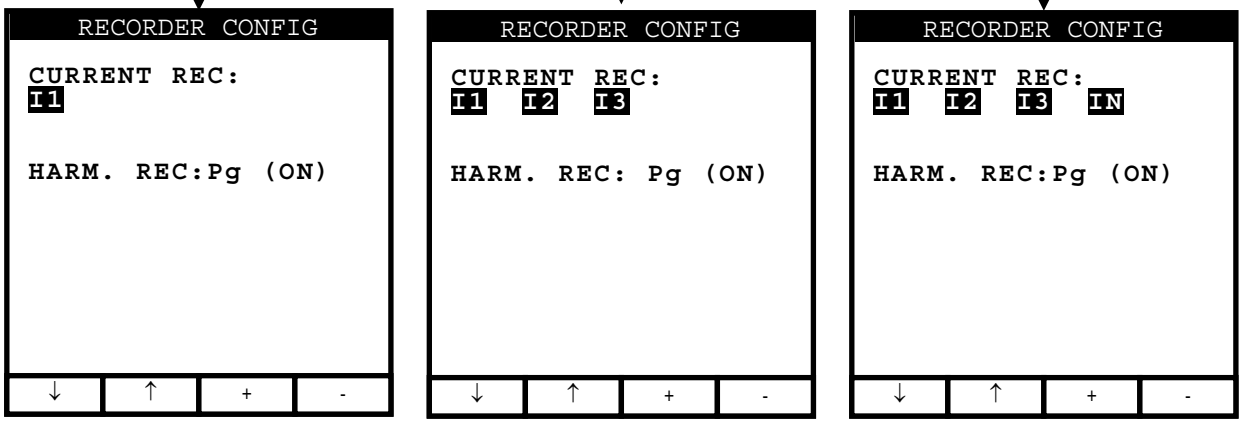
The various pages of the "**RECORDER CONFIG**" can be schemed as follows:


MENU
RECORDER CONFIG
START
MANU
STOP
MANU
INT. PERIOD: 15min
HARM REC: ON
ANOM REC: ON
↓ ↑ + -
To Select MANUAL or AUTOMATIC start/stop mode, place the cursor on MANU or AUTO using the multifunction key F1 or F2 and select the desired mode using F3 or F4.
Use the multifunction keys F1, F2 to position the cursor on the desired word and use the multifunction keys F3 / F4 to modify the value.
Press ENTER to confirm and proceed inside the Menu the Menu keeping the settings made.
Press ESC to leave the Menu without modifying the existing parameters.
Use the multifunction keys F1, F2 to position the cursor on the desired word and use the multifunction keys F3 / F4 to select / deselect the desired parameter (it's selected if marked in black).
Press ENTER to confirm and leave the Menu keeping the settings made.
Press ESC to leave the Menu without modifying the existing parameters.
1st Page of the RECORDER CONFIG MENU
ENTER
RECORDER CONFIG
VOLTAGE:
V1
HARM. REC:Pg (ON)
Vref P-N: 230V
LIM+: 06% (243.8V)
LIM-: 10% (207.0V)
↓ ↑ + -
Example of 2nd page in single-phase mode with ANOM flag enabled
RECORDER CONFIG
VOLTAGE REC:
V12 V32 V31
HARM. REC:Pg (ON)
Vref P-P: 400V
LIM+: 06% (424.0V)
LIM-: 10% (360.0V)
↓ ↑ + -
Example of 2nd page in "3-wire" three-phase mode with ANOM flag enabled
RECORDER CONFIG
VOLTAGE REC:
V1 V2 V3
V12 V32 V31
HARM. REC:Pg (ON)
Vref P-N: 230V
LIM+: 06% (243.8V)
LIM-: 10% (207.0V)
↓ ↑ + -
Example of 2nd page in "4-wire" three-phase mode with ANOM flag enabled
If you want to change Voltage Harm. Selection place the cursor on the corresponding "Pg" symbol then Press F3
ENTER
RECORDER CONFIG
VOLTAGE HARMONICS
Thd DC 01 02 03 04
05 06 07 08 09 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31 32
33 34 35 36 37 38 39
40 41 42 43 44 45 46
47 48 49
↓ ↑ + -
Example of sub-page "VOLTAGE HARMONICS"
Use the multifunction keys F1, F2 to position the cursor on the desired voltage harmonic and use the multifunction keys F3 / F4 to select / deselect (it's selected if highlighted in black).
Press ENTER to confirm.
Press ESC to leave the Menu without modifying the existing settings.
The instrument will record the values of the selected harmonics corresponding to the voltages selected in one of the two pages of the Menu previously illustrated.

Use the multifunction keys F1, F2 to position the cursor on the desired word and use the multifunction keys F3 / F4 to modify the value or select / deselect the desired parameter (it's selected if marked in black).
Press ENTER to confirm.
Press ESC to leave the Menu without modifying the existing settings.

From 2nd page of RECORDER CONFIG MENU

ENTER



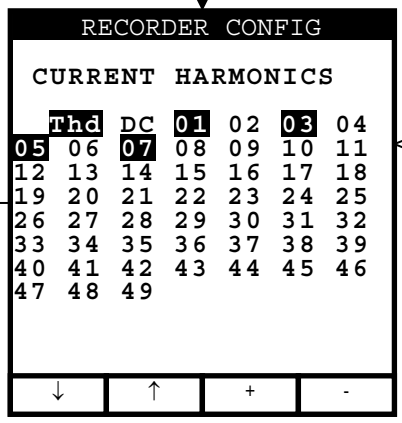
Example of 3rd page in single-phase mode

Example of 3rd page in "3-wire" three-phase mode

Example of 3rd page in "4-wire" three-phase mode

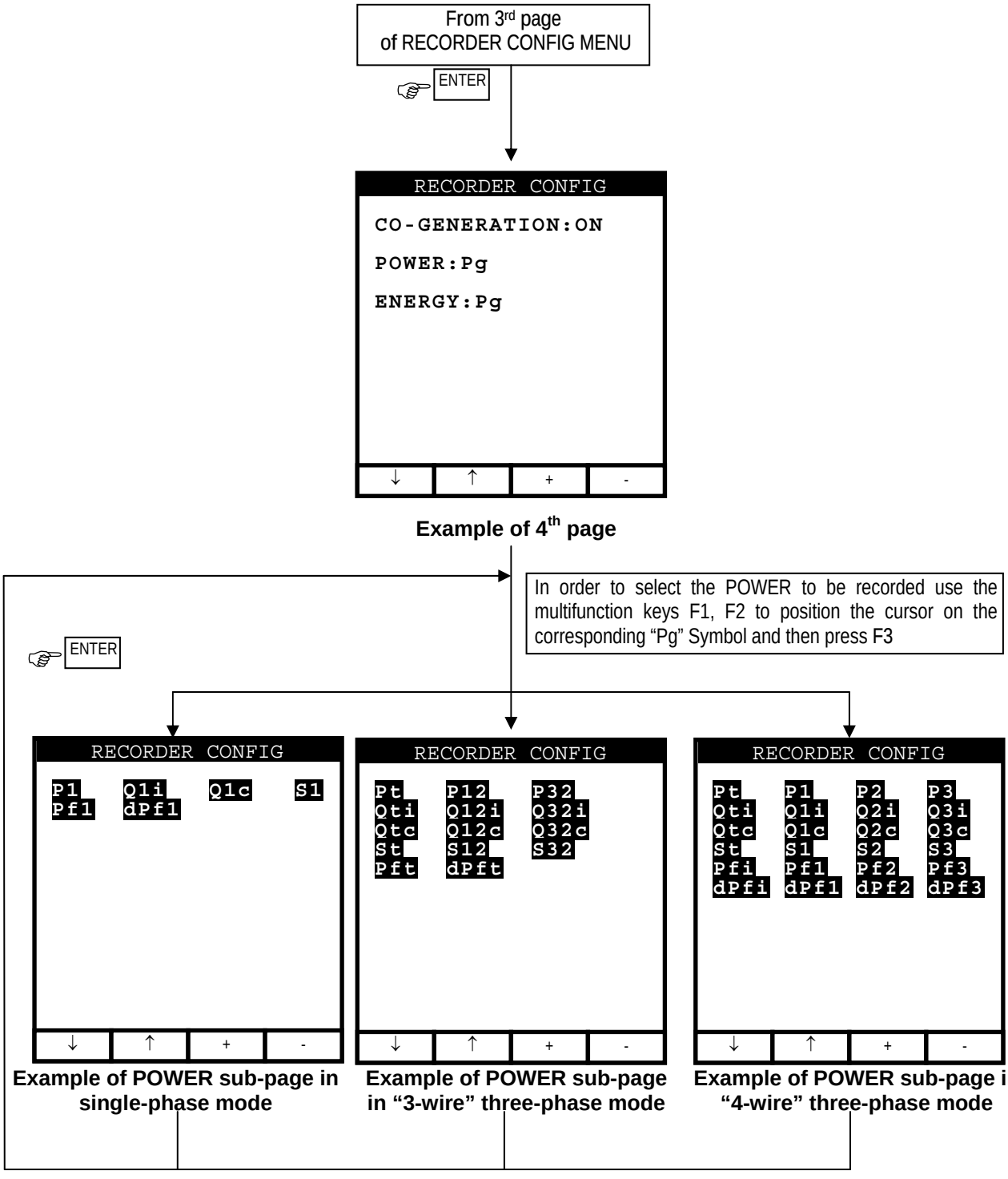
If you want to change Current Harm. Selection place Cursor on the corresponding "Pg" symbol then Press F3

ENTER

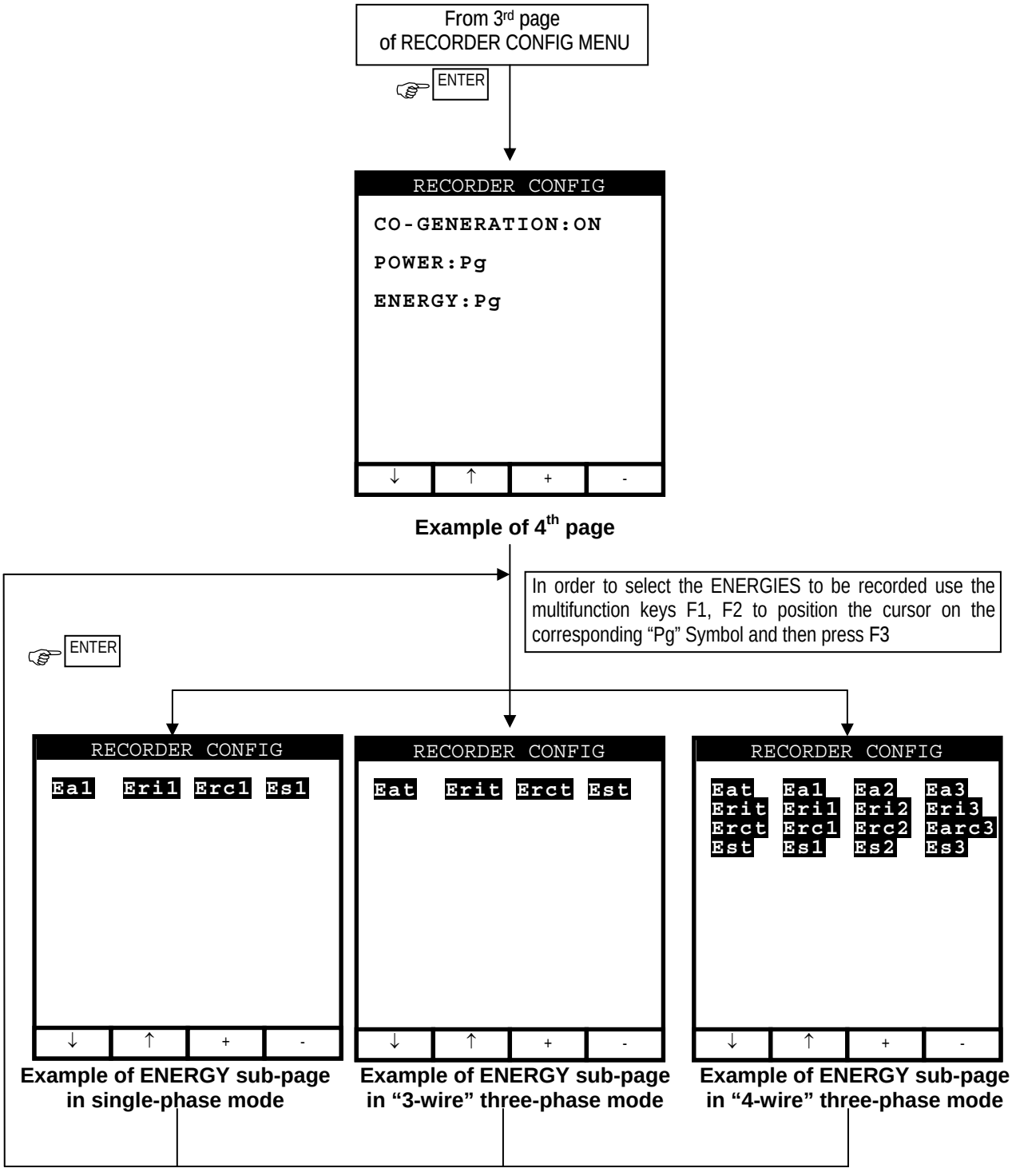


Example of sub-page "CURRENT HARMONICS"

Use the multifunction keys F1, F2 to position the cursor on the desired current harmonic and use the multifunction keys F3 / F4 to select / deselect (it's selected if marked in black).
Press ENTER to confirm.
Press ESC to leave the Menu without modifying the existing settings.
The instrument will record the values of the selected harmonics corresponding to the currents selected in one of the two pages of the Menu previously illustrated.



By selecting the active powers for the recording, the corresponding active energies will be automatically selected.
By selecting the reactive powers for the recording, the corresponding reactive energies will be automatically selected.



By selecting/deselecting the active energies for the recording, the corresponding active powers will be automatically selected/deselected.
By selecting/deselecting the reactive energies for the recording, the corresponding reactive powers will be selected/deselected
By selecting/deselecting the reactive energies for the recording, the corresponding reactive powers will be selected/deselected.

Symbols	Description	Advised settings
START:MAN	The recording of all selected parameters will start at 00 seconds after pressing **START/STOP** (see chapter 7).	☺
STOP:MAN	The recording of all selected parameters will be interrupted manually by pressing **START/STOP** (see chapter 9).	☺
START:AUTO STOP:AUTO	The recording of all selected values will be started / interrupted at the set dates and times. In order to start the recording the user will have to press START/STOP to set the instrument in Stand-by mode until the start date and time previously set (see chapter 7).	
INT. PERIOD	The value of this parameter determines every how many seconds the values of **all the selected parameters** will be memorized (see chapter 16.4.1). Available choices: 5sec, 10sec, 30sec, 1min, 2min, 5min,10min, 5min, 30min, 60min.	**15min** ☺
HARM REC.	**ON** = the instrument will record the values of the selected **voltage and current harmonics** corresponding to the voltages and currents selected in the corresponding pages “Voltage” and “Current”. Example: If the following parameters are selected: **a) Phase Voltage 1 and 2, THd, Harmonics 1,3,5.** **b) Phase Current 2 and 3, THd, Harmonics 3,5,7.** The instrument will record: **a) The Phase Voltage 1 and 2, THD and Harmonics 1,3,5 of the Phase Voltage 1 and 2 while it will not record anything about Phase Voltage 3** **b) The Phase Current 2 and 3, THD and Harmonics 3,5,7 of the Phase Current 2 and 3 while it will not record nothing about Phase Current 1**	☺
	OFF = the instrument **will not record** any voltage or current harmonic selected	
ANOM REC.	**ON** = the instrument will record Voltage Anomalies (voltage Sag and Surge) (see paragraph 16.1)	☺
	OFF = the instrument **will not record** any voltage Sag and Surge	
V1, V2, V3 V12, V23 or V32, V31	RMS value of the voltage of phase 1, phase 2, phase 3 respectively, values of the phase-to-phase voltages 1-2, 2-3 or 3-2 and 3-1.	☺ Single phase: **V1** 3-wire **V_{12} V_{32} V_{31}** 4-wire **V_1, V_2, V_3**
THD, DC, 01...49	Voltage Total Harmonic Distortion, DC Component, 01..49 Harmonics respectively	☺ **THD,01,03,05,07**
Vref (only if ANOM. REC flag has been set ON)	RMS reference value for Voltage used in Voltage Anomalies detection (Voltage Sag and Surge). The Reference is: a) Voltage Phase to Neutral for Single Phase and 4-wire three phase system b) Voltage Phase to Phase for 3-wire three phase system	☺ Single phase: **230V** 3-wire: **400V** 4-wire **230V**
LIM+, LIM- (only if ANOM. REC flag has been set ON)	High and Low Voltage Percent threshold used in Voltage Anomalies detection (Voltage Sag and Surge). Example: Three Phase System 4-wire. Vref = 120, LIM+= 6%, LIM-=10% => High Lim = 127.2V, Low Lim = 108.0V The Instrument will detect a voltage Anomalies if the RMS Voltage Values (calculated every 10ms) beyond the above calculated thresholds (see paragraph 16.1).	☺ Single phase: **120V** 3-wire: **480V** 4-wire **277V**
I1, I2, I3, IN	RMS value of the current of phase 1, phase 2, phase 3 and of the neutral respectively.	☺ Single phase: **I1** 3-wire: **I1**, **I2**, **I3** 4-wire **I1**, **I2**, **I3**, **IN**
THD, DC, 01..49	Current Total Harmonic Distortion, DC Component, 01..49 Harmonics respectively	☺ **THD,01,03,05,07**

CO-GENERATION	ON = the instrument is able to face situations of CO-GENERATION of electrical equipment (that is, the equipment under test is able to generate energy besides absorbing it). Accordingly, the instrument will record the powers and energies both absorbed and generated (see paragraph 16.3.1). **If this flag is enabled the maximum number of parameters which can be selected decrease to 38.**	
	OFF = the instrument will record ONLY the powers and energies absorbed.	☺
Pt, P1, P2, P3, P12, P32	Values of the active power (total, of phase 1, phase 2 and phase 3) (only for 3-wire measurement) value of the power measured by the Wattmeter 1-2 and 3-2 respectively	☺ Single phase: P1 3-wire: Pt 4-wire Pt, P1, P2, P3
Qti, Q1i, Q2i, Q3i, Q12i, Q32i	Values of the inductive reactive power (total, of phase 1, phase 2, phase 3) (only for 3-wire measurement) value of the reactive inductive power measured by the VAR meters 1-2 and 3-2 respectively	☺ Single phase: Q1i Q1c 3-wire: Qti Qtc 4-wire Qti Q1i Q2i, Q3i Qtc Q1c Q2c, Q3c
Qtc, Q1c, Q2c, Q3c, Q12c, Q32c	Values of the capacitive reactive power (total, of phase 1, phase 2, phase 3) (only for 3-wire measurement) value of the reactive capacitive power measured by the VA meters 1-2 and 3-2 respectively	
St, S1, S2, S3, S12, S32	Values of the apparent power (total, of phase 1, phase 2, phase 3) (only for 3-wire measurement) value of the power measured by the VA meters 1-2 and 3-2 respectively	☺ Single phase: S1 3-wire: St 4-wire St, S1, S2, S3
Pft, Pf1, Pf2, Pf3	Values of the power factors (total, of phase 1, phase 2 and phase 3 respectively)	☺ Single phase: Pf1 dPf1 3-wire: Pft dPft 4-wire Pft Pf1 Pf2 Pf3 dPft dPf1 dPf2 dPf3
dpft, dpf1, dpf2, dpf3	Values of the cosφ (total, of phase 1, phase 2 and phase 3 respectively)	
Eat, Ea1, Ea2, Ea3	Values of the active energy (total, of phase 1, phase 2, phase 3)	☺ Single phase: Ea1 3-wire: Eat 4-wire Eat Ea1 Ea2 Ea3
Erit, Eri1, Eri2, Eri3	Values of the inductive reactive energy (total, of phase 1, phase 2 and phase 3)	☺ Single phase: Eri1 Erc1 3-wire: Erit Erct 4-wire Erit Eri1 Eri2 Eri3 Erct Erc1 Erc2 Erc3
Erct, Erc1, Erc2, Erc3	Values of the capacitive reactive energy (total, of phase 1, phase 2, phase 3)	
Est, Es1, Es2, Es3	Values of the Apparent Energy (total, of phase 1, phase 2, phase 3)	☺ Single phase: Es1 3-wire: Est 4-wire Est Es1 Es2 Es3

The value of the network frequency is automatically selected if at least one phase voltage (for the single-phase mode or the 4-wire three phase mode) or at least one phase-to-phase voltage (for the 3-wire three phase mode) is selected.

The symbols "i" and "c" stand for reactive powers (Q), power factors (Pf) and cosφ (dpf) inductive and capacitive respectively.

Selecting a power factor (Pf) or a cosφ (dPf) for the recording automatically their inductive value and their capacitive value will be recorded separately.

For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED.

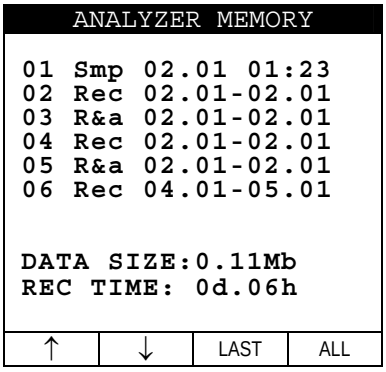
5.4. ANALYZER MEMORY

This option permits to display:

- The present content of the instrument memory
- The size of memorized data
- The residual space available for future recordings (expressed in days and hours)

All stored data can be displayed only if downloaded to a PC by means of the software.

After selecting "ANALYZER MEMORY" from the Main Menu the screen below will be displayed:



Example of ANALYZER MEMORY screen

- Rec: **recordings** effected with respective Start and Stop dates expressed in the format "day.month" (start) – "day.month" (stop) ***without*** Voltage Sag and Surge detection.
- R&a: **recordings** effected with respective Start and Stop dates expressed in the format "day.month" (start) – "day.month" (stop) ***with*** Voltage Anomalies (Sag and Surge) detection (only for Skylab).
- Smp: values of the **samples** of voltage and current stored by pressing SAVE.
- DATA SIZE: size of saved data.
- REC TIME: size of available memory, calculated on the basis of the parameters selected for recording, therefore the most complete one (expressed in the format "days.hours") to make recordings.

The maximum quantity of Rec + R&a + Smp which can be contained by the instrument is **35.**

Following keys are enabled:

- **F1**, **F2**: (only if the quantity of Rec+R&a+Smp is higher than 7) to run over all the recordings stored in the instrument memory.
- **F3**: to cancel the last recording effected.
- **F4**: to cancel all the recordings effected.

5.5. RESET

This option re-establishes the default settings of the instrument.

The default settings of the instrument consist of:

- ANALYZER CONFIG:

Frequency:	50Hz
Full scale of the clamps:	1000A
Transforming ratio of voltmetric transformers:	1
Clamp Type:	FLEX
Type of electrical equipment:	4-wire
Password:	enabled

- RECORDER CONFIG:

Start:	Manual (the recording is started at 00 sec mark on clock after pressing the START/STOP key)
Stop:	Manual
Integration period:	15min
Recording of harmonics:	ON
Recording of Voltage anomalies (Sag and Surge):	ON
Voltage Reference for Sag and Surge detection:	230V
Upper Limit for Sag and Surge detection:	6%
Lower Limit for Sag and Surge detection:	10%
Selected voltages:	V1, V2, V3
Selected voltage harmonics:	THD, 01, 03, 05, 07
Selected currents:	I1, I2, I3, IN
Selected current harmonics:	THD, 01, 03, 05, 07
CO-GENERATION:	OFF
Powers, Pf and cosφ selected:	Pt, P1, P2, P3 Qti, Q1i, Q2i, Q3i Qtc, Q1c, Q2c, Q3c St, S1, S2, S3 Pft, Pf1, Pf2, Pf3 dpft, dpf1, dpf2, dpf3
Energies:	Eat, Ea1, Ea2, Ea3 Erit, Eri1, Eri2, Eri3 Erct, Erc1, Erc2, Erc3 Est, Es1, Es2, Es3

The RESET command will not erase the instrument's memory.

6. SWITCH FUNCTIONS

For a simple usage, the main functions of the instrument can be selected by rotating the selector:

- Position "**VOLTAGE**": to display **voltage and corresponding harmonics** (see paragraph 6.1)
- Position "**CURRENT**": to display **current and corresponding harmonics** (see paragraph 6.2)
- Position "**POWER**": to display **all the parameters measurable by the instrument**: voltage, current, active, reactive and apparent power, power factor, cosφ and energy (see paragraph 6.3)
- Position "**ENERGY**": to display **active, reactive and apparent power, power factor, cosφ and energy** (see paragraph 6.4)

More practically, we may schematize the right procedure of use as follows:

1. Check and eventually modify the basic settings of the instrument
2. By rotating the switch, select the desired type of measurement
3. Connect the instrument to the electrical system to be tested
4. Evaluate the values of the parameters under test
5. If you want to record:
   a) Decide what to record
   b) Press **MENU** and check if the existing parameters meet your requirements
6. Connect the external power supply
7. Start the recording by pressing START/STOP.

6.1. POSITION "VOLTAGE"

This function permits to display in real time the RMS value of AC/DC voltage, the peak and Thd value of the 3 phase voltages (see paragraph 16.2), the waveform and the harmonic spectrum of the 3 phase voltages.

6.1.1. Symbols

The VOLTAGE position has three working modes:

- METER
- WAVE
- HARM

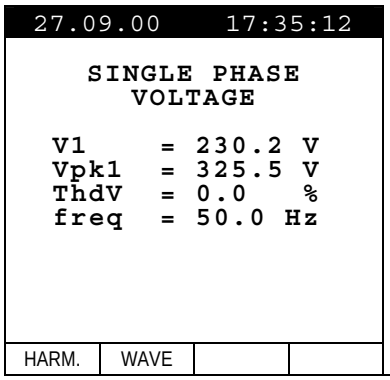
These modes will be described in detail in the next paragraphs. The used symbols are described below:

Symbol	Description
V1, V2, V3	RMS value of the voltage of phase 1, phase 2, phase 3 respectively
V12, V23 or V32, V31	RMS Value of the phase to phase voltages
Vpk1, Vpk2, Vpk3, Vpk12, Vpk32	Peak value of the voltage of phase 1, phase 2, phase 3 and of the phase to phase voltage 12 and 32 respectively
h01 ÷ h49	Harmonic 01 ÷ Harmonic 49.
ThdV	Factor of total harmonic distortion of the voltage (see paragraph 16.2).
freq	Network frequency
Phseq	Phase sequence indicator "123"→ correct "132"→ inverted "023"→ null voltage on the black wire "103"→ null voltage on the red wire "120"→ null voltage on the blue wire "100"→ null voltages on the red and blue wires "020"→ null voltages on the black and blue wires "003"→ null voltages on the black and red wires

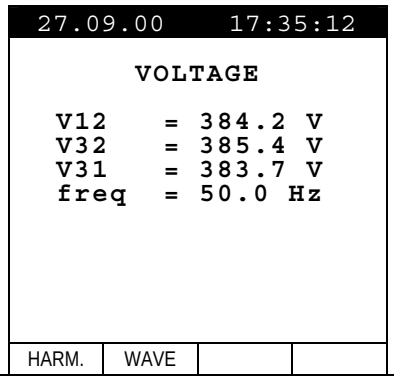
Tab. 1: Symbols used in the position VOLTAGE

6.1.2. "METER" mode

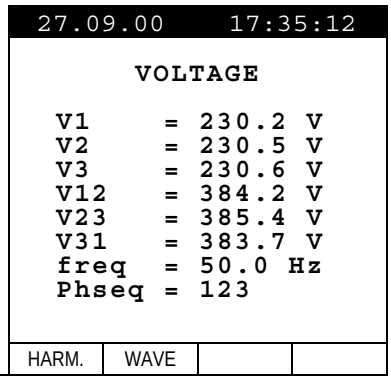
On rotating the switch to this position the instrument selects automatically the METER mode corresponding to one of the below screens according to the settings made as per paragraph 5.2.



Example of screen in single-phase mode



Example of screen in "3-wire" three-phase mode



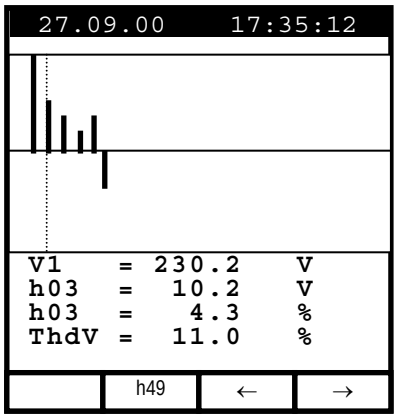
Example of screen in "4-wire" three-phase mode

The symbols used are described in Tab. 1. For eventual messages displayed see chapter 14. Following keys are enabled:

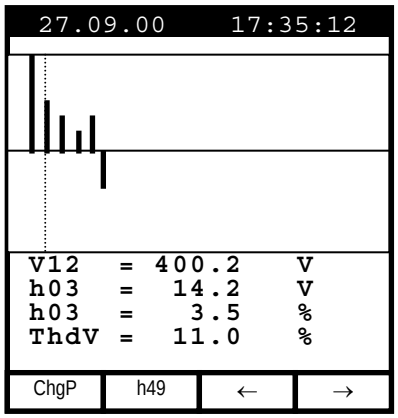
- **F1**: to pass to "HARMONIC" mode (see paragraph 6.1.3).
- **F2**: to pass to "WAVE" mode (see paragraph 6.1.4).
- **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 5.4) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

6.1.3. "HARM" mode

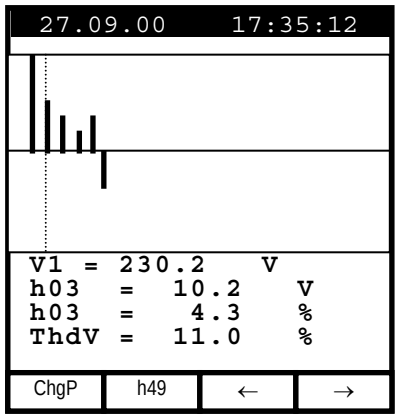
By selecting the HARM mode one of the below screens will be displayed according to the settings made as per paragraph 5.22. The screens show the harmonics (see paragraph 16.2) of the phase or phase-to-phase voltage.



Example of screen in single-phase system



Example of screen in "3-wire" three-phase system



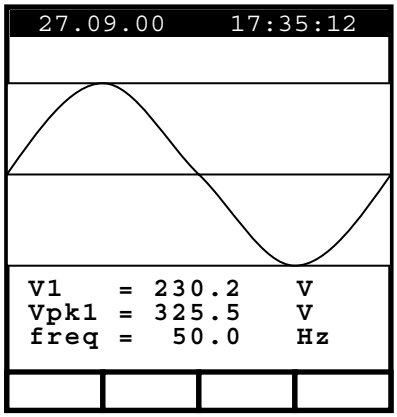
Example of screen in "4-wire" three-phase system

The symbols used are described in Tab. 1. For eventual messages displayed see chapter 14. The displayed histograms represent the harmonic content of the voltage under test. The value of the first harmonic h01 (fundamental at 50Hz) is not represented in scale along with the other harmonics in order to maximize the display of the latter. In case both voltage and current are connected to the instrument inputs, eventual negative values of harmonics (therefore represented under the horizontal axis), indicate that such voltage harmonics are "generated" by the load. Following keys are enabled:

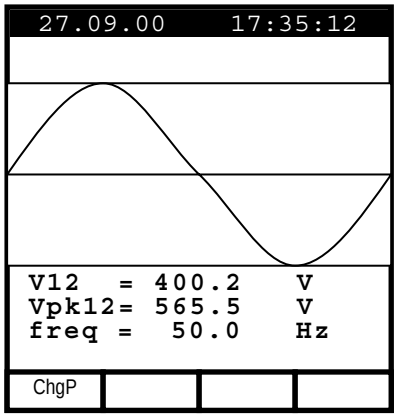
- **F3**, **F4**: to move the cursor of the selected harmonic leftwards and rightwards respectively. At the same time the values relevant to the order no. of the selected harmonic and to the corresponding absolute and relative values (calculated on the basis of the fundamental) are updated.
- **F1** (only for three-phase mode): to display the values of the harmonics of the other voltages available. The voltage displayed is indicated above the F3 key.
- **F2**: to display the page of the harmonics h01 ÷ h24 (symbol **h24**) or the page of the harmonics h25 ÷ h49 (symbol **h49**).
- **ESC**: to return back to METER mode (see paragraph 6.1.2).
- **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 5.4) and the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

6.1.4. "WAVE" mode

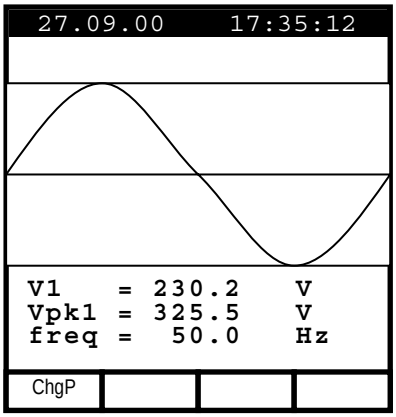
By selecting the WAVE mode one of the below screens will be displayed according to the settings made as per paragraph 5.2. The screens show the waveform of the phase or phase-to-phase voltage.



Example of screen in single-phase system



Example of screen in "3-wire" three-phase system



Example of screen in "4-wire" three-phase system

The symbols used are described in Tab. 1. For eventual messages displayed see chapter 14. Following keys are enabled:

- **F1**: (only for three-phase mode): to display the values corresponding to the following phase.
- **ESC**: to return back to METER mode (see paragraph 6.1.2).
- **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 5.4) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

6.2. POSITION "CURRENT"

This function permits to display in real time the RMS value of AC/DC currents, the peak and ThdI value (see paragraph 16.2) of the 3 phase currents, the waveform and the harmonic spectrum of the 3 phase currents.

6.2.1. Symbols

The CURRENT position has three working modes:

- METER
- WAVE
- HARM

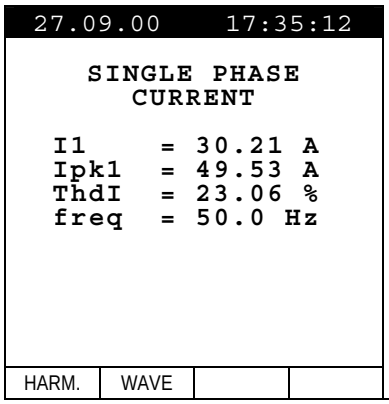
These modes will be described in detail in the next paragraphs.
The symbols used are described below:

Symbol	Description
I1, I2, I3	RMS value of the current of phase 1, phase 2, phase 3 respectively
IN	RMS value of the current on the neutral
Ipk1, Ipk2, Ipk3	Peak value of the current of phase 1, phase 2, phase 3 respectively
h01 ÷ h49	Harmonic 01 ÷ harmonic 49.
ThdI	Total harmonic distortion factor of the current (see paragraph 16.2).
freq	Network frequency

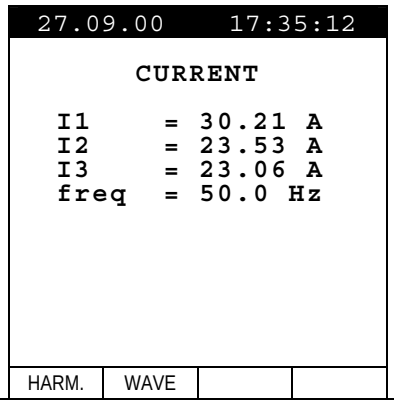
Tab. 2: Symbols used in the position CURRENT

6.2.2. "METER" mode

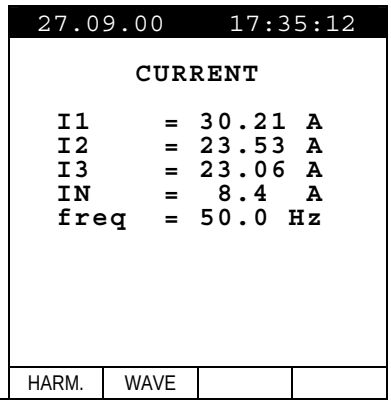
On rotating the switch to this position the instrument selects automatically the METER mode corresponding to one of the screens below according to the settings made as per paragraph 5.2.



Example of screen in single-phase mode



Example of screen in "3-wire" three-phase mode



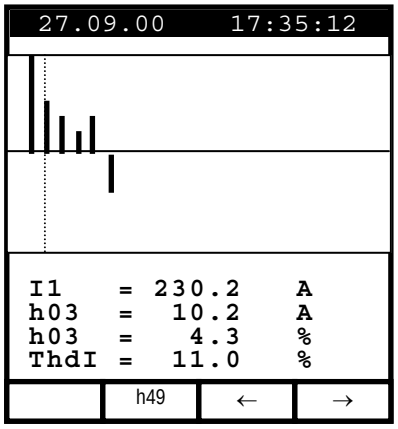
Example of screen in "4-wire" three-phase mode

The symbols used are described in Tab. 2. For eventual messages displayed see chapter 14. Following keys are enabled:

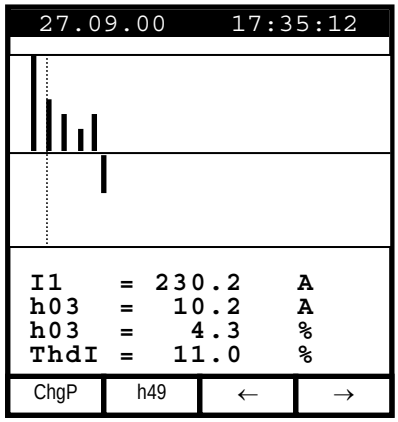
- **F1**: to pass to "HARMONIC" mode (see paragraph 6.2.3).
- **F2**: to pass to "WAVE" mode (see paragraph 6.2.4).
- **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 5.4) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

6.2.3. "HARM" mode

By selecting the HARM mode one of the screens below will be displayed according to the settings made as per paragraph 5.2. The screens show the harmonics (see paragraph 16.2) of the phase currents.



Example of screen in single-phase mode



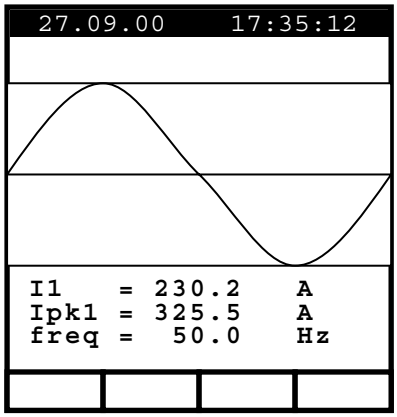
Example of screen in "3-wire" or "4-wire" three-phase mode

The symbols used are described in Tab. 2. For eventual messages displayed see chapter 14. The displayed histograms represent the harmonic content of the current under test. The value of the first harmonic h01 (primary at 50Hz) is not represented in scale along with the other harmonics in order to maximize the display of the latter. In case both voltage and current are connected to the instrument inputs, eventual negative values (therefore represented under the horizontal axis), indicate that such current harmonics are "generated" by the load. Following keys are enabled:

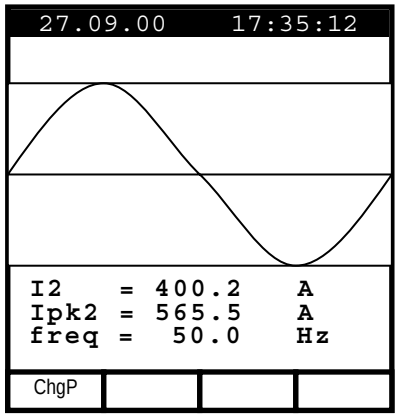
- **F3**, **F4**: to move the cursor of the selected harmonic leftwards and rightwards respectively. At the same time the values relevant to the order no. of the selected harmonic and to the corresponding absolute and relative values (calculated on the basis of the fundamental) are updated.
- **F1** (only for three-phase mode): to display the values of the harmonics of the other voltages available. The voltage displayed is indicated above the F3 key.
- **F2**: to display the page of the harmonics h01 ÷ h24 (**h24** symbol) or that of the harmonics h25 ÷ h49 (**h49** symbol).
- **ESC**: to return back to METER mode (see paragraph 6.2.2)
- **SAVE**: to store in the instrument memory a record of "Smp" type (see paragraph 5.4) and the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

6.2.4. "WAVE" mode

By selecting the WAVE mode one of the below screens will be displayed according to the settings made as per paragraph 5.2. The screens show the waveform of the phase currents.



Example of screen in single-phase mode



Example of screen in "3-wire" or "4-wire" three-phase mode

The symbols used are described in Tab. 2. For eventual messages displayed see chapter 14. Following keys are enabled:

- **F1**: (only for three-phase mode): to display the values relevant to the following phase.
- **ESC**: to return back to METER mode (see paragraph 6.2.2).
- **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 5.4) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

6.3. POSITION "POWER"

This function permits to display in real time the RMS value of AC/DC voltage, the peak and ThdV value of the 3 phase voltages, the waveform of the 3 phase voltages, the RMS value of AC/DC currents, the peak and Thdl of the 3 phase currents, the waveform of the 3 phase currents. Furthermore, the instrument calculates and displays the value of the phase and total active powers, the value of the phase and total reactive and capacitive powers, the value of the phase and total power factors and cosφ.

6.3.1. Symbols

The position POWER has two working modes:

- METER
- WAVE

For voltage and current harmonics see paragraphs 6.1.3 and 6.2.3 respectively.

These modes will be described in detail in the next paragraphs.
The symbols used are described below:

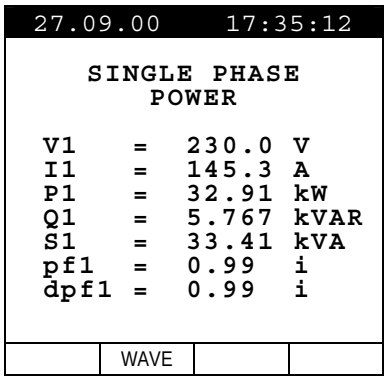
Symbol	Description
V1, V2, V3	RMS value of the voltage of phase 1, phase 2, phase 3 respectively
V12, V23, V32, V31	RMS Value of the phase to phase voltages
freq	Network frequency
Phseq	Phase sequence indicator "123"→ correct "132"→ inverted "023"→ null voltage on the black wire "103"→ null voltage on the red wire "120"→ null voltage on the blue wire "100"→ null voltages on the red and blue wires "020"→ null voltages on the black and blue wires "003"→ null voltages on the black and red wires
I1, I2, I3	RMS value of the current of phase 1, phase 2, phase 3 respectively
IN	RMS value of the current of the neutral
Pt, P1, P2, P3	Values of the active power (total, of phase 1, phase 2, phase 3 respectively)
P12, P32	(only for 3-wire measurement) Value of the power measured by the Wattmeter 1-2 and 3-2 respectively (see paragraph 16.3.2).
Qt, Q1, Q2, Q3	Values of the reactive power (total, of phase 1, phase 2, phase 3 respectively)
Q12, Q32	(only for 3-wire measurement) Value of the power measured by the VAR meter Va1-2 and 3-2 respectively (see paragraph 16.3.2).
St, S1, S2, S3	Values of the apparent power (total, of phase 1, phase 2, phase 3 respectively)
S12, S32	(only for 3-wire measurement) Value of the power measured by the VA meter Va1-2 and 3-2 respectively (see paragraph 16.3.2).
Pft, pf1, pf2, pf3	Values of the power factors (total, of phase 1, phase 2, phase 3 respectively)
dPft, dpf1, dpf2, dpf3	Value of the cosφ (total, of phase 1, phase 2, phase 3 respectively)
Ead, Pd	Values of the Total Active Energy and Active Power On demand respectively
Esd, Sd	Values of the Total Apparent Energy and Apparent Power On demand respectively

Tab. 3: Symbols used in the position POWER

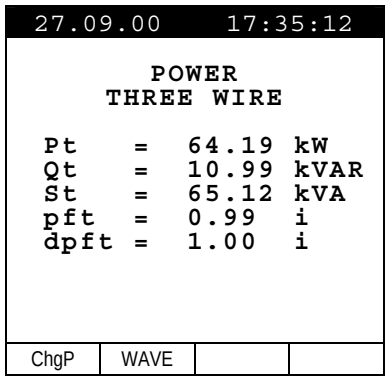
The symbols "**i**" and "**c**" stand for reactive powers (Q), power factors (Pf) and cosφ (dpf) respectively inductive and capacitive.

6.3.2. "METER" mode

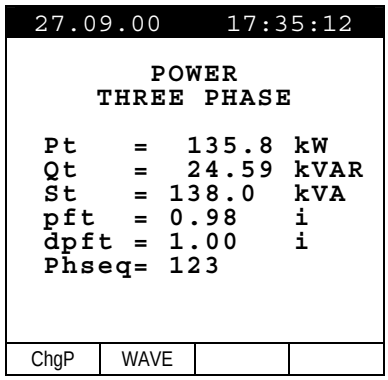
On rotating the switch to this position the instrument selects automatically the METER mode corresponding to one of the below screens according to the settings made as per paragraph 5.2.



Example of screen in single-phase mode



Example of screen in "3-wire" three-phase mode



Example of screen in "4-wire" three-phase mode

The symbols used are described in Tab. 3. For eventual messages displayed see chapter 14. Following keys are enabled:

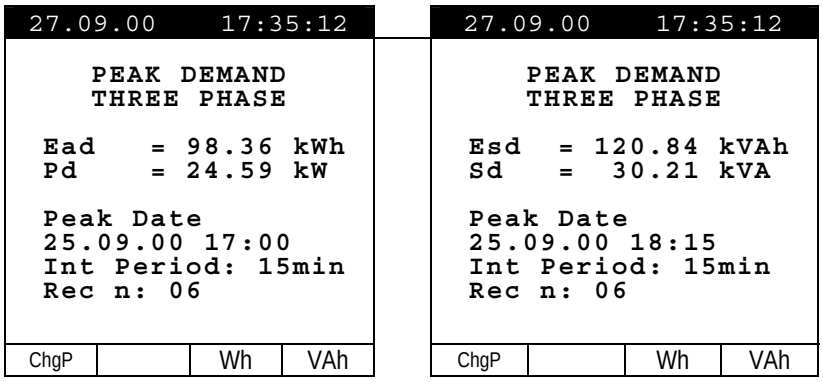
- **F2**: to pass to "WAVE" mode (see paragraph 6.3.3).
- **F1**: (only for three-phase measurement) to display the previous or the following screen. On the basis of the settings made as per paragraph 5.2 following screens are displayed cyclically:

  - Three-phase 3-wire: total three-phase values, Wattmeter phases 1-2 and 2-3 values, Peak Demand
  - Three-phase 4-wire: total three-phase values, phase1, phase2 and phase3 values, Peak Demand

- **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 5.4) and the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

6.3.2.1. Peak energy demand

In three-phase systems, by selecting POWER and pressing **F1** key thrice you can reach the "Peak Demand" mode. This mode shows the values corresponding to the running recording or to last performed recording (if any recording is running).
The "**Peak Demand**" screen shows the Max Average value of Active Power (and the corresponding Energy) or Max Average value of Apparent Power (and the corresponding Energy) measured during the last (or running) recording. The Average value is evaluated in the Integration Period set for the recording. This screen also shows the corresponding Active Energy and the corresponding Peak Date and Time.



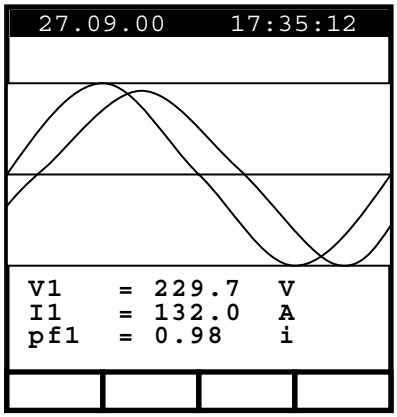
Examples of "PEAK ENERGY DEMAND" screen

The symbols used are described in Tab. 3. For eventual messages displayed see chapter 14. Following keys are enabled:

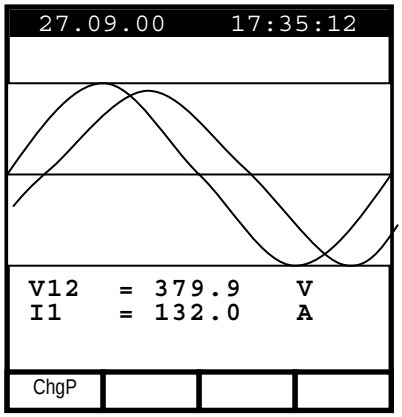
- **F1**: to display the previous or the following screen. On the basis of the settings made as per paragraph 5.2 following screens are displayed cyclically:
  - Three-phase 3-wire: total three-phase values, Wattmeter phases 1-2 and 2-3 values, Peak Demand
  - Three-phase 4-wire: total three-phase values, phase1, phase2 and phase3 values, Peak Demand
- **F3**: to show Active Power and Active Energy values
- **F4**: to show Apparent Power and Apparent Energy values
- **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 5.4) and the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

6.3.3. "WAVE" mode

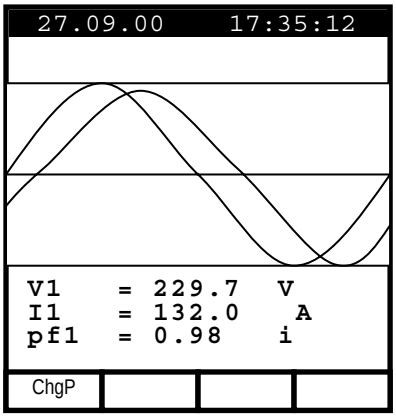
By selecting the WAVE mode one of the below screens will be displayed according to the settings made as per paragraph 5.2. The screens show the waveform of the phase currents and the phase (or phase-to-phase) voltage.



Example of screen in single-phase mode



Example of screen in "3-wire" three-phase mode



Example of screen in "4-wire" three-phase mode

The symbols used are described in Tab. 3. For eventual messages displayed see chapter 14. Following keys are enabled:

- **F1**: (only for three-phase mode): to display the values relevant to the following phase. On the basis of the settings made as per paragraph 5.2 following screens are displayed cyclically:
  - 3-wire three-phase: values of the Wattmeter 1-2, values of the wattmeter 2-3
  - 4-wire three-phase: values of phase 1, phase 2 and phase 3
- **ESC**: to return back to METER mode (see paragraph 6.3.2).
- **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 5.4) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

6.4. POSITION "ENERGY"

This function permits to display the values of the phase and total active powers, the value of the phase and total capacitive and inductive reactive powers, the values of the power factors and phase and total cosφ. Furthermore, the instrument is able to measure directly (see 6.4.2) the values of the phase and total active energies and the values of the phase and total capacitive and inductive reactive energies.

6.4.1. Symbols

The position ENERGY has one working mode:

- METER

This mode will be described in detail in the next paragraphs.
The symbols used are described below:

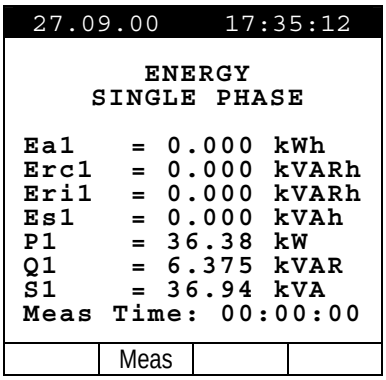
Symbol	Description
Pt, P1, P2, P3	Values of the total active power, of phase 1, phase 2, phase 3 respectively
P12, P32	(only for 3-wire measurement) Value of the power measured by the Wattmeter 1-2 and 3-2 respectively (see paragraph 16.3.2)
Qt, Q1, Q2, Q3	Values of the total reactive power, of phase 1, phase 2, phase 3 respectively
Q12, Q32	(only for 3-wire measurement) Value of the power measured by the VARmeter 1-2 and 3-2 respectively (see paragraph 16.3.2)
St, S1, S2, S3	Values of the total apparent power, of phase 1, phase 2, phase 3 respectively
S12, S32	(only for 3-wire measurement) Value of the power measured by the VAmeter 1-2 and 3-2 respectively (see paragraph 16.3.2)
Eat, Ea1, Ea2, Ea3	Values of the total active energy, of phase 1, phase 2, phase 3 respectively
Erit, Eri1, Eri2, Eri3	Values of the total inductive reactive Energy, of phase 1, phase 2, phase 3 respectively
Erct, Erc1, Erc2, Erc3	Values of the total capacitive reactive Energy, of phase 1, phase 2, phase 3 respectively
Est, Es1, Es2, Es3	Values of the total Apparent Energy, of phase 1, phase 2, phase 3 respectively

Tab. 4: Symbols used in the position ENERGY

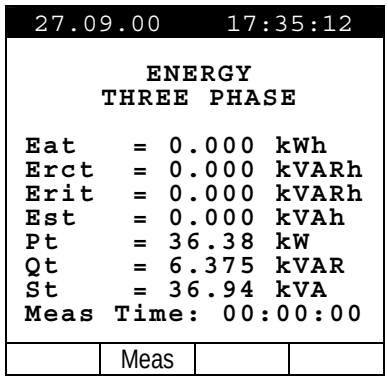
The symbols "**i**" and "**c**" stand for reactive powers (Q) and energies (Er) inductive and capacitive respectively.

6.4.2. "METER" mode

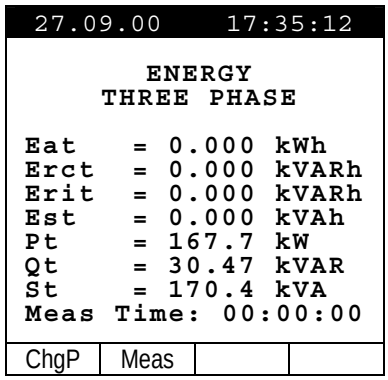
On rotating the switch to this position the instrument selects automatically the METER mode corresponding to one of the below screens according to the settings made as per paragraph 5.2.



Example of screen in single-phase mode



Example of screen in "3-wire" three-phase mode



Example of screen in "4-wire" three-phase mode

The symbols used are described in Tab. 4. For eventual messages displayed see chapter 14. Following keys are enabled:

- **F2**: to start / stop immediately a **direct energy measurement**. The energy counters will start increasing proportionally to the active power absorbed by the load.
  The results obtained cannot be memorized.
  If the active power is negative the counters will not increase.
- **F1**: (only for 4-wire measurement) to display the following screen. On the basis of the settings made as per paragraph 5.2 following screens are displayed cyclically:
  Overall three-phase values, values of phase 1, phase 2 and phase 3
- **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 5.4) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter the **MENU** mode and change the instrument settings (see paragraph 5.2 and 5.3). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 7).

7. STARTING A RECORDING

According to paragraph 5.3 a recording can be started manually or automatically. Therefore, after setting all parameters **and leaving the Menu**, the instrument will start to record:

- MANUALLY: the recording starts when the instrument time reaches “00” seconds value after pressing START/STOP.
- AUTOMATICALLY: **If the operator has pressed START/STOP** the instrument will remain in stand-by until the date and time previously set, then the recording will start. While **if the operator doesn’t press START/STOP the recording will never start.**

CAUTION

For recordings **ALWAYS use the external power supply** although the instrument allows the operator to perform a recording using internal batteries.

If you press START a recording without the external power supply the instrument will display a warning message “**No ext supply**”. Press **START** key again to run the recording or press **ESC** to quit.

If during a recording the external power supply is de-energized, the instrument will continue the recording using the internal battery power until batteries are exhausted (the data stored until the definitive turning off won’t get lost). For this we recommend you **ALWAYS insert a new set of batteries before a long recording**.

The instrument applies sophisticated algorithms to prolong the battery life. Particularly:
- it automatically switches off the backlight after 5 seconds.
- If the instrument is displaying in real time (and the external power supply is not connected), after about 5 minutes from the last pressure on keys or selector rotation the instrument automatically turns off ("AUTOPOWER OFF" procedure).
- If the instrument is recording or is measuring energy (and the external power supply is not connected), after about 5 minutes from the last pressure on keys or selector rotation the instrument starts a special procedure to save batteries ("ECONOMY MODE"): the instrument keeps recording but the display is turned off.

Before starting a recording the operator should first evaluate the state of the equipment, decide what to record and set the instrument accordingly.

In order to facilitate this task we have decided to supply the instrument pre-set with a general configuration which should fit most cases.

The chosen configuration is the following

- ANALYZER CONFIG:

Frequency:	50Hz
Full scale of the clamps:	1000A
Transforming ratio of voltmetric transformers:	1
Clamp Type:	FLEX
Type of electrical equipment:	4-wire
Password:	enabled

- RECORDER CONFIG:

Start:	Manual (the recording is started 1 minute after pressing the START/STOP key)
Stop:	Manual
Integration period:	15min
Recording of harmonics:	ON
Recording of Voltage anomalies (voltage Sag and Surge):	ON
Voltage Reference for Sag and Surge detection:	230V
Upper Limit for Sag and Surge detection:	6%
Lower Limit for Sag and Surge detection:	10%
Selected voltages:	V1, V2, V3
Selected voltage harmonics:	THD, 01, 03, 05, 07
Selected currents:	I1, I2, I3, IN
Selected current harmonics:	THD, 01, 03, 05, 07
CO-GENERATION:	OFF
Powers, Pf and cosφ selected:	Pt, P1, P2, P3 Qti, Q1i, Q2i, Q3i Qtc, Q1c, Q2c, Q3c St, S1, S2, S3 Pft, Pf1, Pf2, Pf3 dpft, dpf1, dpf2, dpf3
Energies:	Eat, Ea1, Ea2, Ea3 Erit, Eri1, Eri2, Eri3 Erct, Erc1, Erc2, Erc3 Est, Es1, Es2, Es3

If the user changed the instrument's settings can quickly resume the above configuration using the RESET option (see paragraph 5.5).

By pressing **START/STOP** the recording of the selected parameters is started according to the settings made in the MENU (see paragraphs 5.2 and 5.3). The rotary switch position doesn't affect the recording setting.

As the default value of the integration periods is set at 15 minutes the instrument will store data in the temporary memory for 15 minutes. Afterwards the instrument will elaborate the results saved in the temporary memory and will save the first series of values in the definitive memory. Therefore, if an integration period of 15 minutes has been set, the recording will continue for about 15 minutes before producing a series of recorded values. If the recording is interrupted before the selected integration period has completely elapsed the data stored in the temporary memory will not be elaborated and the corresponding series of values won't be transferred to the definitive memory.

8. DURING A RECORDING

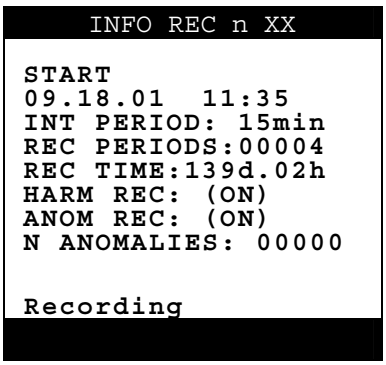
If during a recording the external power supply is de-energized, the instrument will continue the recording using the internal battery power until batteries are exhausted (the data stored up to the point the instrument shuts down won't get lost). For this we recommend you **ALWAYS insert a new set of batteries before a long recording**.

The instrument uses sophisticated algorithms to prolong the battery life. Particularly if the instrument is recording or is measuring energy (and the external power supply is not connected), after about 5 minutes from the last key pressure or switch rotation the instrument starts a special procedure to save the batteries ("ECONOMY MODE"): the instrument keeps recording but the display is turned off.

During a recording the following keys and functions are disabled:

- **AUTOPOWER OFF**
- **ON/OFF**
- **HOLD**
- **SAVE**

Press **MENU** and the following screen will appear:



This page includes:

1. START Date and Time
2. Integration Period
3. Actual Number of Elapsed Integration Periods
4. Actual Recording Time
5. Status of Harmonic Flag
6. Status of Voltage Anomalies Flag
7. Number of Voltage anomalies occurred during the recording

9. STOPPING A RECORDING OR AN ENERGY MEASUREMENT

The instrument uses a protective routine to avoid the risk of being disturbed or interrupted during a recording or an energy measurement. Once a recording or a direct energy measurement (see paragraph 6.4.2) has been started (with the option PASSWORD enabled), after about 3 minutes from the last pressure on keys or switch rotation it won't be sufficient to press START/STOP (if a recording is running) or **F2** (if an energy measuring is running) to stop the recording, it will be necessary to insert the password.
In order to insert the password (which is not changeable), press the multifunction keys in the following sequence (within 10 seconds):

F1, **F4**, **F3**, **F2**

In order to enable/disable this option see paragraph 5.2.

If a wrong password is inserted, the instrument will display an error message and will repeat the request.

If no key is pressed after about 10 seconds the instrument returns back to the original screen.

10. CONNECTING THE INSTRUMENT TO A PC

The instrument can be connected to a PC by means of the serial cable (C232NG1) supplied as a standard accessory.

NOTE: A standard RS-232 cable will not work with VEGA 76.

The available transmission speeds are the following:

9600, 19200, 57600 (default value)

The value of the transmission speed (Baud Rate) is displayed on the initial screen (immediately after turning on the instrument) (see paragraph 2.3). The value of this parameter can be modified only with the management software.

For download instructions please consult the software help file.

In order to transfer the memorized data from the instrument to the PC the following procedure (after Software Installation) must be followed:

1. **Switch ON the instrument and wait for the initial screen to disappear.**
2. **Connect the serial output of the instrument to the serial output of the PC through the serial cable.**
3. **Run the Program and Close the introduction window.**
4. **Select the Download command.**
5. **Refer to the software help file for further instructions.**

11. MEASURING PROCEDURES

11.1. USING THE INSTRUMENT IN A SINGLE PHASE SYSTEM

CAUTION

The maximum voltage between B1 and B4 inputs is 600 V~ (CATII) / 350V~ phase – earth or 600V~ (CATIII) / 300 V~ phase to earth.
Do not measure voltages exceeding the limits prescribed by this manual. Should you exceed the voltage limits you could damage the instrument and/or its components or endanger your safety.

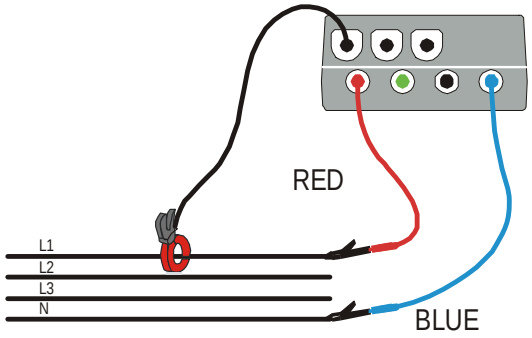


Fig. 1: Instrument connection in a single-phase system

CAUTION

If possible, before connecting the instrument to the electrical equipment to be tested take the power supply off the electrical equipment.

1. Check, and if needed modify, the basic settings of the instrument (see paragraphs 5.2 and 5.3). Particularly, the **single-phase** mode must be set.
2. Rotate the switch to the position corresponding to the type of analysis desired. In case of doubts select **POWER** (see paragraph 6.3).
3. Connect the phase and neutral voltage wires respecting the connections shown in the picture.
4. If you want to measure current and power, connect the clamp meter to the phase conductor respecting the specifications shown on the clamp and the connections shown in the picture.
   In case of doubts select **POWER** and check if the active power P is positive. If it's negative, remove current transducer from the wire and reconnect it so the transducer label faces the opposite direction.
5. Apply voltage to the electrical equipment under test (if previously shut off for the instrument connection).
6. The values of the available electrical parameters will be displayed on the display of the instrument. For further details see the paragraph relevant to the position of the switch.
7. You can press **HOLD** to interrupt the updating in real time of the displayed values.
8. If you want to record:
   a) Check, and if needed modify, the values of the basic parameters (see paragraphs 5.2 and 5.3).
   b) Check, and if needed modify, the recording parameters by pressing **MENU** (see the paragraph corresponding to the position of the rotary switch selected).
   c) To start the recording press **START** (see chapter 6).

11.2. USING THE INSTRUMENT IN A THREE PHASE 4 WIRE SYSTEM

CAUTION

The maximum voltage between B1, B2, B3, B4 inputs is 600 V~ (CATII) / 350V~ phase – earth or 600V~ (CATIII) / 300 V~ phase to earth.
Do not measure voltages exceeding the limits prescribed by this manual. Should you exceed the voltage limits you could damage the instrument and/or its components or endanger your safety.

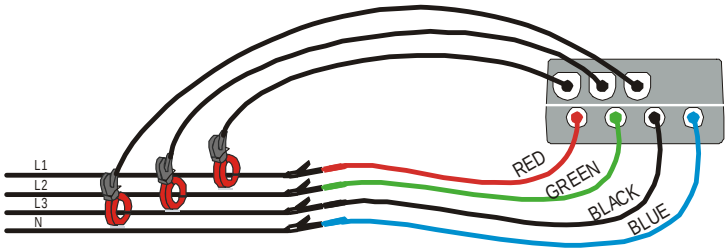


Fig. 2: Instrument connection in a three-phase 4 wire system

CAUTION

If possible, before connecting the instrument to the electrical equipment to be tested take the power supply off the electrical equipment.

1. Check, and if needed modify, the basic settings of the instrument (see paragraphs 5.2 and 5.3). Particularly, the **3PH4W** mode must be set.
2. Rotate the switch to the position corresponding to the type of analysis desired. In case of doubts select **POWER** (see paragraph 6.3).
3. Connect the phase and neutral voltage wires respecting the connections shown in the picture.
4. If you want to measure current and power, connect the clamp meter to the phase conductor respecting the specifications shown on the clamp and the connections shown in the picture. In case of doubts select **POWER** and, connecting one clamp at a time, check if:
   a) the phase sequence is correct (see paragraph 6.1.2).
   b) the active power P of each phase is positive. If it's negative, remove current transducer from the wire and reconnect it so the transducer label faces the opposite direction.
   c) the value of the Pf of each phase is not excessively low (typically it's not lower than 0.4). In case the Pf is lower than 0.4, check if the phase voltage is associated to the right clamp meter (for example the voltage of phase 1 must be associated to the clamp meter no. 1).
5. Apply voltage to the electrical equipment under test (if previously shut off for the instrument connection).
6. The values of the available electrical parameters will be displayed. For further details see the paragraph relevant to the position of the switch.
7. You can eventually press **HOLD** to interrupt the updating in real time of the displayed values.
8. If you want to record:
   a) Check and, if needed, modify the values of the basic parameters (see paragraphs 5.2 and 5.3).
   b) Check and, if needed, modify the recording parameters by pressing **MENU** (see the paragraph corresponding to the position of the rotary switch selected).
   c) To start the recording press **START** (see chapter 6).

11.3. USING THE INSTRUMENT IN A THREE PHASE 3 WIRE SYSTEM

CAUTION

The maximum voltage between B1 and B4 inputs is 600 V~ (CATII) / 350V~ phase – earth or 600V~ (CATIII) / 300 V~ phase to earth.
Do not measure voltages exceeding the limits prescribed by this manual. Should you exceed the voltage limits you could damage the instrument and/or its components or endanger your safety.

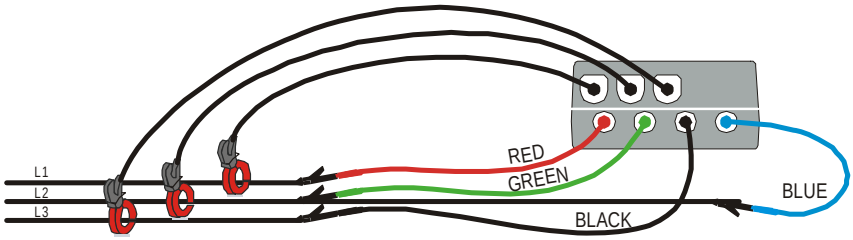


Fig. 3: Instrument connection in a 3-wire three-phase system

CAUTION

- Please note that in this case the blue cable is connected to the green cable on phase 2.
- If possible, before connecting the instrument to the electrical equipment to be tested take the power supply off the electrical equipment.

1. Check, and if needed modify, the basic settings of the instrument (see paragraphs 5.2 and 5.3). Particularly, the **3-wire** mode must be set.
2. Rotate the switch to the position corresponding to the type of analysis desired. In case of doubts select **POWER** (see paragraph 6.3).
3. Connect the phase and neutral voltage wires following the connections shown in Fig. 3.
4. If you want to measure current and power, connect the clamp meter to the phase conductor respecting the specifications shown on the clamp and the connections shown in the picture. In case of doubts set **temporarily** the **3PH4W** mode, then select **POWER**, connect the blue wire of the instrument to earth and, connecting one clamp at a time, check if:
   a) The phase sequence is correct (see paragraph 6.1.2).
   b) The active power P of each phase is positive. If negative, turn the clamp of the phase in question.
   c) The value of the Pf of each phase is not excessively low (typically it's not lower than 0.4). In case the Pf is lower than 0.4, check if the phase voltage is associated to the right clamp meter (for example the voltage of phase 1 must be associated to the clamp meter no. 1).
   d) After checking, and if needed modifying, the connection of the instrument to the equipment re-set the **3-wire** mode and the connections shown in the picture (blue and green wire together).
5. Apply voltage to the electrical equipment under test (if previously shut off for the instrument connection).
6. The values of the available electrical parameters will be displayed of the instrument. For further details see the paragraph relevant to the position of the switch.
7. You can press **HOLD** to interrupt the updating in real time of the displayed values.
8. If you want to record:
   a) Check and eventually modify the values of the basic parameters (see paragraphs 5.2 and 5.3).
   b) Check and eventually modify the recording parameters by pressing **MENU** (see the paragraph corresponding to the position of the rotary switch selected).
   c) To start the recording press **START** (see chapter 6).

12. MAINTENANCE

12.1. GENERAL

This is a precision instrument. Strictly follow the instructions for use and storage reported in this manual to avoid any possible damage or danger during use.
Do not use this tester under unfavorable conditions of high temperature or humidity. Do not expose to direct sunlight.
Be sure to turn off the tester after use. If the instrument is not to be used for a long period you are recommended to remove batteries to avoid leakages of battery liquid which may damage its internal circuits.

12.2. BATTERY REPLACEMENT

When the low battery indication (refer to paragraph 13.1.11) is displayed the batteries are to be replaced.

CAUTION

Only qualified technicians should operate the instrument . Before replacing the battery disconnect test leads from any energised circuits to avoid electrical shocks.

1. Disconnect cables and clamps from the circuit under test.
2. Turn off the instrument by pressing ON/OFF.
3. Remove the cables from the input terminals.
4. Unscrew the battery cover and remove it.
5. Replace batteries with new ones of the same type (refer to paragraph 13.1.11) observing the proper polarities.
6. Reposition the cover and screw it again.
7. Use the appropriate battery disposal methods for your area.

12.3. CLEANING

Use a soft dry cloth to clean the instrument. Never use wet clothes, solvents, water and so on.

13. TECHNICAL SPECIFICATIONS

13.1. FEATURES

The accuracy is stated as [% of the reading ± number of digits]. It refers to the following atmospheric conditions: temperature 73°F± 2°F (23°C ± 1°C) with relative humidity < 75%.

13.1.1. Voltage measurement (Autoranging)

Range	Accuracy	Resolution	Input impedance
15-310V	±(0.5%+2digit)	0.2V	300kΩ (phase-neutral)
310-600V		0.4V	600kΩ (phase-phase)

13.1.2. Detection of voltage anomalies: manual range selection

Voltage

Range	Accuracy	Resolution	Input impedance
15 ÷ 310V	±(0.5%+2digit)	0.2V	300kΩ (phase-neutral)
30 ÷ 600V		0.4V	600kΩ (phase-phase)

Time

Accuracy (ref. to 50Hz)	Resolution
±10ms (½ period of fundamental)	10ms (½ period of fundamental)

13.1.3. Current measurement (using external transducer)

Range	Accuracy	Resolution	Input impedance	Protection against overloads
0.005 ÷ 0.26V	±(0.5%+2digit)	0.0001V	100 kΩ	5V
0.26 ÷ 1V		0.0004V		

Minimal Current measurable is equal to 0.5% of Clamp Full Scale

13.1.4. Power measurement (cosφ: 0.5c – 0.5i)

Value	Range	Accuracy	Resolution
Active power	0 ÷ 999.9W 1KW ÷ 999.9KW 1MW ÷ 999.9MW	±(1.0%+2digit)	0.1W 0.1KW 0.1MW
Reactive power	0 ÷ 999.9VAR 1KVAR ÷ 999.9KVAR 1MVAR ÷ 999.9MVAR		0.1VAR 0.1KVAR 0.1MVAR
Apparent power	0 ÷ 999.9VA 1KVA ÷ 999.9KVA 1MVA ÷ 999.9MVA		0.1VA 0.1KVA 0.1MVA
Active energy	0 ÷ 999.9Wh 1KWh ÷ 999.9KWh 1MWh ÷ 999.9MWh		0.1Wh 0.1KWh 0.1MWh
Reactive energy	0 ÷ 999.9VARh 1KVARh ÷ 999.9KVARh 1MVARh ÷ 999.9MVARh		0.1VARh 0.1KVARh 0.1MVARh

13.1.5. Cosφ measurement

Cosφ	Resolution	Accuracy (expressed in degrees)
0.20	0.01	0.6
0.50		0.7
0.80		1

13.1.6. Measurement of harmonics

Range	Accuracy	Resolution
DC ÷ 25h	±(5.0%+2digit)	0.1V / 0.1A
26h ÷ 33h	±(10.0%+2digit)	
34h ÷ 49h	±(15.0%+2digit)	

13.1.7. Frequency measurement

Instrument set to 50Hz

Range	Accuracy	Resolution
47 ÷ 53	±(1.0%+1digit)	0.1Hz

Instrument set to 60Hz

Range	Accuracy	Resolution
57 ÷ 63.6	±(1.0%+1digit)	0.1Hz

13.1.8. Compliance

VEGA 76 complies with the Standards prescribed for:

- class 2 EN61036 – static counters of active energy
- class 3 IEC1268 – static counters of reactive energy

13.1.9. Temperature drift

Temperature drift: 0,1 x accuracy/K

13.1.10. Safety

The instrument complies with: EN 61010-1 + A2(1996)
Insulation: Class 2
Pollution: 2
Overvoltage category: CAT III 300V~; CAT II 350V~ (Phase-Earth)
CAT III 600V~ (Phase-Phase)

13.1.11. General Features

Mechanical characteristics

Dimensions: 225(L) x 165(W) x 105(H) mm
Weight (including battery): 1.5kg

Power supply

Battery type: 6 batteries x 5V series AA LR6
Indication of low battery: the symbol "" is displayed when the battery is low
Battery life: approx. 50 hours
External power supply: Use only the provided power supplier

Display

Specifications: dot matrix with backlight
Resolution 128 x 128 dots (16384 dots)
Dot size 0.5mm x 0.5mm
Visible area 73mm x 73mm

Sampling

Sampling speed: 156.25usec @ 50Hz.
No. of samples per period: 128

13.2. ENVIRONMENT

13.2.1. Environmental conditions

Reference temperature:	73°F ± 2°F (23°C ± 1°C)
Operating temperature:	32°F to 122°F (0°C ÷ 50 °C)
Relative humidity:	<70%
Storage temperature:	14°F to 140°F (-10°C ÷ 60 °C)
Storage humidity:	<80%

13.2.2. EMC

This instrument has been designed in compliance with the EMS standards in force and its compatibility has been tested for EN61326-1 (1997) + A1 (1997).

This instrument complies with the prescriptions of the European directive on low voltage 73/23/CEE (LVD) and EMC directive 89/336/EEC, amended by 93/68/EEC.

13.3. ACCESSORIES

13.3.1. Standard accessories

Description	Model name
Instrument	**VEGA 76**
Carrying case	**BORSA2051**
External power supply 12VDC	**A0050**
flexible head 300-3000A without integrator (3x)	**HTFLEX33**
Kit composed of 4 cables banana-crocodile (black/red/blue/green)	**KITENERGY2**
software on CD-ROM and serial cable	**TOPLINK**
User's manual	
ISO9001 calibration certificate	

13.3.2. Optional accessories

Description	Model name
Kit of straps and hooks to hang the instrument on the neck	**CN0050**
Case 3x1-5A/1V for connection to TA	**HT903**
Clamp for AC currents 200-2000A	**HP30C2**
Clamp for AC currents 3000A	**HP30C3**
Clamp 10-100-1000A	**HT97U**
Clamp 1-100-1000A	**HT96U**

14. APPENDIX 1 – MESSAGES DISPLAYED

Message	Description	Advices ☺
AUTONOM:	Available memory autonomy for the recording which is being effected	
CLEAR ALL? (Enter)	The operator is trying to cancel all the recordings effected	Press ESC in order not to cancel the whole memory, press ENTER to confirm
CLEAR LAST? (Enter)	The operator is trying to cancel the last recording effected	Press ESC in order not to cancel the last recording, press ENTER to confirm
Data saved	The data have been saved	
DATA SIZE:	Dimensions of the stored data	
HOLD	By pressing the proper key, the HOLD function has been activated	Press HOLD again to disable this function
Password:	A recording has been started and at least 5 minutes have passed from the last activity of the instrument (see paragraph 7).	Insert the password: F1, F4, F3, F2
Invalid date	The inserted date is not correct	Check the inserted date
Energy Measuring	The instrument is taking an energy measurement	Press F1 to stop it
Memory Full	The memory of the instrument is full	Cancel some recordings after transferring them to a PC
No ext supply!	A recording has been started without connecting the external power supply	Verify it you really want to start the recording without the external power supply. In that case press START again.
No parameter sel	A recording has been started without selecting any value to be recorded	Press START/STOP and select at least a value entering the MENU
No Phase selected	Voltage and/or current harmonics have been selected and the corresponding flag has been enabled (HARMONICS ON) but no phase voltage or current has been selected	Select at least one phase voltage and/or current
PASSWORD ERROR	The inserted password is wrong (see paragraph 7).	Check the password
PASSWORD OK	The inserted password is correct	
Please wait	The instrument is waiting for the recording to be started (see paragraph 6)	
Recording	The instrument is recording (see paragraph 6)	
Too many param	More than 63 parameters have been selected (harmonics included) or More than 38 parameters with CO-GENERATION Flag enabled	Deselect some values
Too many record	The quantity of recorded data + Smp exceeds the maximum allowed (35)	Cancel some recordings after transferring them to a PC
ERR: SEQ	The Phase Sequence isn't correct.	Check the Phase Sequence connection.
ERR: P-	The active powers shown on the right side of the message are negative	If there isn't a situation of co-generation check if the clamps are properly connected
ERR: SEQ & P-	The active powers shown on the right side of the message are negative and the Phase Sequence isn't correct.	If there isn't a situation of co-generation check if the clamps are properly connected / check the Phase Sequence connection.
ERR: CONNECTION	The instrument has detected a wrong connection to Voltage inputs	Check the Voltage connections
Error Vref	The user set a Voltage reference not compatible with voltage at instrument's input.	Check Voltage Reference set in "CONFIG RECORDER"
Error1 ÷ Error 5	The instrument memory is damaged.	Contact your dealer for assistance

15. APPENDIX 2 – RECORDABLE PARAMETERS: SYMBOLS

Symbol	Description
V1, V2, V3	RMS value of the voltage of phase 1, phase 2, phase 3 respectively
V12, V23 V31	Value of phase to phase voltages
I1, I2, I3	RMS value of the current of phase 1, phase 2, phase 3 respectively
IN	RMS value of the current of the neutral
DC	Continuous component of voltage or current
h01 ÷ h49	Harmonic 01 ÷ Harmonic 49 of voltage or current
ThdV	Factor of total harmonic distortion of the voltage (see paragraph 16.2)
ThdI	Factor of total harmonic distortion of the current (see paragraph 16.2)

Pt, P1, P2, P3	Values of the total active power, of phase 1, phase 2, phase 3 respectively
P12, P32	(only for 3-wire measurement) Value of the power measured by the Wattmeter 1-2 and 3-2 respectively (see paragraph 16.3.2).
Qt, Q1, Q2, Q3	Values of the total reactive power, of phase 1, phase 2, phase 3 respectively
Q12, Q32	(only for 3-wire measurement) Value of the power measured by the VARmeter 1-2 and 3-2 respectively (see paragraph 16.3.2).
St, S1, S2, S3	Values of the total apparent power, of phase 1, phase 2, phase 3 respectively
S12, S32	(only for 3-wire measurement) Value of the power measured by the VAmeter 1-2 and 3-2 respectively (see paragraph 16.3.2).
Pft, pf1, pf2, pf3	Value of the total power factors, power factors of phase 1, phase 2, phase 3 respectively
dPft, dpf1, dpf2, dpf3	Values of the total cosφ, of phase 1, phase 2, phase 3 respectively

Eat, Ea1, Ea2, Ea3	Values of the total active energy, of phase 1, phase 2, phase 3 respectively
Erit, Eri1, Eri2, Eri3	Values of the total inductive reactive Energy, of phase 1, phase 2, phase 3 respectively
Erct, Erc1, Erc2, Erc3	Values of the total capacitive reactive Energy, of phase 1, phase 2, phase 3 respectively
Est, Es1, Es2, Es3	Values of the total Apparent Energy, of phase 1, phase 2, phase 3 respectively

16. APPENDIX 3 – THEORETICAL OUTLINES

16.1. VOLTAGE ANOMALIES (VOLTAGE SAG AND SURGE)

VEGA 76 is able to record as voltage anomalies all those rms values, calculated every 10ms, beyond the percentage thresholds of the Voltage Reference (Vref) set during the programming from ± 1% to ± 30 % (with step of 1%).

The Reference must be set to:
Nominal Voltage Phase to Neutral: for Single Phase and 4-wire three phase system
Nominal Voltage Phase to Phase: for 3-wire three phase system

Example1: Three Phase System 3-wire.
Vref = 400V, LIM+= 6%, LIM-=10% =>
High Lim = 400 x (1+6/100) = 424,0V
Low Lim = 400 x (1-10/100) = 360

Example2: Three Phase System 4-wire.
Vref = 230V, LIM+= 6%, LIM-=10% =>
High Lim = 230 x (1+6/100) = 243,08V
Low Lim = 230 x (1-10/100) = 207,0V

The Instrument will detect Voltage Anomalies if the RMS Voltage Values (calculated every 10ms) are beyond the above calculated thresholds. These limits remain unchanged throughout the recording period.
When a Voltage anomaly occurs the instrument records:

- The number corresponding to the phase where the anomaly occurred.
- The “direction” of the anomaly: “UP” and “DN” identify respectively voltage drops (sag) and peaks (Surge).
- The date and time of the beginning of the event in the form day, month, year, hour, minutes, seconds, hundredths of second.
- The duration of the event, in seconds with a resolution of 10ms.
- The minimum (or maximum) value of voltage during the event.

16.2. VOLTAGE AND CURRENT HARMONICS

16.2.1. Theory

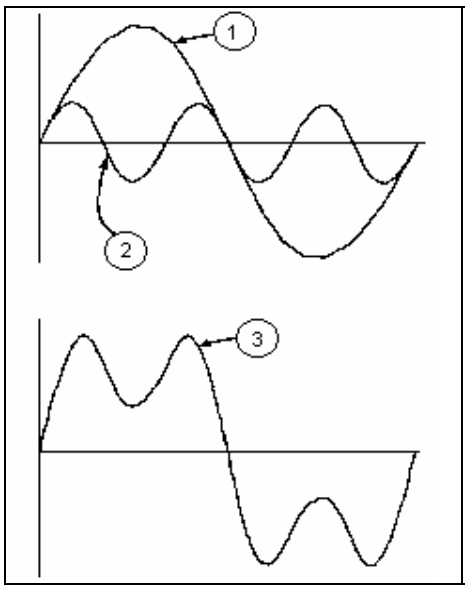
Any periodical non-sinusoidal wave can be represented as a sum of sinusoidal waves having each a frequency that corresponds to an entire multiple of the fundamental, according to the relation:

$$v(t) = V_0 + \sum_{k=1}^{\infty} V_k \sin(\omega_k t + \varphi_k) \qquad (1)$$

where:

V_0 = Average value of v(t)
V_1 = Amplitude of the fundamental of v(t)
V_k = Amplitude of the k^{th} harmonic of v(t)

In the mains voltage, the fundamental has a frequency of 50 Hz, the second harmonic has a frequency of 100 Hz, the third harmonic has a frequency of 150 Hz and so on. Harmonic distortion is a constant problem and should not be confused with short events such as sags, surges or fluctuations.



LEGENDA:

1. Fundamental
2. Third Harmonic
3. Distorted Waveform

Effect of the sum of 2 multiple frequencies.

It can be noted that in (1) the index of the sigma is from 1 to the infinite. What happens in reality is that a signal does not have an unlimited number of harmonics: a number always exists after which the harmonics value is negligible. The EN 50160 standard recommends to stop the index in the expression (1) in correspondence of the 40th harmonic.

A fundamental element to detect the presence of harmonics is THD defined as:

$$THDv = \frac{\sqrt{\sum_{h=2}^{40} V_h^2}}{V_1}$$

This index takes all the harmonics into account. The higher it is, the more distorted the waveform gets.

16.2.2. Limit values for harmonics

EN-50160 fixes the limits for harmonic voltages, which can be introduced into the network by the power supplier. In normal conditions, during whatever period of a week, 95% if the RMS value of each harmonic voltage, mediated on 10 minutes, will have to be inferior than or equal to the values stated in the following table.
The total harmonic distortion (THD) of the supply voltage (including all the harmonics up to 40th order) must be lower than or equal to 8%.

Odd harmonics				Even harmonics	
Not multiple of 3		Multiple of 3		Order h	Relative voltage %Max
Order h	Relative voltage % Max	Order h	Relative voltage % Max		
5	6	3	5	2	2
7	5	9	1,5	4	1
11	3,5	15	0,5	6..24	0,5
13	3	21	0,5		
17	2				
19	1,5				
23	1,5				
25	1,5				

These limits, theoretically applicable only for the supplier of electric energy, provide however a series of reference values within which the harmonics introduced into the network by the users must be contained.

16.2.3. Presence of harmonics: causes

Any equipment that alters the sinusoidal wave or uses only a part of it causes distortions to the sinusoidal wave and consequently harmonics.
All current signals result somehow virtually distorted. The most common situation is the harmonic distortion caused by non-linear loads such as electric household appliances, personal computers or speed control units for motors. Harmonic distortion causes significant currents at frequencies that are odd multiples of the fundamental frequency. Harmonic currents affect considerably the neutral wire of electric installations.
In most countries, the mains power is three-phase 50/60Hz with a delta primary and star secondary transformers. The secondary generally provides 230V AC from phase to neutral and 400V AC from phase to phase. Balancing the loads on each phase has always represented an headache for electric systems designers.
Until some ten years ago, in a well balanced system, the vectorial sum of the currents in the neutral was zero or quite low (given the difficulty of obtaining a perfect balance). The devices were incandescent lights, small motors and other devices that presented linear loads. The result was an essentially sinusoidal current in each phase and a low current on the neutral at a frequency of 50/60Hz.
“Modern” devices such as TV sets, fluorescent lights, video machines and microwave ovens normally draw current for only a fraction of each cycle thus causing non-linear loads and subsequent non-linear currents. All this generates odd harmonics of the 50/60Hz line frequency. For this reason, the current in the transformers of the distribution boxes contains only a 50Hz (or 60Hz) component but also a 150Hz (or 180Hz) component, a 50Hz (or 300Hz) component and other significant components of harmonic up to 750Hz (or 900Hz) and higher.
The vectorial sum of the currents in a well balanced system that feeds non-linear loads may still be quite low. However, the sum does not eliminate all current harmonics. The odd multiples of the third harmonic (called “TRIPLENS”) are added together in the neutral and can cause overheating even with balanced loads.

16.2.4. Presence of harmonics: consequences

In general, even harmonics, i.e. the 2^{nd}, 4^{th} etc., do not cause problems. Triple harmonics, odd multiples of three, are added on the neutral (instead of cancelling each other) thus creating a condition of overheating of the wire which is extremely dangerous.
Designers should take into consideration the three issues given below when designing a power distribution system that will contain harmonic current:

- The neutral wire must be of sufficient gauge.
- The distribution transformer must have an additional cooling system to continue operating at its rated capacity when not suited to the harmonics. This is necessary because the harmonic current in the neutral wire of the secondary circuit circulates in the delta-connected primary circuit. This circulating harmonic current heats up the transformer.
- Phase harmonic currents are reflected on the primary circuit and continue back to the power source. This can cause distortion of the voltage wave so that any power factor correction capacitors on the line can be easily overloaded.

The 5th and the 11th harmonic contrast the current flow through the motors making its operation harder and shortening their average life.
In general, the higher the ordinal harmonic number , the smaller its energy is and therefore the impact it will have on the devices (except for transformers).

16.3. POWER AND POWER FACTOR: DEFINITIONS

In a standard electric installation powered by three sine voltages the following is defined:

Phase Active Power: (n=1,2,3)	$P_n = V_{nN} \cdot I_n \cdot cos(\varphi_n)$
Phase Apparent Power: (n=1,2,3)	$S_n = V_{nN} \cdot I_n$
Phase Reactive Power: (n=1,2,3)	$Q_n = \sqrt{S_n^2 - P_n^2}$
Phase Power Factor: (n=1,2,3)	$P_{F\,n} = \frac{P_n}{S_n}$
Total Active Power:	$P_{TOT} = P_1 + P_2 + P_3$
Total Reactive Power:	$Q_{TOT} = Q_1 + Q_2 + Q_3$
Total Apparent Power:	$S_{TOT} = \sqrt{P_{TOT}^{\ 2} + Q_{TOT}^{\ 2}}$
Total Power Factor:	$P_{F\,TOT} = \frac{P_{TOT}}{S_{TOT}}$

where:

V_{nN} = RMS value of voltage between phase n and Neutral.
I_n = RMS value of n phase current.
f_n = Phase displacement angle between voltage and current of n phase.

In presence of distorted voltages and currents the previous relations vary as follows:

Phase Active Power: (n=1,2,3)	$P_n = \sum_{k=0}^{\infty} V_{k\,n} I_{k\,n} \cos(\varphi_{k\,n})$
Phase Apparent Power: (n=1,2,3)	$S_n = V_{nN} \cdot I_n$
Phase Reactive Power: (n=1,2,3)	$Q_n = \sqrt{S_n^2 - P_n^2}$
Phase Power Factor: (n=1,2,3)	$P_{F\,n} = \frac{P_n}{S_n}$
Distorted Power Factor (n=1,2,3)	$dPF_n = cos f_{1n}$ = phase displacement between the fundamentals of voltage and current of n phase
Total Active Power:	$P_{TOT} = P_1 + P_2 + P_3$
Total Reactive Power:	$Q_{TOT} = Q_1 + Q_2 + Q_3$
Total Apparent Power:	$S_{TOT} = \sqrt{P_{TOT}^{\ 2} + Q_{TOT}^{\ 2}}$
Total Power Factor:	$P_{F\,TOT} = \frac{P_{TOT}}{S_{TOT}}$

where:

V_{kn} = RMS value of kth voltage harmonic between n phase and Neutral.
I_{kn} = RMS value of kth current harmonic of n phase.
f_{kn}= Phase displacement angle between kth voltage harmonic and kth current harmonic of n phase.

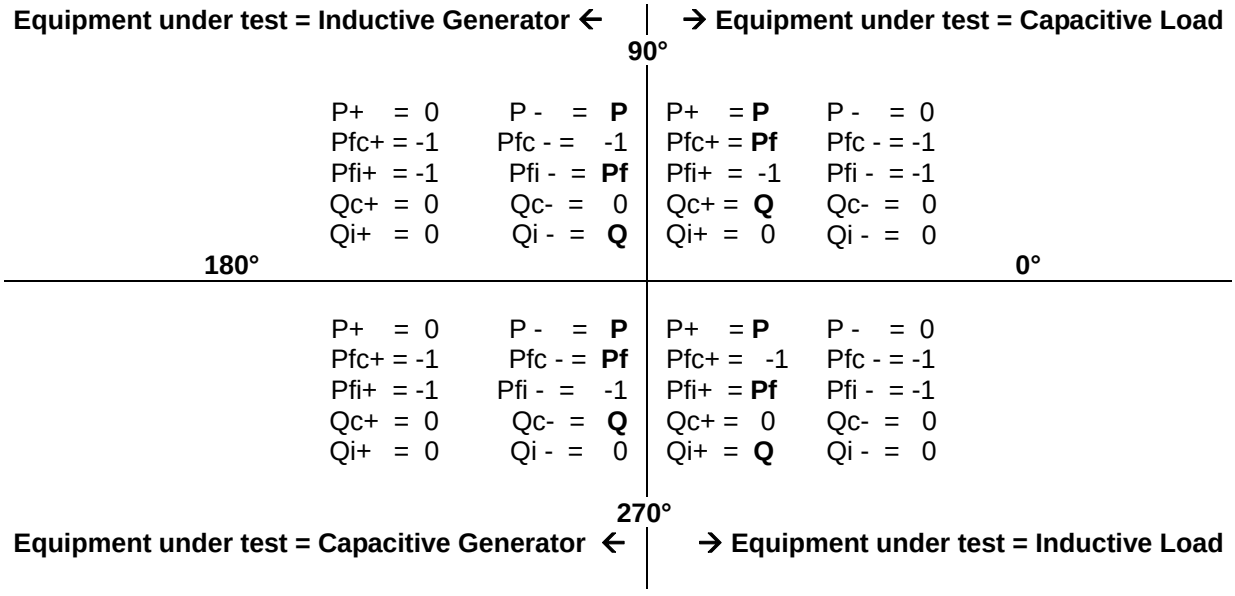
Note:

It is to be noted that the expression of the phase Reactive Power with non sine waveforms, would be wrong. To understand this, it may be useful to consider that both the presence of harmonics and the presence of reactive power produce, among other effects, an increase of line power losses due to the increased current RMS value. With the above given relation the increasing of power losses due to harmonics is added to that introduced by the presence of reactive power. In effect, even if the two phenomena contribute together to the increase of power losses in line, it is not true in general that these causes of the power losses are in phase between each other and therefore that can be added one to the other mathematically.
The above given relation is justified by the relative simplicity of calculation of the same and by the relative discrepancy between the value obtained using this relation and the true value.

It is to be noted moreover, how in case of an electric installation with harmonics, another parameter called distorted Power Factor (dPF) is defined. In practice, this parameter represents the theoretical limit value that can be reached for Power Factor if all the harmonics could be eliminated from the electric installation.

16.3.1. Conventions on powers and power factors

As for the recognition of the type of reactive power, of the type of power factor and of the direction of the active power, the below conventions must be applied. The stated angles are those of phase-displacement of the current compared to the voltage (for example, in the first panel the current is in advance from 0° to 90° compared to the voltage):



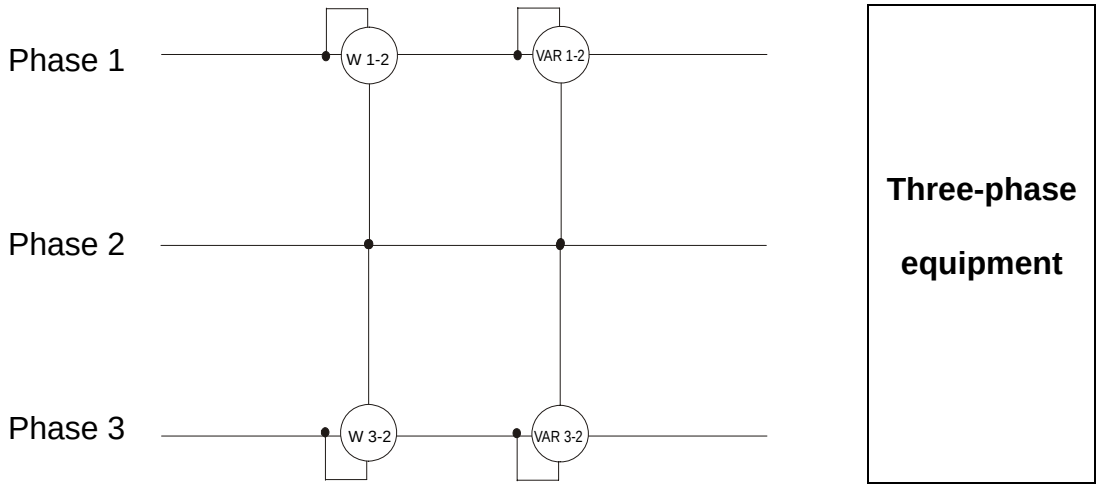
where:

Symbol	Significance	Remarks
P+	Value of the active power +	Positive parameter (user)
Pfc+	Capacitive power factor +	
Pfi+	Inductive power factor +	
Qc+	Value of the capacitive reactive power +	
Qi+	Value of the inductive reactive power +	
P-	Value of the active power -	Negative parameter (generator)
Pfc-	Capacitive power factor -	
Pfi-	Inductive power factor -	
Qc-	Value of the capacitive reactive power -	
Qi-	Value of the inductive reactive power -	

Value	Significance
P	The active power (positive or negative) is defined in the panel and therefore acquires the value of the active power in that moment.
Q	The reactive power (inductive or capacitive, positive or negative) is defined in the panel and therefore acquires the value of the reactive power in that moment.
Pf	The power factor (inductive or capacitive, positive or negative) is defined in the panel and therefore acquires the value of the power factor in that moment.
0	The active power (positive or negative) or the reactive power (inductive or capacitive, positive or negative) is NOT defined in the panel and therefore acquires a null value.
-1	The power factor (inductive or capacitive, positive or negative) is NOT defined in the panel.

16.3.2. 3 Phase 3 Wire System

In the electrical systems distributed without neutral, the phase voltages and the power factors and phase cosφ lose importance. Only the phase to phase voltages, the phase currents and the total powers remain defined.



In this case the potential of one of the three phases (for example, phase 2) is taken on as reference potential. The total values of the active, reactive and apparent power are expressed as sum of the indications of the couples of Wattmeters, VARmeters and VAmeters.

$$P_{TOT} = W_{1-2} + W_{3-2}$$
$$Q_{TOT} = VAR_{1-2} + VAR_{3-2}$$
$$S_{TOT} = \sqrt{(W_{1-2} + W_{3-2})^2 + (VAR_{1-2} + VAR_{3-2})^2}$$

16.4. MEASURING METHOD: OUTLINES

The instrument is able to measure: voltages, currents, active powers, inductive and capacitive reactive powers, apparent powers, inductive and capacitive power factors, analogue or impulse parameters. All these parameters are analyzed in a digital way: for each phase (voltage and current), 6 x 128 samples are acquired on a module of 16 x 20ms, repeated for the three phases.

16.4.1. Integration periods

The storage of all the data would require a huge memory capacity.
Therefore we've tried to find out a storage method which permits to compress the information to be memorized, though providing significant data.
The chosen method is the integration one: after a certain period called "integration period", which can be set from 5 seconds to 60 minutes (3600sec), the instrument extracts from the sampled values the following values:

- Minimum value of the parameter during the integration period (harmonics excluded)
- Medium value of the parameter (intended as arithmetic average of all the values registered during the integration period)
- Maximum value of the parameter during the integration period (harmonics excluded)

Only this information (repeated for each parameter to be memorized) are saved in the memory along with starting time and date of the integration period.
Once these data are memorized, the instrument restarts to take measurements for a new period.

16.4.2. Power factor calculations

According to the standards in force, the medium power factor can't be calculated as average of the instantaneous power factors. It must be obtained from the medium values of active and reactive power.
Each single medium power factor (of phase or total) is therefore calculated, at the end of each integration period, on the medium value of the corresponding powers independently on the fact that they must be registered or not.
Besides, for a better analysis of the type of load present on the line and in order to have terms of comparison when studying the invoicing of the low $\cos\varphi$, the values of inductive and capacitive $\cos\varphi$ are treated as independent parameters.

17. AFTER-SALE SERVICE

17.1. WARRANTY

This instrument is guaranteed against material or production defects, in accordance with our general sales conditions. During the warranty period the manufacturer reserves the right to decide either to repair or replace the product.
Should you need for any reason to return back the instrument for repair or replacement take prior agreements with the local distributor from whom you bought it. Do not forget to enclose a report describing the reasons for returning (detected fault). Use only original packaging. Any damage occurred in transit due to non original packaging will be charged anyhow to the customer.
The manufacturer will not be responsible for any damage to persons or things.

The warranty doesn't apply to:

- Accessories and batteries (not covered by warranty).
- Repairs made necessary by improper use (including adaptation to particular applications not foreseen in the instructions manual) or improper combination with incompatible accessories or equipment.
- Repairs made necessary by improper shipping material causing damages in transit.
- Repairs made necessary by previous attempts for repair carried out by non skilled or unauthorized personnel.
- Instruments for whatever reason modified by the customer himself without explicit authorization of our Technical Dept.

Our products are patented and our logotypes registered. We reserve the right to modify specifications and prices in view of technological improvements or developments which might be necessary.

17.2. SERVICE

Shouldn't the instrument work properly, before contacting your distributor make sure that batteries are correctly installed and working, check the test leads and replace them if necessary. Make sure that your operating procedure corresponds to the one described in this manual.
Should you need for any reason to return back the instrument for repair or replacement take prior agreements with the local distributor from whom you bought it. Do not forget to enclose a report describing the reasons for returning (detected fault). Use only original packaging. Any damage occurred in transit due to non original packaging will be charged anyhow to the customer.
The manufacturer will not be responsible for any damage to persons or things.

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