

# Power analyzers and Energy Meters

## Power Analyzer

### Type WM14-96

CARLO GAVAZZI



- Optional RS422/485 serial port
- Alarms (visual only)  $V_{LN}$ ,  $A_n$

- Class 2 (active energy)
- Class 3 (reactive energy)
- Accuracy  $\pm 0.5$  F.S. (current/voltage)
- Power analyzer
- Display of instantaneous variables: 3x3 digit
- Display of energies: 8+1 digit
- System variables and phase measurements:  $W$ ,  $W_{dmd}$ ,  $var$ ,  $VA$ ,  $VA_{dmd}$ ,  $PF$ ,  $V$ ,  $A$ ,  $A_n$ ,  $A_{dmd}$ ,  $Hz$
- $A_{max}$ ,  $A_{dmd\ max}$ ,  $W_{dmd\ max}$  indication
- Energy measurements: kWh and kvarh
- Hour counter (5+2 DGT)
- TRMS meas. of distorted sine waves (voltages/currents)
- Power supply: 24V, 48V, 115V, 230V 50-60Hz; 18 to 60VDC
- Protection degree (front): IP65
- Front dimensions: 96x96mm

## Product Description

3-phase power analyzer with built-in programming key-pad. Particularly recommended for displaying the main electrical variables.

Housing for panel mounting, (front) protection degree IP65 and optional RS485 serial port.

## How to order

**WM14-96 AV5 3 D X**

Model \_\_\_\_\_  
 Range code \_\_\_\_\_  
 System \_\_\_\_\_  
 Power supply \_\_\_\_\_  
 Option \_\_\_\_\_

## Type Selection

| Range codes                                                                                                                                                                                                                                             | System                                                                    | Power supply                                                                                                                                                                        | Options                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| <b>AV5:</b> 400/660V <sub>L-L</sub> /5(6)AAC<br>VL-N: 185 V to 460 V<br>VL-L: 320 V to 800 V<br><b>AV6:</b> 100/208V <sub>L-L</sub> /5(6)AAC<br>VL-N: 45 V to 145 V<br>VL-L: 78 V to 250 V<br>Phase current: 0.03A to 6A<br>Neutral current: 0.09 to 6A | <b>3 :</b> 1-2-3-phase, balanced/unbalanced load, with or without neutral | <b>A:</b> 24VAC<br>-15+10%, 50-60Hz<br><b>B:</b> 48VAC<br>-15+10%, 50-60Hz<br><b>C:</b> 115VAC<br>-15+10%, 50-60Hz<br><b>D:</b> 230VAC<br>-15+10%, 50-60Hz<br><b>3:</b> 18 to 60VDC | <b>X:</b> None<br><b>S:</b> RS485 port |

## Input specifications

|                                                                                       |                                                                                                                             |                                                                                                     |
|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| <b>Rated inputs</b><br>Current<br>Voltage                                             | 3 (shunt)<br>4                                                                                                              | <b>Sampling rate</b><br>1400 samples/s @ 50Hz<br>1700 samples/s @ 60Hz                              |
| <b>Accuracy</b> (display, RS485)<br>(@25°C $\pm 5^\circ\text{C}$ , R.H. $\leq 60\%$ ) | with CT=1 and VT=1 AV5:<br>1150W-VA-var, FS:230VLN,<br>400VLL; AV6: 285W-VA-var,<br>FS:57VLN, 100VLL                        | <b>Display refresh time</b><br>700ms                                                                |
| Current                                                                               | 0.25 to 6A: $\pm(0.5\% \text{ FS} + 1\text{DGT})$                                                                           | <b>Display</b><br>Type<br>Read-out for instant. var.<br>Read-out for energies                       |
| Neutral current                                                                       | 0.03A to 0.25A: $\pm 7\text{DGT}$<br>0.25 to 6A: $\pm(1.5\% \text{ FS} + 1\text{DGT})$<br>0.09A to 0.25A: $\pm 7\text{DGT}$ | Read-out for hour counter                                                                           |
| Phase-phase voltage                                                                   | $\pm(1.5\% \text{ FS} + 1 \text{ DGT})$                                                                                     | <b>Measurements</b><br>Current, voltage, power, power factor, frequency, energy.                    |
| Phase-neutral voltage                                                                 | $\pm(0.5\% \text{ FS} + 1 \text{ DGT})$                                                                                     | Measuring method<br>Coupling type<br>Crest factor                                                   |
| Active and Apparent power,                                                            | 0.25 to 6A: $\pm(1\% \text{ FS} + 1\text{DGT})$ ;<br>0.03A to 0.25A: $\pm(1\% \text{ FS} + 5\text{DGT})$                    | TRMS measurement of distorted waves.<br>Direct<br>< 3; max 10A peak                                 |
| Reactive power                                                                        | 0.25 to 6A: $\pm(2\% \text{ FS} + 1\text{DGT})$ ;<br>0.03A to 0.25A: $\pm(2\% \text{ FS} + 5\text{DGT})$                    | <b>Input impedance</b><br>400/660V <sub>L-L</sub> (AV5)<br>100/208V <sub>L-L</sub> (AV6)<br>Current |
| Active energy                                                                         | Class 2 (I start up: 30mA)                                                                                                  | 1 M $\Omega$ $\pm 5\%$<br>453 K $\Omega$ $\pm 5\%$                                                  |
| Reactive energy                                                                       | Class 3 (I start up: 30mA)                                                                                                  | $\leq 0.02\Omega$                                                                                   |
| Frequency                                                                             | $\pm 0.1\% \text{ Hz}$ (48 to 62Hz)                                                                                         | <b>Frequency</b><br>48 to 62 Hz                                                                     |
| <b>Additional errors</b><br>Humidity                                                  | $\leq 0.3\% \text{ FS}$ , 60% to 90% RH                                                                                     | <b>Overload protection</b><br>Continuous voltage/current<br>For 500ms: voltage/current              |
| <b>Temperature drift</b>                                                              | $\leq 200\text{ppm}/^\circ\text{C}$                                                                                         | 1.2 F.S.<br>2 Un/36A                                                                                |

## RS485 Serial Port Specifications

|                                 |                                                                                 |                        |                                                    |
|---------------------------------|---------------------------------------------------------------------------------|------------------------|----------------------------------------------------|
| <b>RS422/RS485</b> (on request) |                                                                                 | Data (bidirectional)   |                                                    |
| Type                            | Multidrop<br>bidirectional (static and<br>dynamic variables)                    | Dynamic (reading only) | System, phase variables and<br>energies            |
| Connections                     | 2 or 4 wires, max. distance<br>1200m, termination directly<br>on the instrument | Static (writing only)  | All configuration parameters                       |
| Addresses                       | 1 to 255, key-pad selectable                                                    | Data format            | 1 start bit, 8 data bit,<br>no parity, 1 stop bit. |
| Protocol                        | MODBUS/JBUS                                                                     | Baud-rate              | 9600 bit/s                                         |

## Software functions

|                             |                                                                                                       |               |                                                                                                                                                                                                                                                                                  |
|-----------------------------|-------------------------------------------------------------------------------------------------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Password</b>             | Numeric code of max. 3<br>digits; 2 protection levels<br>of the programming data                      |               | Page 3: A L1, A L2, A L3<br>Page 4: A L1 dmd, A L2 dmd,<br>A L3 dmd                                                                                                                                                                                                              |
| 1st level                   | Password "0", no<br>protection                                                                        |               | Page 5: An, An Alarm                                                                                                                                                                                                                                                             |
| 2nd level                   | Password from 1 to 999,<br>all data are protected                                                     |               | Page 6: W L1, W L2, W L3<br>Page 7: PF L1, PF L2, PF L3<br>Page 8: var L1, var L2, var L3<br>Page 9: VA L1, VA L2, VA L3<br>Page 10: VA Σ, W Σ, var Σ<br>Page 11: VA dmd, W dmd, Hz<br>Page 12: W dmd max<br>Page 13: Wh<br>Page 14: varh<br>Page 15: VL-L Σ, PF Σ,<br>VLN Alarm |
| <b>System selection</b>     | 3-phase with/without n, unbal.<br>3-phase balanced<br>3-phase ARON<br>2-phase<br>Single phase         |               | Page 16: A max<br>Page 17: A dmd max<br>Page 18: working hours                                                                                                                                                                                                                   |
| <b>Transformer ratio</b>    |                                                                                                       |               |                                                                                                                                                                                                                                                                                  |
| CT                          | 1 to 999                                                                                              |               |                                                                                                                                                                                                                                                                                  |
| VT                          | 1.0 to 99.9                                                                                           |               |                                                                                                                                                                                                                                                                                  |
| <b>Filter</b>               |                                                                                                       |               |                                                                                                                                                                                                                                                                                  |
| Operating range             | 0 to 99.9% of the input<br>electrical scale                                                           |               |                                                                                                                                                                                                                                                                                  |
| Filtering coefficient       | 1 to 16                                                                                               |               |                                                                                                                                                                                                                                                                                  |
| Filter action               | Measurements, alarms,<br>serial output (fundamental<br>variables: V, A, W and their<br>derived ones). | <b>Alarms</b> | Programmable, for the $V_{LN\Sigma}$ and<br>An (neutral current).<br>Note: the alarm is only visual,<br>by means of LED on the front<br>of the instrument.                                                                                                                       |
| <b>Displaying</b>           |                                                                                                       | <b>Reset</b>  | Independent alarm ( $V_{L\Sigma}$ , An)<br>max: A dmd, W dmd<br>all counters (Wh, varh, h)                                                                                                                                                                                       |
| 3-phase system with neutral | Up to 3 variables per page<br>Page 1: V L1, V L2, V L3<br>Page 2: V L12, V L23, V L31                 |               |                                                                                                                                                                                                                                                                                  |

## Power Supply Specifications

|                               |                                                                                          |                          |                                           |
|-------------------------------|------------------------------------------------------------------------------------------|--------------------------|-------------------------------------------|
| <b>Auxiliary power supply</b> | 230VAC<br>-15 +10%, 50-60Hz<br>115VAC<br>-15 +10%, 50-60Hz<br>48VAC<br>-15 +10%, 50-60Hz |                          | 24VAC<br>-15 +10%, 50-60Hz<br>18 to 60VDC |
|                               |                                                                                          | <b>Power consumption</b> | AC: 4.5 VA<br>DC: 4W                      |

## General Specifications

|                                  |                                                                                     |                            |                                                                                |
|----------------------------------|-------------------------------------------------------------------------------------|----------------------------|--------------------------------------------------------------------------------|
| <b>Operating temperature</b>     | 0° to +50°C (32° to 122°F)<br>(RH < 90% non condensing)                             |                            | measuring inputs and RS485.<br>4kVAC, 500VDC between<br>power supply and RS485 |
| <b>Storage temperature</b>       | -10° to +60°C (14° to 140°F)<br>(RH < 90% non condensing)                           | <b>Dielectric strength</b> | 4kVAC (for 1 min)                                                              |
| <b>Installation category</b>     | Cat. III (IEC 60664, EN60664)                                                       | <b>EMC</b>                 |                                                                                |
| <b>Insulation</b> (for 1 minute) | 4kVAC, 500VDC<br>between measuring<br>inputs and power supply.<br>500VAC/DC between | Emissions                  | EN50084-1 (class A)<br>residential environment,<br>commerce and light industry |

## General Specifications (cont.)

|                                                  |                                               |                   |                                             |
|--------------------------------------------------|-----------------------------------------------|-------------------|---------------------------------------------|
| Immunity                                         | EN61000-6-2 (class A) industrial environment. | Material          | ABS self-extinguishing: UL 94 V-0           |
| Pulse voltage (1.2/50µs)                         | EN61000-4-5                                   | Mounting          | Panel                                       |
| Safety standards                                 | IEC60664, EN60664                             | Protection degree | Front: IP65 (standard)<br>Connections: IP20 |
| Approvals                                        | CE, UL and CSA                                | Weight            | Approx. 400 g (pack. incl.)                 |
| Connections 5(6) A<br>Max cable cross sect. area | Screw-type<br>2.5 mm <sup>2</sup>             |                   |                                             |
| Housing<br>Dimensions (WxHxD)                    | 96 x 96 x 63 mm                               |                   |                                             |

## Display pages

### Display variables in a 3-phase system with neutral

| No | 1 <sup>st</sup> variable | 2 <sup>nd</sup> variable | 3 <sup>rd</sup> variable | Notes                                                                 |
|----|--------------------------|--------------------------|--------------------------|-----------------------------------------------------------------------|
| 1  | V L1                     | V L2                     | V L3                     |                                                                       |
| 2  | V L12                    | V L23                    | V L31                    | Decimal point blinking on the right of the display                    |
| 3  | A L1                     | A L2                     | A L3                     |                                                                       |
| 4  | A L1 dmd                 | A L2 dmd                 | A L3 dmd                 | dmd = demand (integration time selectable from 1 to 30 minutes)       |
| 5  | An                       | AL.n                     |                          | AL.n if neutral current alarm is active                               |
| 6  | W L1                     | W L2                     | W L3                     | Decimal point blinking on the right of the display if generated power |
| 7  | PF L1                    | PF L2                    | PF L3                    |                                                                       |
| 8  | var L1                   | var L2                   | var L3                   | Decimal point blinking on the right of the display if generated power |
| 9  | VA L1                    | VA L2                    | VA L3                    |                                                                       |
| 10 | VA system                | W system                 | var system               |                                                                       |
| 11 | VA dmd (system)          | W dmd (system)           | Hz (system)              | dmd = demand (integration time selectable from 1 to 30 minutes)       |
| 12 |                          | W dmd MAX                |                          | Maximum sys power demand                                              |
| 13 | Wh (MSD)                 | Wh                       | Wh (LSD)                 | The total indication is given in max 3 groups of 3 digits.            |
| 14 | varh (MSD)               | varh                     | varh (LSD)               | The total indication is given in max 3 groups of 3 digits.            |
| 15 | V LL system              | AL.U                     | PF system                | AL.U= is activated only if one of VLN is not within the set limits.   |
| 16 | A MAX                    |                          |                          | max. current among the three phases                                   |
| 17 | A dmd max                |                          |                          | max. dmd current among the three phases                               |
| 18 | h                        |                          |                          | hour counter                                                          |

MSD: most significant digit

LSD: least significant digit



#### 1) Example of kWh visualization:

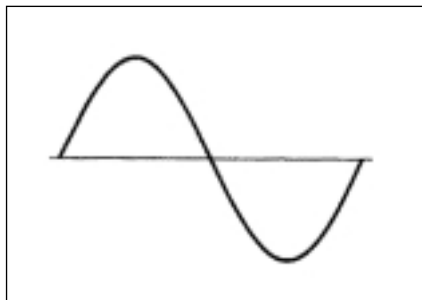
This example is showing 15 933 453.7 kWh

#### 2) Example of kvarh visualization:

This example is showing 3 553 944.9 kvarh

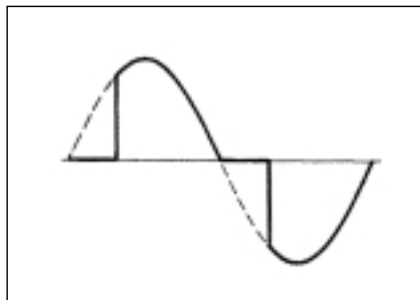


## Waveform of the signals that can be measured



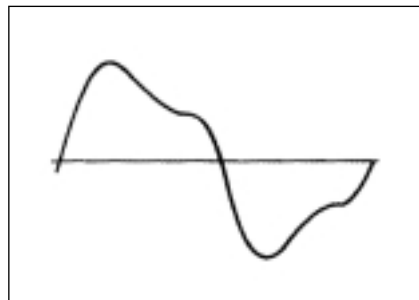
**Figure A**  
**Sine wave, undistorted**

Fundamental content 100%  
Harmonic content 0%  
 $A_{rms} = 1.1107 |A|$



**Figure B**  
**Sine wave, indented**

Fundamental content 10...100%  
Harmonic content 0...90%  
Frequency spectrum: 3rd to 16th harmonic  
Additional error: <1% FS

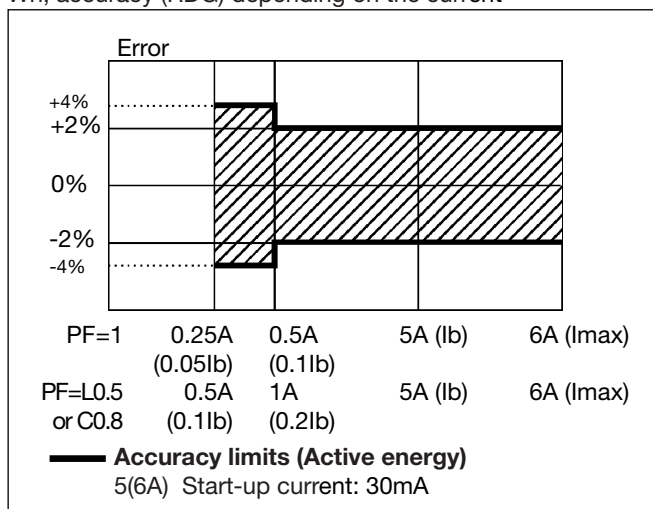


**Figure C**  
**Sine wave, distorted**

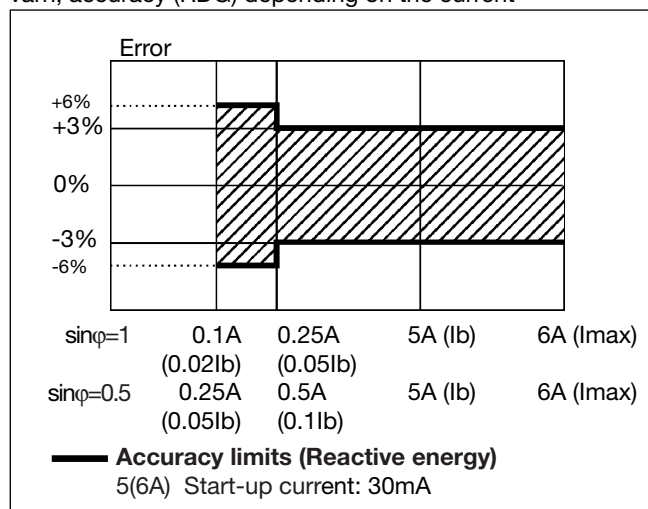
Fundamental content 70...90%  
Harmonic content 10...30%  
Frequency spectrum: 3rd to 16th harmonic  
Additional error: <0.5% FS

## Accuracy

Wh, accuracy (RDG) depending on the current



varh, accuracy (RDG) depending on the current



## Used calculation formulas

## Phase variables

Instantaneous effective voltage

$$V_{IN} = \sqrt{\frac{1}{n} \cdot \sum_{i=1}^n (V_{INi})^2}$$

Instantaneous active power

$$W_1 = \frac{1}{n} \cdot \sum_{i=1}^n (V_{INi}) \cdot (A_{1i})$$

Instantaneous power factor

$$\cos\phi_1 = \frac{W_1}{VA_1}$$

Instantaneous effective current

$$A_1 = \sqrt{\frac{1}{n} \cdot \sum_{i=1}^n (A_{1i})^2}$$

Instantaneous apparent power

$$VA_1 = V_{IN} \cdot A_1$$

Instantaneous reactive power

$$VAR_1 = \sqrt{(VA_1)^2 - (W_1)^2}$$

## System variables

Equivalent 3-phase voltage

$$V_{\Sigma} = \frac{V_1 + V_2 + V_3}{3} \cdot \sqrt{3}$$

3-phase reactive power

$$VAR_{\Sigma} = (VAR_1 + VAR_2 + VAR_3)$$

3-phase active power

$$W_{\Sigma} = W_1 + W_2 + W_3$$

3-phase apparent power

$$VA_{\Sigma} = \sqrt{(W_{\Sigma})^2 + (VAR_{\Sigma})^2}$$

3-phase power factor

$$\cos\phi_{\Sigma} = \frac{W_{\Sigma}}{VA_{\Sigma}}$$

Neutral current

$$A_n = \bar{A}_{L1} + \bar{A}_{L2} + \bar{A}_{L3}$$

## Used calculation formulas (cont.)

### Energy metering

Where:

$i$  = considered phase (L1, L2 or L3)

$P$  = active power

$Q$  = reactive power

$t_1, t_2$  = starting and ending time points of consumption recording

$n$  = time unit

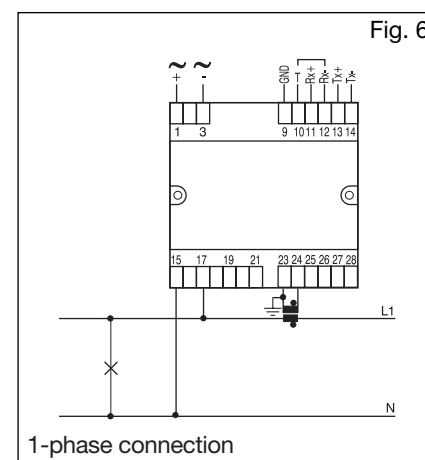
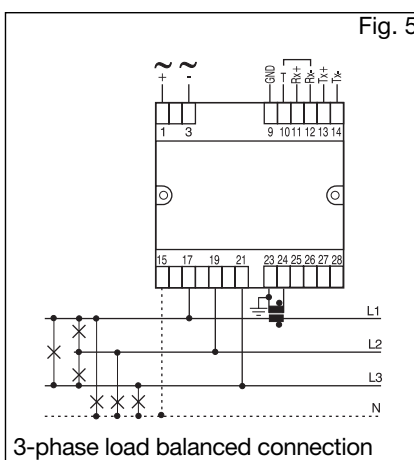
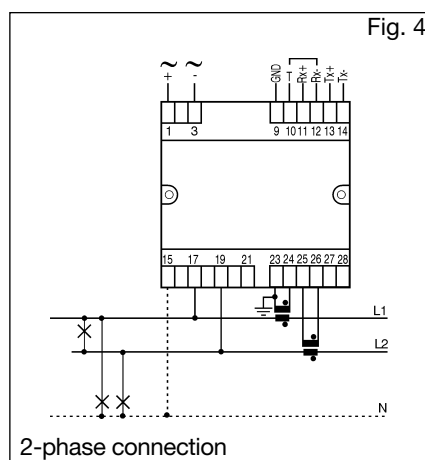
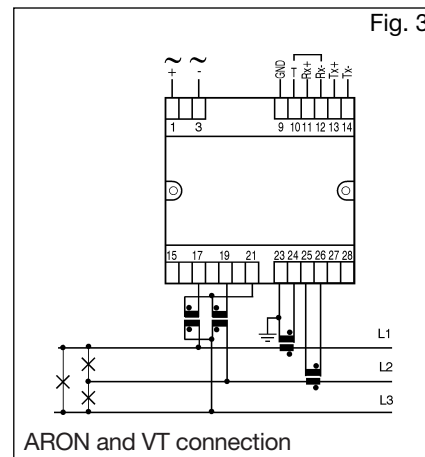
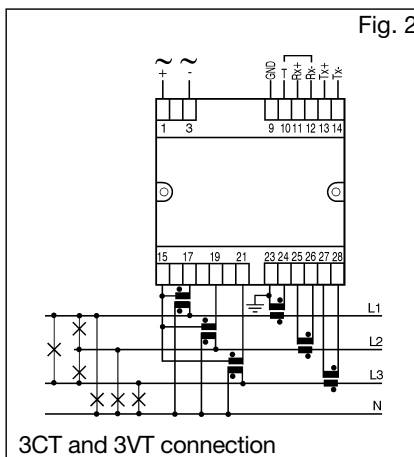
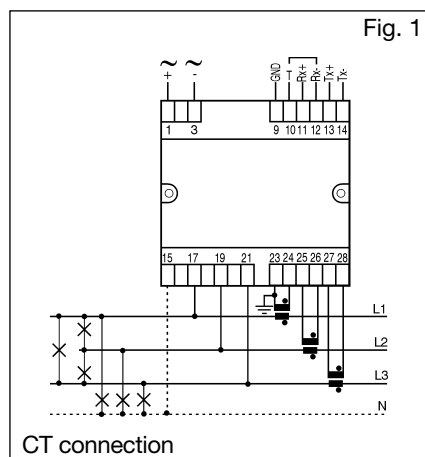
$\Delta t$  = time interval between two successive power consumptions

$n_1, n_2$  = starting and ending discrete time points of consumption recording

$$kWh_i = \int_{t_1}^{t_2} P_i(t) dt \approx \Delta t \sum_{n_1}^{n_2} P_{a,i}$$

$$kVarh_i = \int_{t_1}^{t_2} Q_i(t) dt \approx \Delta t \sum_{n_1}^{n_2} Q_{a,i}$$

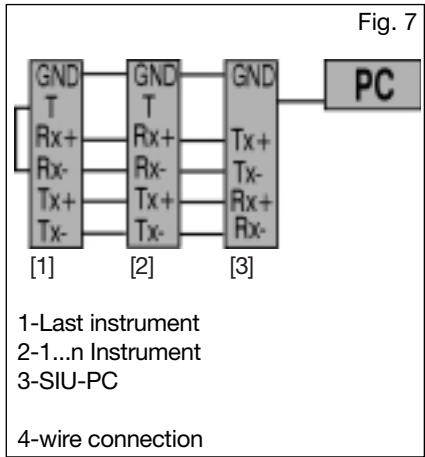
## Wiring diagrams



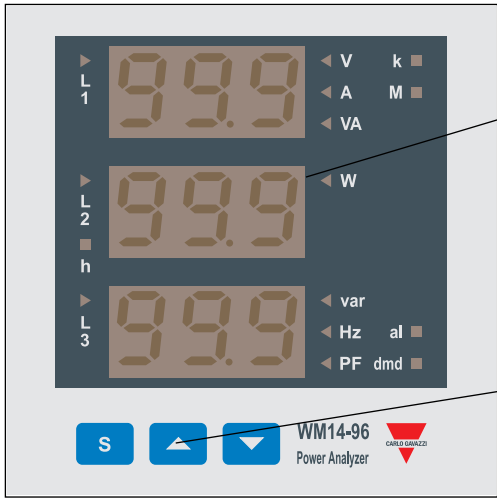
**NOTE:** the current inputs can be connected to the lines ONLY by means of current transformers. The direct connection is not allowed.



RS485 Serial connection



Front Panel Description



- 1. Key-pad**  
To program the configuration parameters and the display of the variables.
- S**  
Key to enter programming and confirm selections;
- Keys to:  
- programme values;  
- select functions;  
- display measuring pages.
- 2. Display**  
LED-type with alphanumeric indications to:  
- display configuration parameters;  
- display all the measured variables.

Dimensions and Panel Cut-out

