

# Power analyzers and Energy Meters

## Power Analyzer

### Type WM14-96 "Basic Version"

CARLO GAVAZZI



- Optional dual pulse output
- Alarms (visual only)  $V_{LN}$ ,  $A_n$
- Optional galvanically insulated measuring inputs

## 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 or dual pulse output. Parameters programmable by means of CptBSoft.

- Class 1 (active energy)
- Class 2 (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
- Optional RS422/485 serial port

## How to order

**WM14-96 AV5 3 D PG**

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

## How to order

**CptBSoft**

CptBSoft (compatible only with S or SG options): software to program the working parameters of the power analyzer and to read the energy and the instantaneous variables.

## Type Selection

Range codes	System	Power supply	Options
<b>AV5:</b> 380/660V <sub>LN</sub> /5(6)AAC VL-N: 185 V to 460 V VL-L: 320 V to 800 V <b>AV6:</b> 120/208V <sub>LN</sub> /5(6)AAC VL-N: 45 V to 145 V VL-L: 78 V to 250 V Phase current: 0.03A to 6A Neutral current: 0.09 to 6A	<b>3 :</b> 1-2-3-phase, balanced/unbalanced load, with or without neutral	<b>A:</b> 24VAC -15+10%, 50-60Hz <b>B:</b> 48VAC -15+10%, 50-60Hz <b>C:</b> 115VAC -15+10%, 50-60Hz <b>D:</b> 230VAC -15+10%, 50-60Hz <b>3:</b> 18 to 60VDC (not available in case of SG or PG options)	<b>X:</b> None <b>S:</b> RS485 port <b>SG:</b> RS485+galvanic insulated measuring inputs <b>PG:</b> Dual pulse output + galvanically insulated measuring inputs.

## Input specifications

Rated inputs	System	Power supply	Options
Current "X-S options" Current "SG-PG options" Voltage	3 (non insulated each other) 3 (insulated each other) 4	Active energy "X-S option" Reactive energy "X-S option" Active energy "SG-PG opt." Reactive energy "SG-PG opt." Frequency	0.03A to 0.25A: $\pm 2\%$ FS +5DGT) Class 2 (start up "I": 30mA) Class 3 (start up "I": 30mA) Class 1 (start up "I": 30mA) Class 2 (start up "I": 30mA) $\pm 0.1$ Hz (48 to 62Hz)
<b>Accuracy</b> (display, RS485) (@25°C $\pm 5^\circ$ C, R.H. $\leq 60\%$ )	with CT=1 and VT=1 AV5: 1150W-VA-var, FS:230VLN, 400VLL; AV6: 285W-VA-var, FS:57VLN, 100VLL	<b>Additional errors</b> Humidity	$\leq 0.3\%$ FS, 60% to 90% RH
Current	0.25 to 6A: $\pm(0.5\%$ FS +1DGT) 0.03A to 0.25A: $\pm(0.5\%$ FS +7DGT)	<b>Temperature drift</b>	$\leq 200$ ppm/ $^\circ$ C
Neutral current	0.25 to 6A: $\pm(1.5\%$ FS +1DGT) 0.09A to 0.25A: $\pm(0.5\%$ FS +7DGT)	<b>Sampling rate</b>	1400 samples/s @ 50Hz 1700 samples/s @ 60Hz
Phase-phase voltage	$\pm(1.5\%$ FS +1 DGT)	<b>Display refresh time</b>	700ms
Phase-neutral voltage	$\pm(0.5\%$ FS + 1 DGT)	<b>Display</b>	LED, 14mm
Active and Apparent power,	0.25 to 6A: $\pm(1\%$ FS +1DGT); 0.03A to 0.25A: $\pm(1\%$ FS +5DGT)	Type	3x3 DGT
Reactive power	0.25 to 6A: $\pm(2\%$ FS +1DGT);	Read-out for instant. var. Read-out for energies	3+3+3 DGT (Max indication: 999 999 99.9)

## Input specifications (cont.)

<b>Display (cont.)</b> Read-out for hour counter	1+3+3 DGT (Max. indication: 9 999 9.99)	120/208V <sub>L-L</sub> (AV6) Current	453 K $\Omega$ $\pm$ 5% $\leq 0.02\Omega$
<b>Measurements</b>	Current, voltage, power, power factor, frequency, energy, TRMS measurement of distorted waves.	<b>Input impedance</b> 380/660V <sub>L-L</sub> (AV5) 120/208V <sub>L-L</sub> (AV6) Current	<b>(PG-SG options)</b> 1 M $\Omega$ $\pm$ 1% 1 M $\Omega$ $\pm$ 1% $\leq 0.02\Omega$
Coupling type Crest factor	Direct < 3, max 10A peak	<b>Frequency</b>	48 to 62 Hz
<b>Input impedance</b> 380/660V <sub>L-L</sub> (AV5)	<b>(X-S options)</b> 1 M $\Omega$ $\pm$ 5%	<b>Overload protection</b> Continuous voltage/current For 500ms: voltage/current	1.2 F.S. 2 Un/36A

## RS485 Serial Port Specifications

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

## CptBSoft software: parameter programming and reading data

<b>CptBSoft</b>	Multi language software to program the working parameters of the power analyzer and to read the energies and the instantaneous variables. The program runs under Windows 95/98/98SE/2000/	Working mode	NT/XP. Two different working modes can be selected: - management of a local RS485 network; - management of communication from a single instrument to PC (RS232);
		<b>Data access</b>	By means of RS485 serial port.

## Dual pulse output

<b>Digital outputs</b> (on request)			Electrical life: min 2*10 <sup>5</sup> cycles Mechanical life: 5*10 <sup>6</sup> cycles
Pulse outputs		Pulse duration	$\geq 100\text{ms}$ <120ms (ON) $\geq 100\text{ms}$ (OFF)
Number of outputs	2 (one for kWh one for kvarh)		According to EN622053-31
Number of pulses	From 0.01 to 999 in compliance with the following formula: [Psys max (kW or kvar)*pulses (pulses/kWh or kvarh)] <14400	Insulation	By means of relays, 4000 V <sub>RMS</sub> outputs to measuring inputs, 4000 V <sub>RMS</sub> output to supply input.
Output type	Relay min current: 0.05A@250VAC/30VDC max current: 5A@250VAC/30VDC		Insulation between the two outputs: 1000V <sub>RMS</sub>

## Software functions

<b>Password</b>	Numeric code of max. 3 digits; 2 protection levels of the programming data Password "0", no protection		
1st level			
2nd level	Password from 1 to 999, all data are protected		
<b>System selection</b>	3-phase with/without n, unbal. 3-phase balanced 3-phase ARON, unbalanced 2-phase Single phase		
<b>Transformer ratio</b>			
CT	1 to 999		
VT	1.0 to 99.9		
<b>Filter</b>			
Operating range	0 to 100% of the input display scale		
Filtering coefficient	1 to 16		
Filter action	Measurements, alarms, serial out. (fundamental var: V, A, W and their derived ones).	<b>Alarms</b>	Page 5: An, An Alarm Page 6: W L1, W L2, W L3 Page 7: PF L1, PF L2, PF L3 Page 8: var L1, var L2, var L3 Page 9: VA L1, VA L2, VA L3 Page 10: VA $\Sigma$ , W $\Sigma$ , var $\Sigma$ Page 11: VA dmd, W dmd, Hz Page 12: W dmd max (*) Page 13: Wh (*) Page 14: varh (*) Page 15: VL-L $\Sigma$ , PF $\Sigma$ , VLN Alarm Page 16: A max (*) Page 17: A dmd max (*) Page 18: hour counter (*) (*) = These variables are stored in EEPROM when the instrument is switched off
<b>Displaying</b>		<b>Reset</b>	
3-phase system with neutral	Up to 3 variables per page Page 1: V L1, V L2, V L3 Page 2: V L12, V L23, V L31 Page 3: A L1, A L2, A L3 Page 4: A L1 dmd, A L2 dmd, A L3 dmd		Programmable, for the VL $\Sigma$ and An (neutral current). Note: the alarm is only visual, by means of LED on the front of the instrument. Independent alarm (VL $\Sigma$ , An) max: A dmd, W dmd all energies (Wh, varh) and hour counter

## Power Supply Specifications

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

## General Specifications

<b>Operating temperature</b>	0° to +50°C (32 to 122°F) (RH < 90% non condensing)		
<b>Storage temperature</b>	-10° to +60°C (14 to 140°F) (RH < 90% non condensing)		
<b>Installation category</b>	Cat. III (IEC 60664, EN60664)	<b>Dielectric strength</b>	measuring inputs and RS485. 4000VAC, 500VDC between power supply and RS485
<b>Insulation (for 1 minute)</b>	4000VAC, 500VDC between measuring inputs and power supply. 500VAC/DC between	<b>EMC</b>	
		Emissions	EN50084-1 (class A) residential environment, commerce and light industry

## General Specifications (cont.)

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

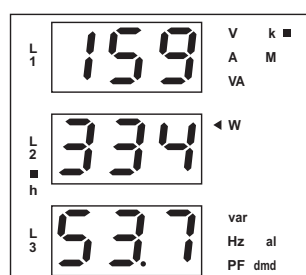
## Display pages

### Display variables in 3-phase systems (in a 3-phase system with neutral)

No	1 <sup>st</sup> variable	2 <sup>nd</sup> variable	3 <sup>rd</sup> variable	Note
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

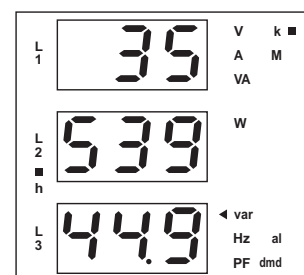


### 1) Example of kWh visualization:

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

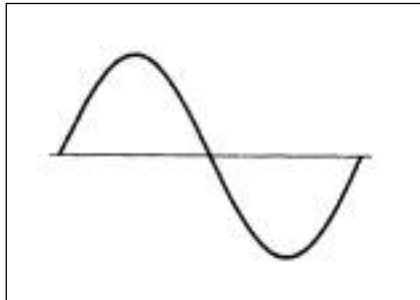


Figure A

## Sine wave, undistorted

Fundamental content 100%  
 Harmonic content 0%  
 $A_{rms} = 1.1107 I_{\bar{A}}$

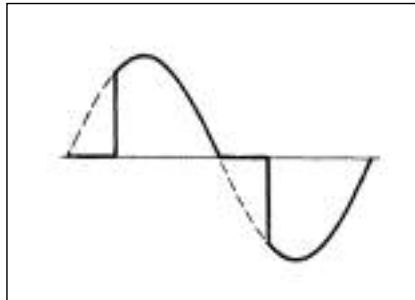


Figure B

## Sine wave, indented

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

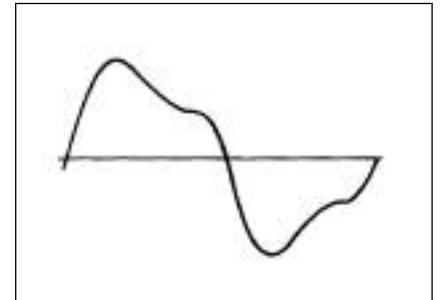


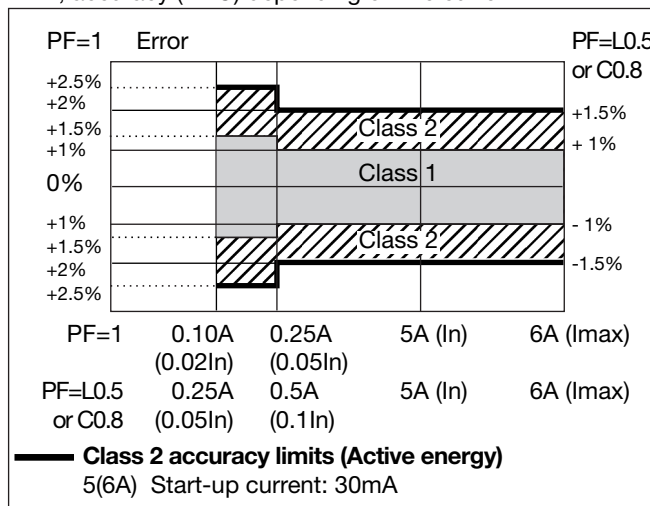
Figure C

## Sine wave, distorted

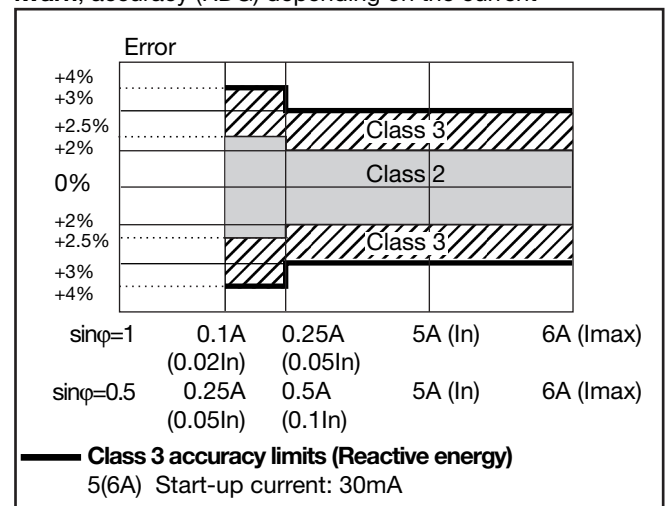
Fundamental content 70...90%  
 Harmonic content 10...30%  
 Frequency spectrum: 3rd to 16th harmonic  
 Additional error: <0.5% FS

## Accuracy

kWh, accuracy (RDG) depending on the current



kvarh, accuracy (RDG) depending on the current



: this graph is only referred to instrument models with the "SG or PG" option.

: this graph is only referred to instrument models with the "X or S" option.

## Used calculation formulas

## Phase variables

Instantaneous effective voltage

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

Instantaneous active power

$$W_1 = \frac{1}{n} \cdot \sum_{i=1}^n (V_{IN})_i \cdot (A_1)_i$$

Instantaneous power factor

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

Instantaneous effective current

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

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

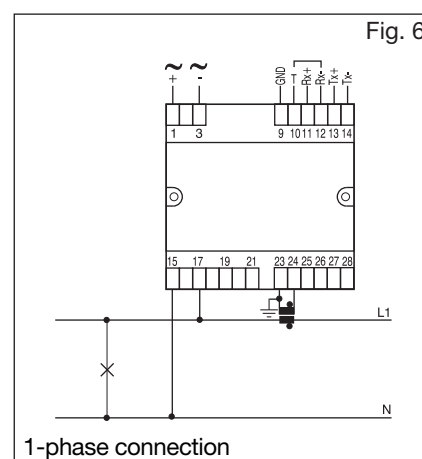
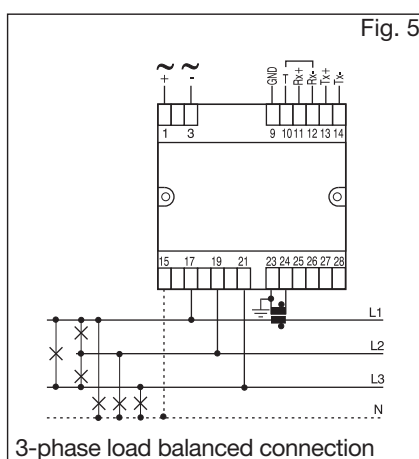
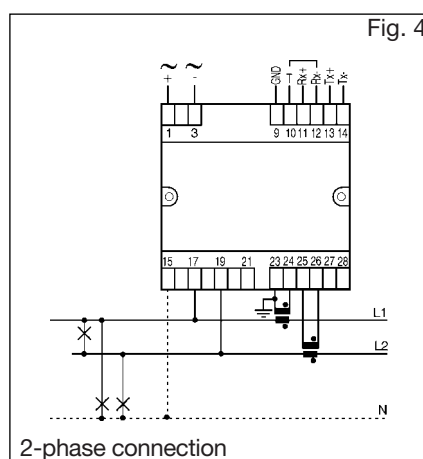
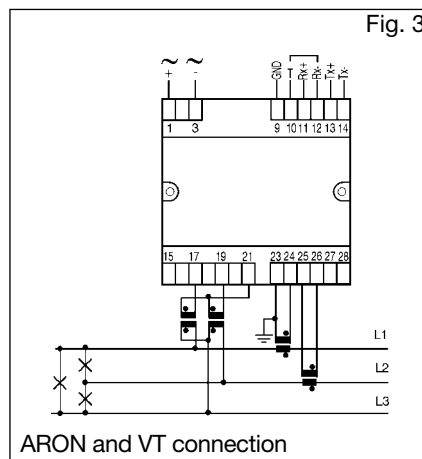
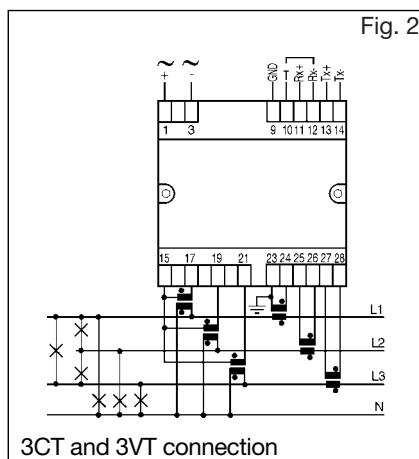
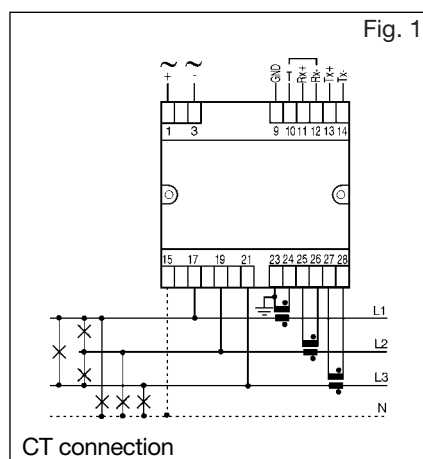
$\Delta t$  = time interval between two successive power consumptions

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

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

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

## Wiring diagrams



**NOTE:** Only for “PG” and “SG” options: the current measuring inputs are galvanically insulated and therefore they can be connected to ground singly.

**NOTE:** For all models except for “PG” or “SG” the current inputs can be connected to the lines ONLY by means of current transformers. The direct connection is not allowed.

## RS485 port connections

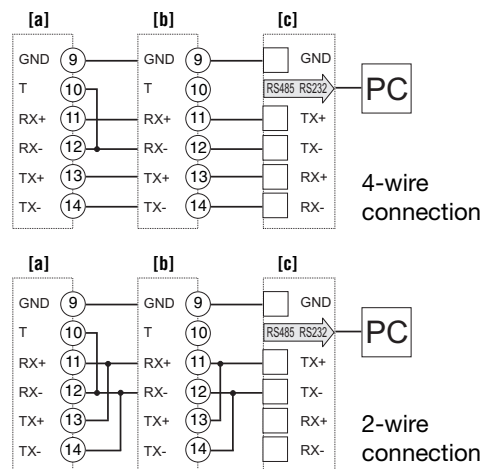
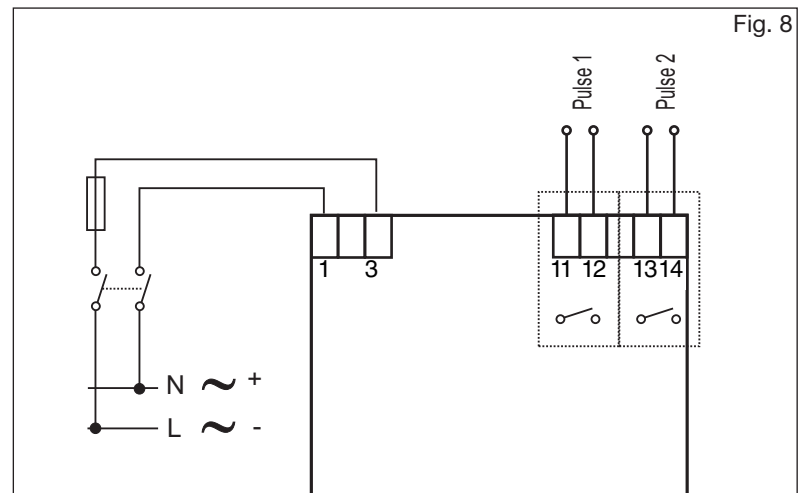
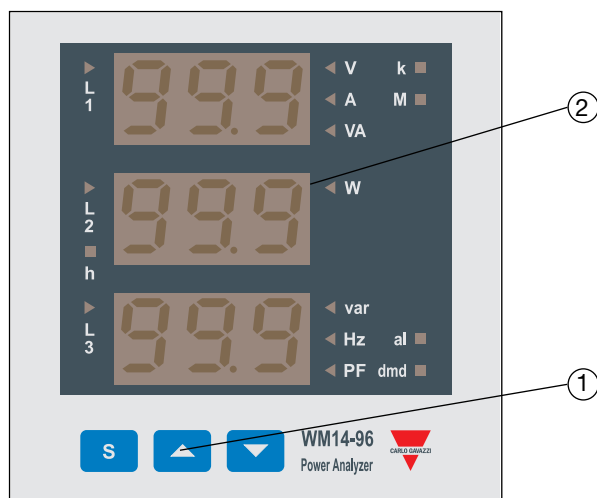


Fig. 7: **a**-Last instrument; **b**-1...n Instrument  
**c**-RS485/232 serial converter

## Dual pulse output connections



## 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

