

# Energy Management Modular Power Analyzers Type WM2-96

CARLO GAVAZZI



- Class 1 (current/voltage)
- Modular power analyzer
- Front size: 96x96 mm
- 3-dgt/6-dgt  $\mu$ P-based indicator
- Manual or automatic scrolling of system and single phase: kW, kVAR, PF, kWh, kVARh, A, VL-L avg, VL1-N, VL2-N, VL3-N.
- TRMS measurement of distorted waves (voltage/current)
- All configuration functions selectable by built-in key-pad
- Password protection of programming parameters
- Degree of protection (front): IP 65
- Optional pulse output (according to DIN43864)
- Optional serial RS 422 /485 port
- MODBUS, JBUS protocol.

## Product Description

$\mu$ P-based modular power analyzer with a built-in configuration key-pad. The power, power factor, current and voltage are system and sin-

gle phase measurements and indications. The housing is easy to mount on a panel and ensures a degree of protection (front) of IP 65.

## Type Selection

Range code	System	Power supply	1st output (pulse)
<b>AV5:</b> 250/433 VAC - 5 AAC (max. 300 V (L-N)/ 520 V (L-L) - 6 A)	<b>3:</b> One phase, three-phase system, 3 or 4 wires, balanced load; three phase system, 3 or 4 wires, unbalanced load	<b>A:</b> 24 VAC, -15% +10%, 50/60 Hz <sup>1) 2)</sup>	<b>XX:</b> No output (standard)
<b>AV7:</b> 400/690 VAC - 5 AAC (max. 480 V (L-N)/ 830 V (L-L) - 6 A) <sup>1)</sup>		<b>B:</b> 48 VAC, -15%+10%, 50/60 Hz <sup>1) 2)</sup>	<b>O1:</b> Single open collector output (30V/100mADC) <sup>1)</sup>
		<b>C:</b> 115 VAC, -15% +10%, 50/60 Hz <sup>1) 2)</sup>	<b>O2:</b> Dual open collector output, the second one is the copy of the first one, like "O1" <sup>1)</sup>
		<b>D:</b> 230 VAC, -15% +10%, 50/60 Hz (standard) <sup>2)</sup>	<b>R1:</b> Single relay output, (AC1-8AAC, 250VAC) <sup>1)</sup>
		<b>L:</b> 18 to 60 VDC/AC <sup>3)</sup>	<b>R2:</b> Dual relay output, the second one is the copy of the first one, like "R1" <sup>1)</sup>
		<b>H:</b> 90 to 260 VDC/AC <sup>3)</sup>	<b>2nd output</b>
			<b>X:</b> No output (standard)
			<b>S:</b> Serial port, RS 485 multidrop bidirectional <sup>1)</sup>

<sup>1)</sup> On request

<sup>2)</sup> **Warning: this power supply cannot be used if the RS485 module is needed**

<sup>3)</sup> Compatible with any kind of output

## Input Specifications

<b>Accuracy (48 to 62 Hz)</b>	Un: 250V (AV5), 400V (AV7) In: 5A	<b>Rated input</b>	
Voltage/current (@ 25°C $\pm$ 5°C, R.H. $\leq$ 60%)	$\pm 0.5\%$ f.s. (0 to 1.2 In, 0.5 to 1.2 Un)	Current	2 inputs (one/three-phase balanced load) 6 inputs (one/three-phase unbalanced load)
Active power (@ 25°C $\pm$ 5°C, R.H. $\leq$ 60%)	$\pm 1\%$ f.s. (PF $\geq$ 0.7 L/C, 0 to 1.2 In, 0.5 to 1.2 Un)	Voltage	2 inputs (one/three-phase balanced load) 4 inputs (one/three-phase unbalanced load)
Reactive power (@ 25°C $\pm$ 5°C, R.H. $\leq$ 60%)	$\pm 1\%$ f.s. (PF $\geq$ 0.7 L/C, 0 to 1 In, 0 to 1 Un)	Insulation	among the voltage and the current inputs: 2000Vrms; among the current inputs: 2000 Vrms
Power factor (PF) (@ 25°C $\pm$ 5°C, R.H. $\leq$ 60%)	$\pm 1\%$ f.s., PF $\geq$ 0.7 L/C, (0.6 to 1.2 In, 1 to 1.2 Un)	<b>Temperature drift</b>	$\pm 250$ ppm/ $^{\circ}$ C
Energy (@ 25°C $\pm$ 5°C, R.H. $\leq$ 60%)	$\pm 1\%$ RDG (kWh), $\pm 2\%$ RDG (kvarh), (PF $\geq$ 0.7L/C, 0 to 1.2 In, 0.5 to 1.2 Un)	<b>Display</b>	Backlighted LCD, h 13mm, 3-dgt (instantaneous meas.) 6-dgt (energies)
<b>Additional errors</b>			
Humidity	$< 0.3\%$ f.s., 60% to 90% R.H.		
Power supply	$\pm 0.5\%$ rdg, -15 +10% p.s.		
Magnetic field	$< 0.1\%$ f.s. @ 400 A/m		

## Input Specifications (cont.)

<b>Decimal point position</b>	Instantaneous measurements: Automatic selection according to the current transformer ratio of the CT being connected (max. indication - single phase): CT ratio $\leq 5 : 11.11$ (25.00A) CT ratio $\leq 50.0 : 111.1$ (250.0A) CT ratio $\leq 500.0 : 1111$ (2500A) CT ratio $\leq 999.9 : 11110$ (6000A)  Energy measurements: max. resolution: 1 Wh/1 VARh min. resolution: 1 kWh/1 kVARh	Coupling type: Direct Crest factor: $\geq 3$
<b>Max. and min. indication</b>	Max. 600 min. 0 Max. 6.00 min. 0.00 Max. 1.00 min. 0.00 Max. 5.40 min. 0.00 Max. 999999 min. -199999 Max. 999999 min. 0	<b>Ranges (impedances)</b>  250 V/433 V ( $\geq 400k\Omega$ ) 5 AAC ( $\leq 0.3 VA / \leq 0.1\Omega$ ) 400V/690V ( $\geq 650k\Omega$ )
<b>Sampling rate</b>	3 times / second	<b>Frequency range</b> 48 to 62 Hz
<b>Measurements</b>	kW, kVAr, PF, $V_{L-L}$ , A, kWh, kvarh kWh, kvarh (the meters are reset automatically when the values reach 14999*CT ratio) kW, kVAr, PF, $V_{L-N}$ , A TRMS measurement of a distorted voltage/current wave	<b>Over-load protection</b>  Continuous: voltage/current For 1 s Voltage: Current:
<b>Measurement method</b>	Single phase variables	Un: 250V (AV5), 400V (AV7) In: 5A 1.2 Un /In
		<b>Keyboard</b> 4 keys: "ΔV": - to enter programming phase and password confirmation; - for value programming and basic measurement scrolling. "L": - for confirmation of new programmed values and going ahead to the next programming step, - single phase measurement scrolling. "R": - for the reset of the partial counted active and/or reactive energy.

## Output Specifications

<b>Pulse output (on request)</b>	1, independent From 0.1 to 999.9 programmable pulses for kWh, kVARh, open collector (NPN transistor) $V_{ON}$ 1.2 VDC/ max. 100 mA $V_{OFF}$ 30 VDC max. 1 x SPDT AC 1 - 8A, 250VAC DC 12 - 5A, 24VDC AC 15 - 2.5A, 250VAC DC 13 - 2.5A, 24VDC 200 ms (ON), $\geq 200$ ms (OFF) By means of optocouplers, 4000 $V_{rms}$ output to measuring input, 4000 $V_{rms}$ output to supply input.	<b>Protocol</b>  Data (bidirectional) Dynamic (reading only)	<b>MODBUS/JBUS</b>  System variables: P, Q, PF, $V_{L-L}$ , energies, Single phase variables: $P_{L1}$ , $Q_{L1}$ , $P_{FL1}$ , $V_{L1-N}$ , $A_{L1}$ , $P_{L2}$ , $Q_{L2}$ , $P_{FL2}$ , $V_{L2-N}$ , $A_{L2}$ , $P_{L3}$ , $Q_{L3}$ , $P_{FL3}$ , $V_{L3-N}$ , $A_{L3}$ All programming data, reset of energy: - partial kWh - partial kVARh - total kWh - total kVARh Stored energy (EEPROM) $\leq 999999$ kWh $\leq 999999$ kVARh
<b>Static type (according to DIN 43864)</b>		Static (writing only)	
<b>Relay type</b>			
<b>Pulse duration</b>			
<b>Insulation</b>			
<b>Serial port (on request)</b>	RS422/RS485; Multidrop bidirectional (static and dynamic variables)	<b>Data format</b>	1-start bit, 8-data bit, no parity/even parity, 1 stop bit
<b>Type</b>		<b>Baud-rate</b>	1200, 2400, 4800 and 9600 selectable bauds
<b>Connections</b>	4 wires, max. distance 1200m, termination directly on the module	<b>Insulation</b>	By means of optocouplers, 4000 $V_{rms}$ output to measuring inputs 4000 $V_{rms}$ output to supply input
<b>Addresses</b>	1 to 255, selectable by key-pad		

## Software Functions

<b>Password</b>	Numeric code of max. 3 digits; 2 protection levels of the programming data Password "0", no protection Password from 1 to 255, all data are protected	Single phase:	Example: the CT is a 100A/5A so the ratio is 20, consequently the maximum counted energy is 299980 kWh or kVArh. Active power (kW), reactive power (kVAh), power factor (cos φ), current (A), phase-neutral voltage (V)
1st level 2nd level			
<b>Measurement scrolling</b> System:	Active power (kW), reactive power (kVAh), power factor (cos φ), current (A), average phase-phase voltage (V) total and partial active energy (kWh), total and partial reactive energy (kVAh) Partial energy meters: the counters of kWh and kVAh are automatically reset when the energy reaches the value (14999°CT).		
		<b>Transformer ratio</b>	For CT up to 5000 A
		<b>Programmable ratio</b>	0.1 to 999.9
		<b>Digital Filter</b> Filter operating range	0 to 100% of the input electrical scale 1 to 64 On the display and on the variable being transmitted by the serial communication port.
		Filtering coefficient	
		Filter action	

## Supply Specifications

<b>AC voltage</b>	230 VAC (standard), -15%+10% 50/60 Hz 24 VAC, 48 VAC, 115 VAC (on request), -15%+10% 50/60 Hz 18 to 60VDC/AC	<b>Power consumption</b>	90 to 260VDC/AC ≤ 30VA / 12W (90 to 260V) ≤ 20VA / 12W (18 to 60V)
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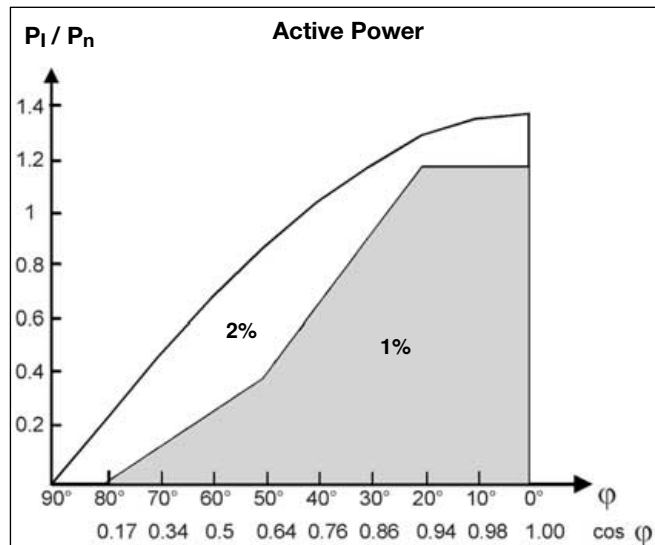
## General Specifications

<b>Operating temperature</b>	0° to +50°C (32° to 122°F) (R.H. < 90% non-condensing)	<b>Safety standards</b>	IEC 61010-1, EN 61010-1
<b>Storage temperature</b>	-10° to +60°C (14° to 140°F) (R.H. < 90% non-condensing)	<b>Other standards</b>	Pulse output: DIN43864
<b>Insulation reference voltage</b>	300 Vrms to ground	<b>Approvals</b>	CE UL, CSA
<b>Insulation</b>	4000 Vrms between all inputs/outputs to ground	<b>Connector</b>	Screw-type, max. 2.5 mm <sup>2</sup> wires x 2
<b>Dielectric strength</b>	4000 Vrms for 1 minute	<b>Housing</b> Dimensions Material	96 x 96 x 140 mm ABS, self-extinguishing: UL 94 V-0
<b>Noise rejection</b> CMRR	100 dB, 48 to 62 Hz	<b>Degree of protection</b>	Front: IP65
<b>EMC</b>	EN 50081-2, EN 50082-2	<b>Weight</b>	Approx. 500 g (packing included)

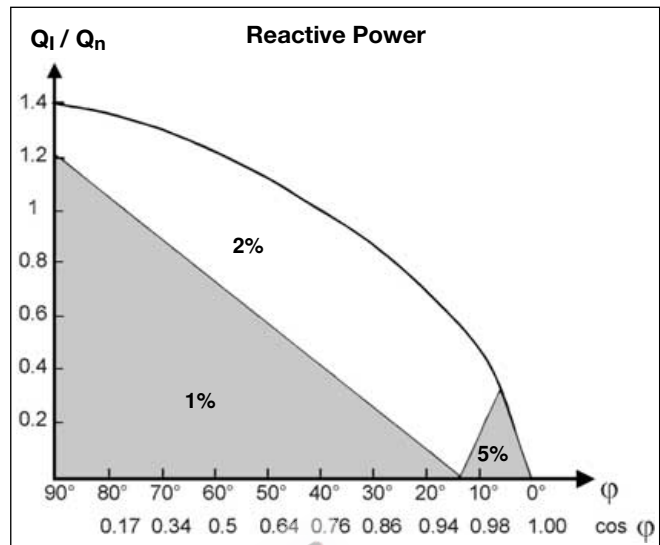


## Mode of Operation

Accuracy class of the instrument as a relation of  $P_I/P_N$  and  $\cos \varphi$  (power factor)



**Test conditions:**  
 $V = 0.8$  to  $1.2 U_n$ ,  
 $I = 0.1$  to  $1.2 I_n$ ,  
 $f = 48$  to  $62$  Hz



**Test conditions:**  
 $V = 0.8$  to  $1.2 U_n$ ,  
 $I = 0.1$  to  $1.2 I_n$ ,  
 $f = 48$  to  $62$  Hz

Input	Star voltage	Delta voltage	Current
AV5	$U_n = 250$ V	$U_n = 430$ V	$I_n = 5$ A

### $P_I/Q_I$ (installation power)

One phase system:

$$P_I = U_I \cdot I_I \cdot \cos \varphi$$

$$Q_I = U_I \cdot I_I \cdot \sin \varphi$$

Three phase, 3-wire system:

$$P_I = \sqrt{3} \cdot U_I \cdot I_I \cdot \cos \varphi$$

$$Q_I = \sqrt{3} \cdot U_I \cdot I_I \cdot \sin \varphi$$

Three phase, 4-wire system:

$$P_I = 3 \cdot U_I \cdot I_I \cdot \cos \varphi$$

$$Q_I = 3 \cdot U_I \cdot I_I \cdot \sin \varphi$$

where:

$U_I$  = the real star voltage of the electrical system being measured.

$I$  = the maximum phase current of the electrical system being measured.

$\cos \varphi$  = the average  $\cos \varphi$  of the electrical system being measured.

### $P_N / Q_N$ (rated power of the instrument):

One phase system:

$$P_N = Q_N = U_n \cdot I_n \cdot CT(\text{ratio})$$

Three phase, 3-wire system:

$$P_N = Q_N = \sqrt{3} \cdot U_n \cdot I_n \cdot CT(\text{ratio})$$

Three phase, 4-wire system:

$$P_N = Q_N = 3 \cdot U_n \cdot I_n \cdot CT(\text{ratio})$$

where:

$U_n$  = the rated input voltage of WM2-96.

$I_n$  = the rated input current of WM2-96.

$CT(\text{ratio})$  = the value of the current transformer ratio.

### Example 1: Model AV5.3 (3-wire system).

$U_I = 400$  V (delta voltage)  
 $I_I = 265$  A (single phase current)  
 $\cos \varphi = 0.85$  (system power factor) (CT=300A)  
 $U_n = 430$  V  
 $I_n = 5$  A

$$CT(\text{ratio}) = \frac{300}{5} = 60$$

$$P_I = \sqrt{3} \cdot U_I \cdot I_I \cdot \cos \varphi$$

$$= \sqrt{3} \cdot 400 \cdot 265 \cdot 0.85$$

$$= 155.87 \text{ kW}$$

$$P_N = \sqrt{3} \cdot U_n \cdot I_n \cdot CT(\text{ratio})$$

$$= \sqrt{3} \cdot 430 \cdot 5 \cdot 60$$

$$= 233.17 \text{ kW}$$

$$\frac{P_I}{P_N} = \frac{155.87}{233.17} = 0.698$$

### Example 2: Model AV5.3 (4-wire system).

$U_I = 230$  V  
 $I_I = 110$  A (CT=300A)  
 $\cos \varphi = 0.85$  ( $\sin \varphi = 0.52$ )  
 $U_n = 250$  V  
 $I_n = 5$  A

$$CT(\text{ratio}) = \frac{300 \text{ A}}{5 \text{ A}} = 60$$

$$Q_N = 3 \cdot U_I \cdot I_I \cdot \sin \varphi$$

$$= 3 \cdot 230 \cdot 110 \cdot 0.52$$

$$= 39.46 \text{ kvar}$$

$$Q_N = 3 \cdot U_n \cdot I_n \cdot CT(\text{ratio})$$

$$= 3 \cdot 250 \cdot 5 \cdot 60$$

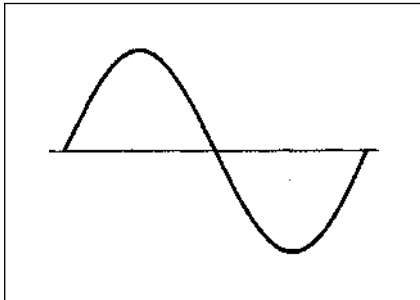
$$= 225 \text{ kvar}$$

$$\frac{P_I}{P_N} = \frac{39.46}{225} = 0.175$$

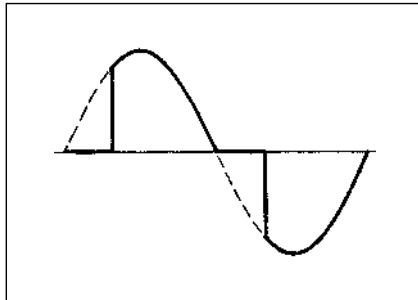
In both examples the accuracy of the measurement is 1% f.s. when considering the changing of the measured voltage from  $0.9 U_n$  to  $1 U_n$  and the measured current from  $0.1 I_n$  to  $0.9 I_n$  with a  $\cos \varphi$  of 0.85 ( $\sin \varphi$  0.52).

## Mode of Operation (cont.)

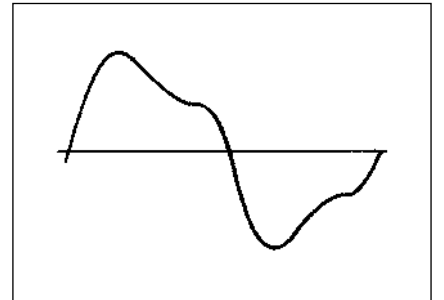
Waveform of the signals that can be measured



**Figure G**  
**Sine wave, undistorted**  
 Fundamental content 100%  
 Harmonic content 0%  
 $A_{rms} = 1.1107 | \bar{A} |$



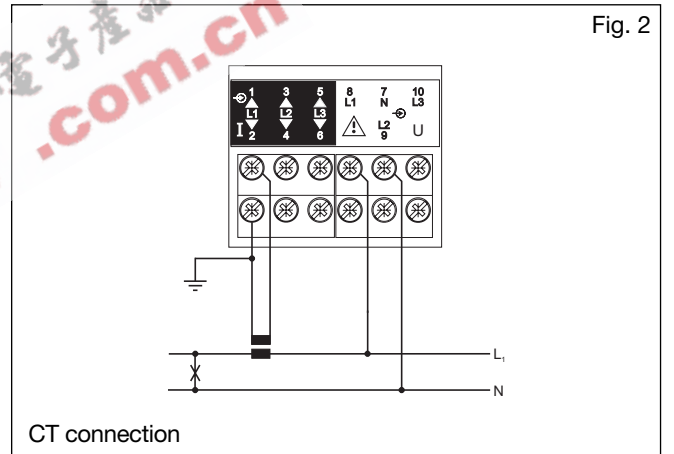
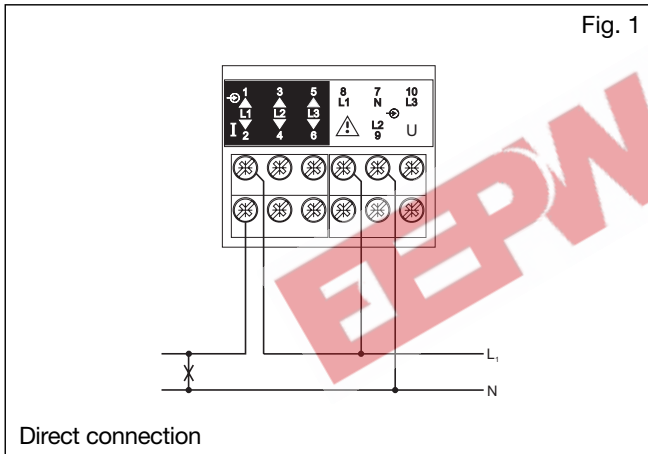
**Figure H**  
**Sine wave, indented**  
 Fundamental content 10...100%  
 Harmonic content 0...90%  
 Frequency spectrum 3rd to 16th harmonic  
 Required result: additional error < 1%



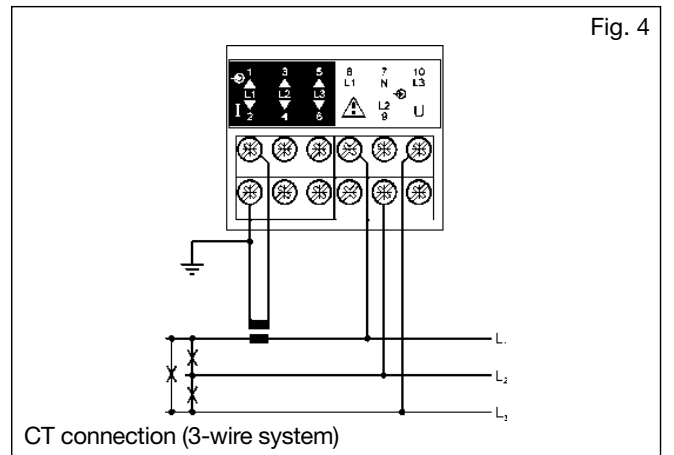
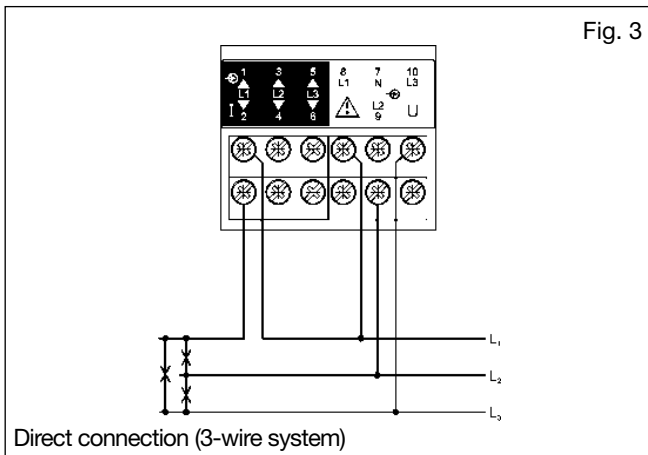
**Figure I**  
**Sine wave, distorted**  
 Fundamental content 70...90%  
 Harmonic content 10...30%  
 Frequency spectrum 3rd to 15th harmonic  
 Required result: additional error < 0.5%

## Wiring Diagrams

Single phase input connections

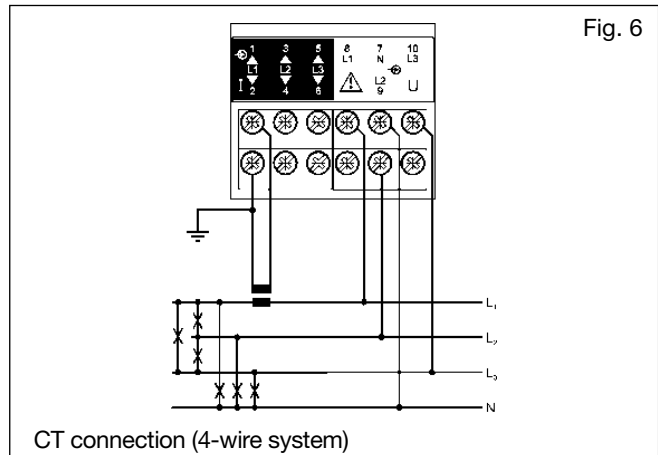
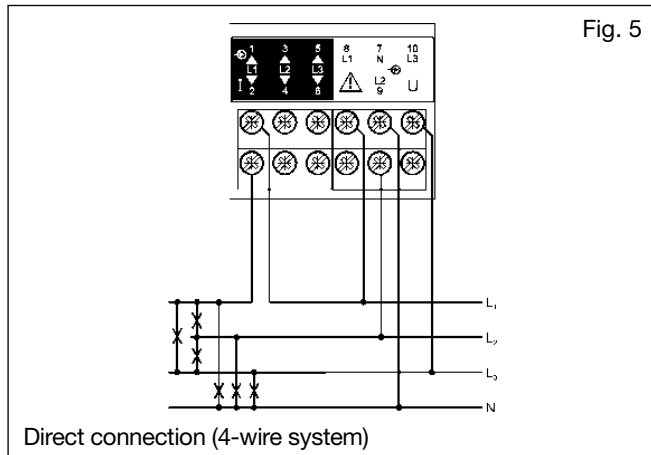


Three phase 3-wire input connections - Balanced loads

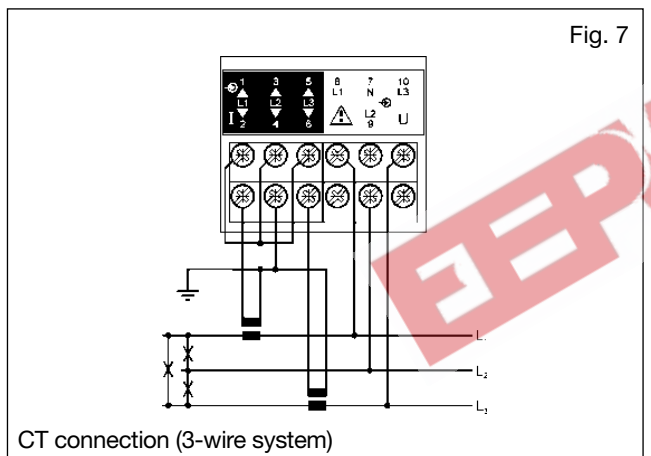


## Wiring Diagrams (cont.)

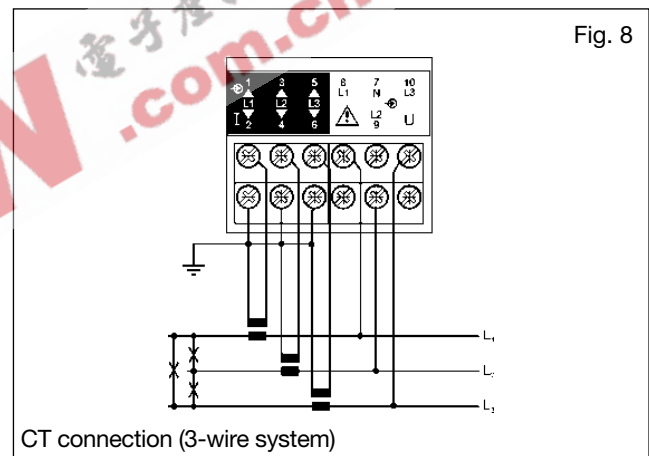
### Three phase, 4-wire input connections - Balanced loads



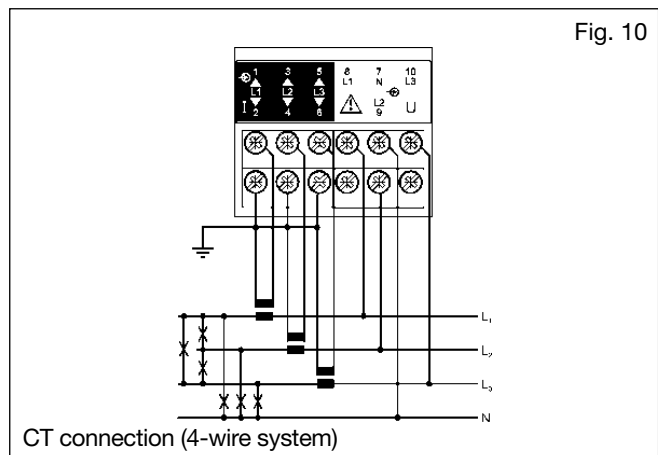
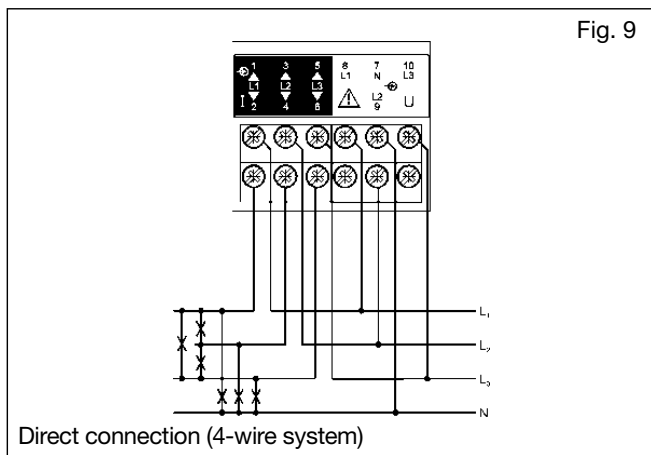
### Three-phase, 3-wire input ARON connections - Unbalanced load



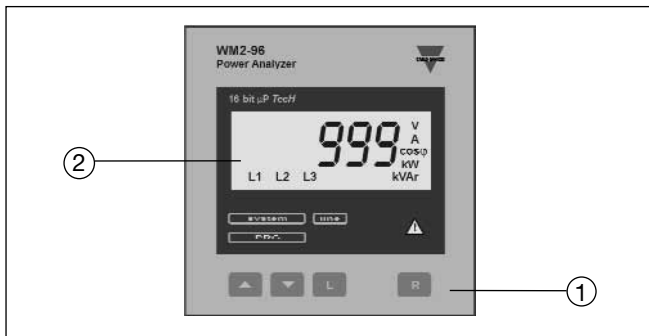
### Three-phase, 3-wire input connections - Unbalanced load



### Three phase, 4-wire input connections - Unbalanced load



## Front Panel Description



- To enter into the programming procedure and select programming functions together with the "L" key.
- "L": To scroll all the single phase variable of each basic measurement
- "R": To reset the partial counted energies (kWh, kVArh).

### 2. Display

- Instantaneous measurements:
- 3-digit (maximum read-out 999)
- Energies:
- 6-digit (maximum read-out 999999).

Alphanumeric indication by means of LCD display for:

- Displaying the configuration parameters
- All the measured variables.

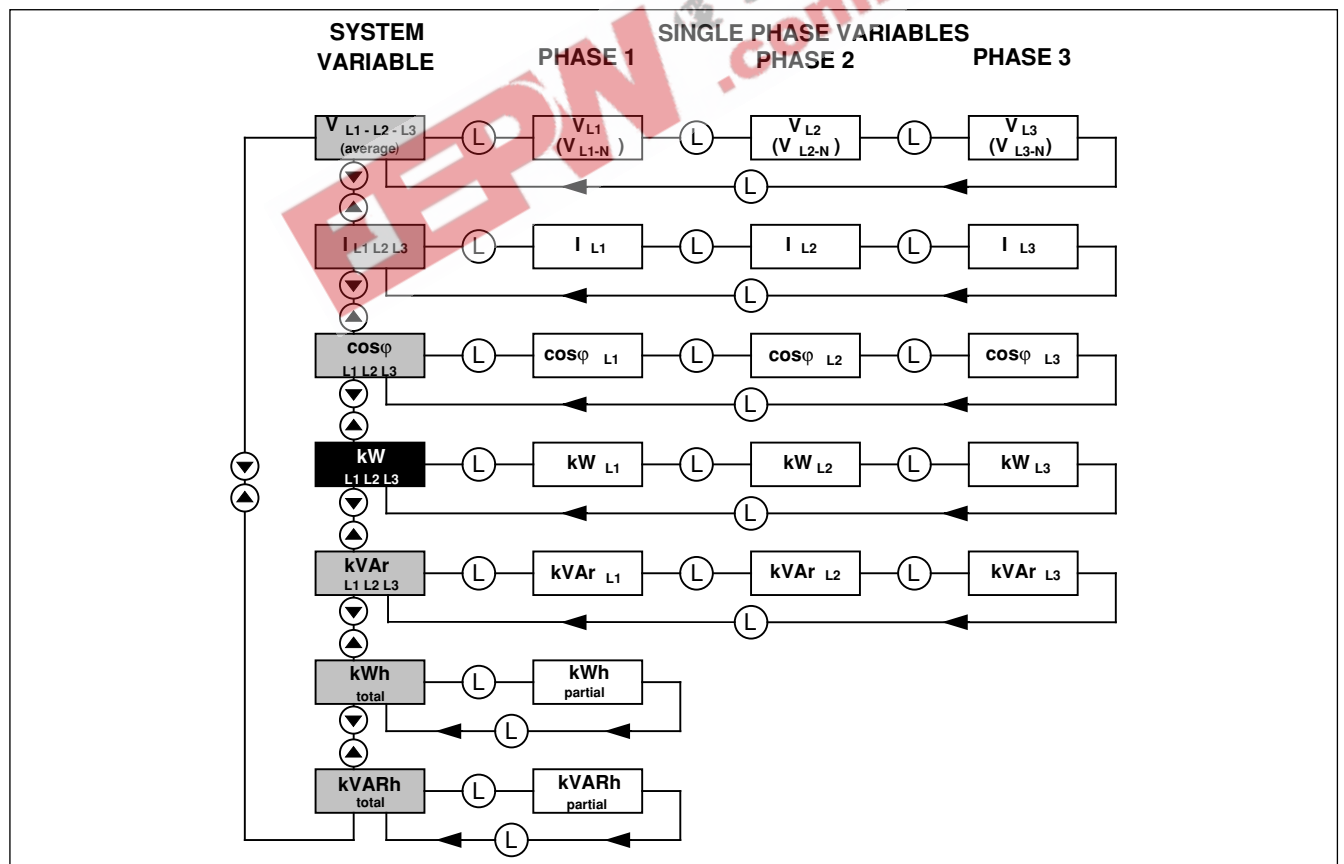
### 1. Key-pad

Set-up and programming procedures are easily controlled by the 4 pushbuttons.

▲ and ▼

- To scroll all the basic measurements (system variables)
- To increase or decrease programming values

## Sequence of the variables on the display



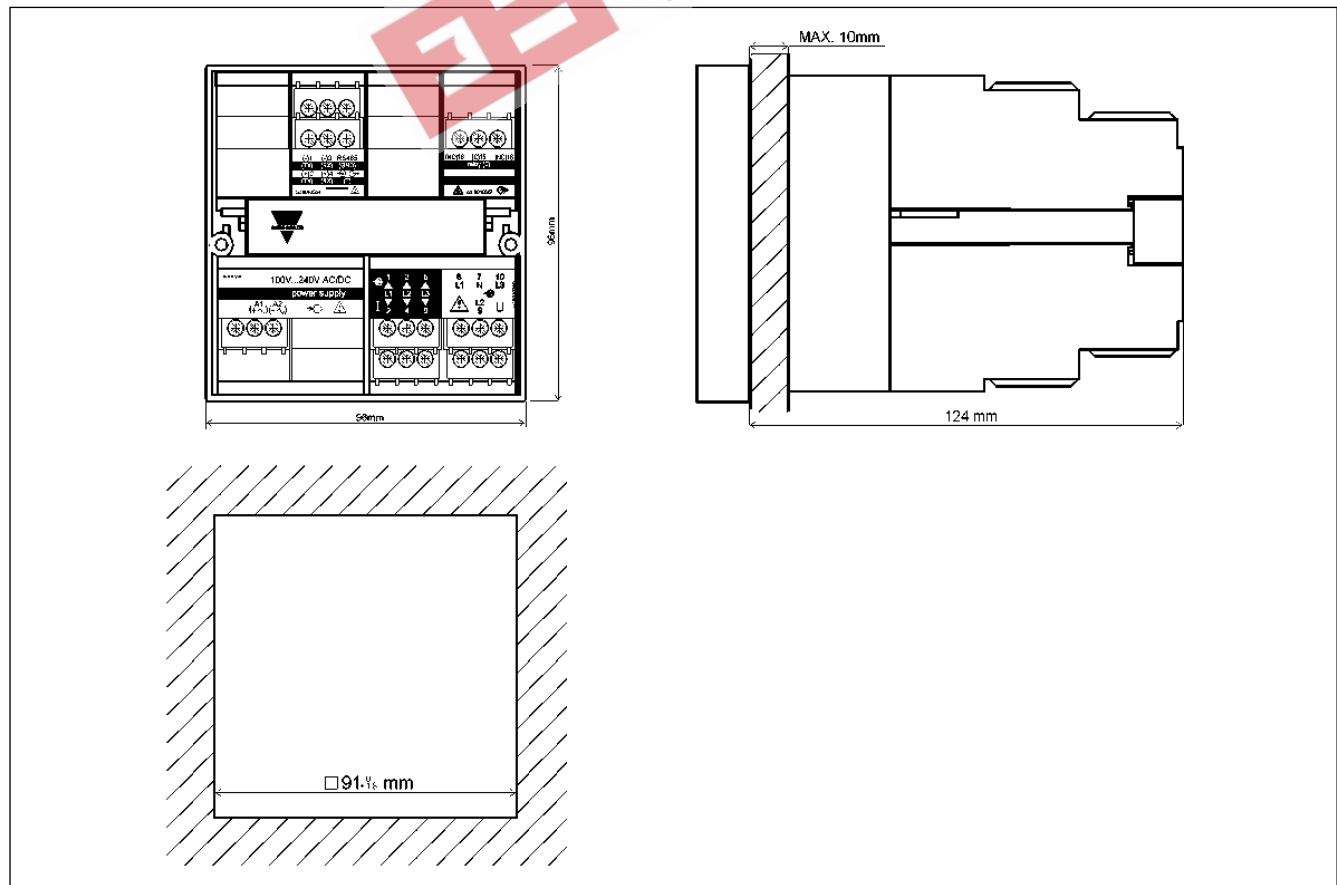
## The available modules

Type	N. of channels	Ordering code	Note
WM2-96 base + AV5.3 input		AB1012	
WM2-96 base + AV7.3 input		AB1013	
24VAC power supply		AP1025	Neither UL nor CSA approved
48VAC power supply		AP1024	Neither UL nor CSA approved
115VAC power supply		AP1023	Neither UL nor CSA approved
230VAC power supply		AP1022	Neither UL nor CSA approved
18-60VAC/DC power supply		AP1021	
90-260VAC/DC power supply		AP1020	
RS485 port	1	AR1034	
Relay output	1	AO1058	
Relay output	2	AO1035	The second output can be used as redundant output
Open collector output	1	AO1059	
Open collector output	2	AO1036	The second output can be used as redundant output

## The possible module combinations

Slot	B	D	Slot	B	D
Basic unit	Out 1	Out 2	Basic unit	Out 1	Out 2
RS485 port	●		RS485 port	●	
Single relay output (pulse)		●	Dual relay output (pulse)		●
Single open collector output (pulse)		●	Dual open collector output (pulse)		●

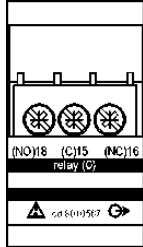
## Dimensions



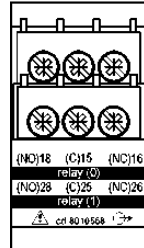


## Terminal boards

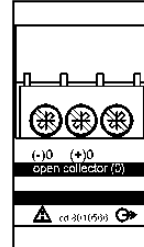
### Digital output modules



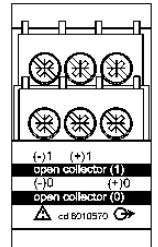
**AO1058**  
Single relay output



**AO1035**  
Dual relay output

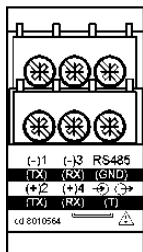


**AO1059**  
Single open collector output



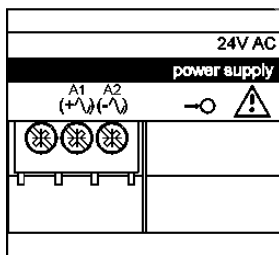
**AO1036**  
Dual open collector output

### Other input/output modules

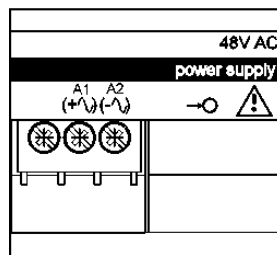


**AR1034**  
RS485 port

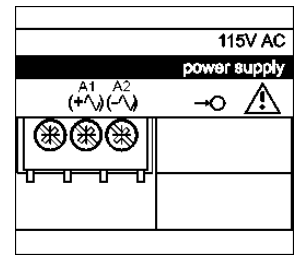
### Power supply modules



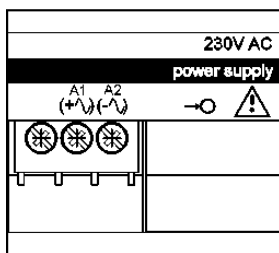
**AP1025**  
24VAC power supply



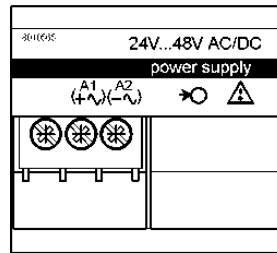
**AP1024**  
48VAC power supply



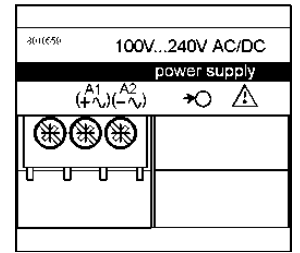
**AP1023**  
115VAC power supply



**AP1022**  
230VAC power supply



**AP1021**  
18-60VAC/DC power supply



**AP1020**  
90-260 VAC/DC power supply