

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 μ 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

μ 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

Ordering Key WM2-96 AV53DXXX

Model _____
Range code _____
System _____
Power supply _____
1st output _____
2nd output _____

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

¹⁾ On request

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

³⁾ Compatible with any kind of output

Input Specifications

Accuracy (48 to 62 Hz)	Un: 250V (AV5), 400V (AV7) In: 5A	Rated input	
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)	Temperature drift	± 250 ppm/ $^{\circ}$ C
Energy (@ 25°C \pm 5°C, R.H. \leq 60%)	$\pm 1\%$ RDG (kWh), $\pm 2\%$ RDG (kvarh), (PF \geq 0.7 L/C, 0 to 1.2 In, 0.5 to 1.2 Un)	Display	Backlighted LCD, h 13mm, 3-dgt (instantaneous meas.) 6-dgt (energies)
Additional errors			
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.)

Decimal point position	Instantaneous measurements: Automatic selection according to the current transformer ratio of the CT being connected (max. indication - single phase): CT ratio ≤ 5 : 11.11 (25.00A) CT ratio ≤ 50.0 : 111.1 (250.0A) CT ratio ≤ 500.0 : 1111 (2500A) CT ratio ≤ 999.9 : 11110 (6000A) Energy measurements: max. resolution: 1 Wh/1 VARh min. resolution: 1 kWh/1 kVARh		Coupling type: Direct Crest factor: ≥ 3
Max. and min. indication	Voltage Current (CT ratio = 1) PF Power (CT ratio = 1) Active energy Reactive energy		Ranges (impedances) 250 V/433 V ($\geq 400\text{k}\Omega$) 5 AAC ($\leq 0.3\text{ VA} / \leq 0.1\Omega$) 400V/690V ($\geq 650\text{k}\Omega$) Frequency range 48 to 62 Hz Over-load protection Un: 250V (AV5), 400V (AV7) In: 5A 1.2 Un /In Continuous: voltage/current For 1 s Voltage: Current: 2 Un 20 In Keyboard 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.
Sampling rate	3 times / second		
Measurements	System variables Total energies Partial energies Single phase variables Measurement method		
	kW, kVAR, PF, VL-L, A, kWh, kvarh kWh, kvarh (the meters are reset automatically when the values reach 14999*CT ratio) kW, kVAR, PF, VL-N, A TRMS measurement of a distorted voltage/current wave		

Output Specifications

Pulse output (on request)	Protocol		MODBUS/JBUS
Number of outputs	1, independent		
Static type (according to DIN 43864)	From 0.1 to 999.9 programmable pulses for kWh, KVARh, open collector (NPN transistor) VON 1.2 VDC/ max. 100 mA VOFF 30 VDC max. 1 x SPDT AC 1 - 8A, 250VAC DC 12 - 5A, 24VDC AC 15 - 2.5A, 250VAC DC 13 - 2.5A, 24VDC		
Relay type	200 ms (ON), ≥ 200 ms (OFF) By means of optocouplers, 4000 Vrms output to measuring input, 4000 Vrms output to supply input.		
Pulse duration	Data (bidirectional)		
Insulation	Dynamic (reading only)		System variables: P, Q, PF, VL-L, energies, Single phase variables: PL1, QL1, PFL1, VL1-N, AL1, PL2, QL2, PFL2, VL2-N, AL2, PL3, QL3, PFL3, VL3-N, AL3 All programming data, reset of energy: - partial kWh - partial kVARh - total kWh - total kVARh Stored energy (EEPROM) ≤ 999999 kWh ≤ 999999 kVARh 1-start bit, 8-data bit, no parity/even parity, 1 stop bit 1200, 2400, 4800 and 9600 selectable bauds By means of optocouplers, 4000 Vrms output to measuring inputs 4000 Vrms output to supply input
Serial port (on request)	Static (writing only)		
Type	Data format		
Connections	Baud-rate		
Addresses	Insulation		
	RS422/RS485; Multidrop bidirectional (static and dynamic variables) 4 wires, max. distance 1200m, termination directly on the module 1 to 255, selectable by key-pad		

Software Functions

Password	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 kVAh. Active power (kW), reactive power (kVAh), power factor (cos φ), current (A), phase-neutral voltage (V)
Measurement scrolling	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).	Transformer ratio Programmable ratio Digital Filter Filter operating range Filtering coefficient Filter action	For CT up to 5000 A 0.1 to 999.9 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.

Supply Specifications

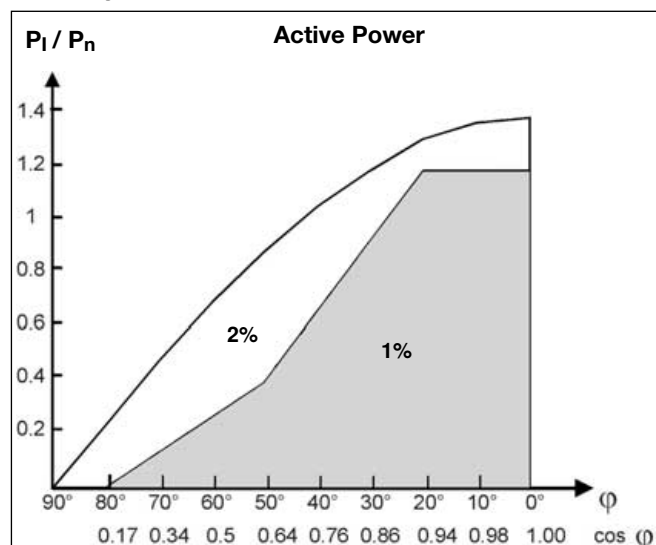
AC voltage	230 VAC (standard), -15%+10% 50/60 Hz 24 VAC, 48 VAC, 115 VAC (on request), -15%+10% 50/60 Hz 18 to 60VDC/AC	Power consumption	90 to 260VDC/AC ≤ 30VA / 12W (90 to 260V) ≤ 20VA / 12W (18 to 60V)
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General Specifications

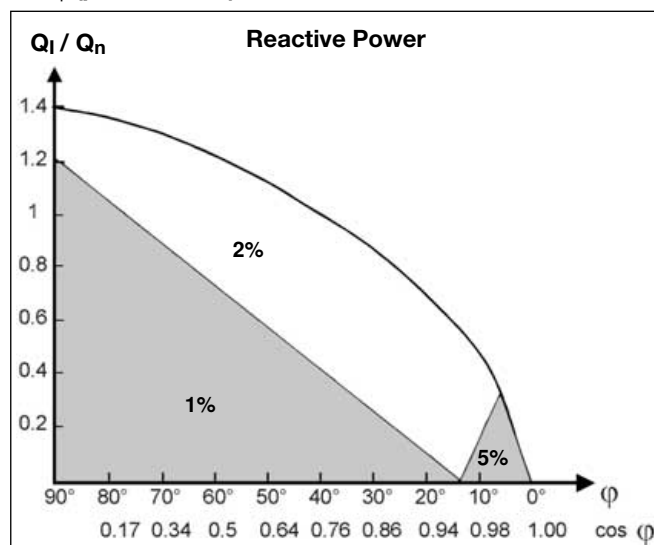
Operating temperature	0° to +50°C (32° to 122°F) (R.H. < 90% non-condensing)	Safety standards	IEC 61010-1, EN 61010-1
Storage temperature	-10° to +60°C (14° to 140°F) (R.H. < 90% non-condensing)	Other standards	Pulse output: DIN43864
Insulation reference voltage	300 Vrms to ground	Approvals	CE UL, CSA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

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

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

$$Q_n = 3 \cdot U_I \cdot I_I \cdot \sin \varphi \\ = 3 \cdot 230 \cdot 110 \cdot 0.52 \\ = 39.46 \text{ kvar}$$

$$Q_n = 3 \cdot U_n \cdot I_n \cdot CT \text{ (ratio)} \\ = 3 \cdot 250 \cdot 5 \cdot 60 \\ = 225 \text{ kvar}$$

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

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 ($\sin \varphi 0.52$).

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 (ratio) = the value of the current transformer ratio.

Mode of Operation (cont.)

Waveform of the signals that can be measured

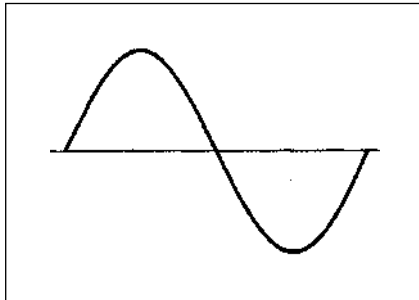


Figure G

Sine wave, undistorted

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

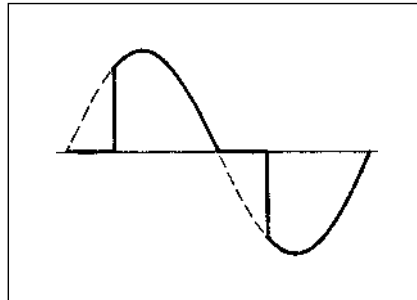


Figure H

Sine wave, indented

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

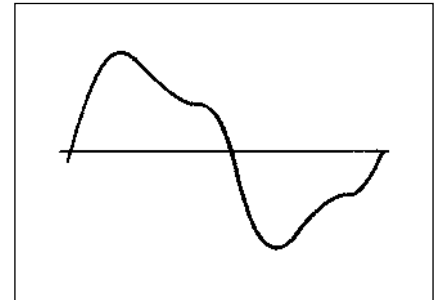


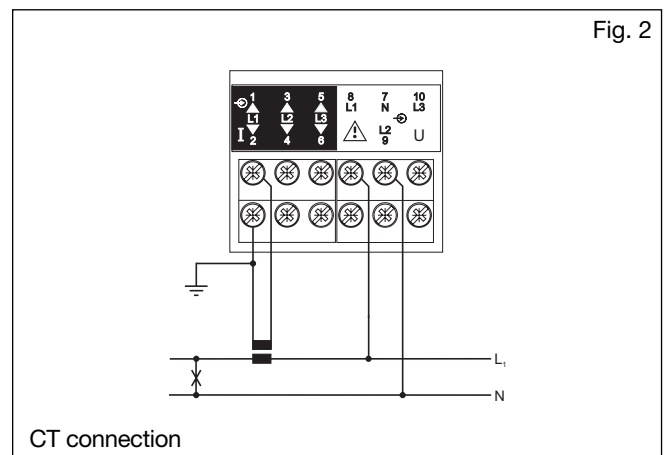
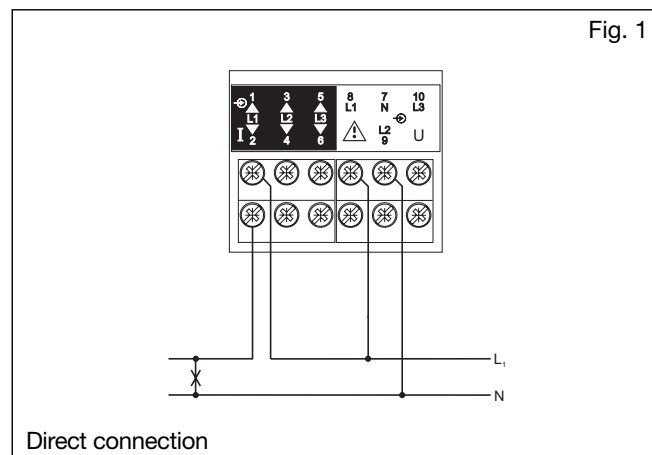
Figure I

Sine wave, distorted

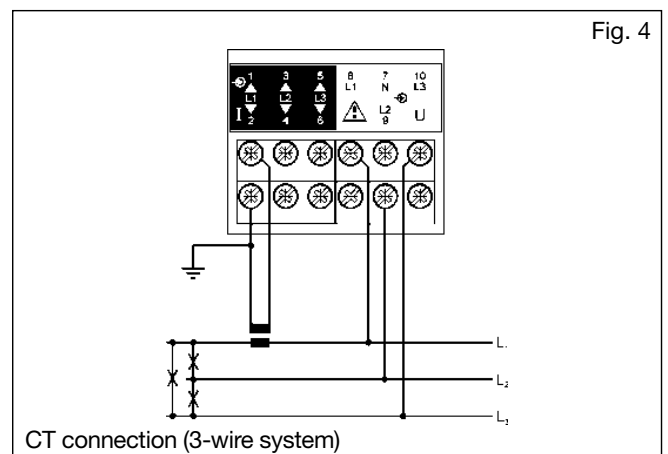
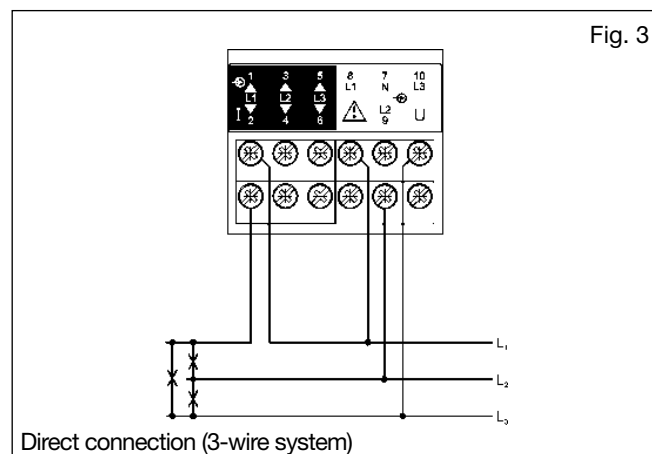
Fundamental content 70...90%
Harmonic content 10...30%
Frequency spectrum 3rd to 15th harmonic
Required result: additional error < 0.5%

Wiring Diagrams

Single phase input connections

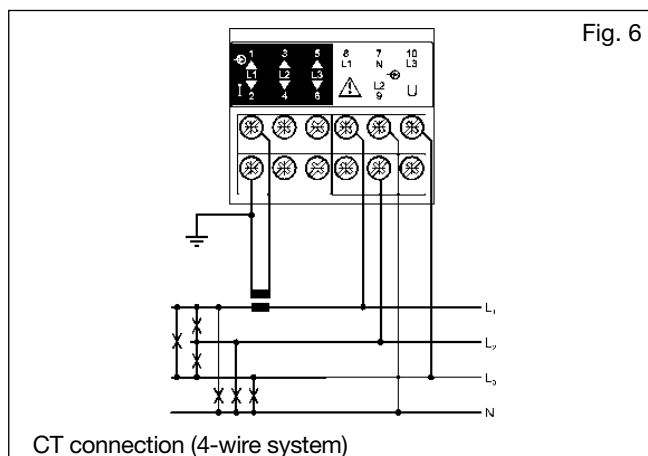
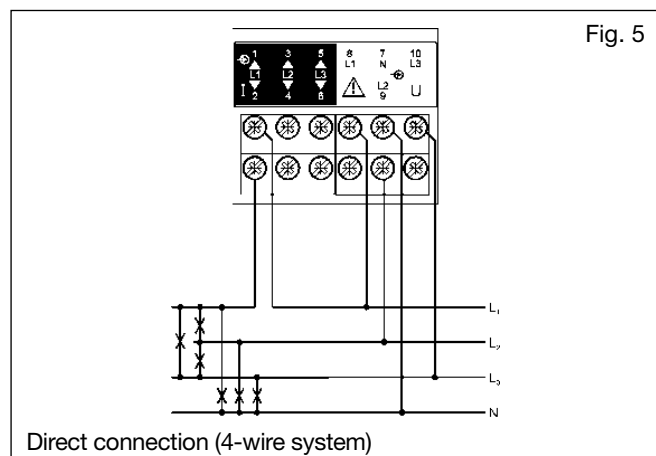


Three phase 3-wire input connections - Balanced loads

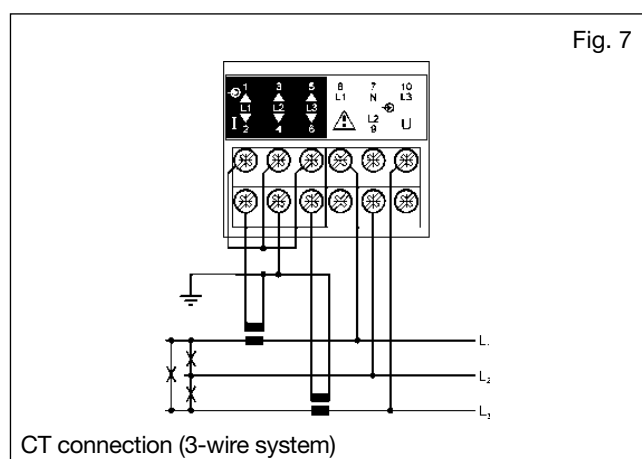


Wiring Diagrams (cont.)

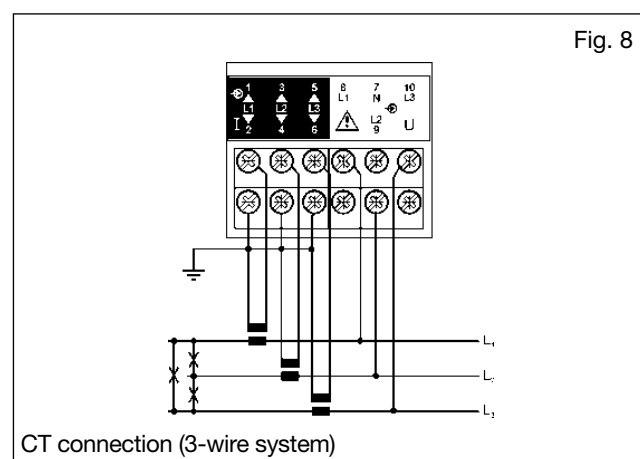
Three phase, 4-wire input connections - Balanced loads



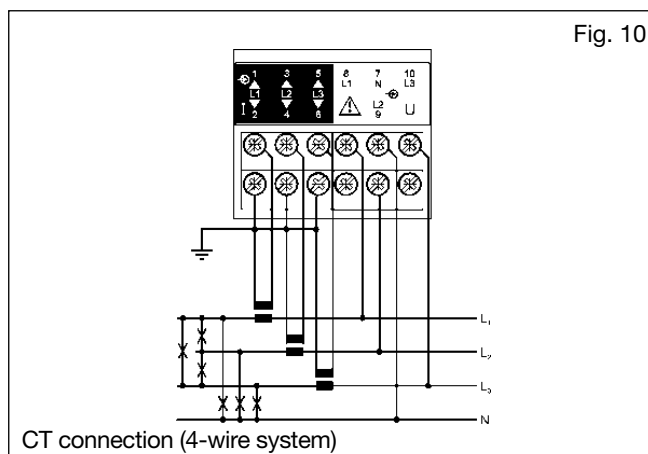
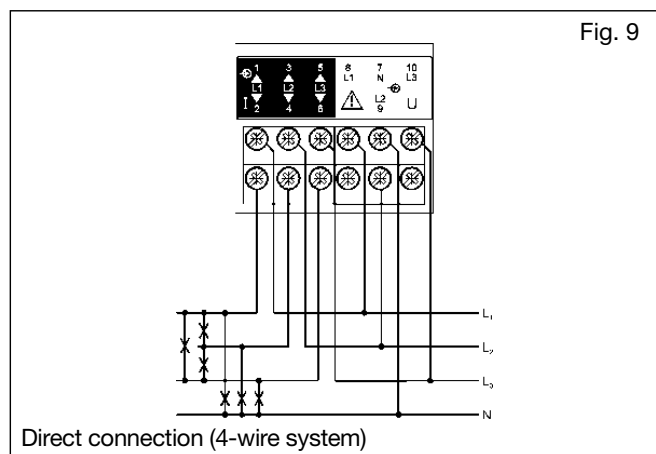
Three-phase, 3-wire input ARON connections - Unbalanced load



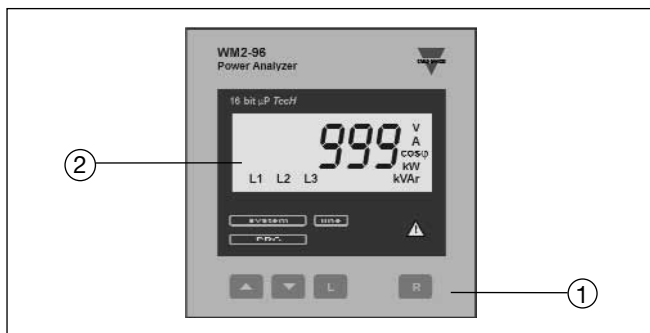
Three-phase, 3-wire input connections - Unbalanced load



Three phase, 4-wire input connections - Unbalanced load



Front Panel Description



1. Key-pad

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



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

- 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)

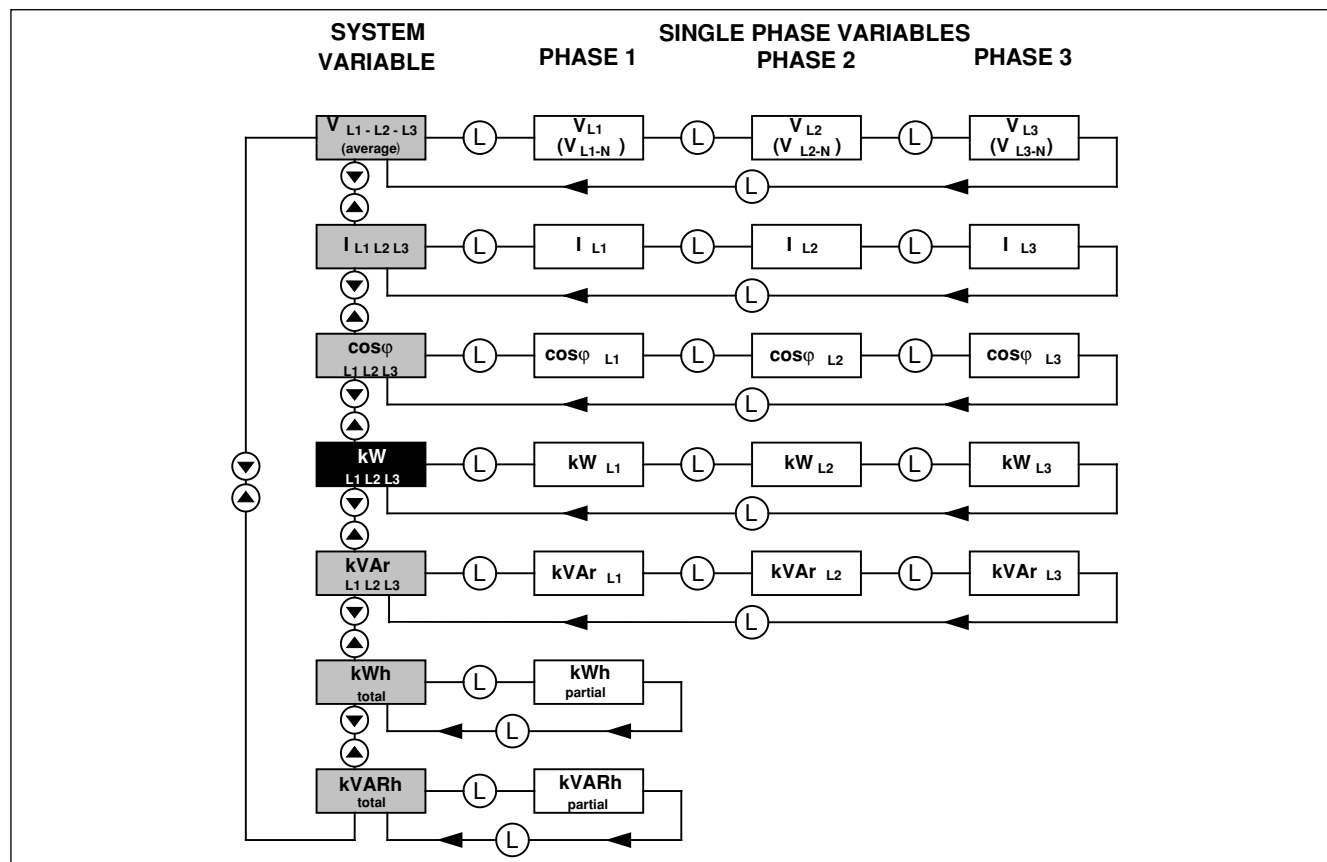
Energies:

- 6-digit (maximum read-out 999999).

Alphanumeric indication by means of LCD display for:

- Displaying the configuration parameters
- All the measured variables.

Sequence of the variables on the display



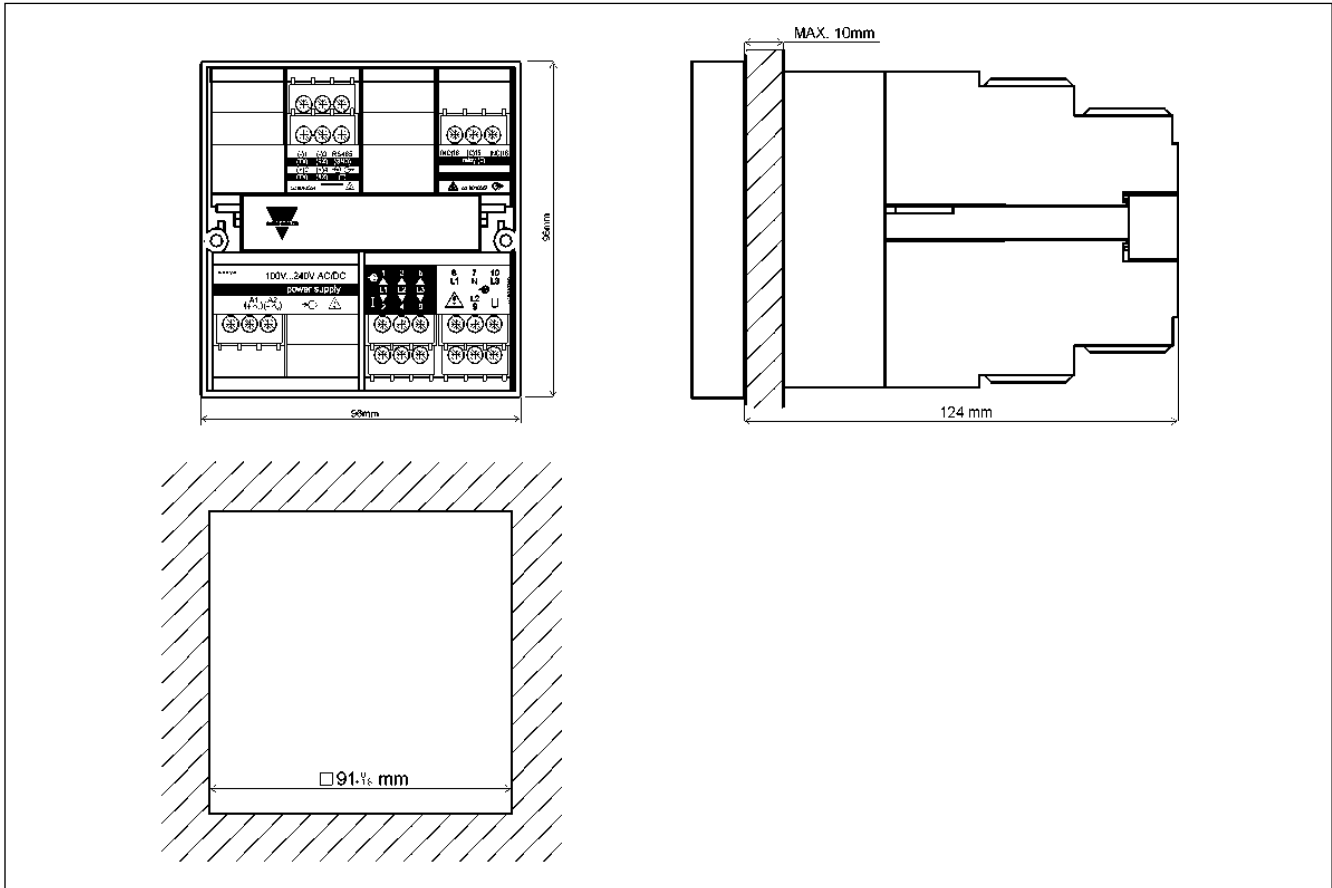
The available modules

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 redondant output
Open collector output	1	AO1059	
Open collector output	2	AO1036	The second output can be used as redondant output

The possible module combinations

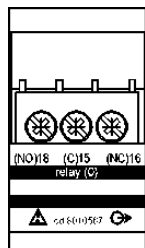
Slot	B	D	Slot	B	D
Basic unit	Out 1	Out 2	Basic unit	Out 1	Out 2
RS485 port	●		RS485 port	●	
Single relay output (pulse)		●	Dual relay output (pulse)		●
Single open collector output (pulse)		●	Dual open collector output (pulse)		●

Dimensions

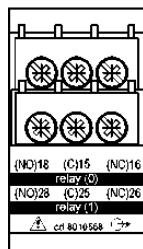


Terminal boards

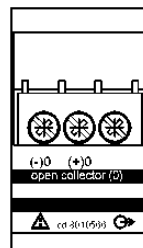
Digital output modules



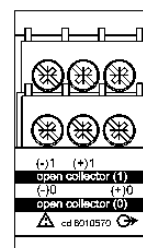
AO1058
Single relay output



AO1035
Dual relay output

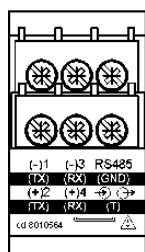


AO1059
Single open collector output



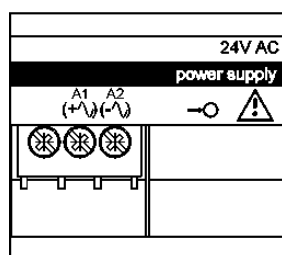
AO1036
Dual open collector output

Other input/output modules

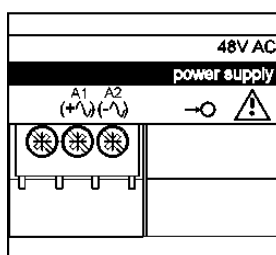


AR1034
RS485 port

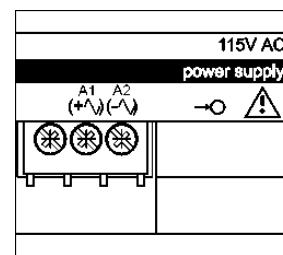
Power supply modules



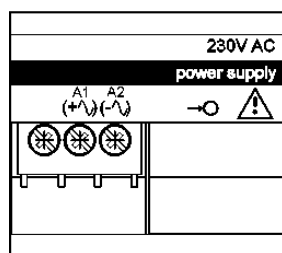
AP1025
24VAC power supply



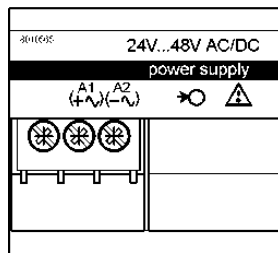
AP1024
48VAC power supply



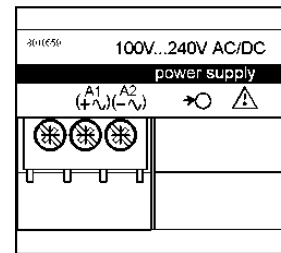
AP1023
115VAC power supply



AP1022
230VAC power supply



AP1021
18-60VAC/DC power supply



AP1020
90-260 VAC/DC power supply