

# Energy Management Modular Smart Power Quality Analyzer Type WM3-96

CARLO GAVAZZI



- Display refresh time: 100 msec @ 50 Hz
- Harmonic distortion analysis (FFT) up to 50th harmonic with both graph and numerical indication (of current and voltage)
- Harmonics source detection
- Optional RS232 + real time clock function with data logging of alarm and MIN/MAX events, monthly energy metering recording

- Class 0.5 (current/voltage)
- 32-bit  $\mu$ P-based modular smart power quality analyzer
- Graph display (128x64 dots)
- Front size: 96x96 mm
- Measurements of single phase and system variables: W, Wdmd, var, VA, VAdmd, PF, PFavg, V, A, An dmd (for all of them max. and min. values). Energies: kWh and kvarh on 4 quadrants.
- Neutral current measurement
- TRMS measurement of distorted waves (voltage/current)
- Current and voltage inputs with autoranging capability
- 4x4-dgt instantaneous variable read-out
- 4x9-dgt total energies read-out
- 4x6-dgt partial energies read-out
- 48 independent energy meters to be used as single, dual, multi-time energy management

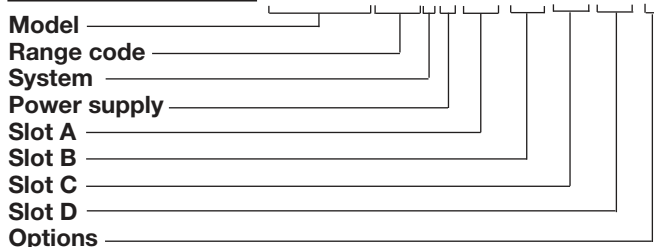
- Degree of protection (front): IP 65
- Up to 4 optional alarm setpoints
- Up to 4 optional pulse outputs
- Up to 4 optional analogue outputs
- Optional serial RS 422/485 output
- Universal power supply: 18 to 60VAC/DC - 90 to 260 VAC/DC
- MODBUS RTU, JBUS, (N2 METASYS protocols on request)

## Product Description

32-bit  $\mu$ P-based smart power quality analyzer with a built-in configuration key-pad. The housing is for panel mounting and ensures a degree of protection (front) of IP 65. The instrument is par-

ticularly indicated for those application where there is the need to control the power supply quality. The variables being displayed are more than 400.

## Ordering Key WM3-96AV53H XX XX XX XX X



## Type Selection

Range code	Slot A (signal retransmission)	Slot B (signal retransmission)	Slot C (alarm or pulse out)
<b>AV5:</b> 240/415 VAC - 1/5 AAC (max. 300 V (L-N)/ 520 V (L-L) - 6 A) (standard)	<b>XX:</b> None	<b>XX:</b> None	<b>XX:</b> None
<b>AV7:</b> 400/690VAC - 1/5 AAC (max. 480V (L-N) / 830 V (L-L) / 6 A <sup>1)</sup> )	<b>A1:</b> Single analogue output, 20mADC (standard)	<b>B1:</b> Dual analogue output, 20mADC (standard)	<b>R1:</b> Single relay output, (AC1-8AAC, 250VAC) <sup>1)</sup>
<b>System</b>	<b>A2:</b> Single analogue output, $\pm 5$ mADC <sup>1)</sup>	<b>B2:</b> Dual analogue output, $\pm 5$ mADC <sup>1)</sup>	<b>R2:</b> Dual relay output, (AC1-8AAC, 250VAC) <sup>1)</sup>
<b>3:</b> One phase, three-phase system (3 or 4 wires, balanced load)	<b>A3:</b> Single analogue output, $\pm 10$ mADC <sup>1)</sup>	<b>B3:</b> Dual analogue output, $\pm 10$ mADC <sup>1)</sup>	<b>O1:</b> Single open collector output (30V/100mADC) <sup>1)</sup>
Three phase system (3 or 4 wires, unbalanced load)	<b>A4:</b> Single analogue output, $\pm 20$ mADC <sup>1)</sup>	<b>B4:</b> Dual analogue output, $\pm 20$ mADC <sup>1)</sup>	<b>O2:</b> Dual open collector output (30V/100mADC) <sup>1)</sup>
<b>Power supply</b>	<b>B1:</b> Dual analogue output, 20mADC (standard)	<b>W1:</b> Dual analogue output, 10VDC (standard)	<b>D1:</b> 3 digital inputs <sup>1)</sup>
<b>L:</b> 18 to 60VAC/DC <sup>1)</sup>	<b>B2:</b> Dual analogue output, $\pm 5$ mADC <sup>1)</sup>	<b>W2:</b> Dual analogue output, $\pm 1$ VDC <sup>1)</sup>	<b>Slot D (alarm or pulse out)</b>
<b>H:</b> 90 to 260VAC/DC	<b>B3:</b> Dual analogue output, $\pm 10$ mADC <sup>1)</sup>	<b>W3:</b> Dual analogue output, $\pm 5$ VDC <sup>1)</sup>	<b>XX:</b> None
<sup>1)</sup> On request	<b>B4:</b> Dual analogue output, $\pm 20$ mADC <sup>1)</sup>	<b>W4:</b> Dual analogue output, $\pm 10$ VDC <sup>1)</sup>	<b>R2:</b> Dual relay output, (AC1-8AAC, 250VAC) <sup>1)</sup>
	<b>V1:</b> Single analogue output, 10VDC (standard)	<b>S1:</b> Serial port, RS485 multidrop, bidirectional <sup>1)</sup>	<b>O2:</b> Dual open collector output (30V/100mADC) <sup>1)</sup>
	<b>V2:</b> Single analogue output, $\pm 1$ VDC <sup>1)</sup>	<b>Note:</b>	<b>O4:</b> 4 open collector outputs (30V/100mADC) <sup>1)</sup>
	<b>V3:</b> Single analogue output, $\pm 5$ VDC <sup>1)</sup>	Slot A + Slot B Max 4 analogue outputs	<b>Options</b>
	<b>V4:</b> Single analogue output, $\pm 10$ VDC <sup>1)</sup>	Slot C + Slot D max 4 digital outputs	<b>X:</b> None
	<b>W1:</b> Dual analogue output, 10VDC (standard)		<b>S:</b> Serial RS232 + RTC
	<b>W2:</b> Dual analogue output, $\pm 1$ VDC <sup>1)</sup>		<b>N:</b> With N2 Metasys protocol
	<b>W3:</b> Dual analogue output, $\pm 5$ VDC <sup>1)</sup>		<b>C:</b> options: S+N
	<b>W4:</b> Dual analogue output, $\pm 10$ VDC <sup>1)</sup>		

## Input Specifications

<b>Number of inputs</b>			Magnetic field	≤ 0.5%RDG, @ 400 A/m
Current	2 (system: single phase) 6 (system: 3-phase)		<b>Temperature drift</b>	≤ 200ppm/°C
Voltage	2 (system: single phase) 4 (system: 3-phase)		<b>Sampling rate</b>	6400 samples/s @ 50Hz
Digital	3 free of voltage contacts for Wdmd, VAdmd, An dmd, PFavg synchronization Reading voltage/current: 17.5 to 25VDC/<8mA		<b>Display</b>	Graph LCD, 128x64pixel, back-lighted. Selectable read-out for the instantaneous variables: 4x4-dgt or 4x3 <sup>1/2</sup> -dgt Total Energies: 4x9-dgt; Partial: 4x6-dgt
<b>Accuracy</b> (display, RS232, RS485)	In: 5A, If.s.: 6A, start-up I: 15mA		<b>Max. and min. indication</b>	Max. 9999 (999,999,999), Min. -9999 (-999,999,999)
Current (A <sub>L1</sub> , A <sub>L2</sub> , A <sub>L3</sub> )	±0.5% RDG (0.2 to 1.2 In) ±5mA (0.02 to 0.2 In)		<b>Measurements</b>	Current, voltage, power, energy, harmonic distortion (see "Display pages" table). TRMS measurement of a distorted wave (voltage/current). Coupling type: Direct Crest factor: ≤3 (max. 15Ap/500Vp (V L-N) or 15Ap/800Vp (V L-N))
Current (A <sub>r</sub> )	±1% RDG (0.2 to 1.2 In) @ 40 to 100 Hz		<b>Ranges (impedances)</b>	
Voltage	AV5 range: ±0.5% RDG (48 to 300 V <sub>L-N</sub> ) ±1% RDG (84 to 519 V <sub>L-L</sub> ) AV7 range: ±0.5% RDG (80 to 480 V <sub>L-N</sub> ) ±1% RDG (139 to 830 V <sub>L-L</sub> ) includes also: frequency, power supply and output load influences		AV5	58/100 V (>500 kΩ) - 1 AAC (≤ 0.3 VA) 58/100 V (>500 kΩ) - 5 AAC (≤ 0.3 VA) 240/415 V (>500 kΩ) - 1 AAC (≤ 0.3 VA) 240/415 V (>500 kΩ) - 5 AAC (≤ 0.3 VA)
Frequency	±0.1% RDG (40 to 440 Hz)		AV7	100/170 V (>500 kΩ) 1 AAC (≤ 0.3 VA) 100/170 V (>500 kΩ) - 5 AAC (≤ 0.3 VA) 400/690 V (>500 kΩ) - 1 AAC (≤ 0.3 VA) 400/690 V (>500 kΩ) - 5 AAC (≤ 0.3 VA)
Active power (@ 25°C ± 5°C, R.H. ≤ 60%)	±0.5% (RDG + FS) (PF 0.5 L/C, 0.1 to 1.2 In, AV5 range) or ±1% RDG (PF 0.5 L/C, 0.1 to 1.2 In, AV5 range)		<b>Frequency range</b>	40 to 440 Hz
Reactive power (@ 25°C ± 5°C, R.H. ≤ 60%)	±0.5% (RDG + FS) (PF 0.5 L/C, 0.1 to 1.2 In, AV5 range) or ±1% RDG (PF 0.5 L/C, 0.1 to 1.2 In, AV5 range)		<b>Over-load protection</b>	
Apparent power (@ 25°C ± 5°C, R.H. ≤ 60%)	±0.5% (RDG + FS) (0.1 to 1.2 In, AV5 range) or ±1% RDG (0.1 to 1.2 In, AV5 range)		Continuous: voltage/current	AV5: 300 V <sub>LN</sub> /520 V <sub>LL</sub> /6A AV7: 480 V <sub>LN</sub> /830 V <sub>LL</sub> /6A
Energies (@ 25°C ± 5°C, R.H. ≤ 60%)	Active: class 1 according to EN61036 Reactive: class 2 according to EN61268 Ib: 5A, I <sub>max</sub> : 6A 0.1Ib: 500mA Start up current: 20mA Un: 240V (AV5), 400V (AV7) 1% FS (FS: 100%) phase: ±2°; I <sub>min</sub> : 0.1Arms; I <sub>max</sub> : 15Ap; U <sub>min</sub> : 50Vrms; U <sub>max</sub> : 500Vp Sampling frequency 6400 samples/s @ 50Hz		For 1 s	AV5 600 V <sub>LN</sub> /1040 V <sub>LL</sub> /120A AV7 960 V <sub>LN</sub> /1660 V <sub>LL</sub> /120A
Harmonic distortion (@ 25°C ± 5°C, R.H. ≤ 60%)			<b>Keypad</b>	4 keys: "S" for enter programming phase and password confirmation, "UP" and "DOWN" for value programming/function selection, page scrolling "F" for special functions
<b>Additional errors</b>				
Humidity	≤ 0.3%RDG, 60% to 90% R.H.			
Input frequency	≤ 0.4%RDG, 62 to 400 Hz			

## Output Specifications

### Analogue outputs (on request)

Number of outputs	Up to 4 (on request)	0 to ±10 mADC,
Accuracy	±0.2% FS (@ 25°C ± 5°C, R.H. ≤ 60%)	0 to ±5 mADC 0 to 10 VDC, 0 to ±10 VDC 0 to ±5 VDC 0 to ±1 VDC
Range	0 to 20 mADC, 0 to ±20 mADC	

## Output Specifications (cont.)

Scaling factor	Programmable within the whole range of retransmission; it allows the retransmission management of all values from: 0 to 20 mADC, 0 to ±20 mADC 0 to ±10 mADC, 0 to ±5 mADC 0 to 10 VDC, 0 to ±10 VDC 0 to ±5 VDC 0 to ±1 VDC	Connections Data format  Baud-rate Protocol Other data	3 wires, max. distance 15m, 1-start bit, 8-data bit, no parity, 1-stop bit 9600 bauds MODBUS (JBUS) as for RS422/485
Variables to be retransmitted	All (see table "List of the variables that can be connected to:...")	<b>Digital outputs (on request)</b>	Up to 4 outputs (combination of alarms and pulse outputs) The working of the outputs: pulse or alarm or both of them is fully programmable and is independent from the chosen output module. Outputs remotely controlled by the serial communication port
Response time	≤ 200 ms typical (filter excluded, FFT excluded 3 1/2 dgt indication)	<b>Pulse outputs (on request)</b>	
Ripple	≤ 1% according to IEC 60688-1 and EN 60688-1	Number of outputs Type	Up to 4, independent From 1 to 1000 programmable pulses for K-M-G Wh, K-M-G varh, open collector (NPN transistor) V <sub>ON</sub> 1.2 VDC/ max. 100 mA V <sub>OFF</sub> 30 VDC max. Outputs connectable to total and partial energy meters
Temperature drift	200 ppm/°C	Pulse duration	220 ms (ON), ≥ 220 ms (OFF)
Load:		Insulation	According to DIN43864 By means of optocouplers, 4000 V <sub>rms</sub> output to measuring input, 4000 V <sub>rms</sub> output to supply input.
20 mA output	≤ 600 Ω	Note	The outputs can be either open collector type or relay type (for this latter one see the characteristics mentioned in the ALARMS).
±20 mA output	≤ 550 Ω		
±10 mA output	≤ 1100 Ω		
± 5 mA output	≤ 2200 Ω		
10 V output	≥ 10 kΩ		
±10 V output	≥ 10 kΩ		
± 5 V output	≥ 10 kΩ		
± 1 V output	≥ 10 kΩ		
Insulation	By means of optocouplers, 4000V <sub>RMS</sub> output to measuring input 4000V <sub>RMS</sub> output to supply input		
<b>RS422/RS485 output (on request)</b>	Multidrop bidirectional (static and dynamic variables)	<b>Alarms outputs (on request)</b>	
Connections	4 wires, max. distance 1200m, termination directly on the module	Number of setpoints Alarm type	Up to 4, independent Up alarm, down alarm, up alarm with latch, down alarm with latch, phase asymmetry, phase loss, neutral loss
Addresses	1 to 255, selectable by key-pad	Variables to be controlled	All (see table "List of the variables that can be connected to:...")
Protocol	MODBUS RTU /JBUS, (N2 METASYS on request)	Setpoint adjustment Hysteresis On-time delay Relay status	0 to 100% of the electrical scale 0 to 100% of the electrical scale 0 to 255 s Selectable, Normally de-energized, normally energized
Data (bidirectional)		Output type	Relay, SPDT AC 1-8A, 250VAC DC 12-5A, 24VDC AC 15-2.5A, 250VAC DC 13-2.5A, 24VDC
Dynamic (reading only)	All display variables (see also the table, "List of the variables that can be connected to"...)	Min. response time	≤ 150 ms, filter excluded, FFT excluded, setpoint on-time delay: "0s"
Static (writing only)	All configuration parameters, reset of energy, activation of digital output Stored energy (EEPROM) max. 999.999.999 kWh/kvarh	Insulation	4000 V <sub>RMS</sub> output to measuring input, 4000V <sub>RMS</sub> output to supply input
Data format	1-start bit, 8-data bit, no parity/even parity, odd parity, 1 stop bit	Note	The outputs can be either relay type or open collector type (for this latter one, see the characteristics mentioned in the PULSE OUTPUTS).
Baud-rate	1200, 2400, 4800 and 9600 selectable bauds		
Insulation	By means of optocouplers, 4000 V <sub>RMS</sub> output to measuring inputs 4000 V <sub>RMS</sub> output to supply input		
<b>RS232 output (on request)</b>	Bidirectional (static and dynamic variables)		

## Software Functions

<b>Password</b> 1st level 2nd level	Numeric code of max. 3 digits; 2 protection levels of the programming data Password "0", no protection Password from 1 to 499, all data are protected	<b>Filter action</b>	Display, alarm, analogue and serial outputs (fundamental variables: V, A, W and their derived ones)
<b>Transformer ratio</b>	For CT up to 30000 A, For VT up to 600 kV	<b>Event logging</b>	Only with RS232 + RTC module. The alarms max/min values will be stored with time (hh:mm:ss) and date (dd:mm:yy) references Max. capacity: 480 events
<b>Scaling factor</b> Operating mode  Electrical range	Electrical scale: compression/expansion of the input scale to be connected to up to 4 analogue outputs. Programmable within the whole measuring range	<b>Page Variables</b>	Max. 4/page, one freely prog. page + 26 variable pages + according to the kind of period selection: up to 12 energy meter pages.
<b>Filter</b> Filter operating range  Filtering coefficient	0 to 99.9% of the input electrical scale 1 to 255	<b>Display language</b>	English, Italian, French, German, Spanish

## Supply Specifications

<b>AC/DC voltage</b>	90 to 260VAC/DC (standard), 18 to 60VAC/DC (on request),	<b>Power consumption</b>	≤ 30VA/12W (90to 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>Product requirements</b>	Energy measurements: EN61036, EN61268. DIN43864
<b>Storage temperature</b>	-10 to +60°C (14 to 140°F) (R.H. < 90% non-condensing)	<b>Pulse output:</b>	
<b>Insulation reference voltage</b>	300 V <sub>RMS</sub> to ground (AV5 input)	<b>Approvals</b>	CE, UL, CSA
<b>Insulation</b>	4000 V <sub>RMS</sub> 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 V <sub>RMS</sub> for 1 minute	<b>Housing</b> Dimensions Material	96x96x140 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, NEMA4x, NEMA12
<b>EMC</b> <b>Other standards</b> Safety requirements: Product requirements:	EN 50081-2, EN 50082-2  IEC 61010-1, EN 61010-1 IEC 60688-1, EN 60688-1	<b>Weight</b>	Approx. 600 g (packing included)

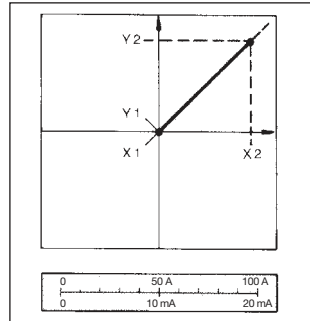
## Function Description

### Input and output scaling capability

Working of the analogue outputs (y) versus input variables (x)

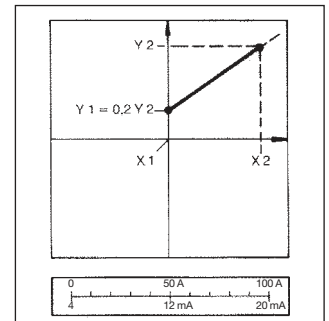
**Figure A**

The sign of measured quantity and output quantity remains the same. The output quantity is proportional to the measured quantity.



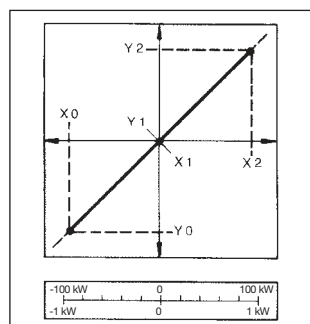
**Figure D**

The sign of measured quantity and output quantity remains the same. With the measured quantity being zero, the output quantity already has the value  $Y1 = 0.2 Y2$ . Live zero output.



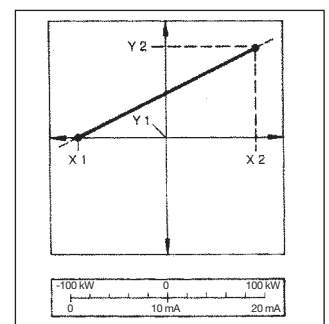
**Figure B**

The sign of measured quantity and output quantity changes simultaneously. The output quantity is proportional to the measured quantity.



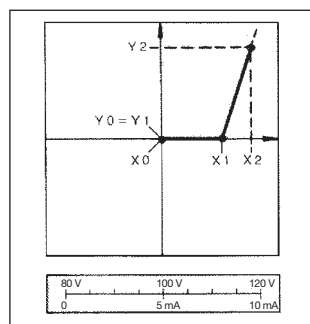
**Figure E**

The sign of the measured quantity changes but that of the output quantity remains the same. The output quantity steadily increases from value X1 to value X2 of the measured quantity.



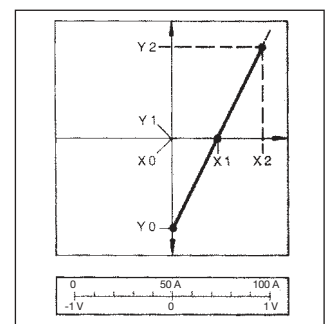
**Figure C**

The sign of measured quantity and output quantity remains the same. On the range X0...X1, the output quantity is zero. The range X1...X2 is delineated on the entire output range  $Y0 = Y1...Y2$  and thus presented in strongly expanded form.



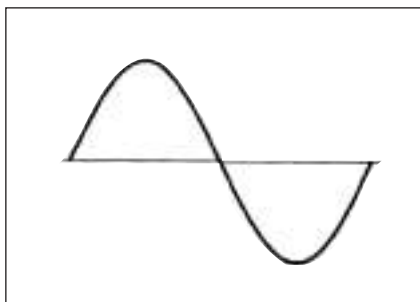
**Figure F**

The sign of the measured quantity remains the same, that of the output quantity changes as the measured quantity leaves range X0...X1 and passes to range X1...X2 and vice versa.



## Mode of Operation

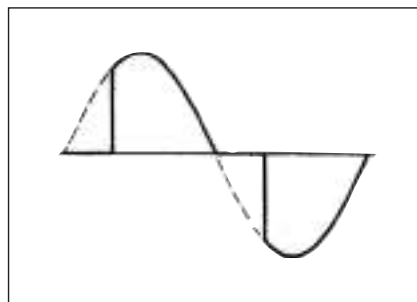
### Waveform of the signals that can be measured



**Figure G**

**Sine wave, undistorted**

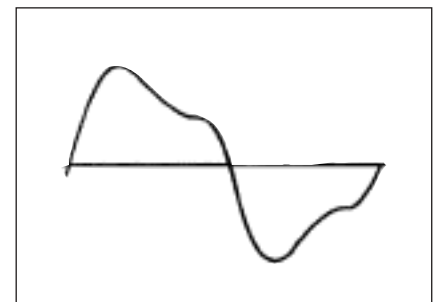
Fundamental content 100%  
 Harmonic content 0%  
 $A_{rms} = 1.1107 | \bar{A} |$



**Figure H**

**Sine wave, indented**

Fundamental content 10...100%  
 Harmonic content 0...90%  
 Frequency spectrum 3rd to 50th harmonic



**Figure I**

**Sine wave, distorted**

Fundamental content 70...90%  
 Harmonic content 10...30%  
 Frequency spectrum 3rd to 50th harmonic



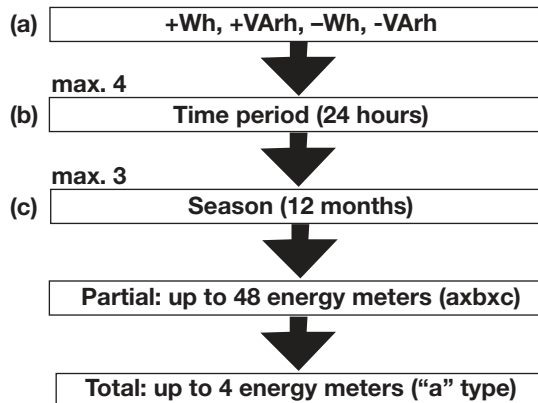
## Harmonic distortion analysis

<b>Analysis principle</b>	FFT	
<b>Harmonic measurement</b> Current Voltage	Up to 50th harmonic Up to 50th harmonic	
<b>Type of harmonics</b>	THD (VL1) THD odd (VL1) THD even (VL1) and also for the other phases: L2, L3. THD (IL1) THD odd (IL1) THD even (IL1) and also for the other phases: L2, L3.	
<b>Harmonic phase angle</b>	The instrument measures the angle between the single harmonic of "V" and the single harmonic of "I" of the same order. According to the value of the electrical angle, it is possible to know if the distortion is absorbed or generated. Note: if the system has 3	wires the angle cannot be measured.
		<b>Harmonic details</b> For every THD page it is possible to see the harmonic order.
		<b>Display pages</b> The harmonics content is displayed as a graph showing the whole harmonic spectrum. The information is given also as numerical information: THD in % / RMS value THD odd in % / RMS value THD even in % / RMS value single harmonic in % / RMS value
		<b>Others</b> The harmonic distortion can be measured in 2-wire, 3-wire or 4-wire systems. Tw: 0.02

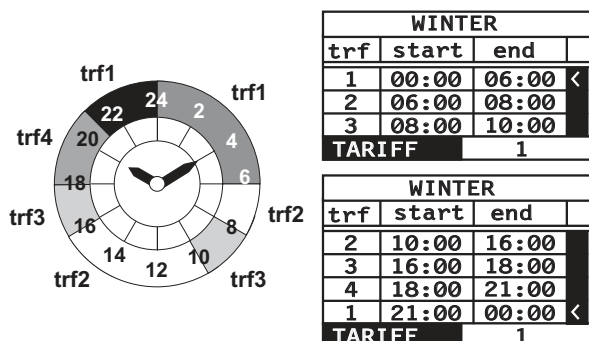
## Energy time period management

<b>Time periods</b>	Selectable: single time, dual time and multi-time
<b>Single time</b> Number of energy meters	Total: 4 (9-digit) (no partial meters)
<b>Dual time</b> Number of energy meters Time periods	Total: 4 (9-digit) Partial: 8 (6-digit) 2, programmable within 24 hours
<b>Multi time</b> Number of energy meters Time periods Time seasons	Total: 4 (9-digit) Partial: 48 (6-digit) 4, programmable within 24 hours 3, programmable within 12 months
<b>Pulse outputs</b>	Connectable to total and partial energy meters (Single time, dual time, multi time periods)
<b>Energy metering recording</b>	Energy consumption story, recording of energy metering by months, oldest data: 2 months before current month. Recording of total and partial energy metering

### Management concept (multi-time)



### Example of Multi-time energy metering



## Display pages

Variables that can be displayed in case of a three-phase system, 4-wire connection.

No	1st variable	2nd variable	3rd variable	4th variable	Note
	Selectable	Selectable	Selectable	Selectable	
1	V L1	V L2	V L3	V L-N sys	Sys = $\Sigma$
2	V L1-2	V L2-3	V L3-1	V L-L sys	Sys = $\Sigma$
3	A L1	A L2	A L3	A n	
4	W L1	W L2	W L3	W sys	Sys = $\Sigma$
5	var L1	var L2	var L3	var sys	Sys = $\Sigma$
6	VA L1	VA L2	VA L3	VA sys	Sys = $\Sigma$
7	PF L1	PF L2	PF L3	PF sys	
8	V L1	A L1	PF L1	W L1	
9	V L2	A L2	PF L2	W L2	
10	V L3	A L3	PF L3	W L3	
11	V L-L sys	PF sys	var sys	W sys	Sys = $\Sigma$
12	A n	PF sys	Hz	W sys	Sys = $\Sigma$
13	A n dmd	VA dmd	PF avg	W dmd	dmd=demand, avg=average
14	(MAX1)	(MAX2)	(MAX3)	(MAX4)	The MAX value can be one of the above mentioned (No. 1 to No. 13)
15	(MAX5)	(MAX6)	(MAX7)	(MAX8)	
16	(MAX9)	(MAX10)	(MAX11)	(MAX12)	
17	(MIN1)	(MIN2)	(MIN3)	(MIN4)	
18	(MIN5)	(MIN6)	(MIN7)	(MIN8)	The MIN value can be one of the above mentioned (No. 1 to No. 13)
19	Histogram FFT V1 (THD, TADo, THDe, Single harmonic)				Only if analysis V1-A1 is activated
20	Histogram FFT A1 (THD, TADo, THDe, Single harmonic)				Only if analysis V1-A1 is activated
21	Histogram FFT V2 (THD, TADo, THDe, Single harmonic)				Only if analysis V2-A2 is activated
22	Histogram FFT A2 (THD, TADo, THDe, Single harmonic)				Only if analysis V2-A2 is activated
23	Histogram FFT V3 (THD, TADo, THDe, Single harmonic)				Only if analysis V3-A3 is activated
24	Histogram FFT A3 (THD, TADo, THDe, Single harmonic)				Only if analysis V3-A3 is activated
25	KWh + TOT	KWh - TOT	Kvar+ TOT	Kvar- TOT	
26	KWh+	KWh-	Kvar+	Kvar-	Partial energy meters

### Used Calculation Formulas

#### Formulas being used for single-phase measurements

Instantaneous effective voltage

$$V_{IN} = \sqrt{\frac{1}{n} \cdot \sum_1^n (V_{INi})^2}$$

Instantaneous active power

$$W_1 = \frac{1}{n} \cdot \sum_1^n (V_{INi}) \cdot (A_1)_i$$

Instantaneous power factor

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

Instantaneous effective current

$$A_1 = \sqrt{\frac{1}{n} \cdot \sum_1^n (A_1)_i^2}$$

Instantaneous apparent power

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

Instantaneous reactive power

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

### Formulas being used for 3-phase measurements

Equivalent three-phase voltage

$$V_{\Sigma} = \frac{V_{12} + V_{23} + V_{31}}{3}$$

Three-phase reactive power

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

Neutral current

$$A_n = \overline{A_{L1}} + \overline{A_{L2}} + \overline{A_{L3}}$$

Three-phase active power

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

Three-phase apparent power

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

Equivalent three-phase power factor

$$\cos\phi_{\Sigma} = \frac{W_{\Sigma}}{VA_{\Sigma}} \quad (\text{TPF})$$

Total harmonic distortion

$$THD_i = \sqrt{\frac{\sum_{n=2}^{\infty} T_{ni}^2}{T_{1i}}}$$

Harmonic values:

THDi-THD of parameter T at phase i

T<sub>n,i</sub> - value of parameter T at the n'th harmonic of phase i

### Energy metering

$$kWh_i = \int_{t_1}^{t_2} P_1(t) dt \approx \Delta t \sum_{n_1}^{n_2} P_{n,i}$$

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

kWh<sub>i</sub> = total consumed active energy at phase i

kVarh<sub>i</sub> = total consumed reactive energy at phase i

P(t) = total RMS active power at phase i of time t

Q<sub>i</sub>(t) = total RMS reactive power at phase i of time t

t<sub>1</sub>, t<sub>2</sub> = starting and ending time points of consumption recording

P<sub>n,i</sub> = total RMS active power at phase i of discrete time n

Q<sub>n,i</sub> = total RMS reactive power at phase i of discrete time n

Δt = time interval between two successive power consumptions

n<sub>1</sub>, n<sub>2</sub> = starting and ending discrete time points of consumption recording

## List of the variables that can be connected to:

- max/min variable detection;
- analogue outputs;
- alarm outputs.

No	Variable	1-phase Sys.	3-ph. + N Bal. Sys.	3-ph. + N Unbal. Sys.	3-ph. Bal. Sys.	3-ph. Unbal. Sys.	Note
1	V L1	o	x	x	o	o	
2	V L2	o	x	x	o	o	
3	V L3	o	x	x	o	o	
4	V L-N sys	o	x	x	o	o	Sys = $\Sigma$
5	V L1-2	x	x	x	x	x	
6	V L2-3	o	x	x	x	x	
7	V L3-1	o	x	x	x	x	
8	V L-L sys	o	x	x	x	x	Sys = $\Sigma$
9	A L1	x	x	x	x	x	
10	A L2	o	x	x	x	x	
11	A L3	o	x	x	x	x	
12	A n	o	x	x	o	o	Neutral current
13	W L1	x	x	x	o	o	
14	W L2	o	x	x	o	o	
15	W L3	o	x	x	o	o	
16	W sys	o	x	x	x	x	Sys = $\Sigma$
17	var L1	x	x	x	o	o	
18	var L2	o	x	x	o	o	
19	var L3	o	x	x	o	o	
20	var sys	o	x	x	x	x	Sys = $\Sigma$
21	VA L1	x	x	x	o	o	
22	VA L2	o	x	x	o	o	
23	VA L3	o	x	x	o	o	
24	VA sys	o	x	x	x	x	Sys = $\Sigma$
25	PF L1	x	x	x	o	o	
26	PF L2	o	x	x	o	o	
27	PF L3	o	x	x	o	o	
28	PF sys	o	x	x	x	x	Sys = $\Sigma$
29	Hz	x	x	x	x	x	
30	THD V1	x	x	x	x	x	if FFT V1-A1 is activated
31	THDo V1	x	x	x	x	x	if FFT V1-A1 is activated
32	THDe V1	x	x	x	x	x	if FFT V1-A1 is activated
33	THD V2	o	x	x	x	x	if FFT V2-A2 is activated
34	THDo V2	o	x	x	x	x	if FFT V2-A2 is activated
35	THDe V2	o	x	x	x	x	if FFT V2-A2 is activated
36	THD V3	o	x	x	x	x	if FFT V3-A3 is activated
37	THDo V3	o	x	x	x	x	if FFT V3-A3 is activated
38	THDe V3	o	x	x	x	x	if FFT V3-A3 is activated
39	THD A1	x	x	x	x	x	if FFT V1-A1 is activated
40	THDo A1	x	x	x	x	x	if FFT V1-A1 is activated
41	THDe A1	x	x	x	x	x	if FFT V1-A1 is activated
42	THD A2	o	x	x	x	x	if FFT V2-A2 is activated
43	THDo A2	o	x	x	x	x	if FFT V2-A2 is activated
44	THDe A2	o	x	x	x	x	if FFT V2-A2 is activated
45	THD A3	o	x	x	x	x	if FFT V3-A3 is activated
46	THDo A3	o	x	x	x	x	if FFT V3-A3 is activated
47	THDe A3	o	x	x	x	x	if FFT V3-A3 is activated
48	A n dmd	x	x	x	x	x	Integration time programmable from 1 to 30 minutes
49	VA dmd	x	x	x	x	x	Integration time prog. from 1 to 30 min.
50	PF avg	x	x	x	x	x	Integration time prog. from 1 to 30 min.
51	W dmd	x	x	x	x	x	Integration time prog. from 1 to 30 min.
52	ASY	o	x	x	x	x	Integration time prog. from 1 to 30 min.

Note: (x) stands for an "available" variable, (o) stands for a "not-available" variable.



## The available modules

Type	N. of channels	Ordering code
WM3-96 base		AD 1016H
WM3-96 N2 METASYS base		AD 1016HN2
AV5.3 measuring inputs		AQ 1018
AV7.3 measuring inputs		AQ 1019
18-60VAC/DC power supply		AP1021
90-260VAC/DC power supply		AP1020
20mADC analogue output	1	AO1050
10VDC analogue output	1	AO1051
±5mADC analogue output	1	AO1052
±10mADC analogue output	1	AO1053
±20mADC analogue output	1	AO1054
±1VDC analogue output	1	AO1055
±5VDC analogue output	1	AO1056
±10VDC analogue output	1	AO1057
20mADC analogue output	2	AO1026
10VDC analogue output	2	AO1027
±5mADC analogue output	2	AO1028
±10mADC analogue output	2	AO1029
±20mADC analogue output	2	AO1030
±1VDC analogue output	2	AO1031
±5VDC analogue output	2	AO1032
±10VDC analogue output	2	AO1033
RS485 output	1	AR1034
Relay output	1	AO1058
Relay output	2	AO1035
Open collector output	1	AO1059
Open collector output	2	AO1036
Open collector output	4	AO1037
Digital inputs	3	AQ1038
RS232 output + RTC (1)	1	AR1039

## The possible module combinations

Basic unit	Slot A	Slot B	Slot C	Slot D
Single analogue output	●			
Dual analogue output	●	●		
RS485 input/output		●		
Single relay output (*)			●	
Single open collector out (*)			●	
Dual relay output (*)			●	●
Dual open coll. out (*)			●	●
4 open coll. output (*)				●
3 digital inputs			●	
Basic unit	Slot E			
RS232 input/output + RTC		●		

(\*) alarm or pulse

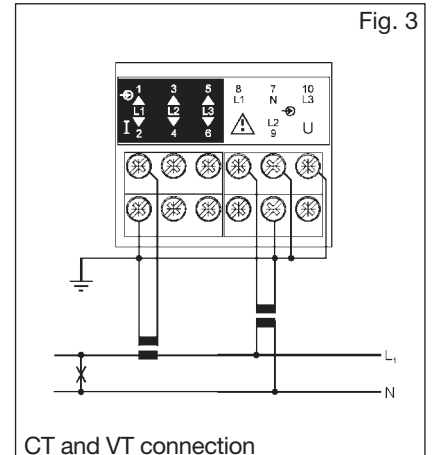
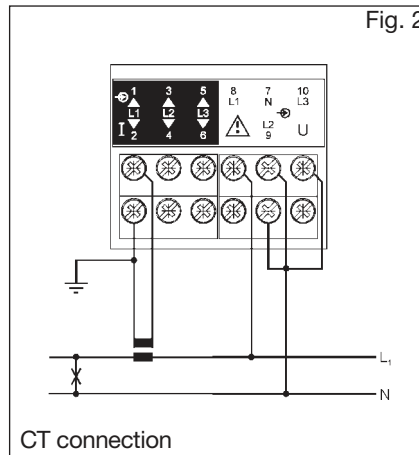
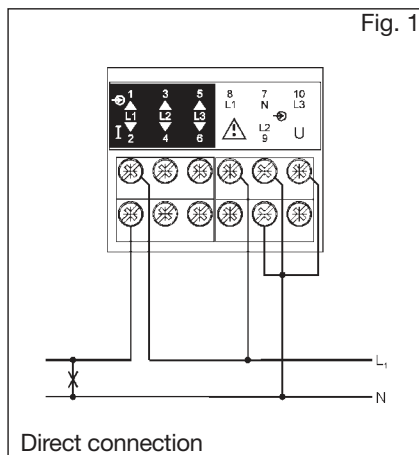


N2-Open Metasys protocol full compatibility (available on request).

(1) The RS232 communication port works as alternative of the RS485 module.

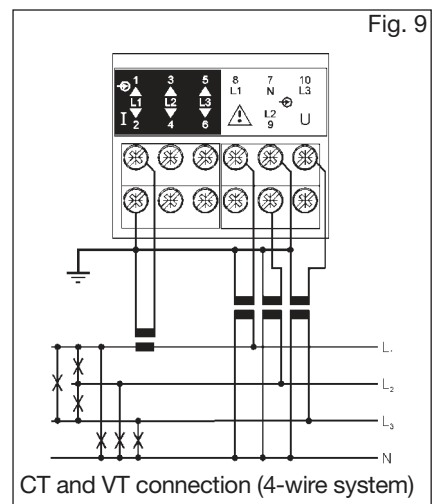
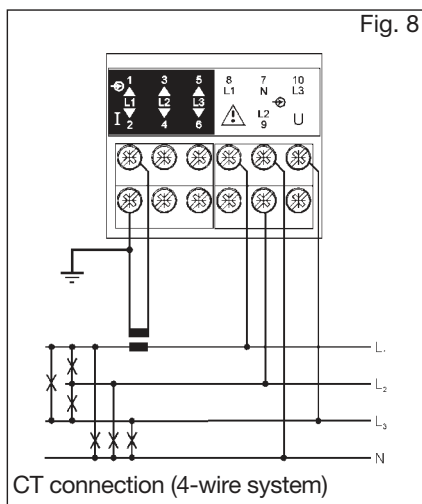
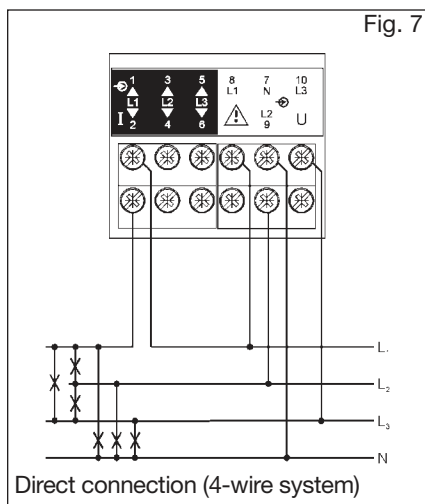
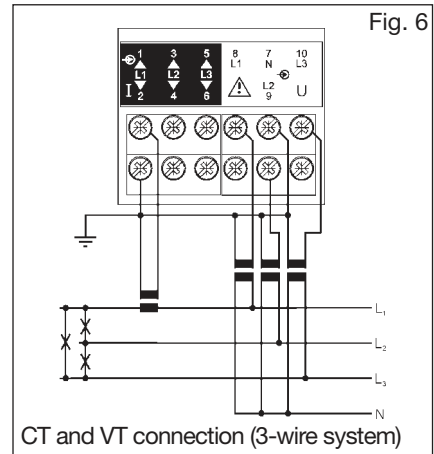
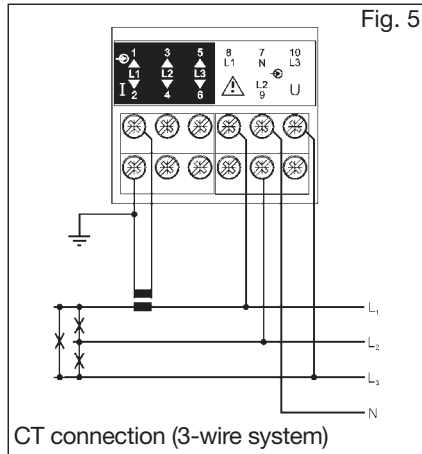
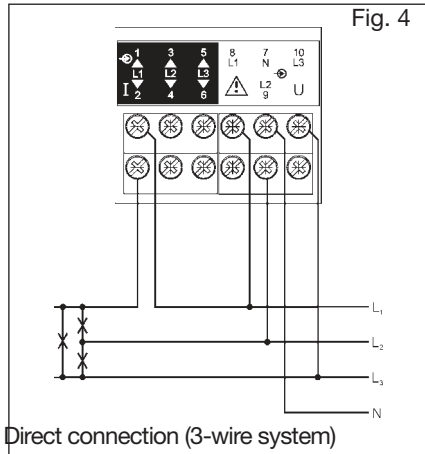
## Wiring Diagrams

### Single phase input connections

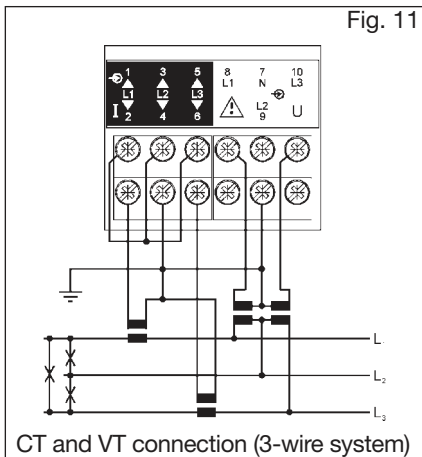
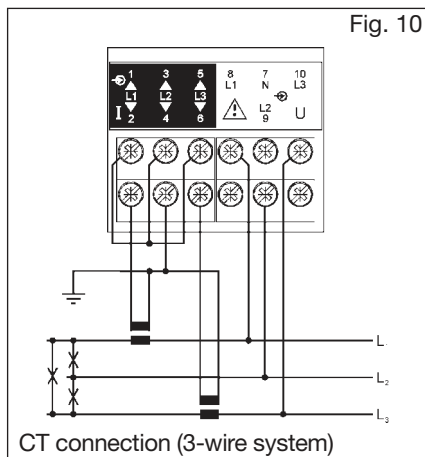


## Wiring Diagrams (cont.)

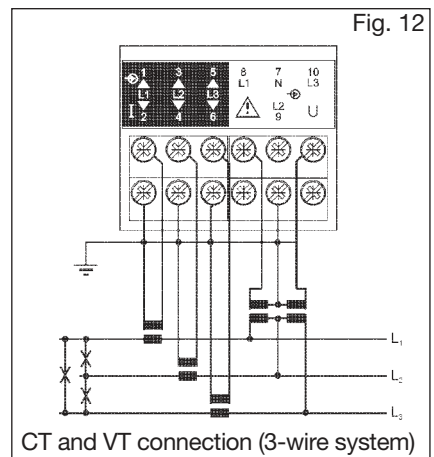
### Three-phase wire input connections - Balanced loads



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

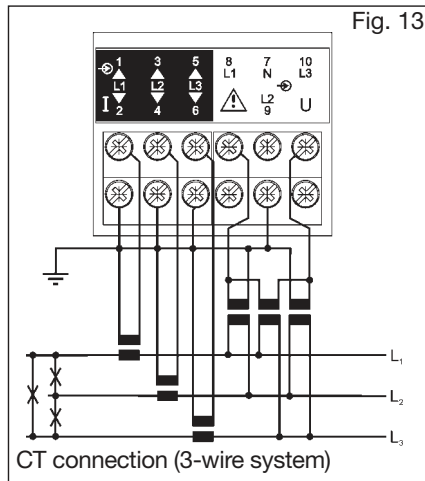


### Three-phase, 3-wire input connections - Unbalanced loads

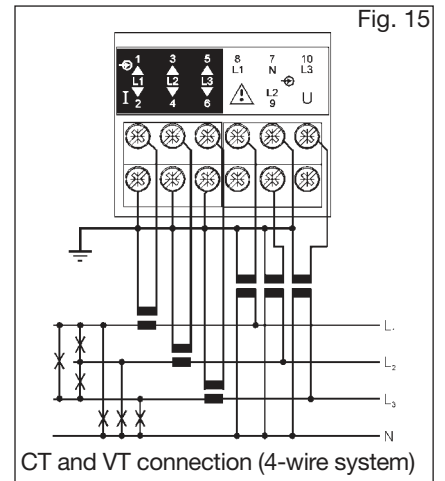
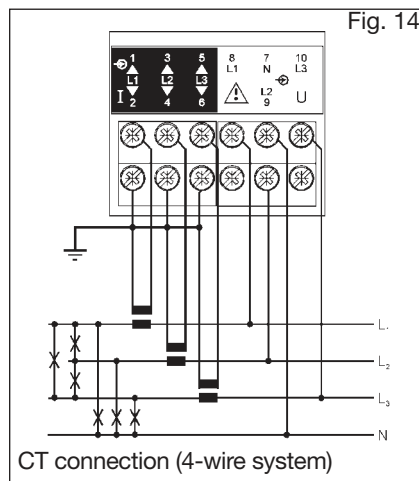


## Wiring Diagrams (cont.)

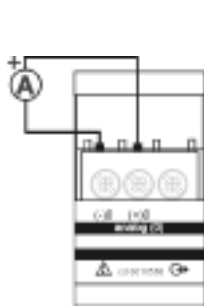
Three-phase three-wire input connections  
Unbalanced load



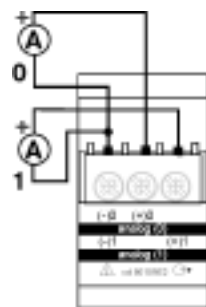
Three-phase four-wire input connections - Unbalanced load



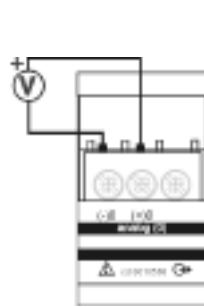
## Wiring diagrams (optional modules)



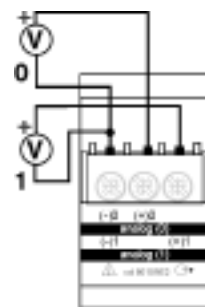
**AO1050**  
1 analogue output (mA)



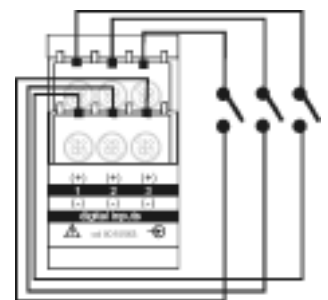
**AO1026**  
2 analogue outputs (mA)



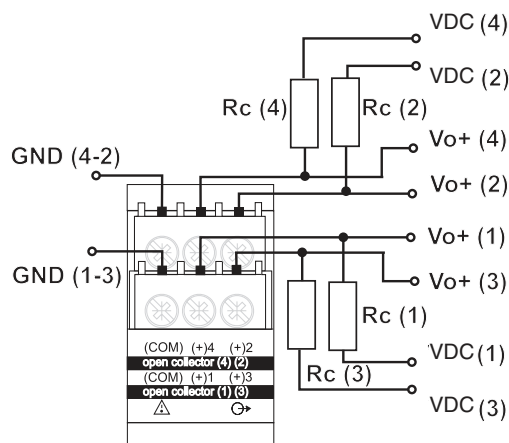
**AO1051**  
1 analogue output (V)



**AO1027**  
2 analogue outputs (V)



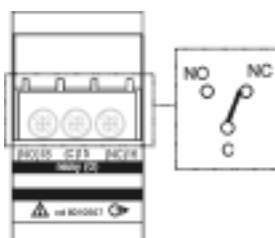
**AO1038**  
3 digital inputs



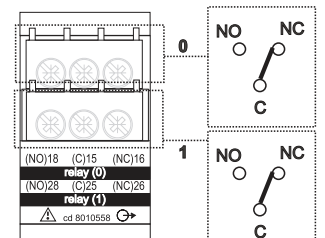
**AO1037**

**4 open collector outputs:** The load resistance ( $R_c$ ) must be designed so that the closed contact current is lower than 100mA; the VDC voltage must be lower than or equal to 30V.

VDC: power supply voltage output. Vo+: positive output contact (open collector transistor). GND: ground output contact (open collector transistor).



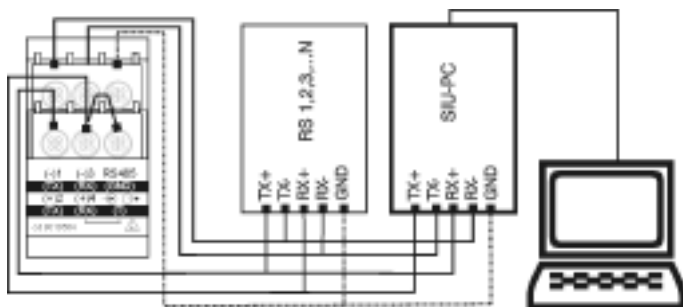
**AO1058**  
1 relay output



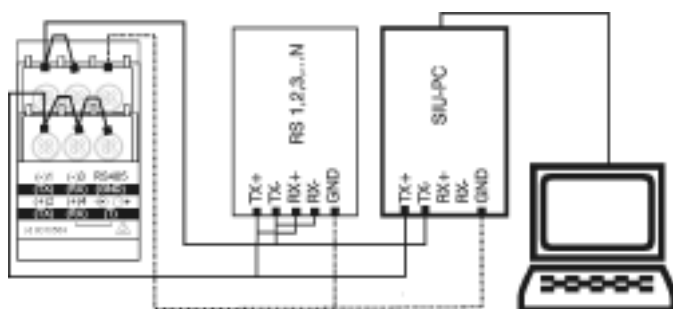
**AO1035**  
2 relay outputs



## Wiring diagrams (optional modules, cont.)

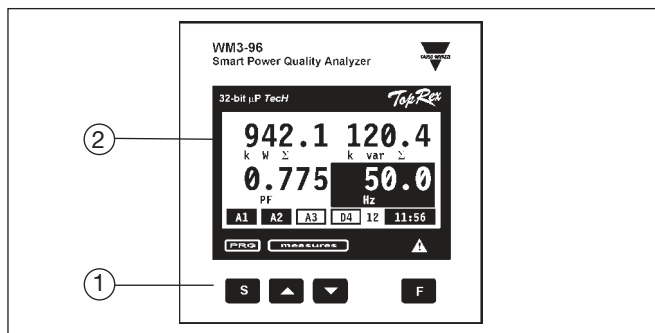


**RS422/485 4-wires connection:** additional devices provided with RS422/485 (that is RS 1, 2, 3...N) are connected in parallel. The termination of the serial output is carried out only on the last instrument of the network, by means of a jumper between (Rx+) and (T).



**RS422/485 2-wires connection:** additional devices provided with RS422/485 (that is RS 1, 2, 3...N) are connected in parallel. The termination of the serial output is carried out only on the last instrument of the network, by means of a jumper between (Rx+) and (T).

## Front Panel Description



- for value programming/function selection, page scrolling
- "F" for special functions

### 2. Display

- Instantaneous measurements:
- 4-digit (maximum read-out 9999)
- Energies:
- 9-digit (maximum read-out 999999999).

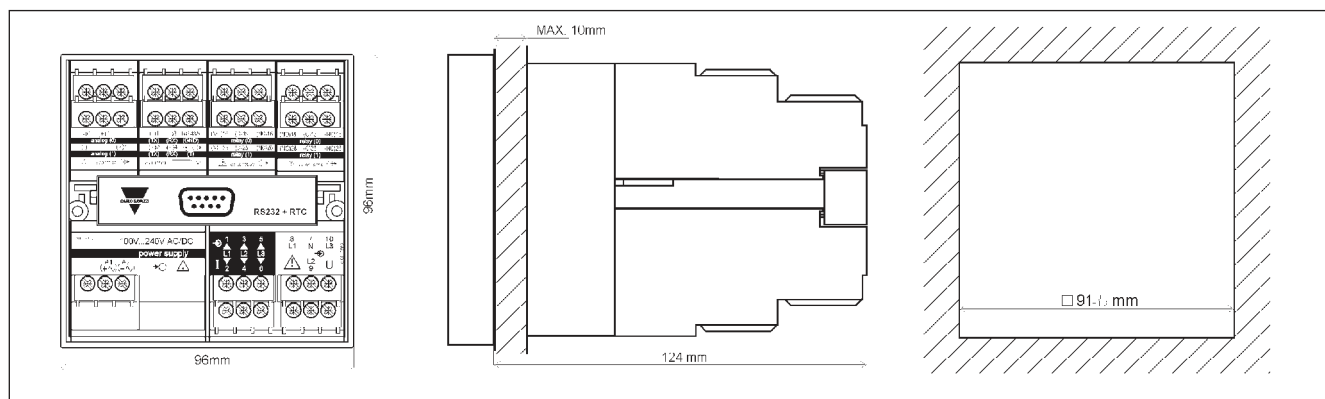
- Alphanumeric indication by means of LCD display for:
- Displaying the configuration parameters
  - All the measured variables.

### 1. Key-pad

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

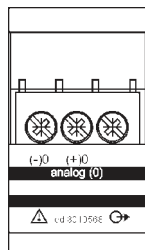
- "S" for enter programming phase and password confirmation,

## Dimensions



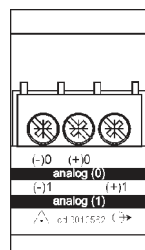
## Terminal boards

### Single analogue output modules



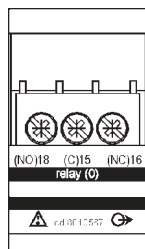
- AO1050** (20mADC)
- AO1051** (10VDC)
- AO1052** ( $\pm 5$ mADC)
- AO1053** ( $\pm 10$ mADC)
- AO1054** ( $\pm 20$ mADC)
- AO1055** ( $\pm 1$ VDC)
- AO1056** ( $\pm 5$ VDC)
- AO1057** ( $\pm 10$ VDC)

### Dual analogue outputs

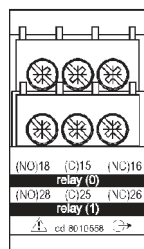


- AO1026** (20mADC)
- AO1027** (10VDC)
- AO1028** ( $\pm 5$ mADC)
- AO1029** ( $\pm 10$ mADC)
- AO1030** ( $\pm 20$ mADC)
- AO1031** ( $\pm 1$ VDC)
- AO1032** ( $\pm 5$ VDC)
- AO1033** ( $\pm 10$ VDC)

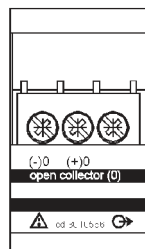
### Digital output modules



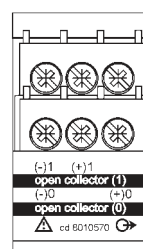
**AO1058**  
Single relay output



**AO1035**  
Dual relay output

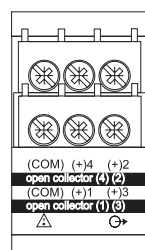


**AO1059**  
Single open collector output

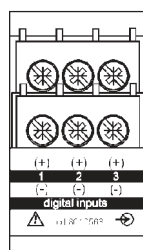


**AO1036**  
Dual open collector output

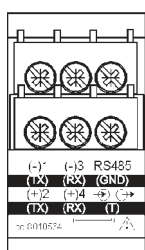
### Other input/output modules



**AO1037**  
4 open collector outputs



**AQ1038**  
3 Digital inputs

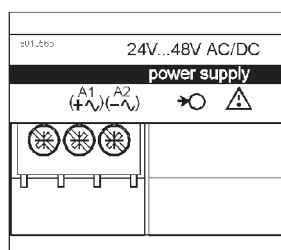


**AR1034**  
RS485 port

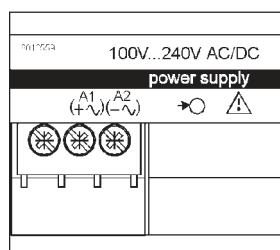


**AR1039**  
RS232 port + RTC

### Power supply modules



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



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