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 µP-based indicator**
- **Manual or automatic scrolling of system and single phase: kW, kVAr, PF, kWh, kVArh, A, V_{L-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 output**
- **MODBUS, JBUS protocol.**

Product Description

µP-based modular power analyzer with a built-in configuration key-pad. The power, power factor, current and voltage are system and single phase measurements and indications. The housing is easy to mount on a panel and ensures a degree of protection (front) of IP 65.

Ordering Key

WM2-96 AV53D XXX

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

Type Selection

Range code

AV5: 250/433 VAC - 5 AAC (max. 300 V (L-N)/ 520 V (L-L) - 6 A)
AV7: 400/690 VAC - 5 AAC (max. 480 V (L-N)/ 830 V (L-L) - 6 A) [1]

System

3: One phase, three-phase system, 3 or 4 wires, balanced load; three phase system, 3 or 4 wires, unbalanced load

Power supply

A: 24 VAC, -15% +10%, 50/60 Hz [1] [2]
B: 48 VAC, -15%+10%, 50/60 Hz [1] [2]
C: 115 VAC, -15% +10%, 50/60 Hz [1] [2]
D: 230 VAC, -15% +10%, 50/60 Hz (standard) [2]
L: 18 to 60 VDC/AC [3]
H: 90 to 260 VDC/AC [3]

1st output (pulse)

XX: No output (standard)
O1: Single open collector output (30V/100mADC) [1]
O2: Dual open collector output, the second one is the copy of the first one, like "O1" [1]
R1: Single relay output, (AC1-8AAC, 250VAC) [1]
R2: Dual relay output, the second one is the copy of the first one, like "R1" [1]

2nd output

X: No output (standard)
S: Serial output, 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
Voltage/current (@ 25°C ± 5°C, R.H. ≤ 60%)	±0.5% f.s. (0 to 1.2 In, 0.5 to 1.2 Un)
Active power/energy (@ 25°C ± 5°C, R.H. ≤ 60%)	±1% f.s. (PF ≥ 0.7 L/C, 0 to 1.2 In, 0.5 to 1.2 Un)
Reactive power/energy (@ 25°C ± 5°C, R.H. ≤ 60%)	±1% f.s. (PF ≥ 0.7 L/C, 0 to 1 In, 0 to 1 Un)
Power factor (PF) (@ 25°C ± 5°C, R.H. ≤ 60%)	±1% f.s., PF ≥ 0.7 L/C, (0.6 to 1.2 In, 1 to 1.2 Un)
Additional errors	
Humidity	< 0.3% f.s., 60% to 90% R.H.
Power supply	±0.5% rdg, -15 +10% p.s.
Magnetic field	< 0.1% f.s. @ 400 A/m

Rated input	
Current	2 inputs (one/three-phase balanced load) 6 inputs (one/three-phase unbalanced load)
Voltage	2 inputs (one/three-phase balanced load) 4 inputs (one/three-phase unbalanced load)
Insulation	among the voltage and the current inputs: 2000Vrms; among the current inputs: 2000 Vrms
Temperature drift	±250 ppm/°C
Display	Backlighted LCD, h 13mm, 3-dgt (instantaneous meas.) 6-dgt (energies)

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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
Max. and min. indication	
Voltage	Max. 600 min. 0
Current (CT ratio = 1)	Max. 6.00 min. 0.00
PF	Max. 1.00 min. 0.00
Power (CT ratio = 1)	Max. 5.40 min. 0.00
Active energy	Max. 999999 min. –199999
Reactive energy	Max. 999999 min. 0
Sampling rate	3 times / second
Measurements	
System variables	kW, kVAr, PF, V_{L-L}, A, kWh tot, kVArh tot, kWh partial, KVarh partial
Single phase variables	kW, kVAr, PF, V_{L-N}, A
Measurement method	TRMS measurement of a distorted voltage/current wave Coupling type: Direct Crest factor: ≥ 3

Ranges (impedances)	250 V/433 V (≥400kΩ) 5 AAC (≤ 0.3 VA / ≤ 0.1Ω) 400V/690V (≥650kΩ)
Frequency range	48 to 62 Hz
Over-load protection	Un: 250V (AV5), 400V (AV7) In: 5A
Continuous: voltage/current	1.2 Un /In
For 1 s	
Voltage:	2 Un
Current:	20 In
Keyboard	4 keys: "∆∇": - 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

Pulse output (on request)	
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) V_{ON} 1.2 VDC/ max. 100 mA V_{OFF} 30 VDC max.
Relay type	1 x SPDT AC 1 - 8A, 250VAC DC 12 - 5A,24VDC AC 15 - 2.5A, 250VAC DC 13 - 2.5A, 24VDC
Pulse duration	200 ms (ON), ≥ 200 ms (OFF)
Insulation	By means of optocouplers, 4000 V_{rms} output to measuring input, 4000 V_{rms} output to supply input.
Serial output (on request)	
Type	RS422/RS485; Multidrop bidirectional (static and dynamic variables)
Connections	4 wires, max. distance 1200m, termination directly on the module
Addresses	1 to 255, selectable by key-pad

Protocol	MODBUS/JBUS
Data (bidirectional)	
Dynamic (reading only)	System variables: P, Q, PF, V_{L-L}, energies, Single phase variables: P_{L1}, Q_{L1}, PF_{L1}, V_{L1-N}, A_{L1}, P_{L2}, Q_{L2}, PF_{L2}, V_{L2-N}, A_{L2}, P_{L3}, Q_{L3}, PF_{L3}, V_{L3-N}, A_{L3}
Static (writing only)	All programming data, reset of energy: - partial kWh - partial kVArh - total kWh - total kVArh Stored energy (EEPROM) ≤ 999999 kWh ≤ 999999 kVArh
Data format	1-start bit, 8-data bit, no parity/even parity, 1 stop bit
Baud-rate	1200, 2400, 4800 and 9600 selectable bauds
Insulation	By means of optocouplers, 4000 Vrms output to measuring inputs 4000 Vrms output to supply input

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Software Functions

Password	Numeric code of max. 3 digits; 2 protection levels of the programming data
1st level	Password “0”, no protection
2nd level	Password from 1 to 255, all data are protected
Measurement scrolling	
System:	Active power (kW), reactive power (kVAr), power factor (cos φ), current (A), average phase-phase voltage (V) total and partial active energy (kWh), total and partial reactive energy (kVArh) Partial energy meters: the counters of kWh and kVArh are automatically reset when the energy reaches the value (14999*CT).
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 (kVAr), power factor (cos φ), current (A), phase-neutral voltage (V)
Transformer ratio	For CT up to 5000 A
Programmable ratio	0.1 to 999.9
Digital Filter	
Filter operating range	0 to 100% of the input electrical scale
Filtering coefficient	1 to 64
Filter action	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
	90 to 260VDC/AC
Power consumption	≤ 30VA / 12W (90 to 260V) ≤ 20VA / 12W (18 to 60V)

General Specifications

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

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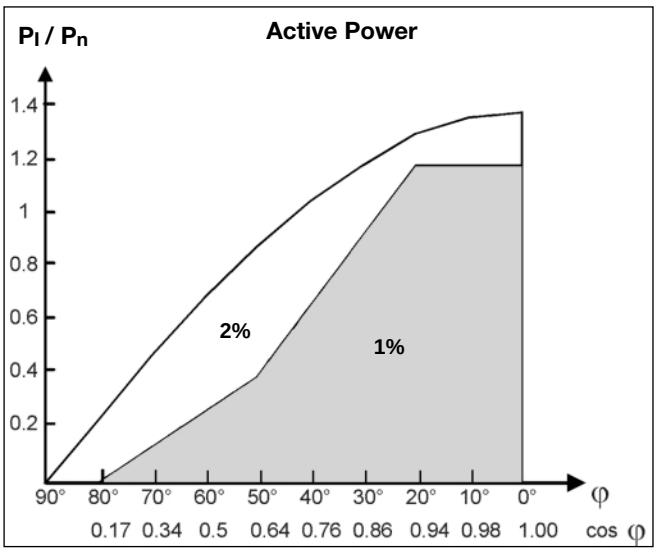
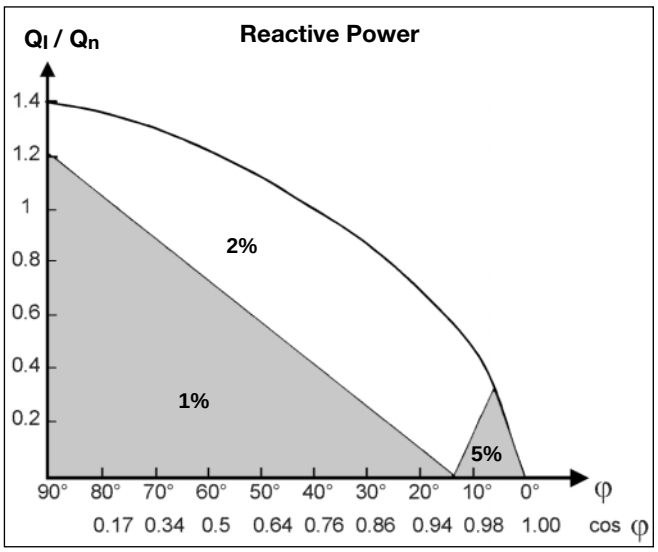
Mode of Operation

Accuracy class of the instrument as a relation of P_I/P_n and cos φ (power factor)



Test conditions:
V = 0.8 to 1.2 Un,
I = 0.1 to 1.2 In,
f = 48 to 62 Hz



Test conditions:
V = 0.8 to 1.2 Un,
I = 0.1 to 1.2 In,
f = 48 to 62 Hz

Input	Star voltage	Delta voltage	Current
AV5	Un: 250 V	Un: 430 V	In: 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 φ = the average cos φ of the electrical system being measured.

Pn /Qn (rated power of the instrument):
One phase system:

$$P_n = Q_n = U_n \cdot I_n \cdot CT(ratio)$$

Three phase, 3-wire system:

$$P_n = Q_n = \sqrt{3} \cdot U_n \cdot I_n \cdot CT(ratio)$$

Three phase, 4-wire system:

$$P_n = Q_n = 3 \cdot U_n \cdot I_n \cdot CT(ratio)$$

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.

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

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

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

$$P_I = \sqrt{3} \cdot U_I \cdot I_I \cdot \cos\varphi$$
$$= \sqrt{3} \cdot 400 \cdot 265 \cdot 0.85$$
$$= 155.87\ kW$$

$$P_n = \sqrt{3} \cdot U_n \cdot I_n \cdot CT\ (ratio)$$
$$= \sqrt{3} \cdot 430 \cdot 5 \cdot 60$$
$$= 233.17\ kW$$

$$\frac{P_I}{P_n} = \frac{155.87}{223.17} = 0.698$$

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

U_I = 230 V
I_I = 110 A (CT=300A)

Cos φ = 0.85 (sin φ = 0.52)
U_n = 250 V
I_n = 5 A

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

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

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

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

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

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Mode of Operation (cont.)

Waveform of the signals that can be measured

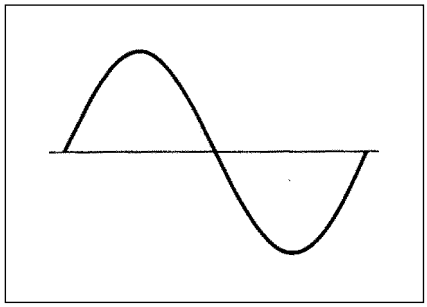


Figure G
Sine wave, undistorted
Fundamental content 100%
Harmonic content 0%
A_{rms} = 1.1107 | $\overline{A}$ |

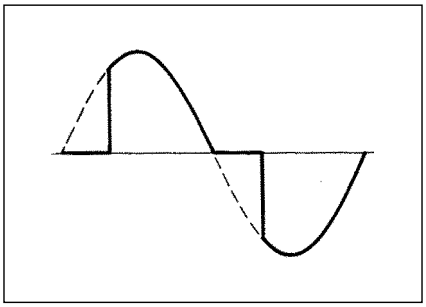


Figure H
Sine wave, indented
Fundamental content 10...100%
Harmonic content 0...90%
Frequency spectrum 3rd to 16th harmonic
Required result: additional error < 1%

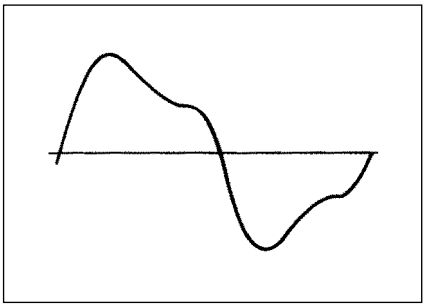
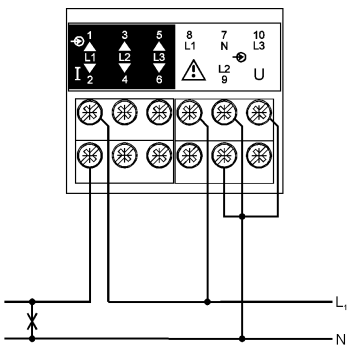


Figure I
Sine wave, distorted
Fundamental content 70...90%
Harmonic content 10...30%
Frequency spectrum 3rd to 15th harmonic
Required result: additional error < 0.5%

Wiring Diagrams

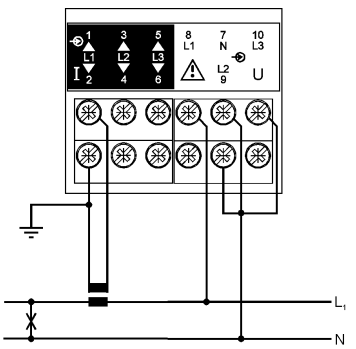
Single phase input connections

Fig. 1



Direct connection

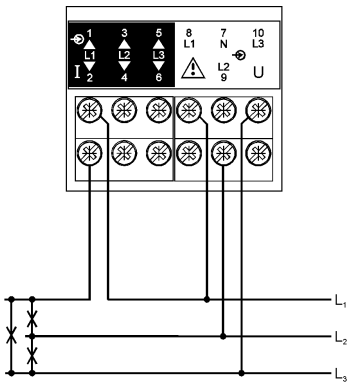
Fig. 2



CT connection

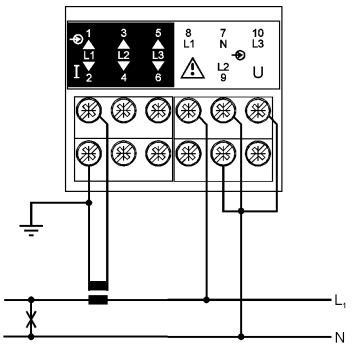
Three phase 3-wire input connections - Balanced loads

Fig. 3



Direct connection (3-wire system)

Fig. 4



CT connection (3-wire system)

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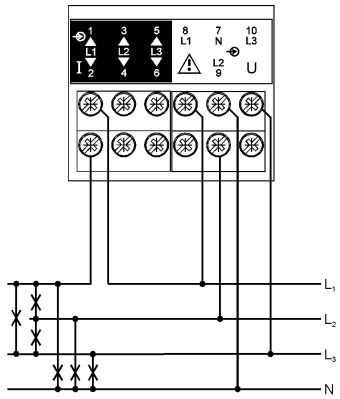
Wiring Diagrams (cont.)

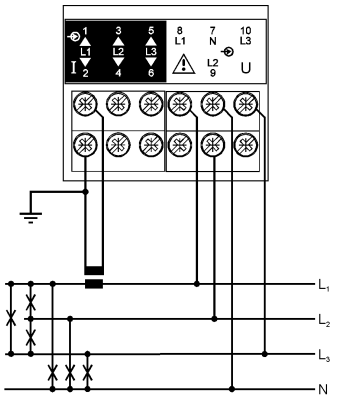
Three phase, 4-wire input connections - Balanced loads

Fig. 5



Direct connection (4-wire system)

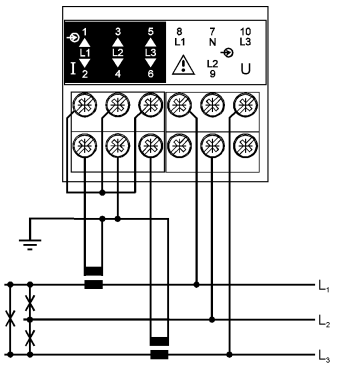
Fig. 6



CT connection (4-wire system)

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

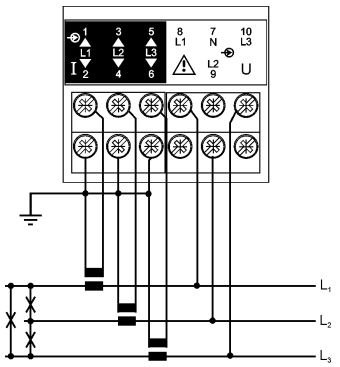
Fig. 7



CT connection (3-wire system)

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

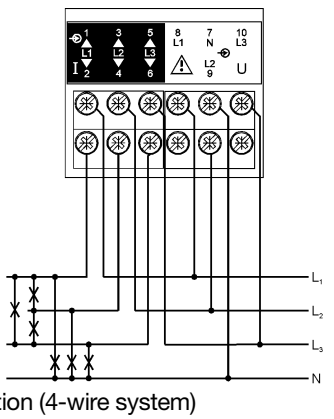
Fig. 8



CT connection (3-wire system)

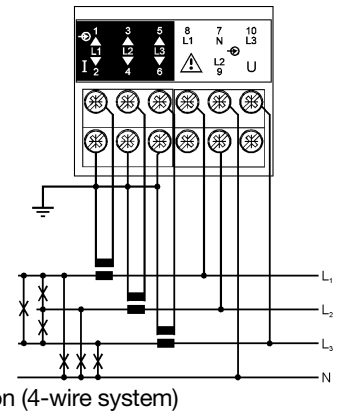
Three phase, 4-wire input connections - Unbalanced load

Fig. 9



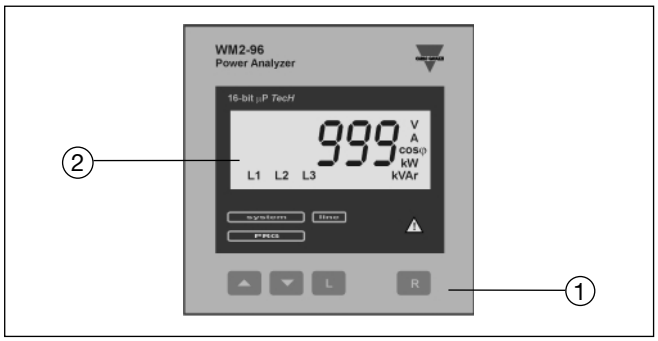
Direct connection (4-wire system)

Fig. 10



CT connection (4-wire system)

Front Panel Description



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
- 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

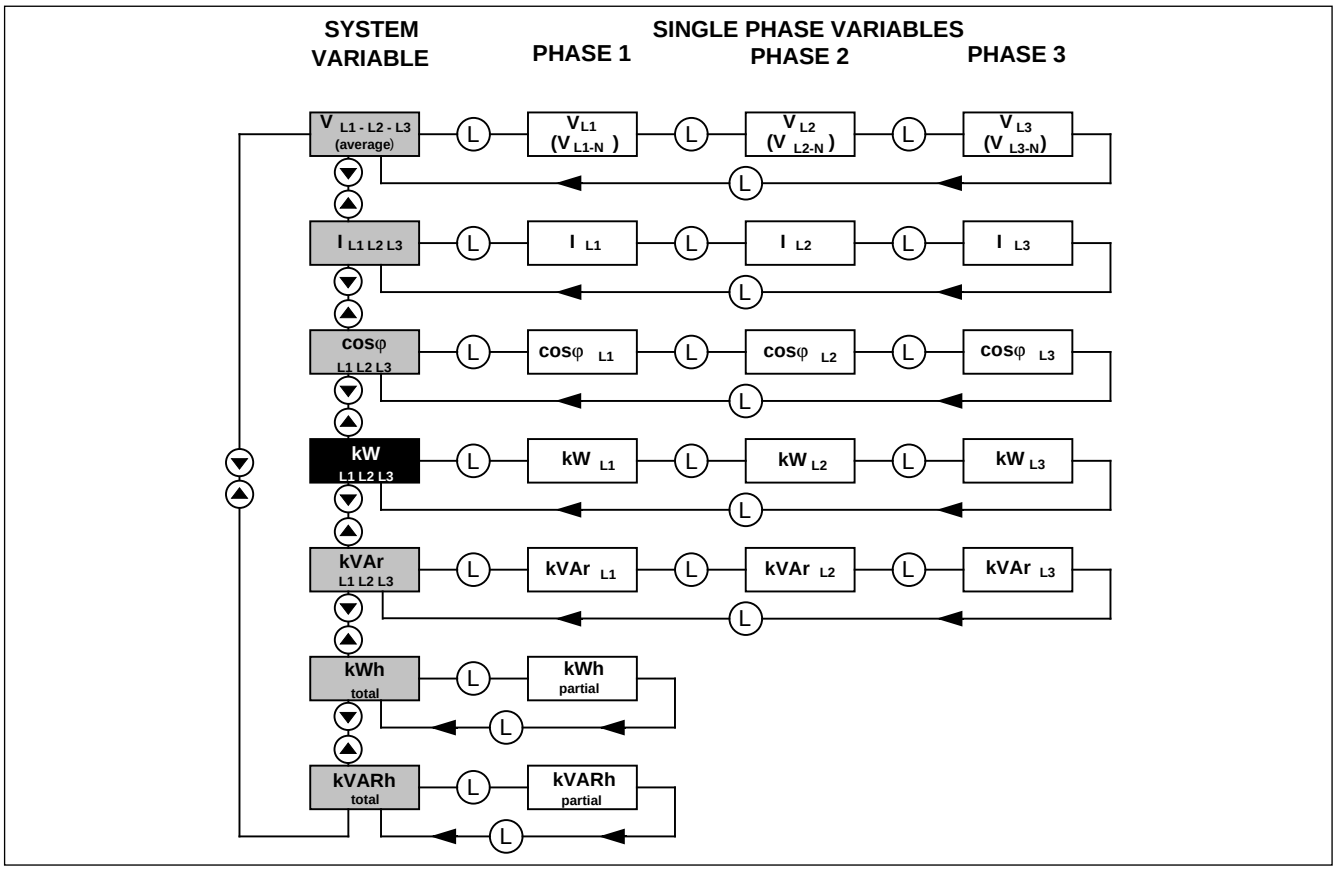
"R":
To reset the partial counted energies (kWh, kVArh).

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

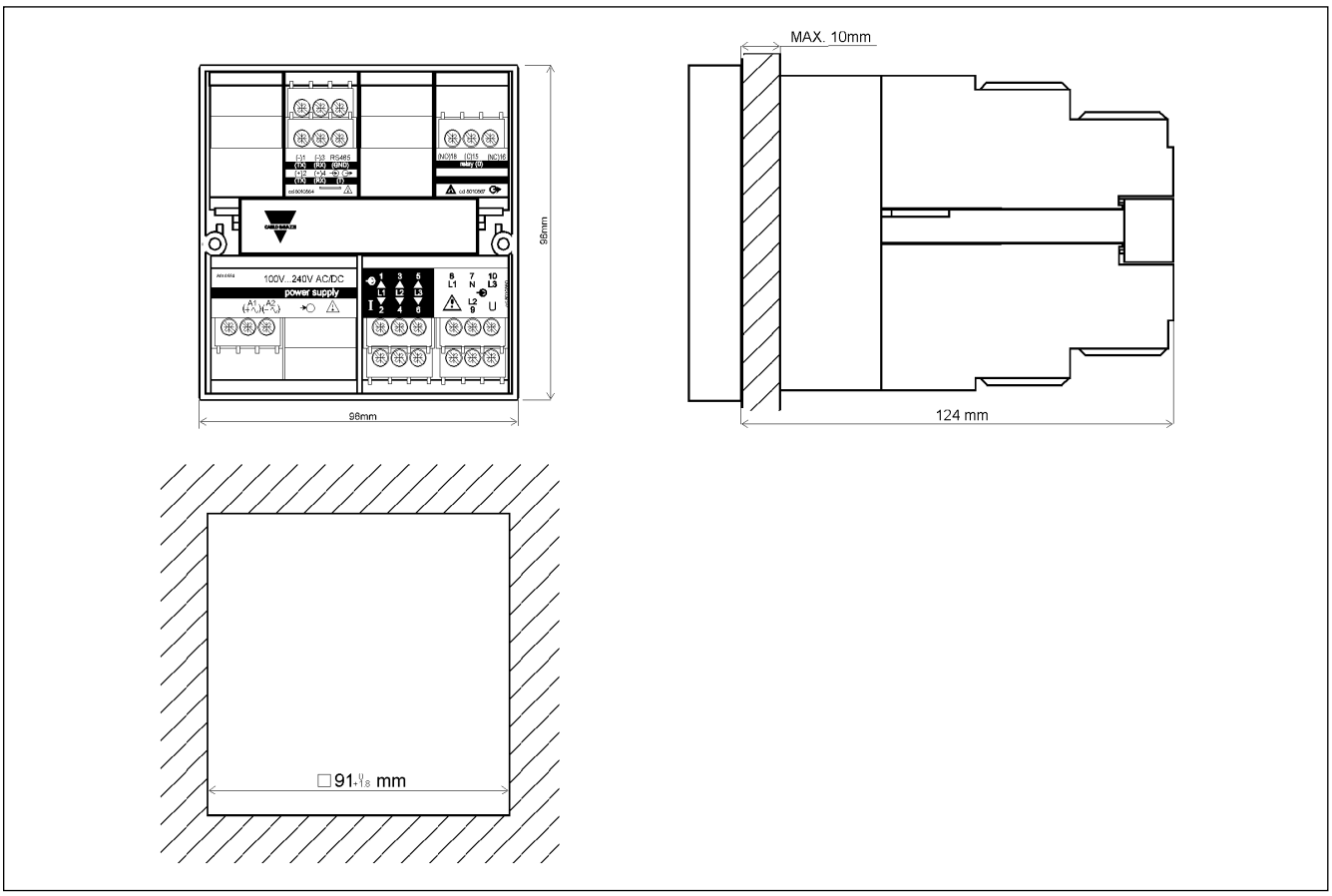
Type	N. of channels	Ordering code	Note
WM2-96 base + AV5.3 input		AB1012	
WM2-96 base + AV7.3 input		AB1013	
24VAC power supply		AP1025	
48VAC power supply		AP1024	
115VAC power supply		AP1023	
230VAC power supply		AP1022	
18-60VAC/DC power supply		AP1021	
90-260VAC/DC power supply		AP1020	
RS485 output	1	AR1034	
Relay output	1	AO1058	
Relay output	2	AO1035	The second output can be used as redoundant output
Open collector output	1	AO1059	
Open collector output	2	AO1036	The second output can be used as redoundant output

The possible module combinations

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

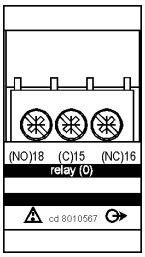
Slot	B	D
Basic unit	Out 1	Out 2
RS485 output	●	
Dual relay output (pulse)		●
Dual open collector output (pulse)		●

Dimensions

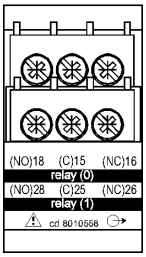


Terminal boards

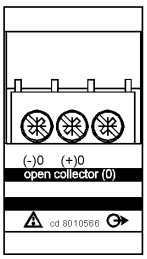
Digital output modules



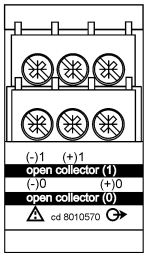
AO1058
Single relay output



AO1035
Dual relay output

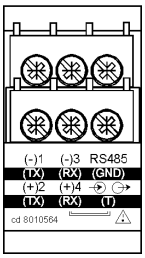


AO1059
Single open collector output



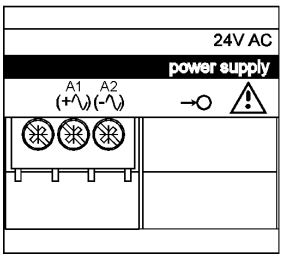
AO1036
Dual open collector output

Other input/output modules

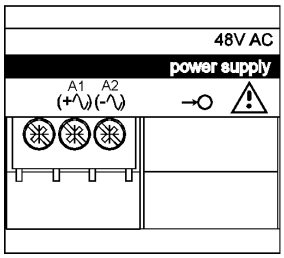


AR1034
RS485 output

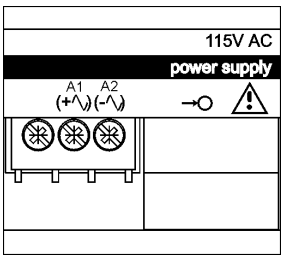
Power supply modules



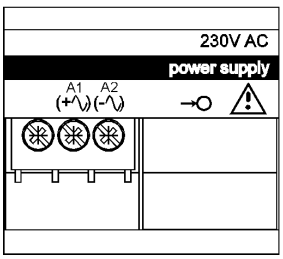
AP1025
24VAC power supply



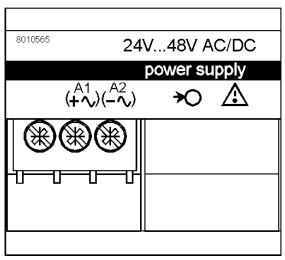
AP1024
48VAC power supply



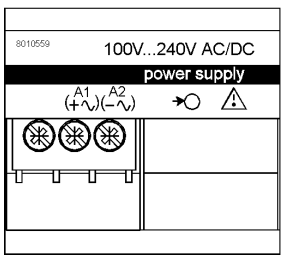
AP1023
115VAC power supply



AP1022
230VAC power supply



AP1021
18-60VAC/DC power supply



AP1020
90-260 VAC/DC power supply