Power analyzers and Energy Meters
Power Analyzer
Type WM14 96 "Advanced version"

CARLO GAVAZZI

- Protection degree (front): IP65
- 2 digital outputs
- 16 freely configurable alarms with OR/AND logic linkable with up to 2 digital outputs
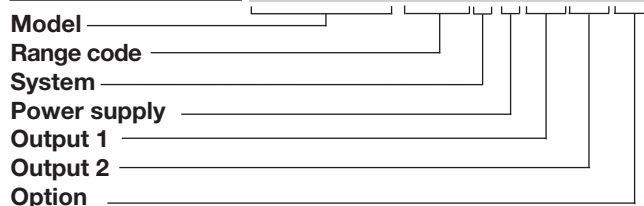- RS422/485 serial output (MODBUS-RTU), iFIX SCADA compatibility

- Class 1 (kWh), Class 2 (kvarh)
- Accuracy ±0.5 F.S. (current/voltage)
- Power Analyzer
- Instantaneous variables read-out: 3 DGT
- Energies readout: 8+1 DGT
- System variables: V_{LL}, V_{LN}, An, $A_{dmd\ max}$, VA, VA_{dmd}, $VA_{dmd\ max}$, W, W_{dmd}, $W_{dmd\ max}$, var, PF, Hz, ASY
- Single phase variables: V_{LL}, V_{LN}, $V_{LN\ min}$, $V_{LN\ max}$, A, A_{min}, A_{max}, A_{dmd}, VA, W, W_{dmd}, W_{max}, var, PF, PF_{min}
- Harmonic analysis (FFT) up to the 15th harmonic (current and voltage)
- Four quadrant power measurement
- Energy measurements: total and partial kWh and kvarh
- Hour counter (5+2 DGT)
- TRMS meas. of distorted sine waves (voltages/currents)
- Universal power supply: 90 to 260 VAC/DC, 18 to 60 VAC/DC
- Front dimensions: 96x96mm
- Voltage asymmetry, phase sequence, phase loss control

Product Description

3-phase advanced power analyzer with integrated programming key-pad. Particularly recommended for the measurement of the main electrical variables.

Housing for panel mounting, with RS485 communication port or pulse and/or alarm outputs.

How to order WM14-96 AV5 3 H R2 S1 AX

- Model
- Range code
- System
- Power supply
- Output 1
- Output 2
- Option

Type Selection

Range codes	System	Output 1	Output 2
AV5: 380/660V_{L-L}/1/5(6)AAC V_{L-N}: 185 V to 460 V V_{L-L}: 320 V to 800 V	**3 :** 1, 2 or 3 phase, balanced/unbalanced load, with or without neutral	**R2:** 2-relay outputs **O2:** 2-open collector outputs	**XX:** None **S1:** RS485/RS422 port
AV6: 120/208V_{L-L}/1/5(6)AAC V_{L-N}: 45 V to 145 V V_{L-L}: 78 V to 250 V			
Phase current: 0.03A to 6A	**Power supply**		**Options**
Neutral current: 0.09A to 6A	**L:** 18 to 60 VAC/VDC **H:** 90 to 260 VAC/VDC		**AX:** advanced functions

Input specifications

Rated inputs	System type: 3	Phase-neutral voltage	±(0.5% FS + 1 DGT)
Current	3 (Shunts)	Active and Apparent power,	0.25 to 6A: ±(1% FS +1DGT);
Voltage	4		0.03A to 0.25A: ±(1% FS +5DGT)
Accuracy (display, RS485) (@25°C ±5°C, R.H. ≤60%)	with CT=1 and VT=1 AV5: 1150W-VA-var, FS:230VLN, 400VLL; AV6: 285W-VA-var, FS:57VLN, 100VLL	Reactive power	0.25 to 6A: ±(2% FS +1DGT); 0.03A to 0.25A: ±(2% FS +5DGT)
Current	0.25 to 6A: ±(0.5% FS +1DGT) 0.03A to 0.25A: ±(0.5% FS +7DGT)	Active energy Reactive energy	Class 1 (I start up: 30mA) Class 2 (I start up: 30mA)
Neutral current	0.25 to 6A: ±(1.5% FS +1DGT) 0.09A to 0.25A: ±(1.5% FS +7DGT)	Frequency Harmonic distortion	±0.1Hz (48 to 62Hz) ±3% F.S. (up to 15th harmonic)
Phase-phase voltage	±(1.5% FS +1 DGT)		(F.S.: 100%)

Input specifications (cont.)

Additional errors		**Measurements**	Current, voltage, power, power factor, frequency
Humidity	≤0.3% FS, 60% to 90% RH	Type	TRMS measurement of distorted waves.
Temperature drift	≤ 200ppm/°C		
Sampling rate	1600 samples/s @ 50Hz	Coupling type	Direct
	1900 samples/s @ 60Hz	Crest factor	< 3, max 10A peak
Display refresh time	200ms (FFT off)	**Input impedance**	
	500ms (FFT on)	380/660V$_{L-L}$ (AV5)	1.6 MΩ ±5%
Display		120/208V$_{L-L}$ (AV6)	1.6 MΩ ±5%
		Current	≤ 0.02Ω
Type	LED, 14mm	**Frequency**	48 to 62 Hz
Read-out for instant. var.	3x3 DGT	**Overload protection**	(max values)
Read-out for energies	3+3+3 DGT (Max indication: 999 999 99.9)	Continuous: voltage/current	AV5: 460V$_{LN}$, 800V$_{LL}$/6A AV6: 145V$_{LN}$, 250V$_{LL}$/6A
Read-out for hour counter	1+3+3 DGT (Max. indication: 9 999 9.99)	For 500ms: voltage/current	AV5: 800V$_{LN}$, 1380V$_{LL}$/36A AV6: 240V$_{LN}$, 416V$_{LL}$/36A

Output Specifications

Digital outputs		**Relay outputs**	
Pulse type		Purpose	For alarm outputs or for pulse outputs
Number of outputs	Up to 2		
Type	Programmable from 0.01 to 500 pulses per kWh/kvarh Pulse duration ≥ 100ms < 120msec (ON), ≥ 100ms (OFF) according to EN62053-31	Type	Relay, SPST type AC 1-5A @ 250VAC DC 12-5A @ 24VDC AC 15-1.5A @ 250VAC DC 13-1.5A @ 24VDC
		Insulation	4000 V$_{RMS}$ output to measuring input, 4000 V$_{RMS}$ output to supply input.
Alarm type		**RS422/RS485**	(on request)
Number of outputs	Up to 2, independent		Multidrop
Alarm modes	Up alarm, down alarm, in window alarm, out window alarm. Start-up deactivation function available for all kinds of alarm. All of them connectable on all variables (see the table "List of the variables that can be connected to")		bidirectional (static and dynamic variables)
		Connections	2 or 4 wires, max. distance 1200m, termination directly on the instrument
		Addresses	From 1 to 255, selectable
Set-point adjustment	From 0 to 100% of the display scale	Protocol	MODBUS/JBUS (RTU)
		Data (bidirectional)	
Hysteresis	From 0 to full scale	Dynamic (reading only)	System and phase variables: see table "List of variables..."
On-time delay	0 to 255s		
Output status	Selectable; normally de-energized and normally energized	Static (writing only)	All the configuration parameters.
		Data format	1 start bit, 8 data bit, no parity,1 stop bit
Min. response time	≤400ms, filters excluded, With FFT off; ≤1s, with FFT on. Set-point on-time delay: "0 s"	Baud-rate	4800, 9600,19200, 38400bits/s
Note	The 2 digital outputs can also work as pulse output and alarm output.	Insulation	By means of optocouplers, 4000 V$_{RMS}$ output to measuring input 4000 V$_{RMS}$ output to supply input
Static outputs			
Purpose	For pulse outputs or for alarm outputs		
Signal	V$_{ON}$ 1.2 VDC/ max. 100 mA V$_{OFF}$ 30 VDC max.		
Insulation	By means of optocuplers, 4000 V$_{RMS}$ output to measuring inputs, 4000 V$_{RMS}$ output to power supply input.		

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 999, all data are protected

System selection	
System 3, unbalanced	3-phase (3-wire, 4-wire) 3-phase ARON 2-phase (3-wire)
System 3, balanced	3-phase (3-wire, 4-wire) 3-phase (3-wire) "1CT+1VT" 3-phase (3-wire) "1CT+3VT" 1-phase (2-wire)

Transformer ratio	
CT	1 to 60000
VT/PT	1.0 to 6000.0

Filter	
Operating range	0 to 100% of the input display scale
Filtering coefficient	1 to 32
Filter action	Measurements, alarms, serial output (fundamental variables: V, A, W and their derived ones).

Displaying	Up to 3 variables per page See table "Display pages"

Alarms	
Working mode	"OR" or "AND" or "OR+AND" functions (see "Alarm parameter and logic" page). Freely programmable on up to 16 total alarms (out1+out2). The alarms can be connected to any variables available in the table "List of the variables that can be connected to"

Reset	By means of keypad: The following kinds of reset are available: - all values stored as "dmd max": Idmd max, Wdmd max, VAdmd max - all values stored as "max": A_1, A_2, A_3, WL_1, WL_2, WL_3, VL_1, VL_2, VL_3, and as "Min": PF_1, PF_2, PF_3, A_1, A_2, A_3, VL_1, VL_2, VL_3 . - Only the kWh and kvarh partial counters - Both the kWh and kvarh total and partial counters - the hour counter.

Power Supply Specifications

AC/DC voltage	90 to 260VAC/DC 16 to 60VAC/DC	Power consumption	AC: 6 VA DC: 3.5 W

General Specifications

Operating temperature	0° to +50°C (32° to 122°F) (RH < 90% non condensing)	Immunity	EN61000-6-2 industrial environment.
Storage temperature	-10° to +60°C (14° to 140°F) (RH < 90% non condensing)	**Pulse voltage (1.2/50µs)**	EN61000-4-5
Overvoltage category	Cat. III (IEC 60664, EN60664)	**Safety standards**	IEC60664, IEC61010-1 EN60664, EN61010-1
Insulation (for 1 minute)	$4kVAC_{RMS}$ between measuring inputs and power supply. 4kVAC/DC @ I ≤3mA between measuring inputs and RS485. $4kVAC_{RMS}$ between power supply and RS485.	**Approvals**	CE
		Connections 5(6) A Max cable cross sect. area	Screw-type 2.5 mm^2
		Housing	
		Dimensions (WxHxD) Material	96 x 96 x 63 mm ABS self-extinguishing: UL 94 V-0
Dielectric strength	$4kVAC_{RMS}$ (for 1 min)	**Mounting**	Panel
EMC		**Protection degree**	Front: IP65 (standard) Connections: IP20
Emissions	EN61000-6-3 residential environment, commerce and light industry	**Weight**	Approx. 400 g (pack. incl.)

Insulation between inputs and outputs

	Measuring Inputs V	Measuring Inputs A	Relay outputs	Open collector outputs	Communication Port	Power Supply 90-260VAC/DC	Power Supply 18-60VAC/DC
Measuring Inputs V	-	-	4kV	4kV	2.5kV	4kV	4kV
Measuring Inputs A	-	-	4kV	4kV	2.5kV	4kV	4kV
Relay outputs	4kV	4kV	-	-	2.5kV	4kV	4kV
Open col. outputs	4kV	4kV	-	-	2.5kV	4kV	4kV
Communication Port	2.5kV	2.5kV	-	-	-	4kV	4kV
90-260VAC/DC	4kV	4kV	4kV	4kV	4kV	-	-
18-60VAC/DC	4kV	4kV	4kV	4kV	4kV	-	-

NOTE: In case of fault of first insulation the current from the measuring inputs to the ground is lower than 2 mA.

List of the variables that can be connected to:

- RS485/RS422 communication port
- Alarm outputs ("max / min" variable, "energies" and "hour counter" excluded)
- Pulse outputs (only "energies")

No	Variable	1-phase system	2-phase system	3-ph. 4-wire balanced sys.	3-ph. 4-wire unbal. sys.	3 ph. 3-wire bal. sys.	3 ph. 3-wire unbal. sys.	Notes
1	V L1	x	x	x	x	o	o	◆ ★
2	V L2	o	x	x	x	o	o	◆ ★
3	V L3	o	o	x	x	o	o	◆ ★
4	V L-N sys	o	x	x	x	o	o	Sys = system
5	V L1-2	o	x	x	x	x	x	
6	V L2-3	o	x	x	x	x	x	
7	V L3-1	o	o	x	x	x	x	
8	V L-L sys	o	x	x	x	x	x	Sys = system
9	A L1	x	x	x	x	x	x	◆ ★
10	A L2	o	x	x	x	x	x	◆ ★
11	A L3	o	o	x	x	x	x	◆ ★
12	An	o	x	x	x	x	x	
13	W L1	x	x	x	x	o	o	◆
14	W L2	o	x	x	x	o	o	◆
16	W L3	o	o	x	x	o	o	◆
17	W sys	o	x	x	x	x	x	Sys = system
18	var L1	x	x	x	x	o	o	
19	var L2	o	x	x	x	o	o	
20	var L3	o	o	x	x	o	o	
21	var sys	o	x	x	x	x	x	Sys = system
22	VA L1	x	x	x	x	o	o	
23	VA L2	o	x	x	x	o	o	
24	VA L3	o	o	x	x	o	o	
25	VA sys	o	x	x	x	x	x	Sys = system
26	PF L1	x	x	x	x	o	o	★
27	PF L2	o	x	x	x	o	o	★
28	PF L3	o	o	x	x	o	o	★
29	PF sys	o	x	x	x	x	x	Sys = system
30	Hz	x	x	x	x	x	x	
31	Phase seq.	o	x	x	x	x	x	
32	ASY L-N	o	x	x	x	x	x	
33	ASY L-L	o	x	x	x	x	x	
34	Phase loss	o	x	x	x	x	x	
35	VA sys dmd	x	x	x	x	x	x	Sys = system ◆○
36	W sys dmd	x	x	x	x	x	x	Sys = system ◆○
37	A L1 dmd	x	x	x	x	x	x	◆
38	A L2 dmd	o	x	x	x	x	x	◆
39	A L3 dmd	o	o	x	x	x	x	◆
40	A L dmd	x	x	x	x	x	x	❑
41	A L1 THD	x	x	x	x	x	x	
42	A L2 THD	o	x	x	x	x	x	
43	A L3 THD	o	o	x	x	x	x	
44	V L1 THD	x	x	x	x	x	x	
45	V L2 THD	o	x	x	x	x	x	
46	V L3 THD	o	o	x	x	x	x	
47	kWh	x	x	x	x	x	x	Total and partial
48	kvarh	x	x	x	x	x	x	Total and partial
49	hours	x	x	x	x	x	x	

(x) = available   (o) = not available

(◆) These variables are available also as MAX detection and data storage (on EEPROM at power down).
(★) These variables are available also as MIN detection and data storage (on EEPROM at power down).
(❑) Highest value among the 3-phase.
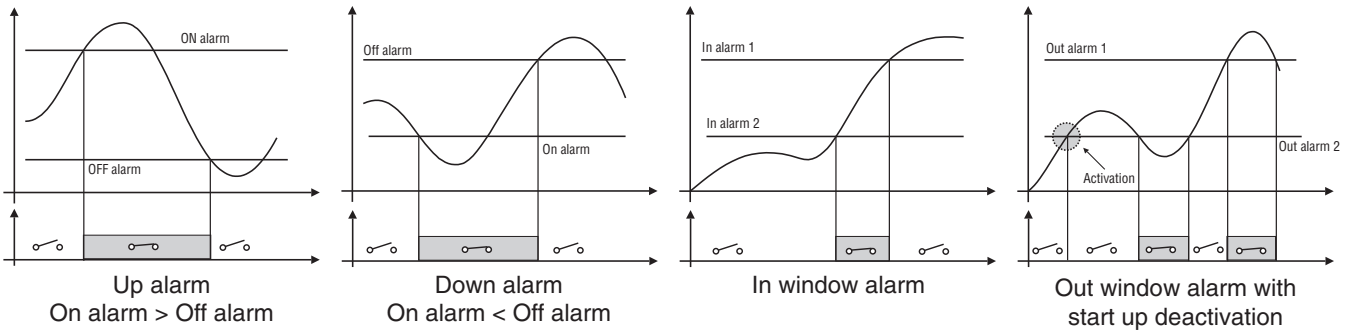(○) Alarm available only on the consumed power (+).
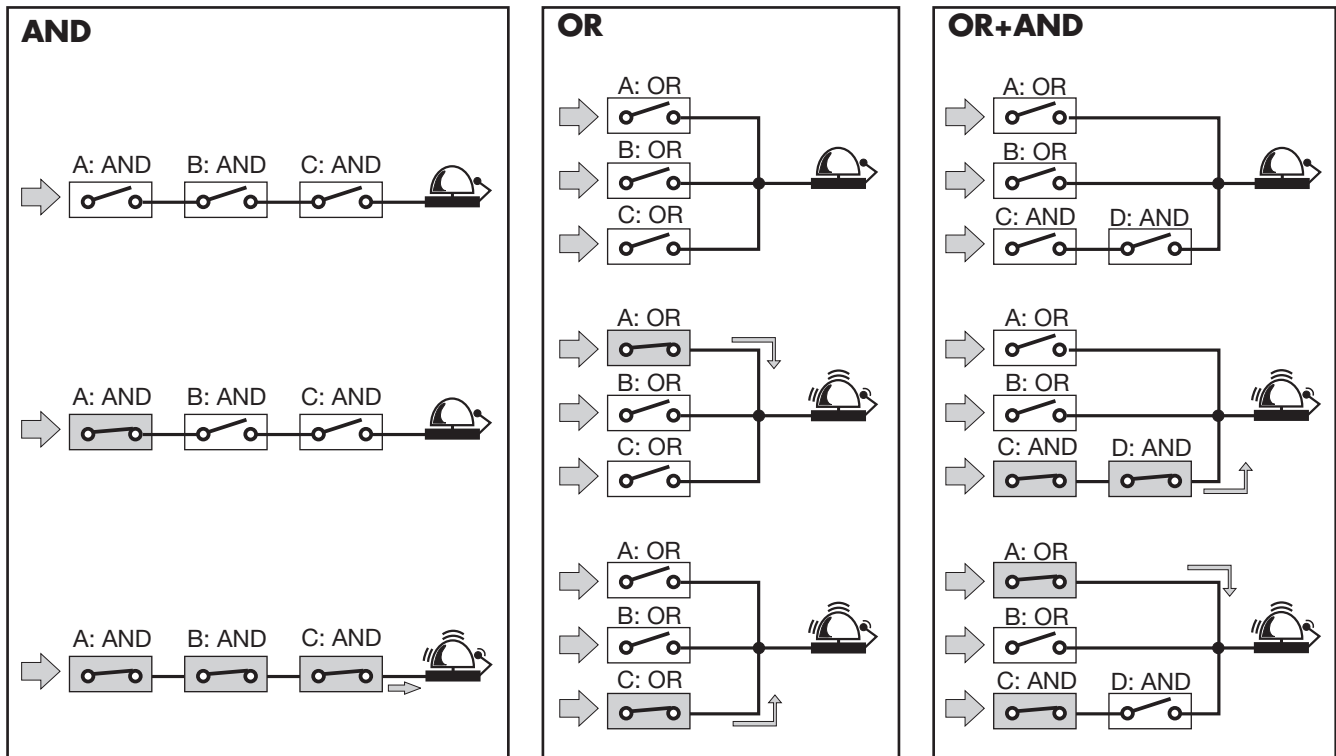
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Alarm parameters and logic

- Block enable.
- Controlled variable (VLN, ...).
- Alarm type (up, down, window int, window ext).
- Activation function.

- ON set-point.
- OFF set-point.
- ON delay.
- Logical function (AND, OR).
- Digital output (1, 2).

} **A, B, C... up to 16** parameter control blocks.

Up alarm
On alarm > Off alarm

Down alarm
On alarm < Off alarm

In window alarm

Out window alarm with start up deactivation

Note: any alarm working mode can be linked to the "Start-up deactivation" function which disables only the first alarm after power on of the instrument.

AND/OR logical alarm examples:

AND

A: AND   B: AND   C: AND

A: AND   B: AND   C: AND

A: AND   B: AND   C: AND

OR

A: OR
B: OR
C: OR

A: OR
B: OR
C: OR

A: OR
B: OR
C: OR

OR+AND

A: OR
B: OR
C: AND   D: AND

A: OR
B: OR
C: AND   D: AND

A: OR
B: OR
C: AND   D: AND

Display pages

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

No	1st variable	2nd variable	3rd variable	Note
1	%	"ASY"	"L N"	Phase to neutral asymmetry
2	V L1	V L2	V L3	
3	V LN sys		PF sys	Sys = system
4	V LL sys		PF sys	Decimal point blinking on the right of the display
5	V L1 2	V L2 3	V L3 1	Decimal point blinking on the right of the display
6	%	"ASY"	"L L"	Phase to phase asymmetry
7	"PH"	"SEq"	1 2 3 / 1 3 2	Phase sequence
8	A L1	A L2	A L3	
9	A dmd L1	A dmd L2	A dmd L3	dmd = demand (integration time selectable from 1 to 30 minutes)
10	An	"n"	Hz	An= neutral current
11	W L1	W L2	W L3	
12	W dmd L1	W dmd L2	W dmd L3	dmd = demand (integration time selectable from 1 to 30 minutes)
13	PF L1	PF L2	PF L3	
14	var L1	var L2	var L3	
15	VA L1	VA L2	VA L3	
16	VA sys	W sys	var sys	
17	VA dmd sys	W dmd sys	Hz	dmd = demand (integration time selectable from 1 to 30 minutes)
18	V max L1	V max L2	V max L3	Max value of phase to neutral voltage
19	V min L1	V min L2	V min L3	Min value of phase to neutral voltage
20	A max L1	A max L2	A max L3	Max value of current
21	A min L1	A min L2	A min L3	Min value of current
22	W max L1	W max L2	W max L3	Max value of W
23	PF min L1	PF min L2	PF min L3	Min value of PF
24	VA dmd sys max	W dmd sys max	"H"	Max system dmd
25	A dmd max		"H"	Highest value among the 3-phase
26	V L1 THD	V L2 THD	V L3 THD	
27	A L1 THD	A L2 THD	A L3 THD	
28	h (MSD)	h	h (LSD)	Hour counter
29	kvarh (MSD)	kvarh	kvarh (LSD)	Partial counter
30	kWh (MSD)	kWh	kWh (LSD)	Partial counter
31	kvarh (MSD)	kvarh	kvarh (LSD)	Total counter
32	kWh (MSD)	kWh	kWh (LSD)	Total counter

MSD: most significant digit
LSD: least significant digit
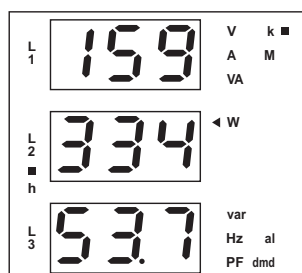
1) Example of kWh visualization:

This example is showing 15 933 453.7 kWh

2) Example of kvarh visualization:
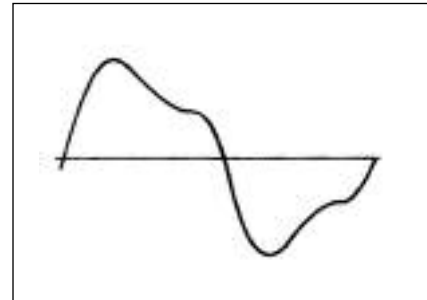
This example is showing 3 553 944.9 kvarh
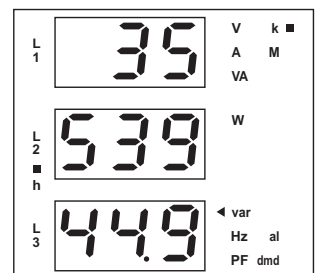
Waveform of the signals that can be measured
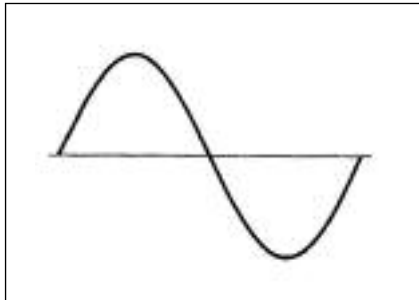
Figure A
Sine wave, undistorted

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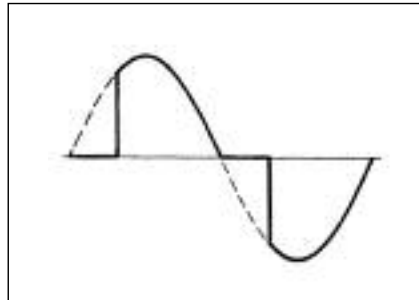
Figure B
Sine wave, indented

Fundamental content	10...100%
Harmonic content	0...90%

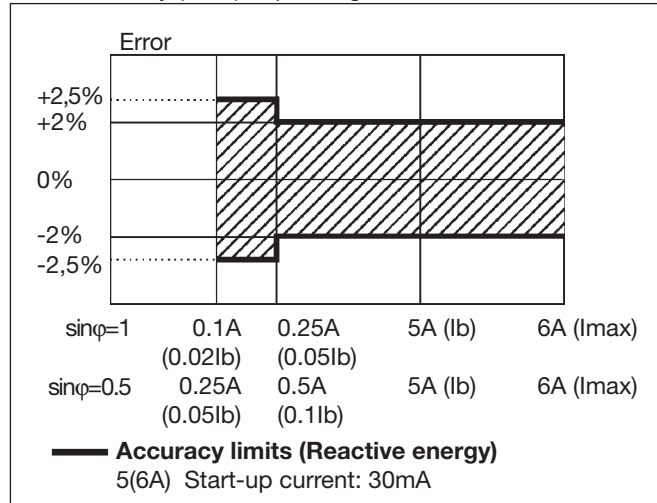Frequency spectrum: 3rd to 16th harmonic
Additional error: <1% FS

Figure C
Sine wave, distorted

Fundamental content	70...90%
Harmonic content	10...30%

Frequency spectrum: 3rd to 16th harmonic
Additional error: <0.5% FS

Accuracy

Wh, accuracy (RDG) depending on the current

PF=1	0.25A (0.05Ib)	0.5A (0.1Ib)	5A (Ib)	6A (Imax)
PF=L0.5 or C0.8	0.5A (0.1Ib)	1A (0.2Ib)	5A (Ib)	6A (Imax)

— **Accuracy limits (Active energy)**
5(6A) Start-up current: 30mA

varh, accuracy (RDG) depending on the current

sinφ=1	0.1A (0.02Ib)	0.25A (0.05Ib)	5A (Ib)	6A (Imax)
sinφ=0.5	0.25A (0.05Ib)	0.5A (0.1Ib)	5A (Ib)	6A (Imax)

— **Accuracy limits (Reactive energy)**
5(6A) Start-up current: 30mA
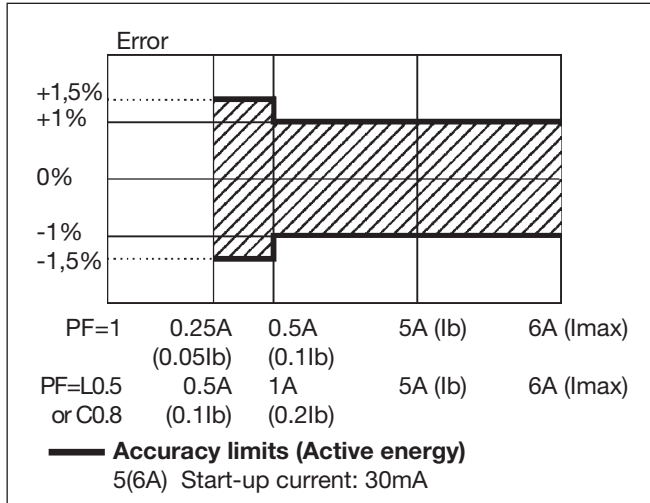
Used calculation formulas

Phase variables

Instantaneous effective voltage

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

Instantaneous active power

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

Instantaneous power factor

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

Instantaneous effective current

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

Instantaneous apparent power

$$VA_1 = V_{1N} \cdot A_1$$

Instantaneous reactive power

$$VAr_1 = \sqrt{(VA_1)^2 - (W_1)^2}$$

System variables

Equivalent three-phase voltage

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

Voltage asymmetry

$$ASY_{LL} = \frac{(V_{LL\,max} - V_{LL\,min})}{V_{LL\,\Sigma}}$$

$$ASY_{LN} = \frac{(V_{LN\,max} - V_{LN\,min})}{V_{LN\,\Sigma}}$$

Three-phase reactive power

$$VAr_\Sigma = (VAr_1 + VAr_2 + VAr_3)$$

Neutral current

$$An = \overline{A}_{L1} + \overline{A}_{L2} + \overline{A}_{L3}$$

Three-phase active power

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

Three-phase apparent power

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

Three-phase power factor

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

Energy metering

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

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

Where:

i= considered phase (L1, L2 or L3)
P= active power; **Q**= reactive power;
t₁, t₂ =starting and ending time points of consumption recording; **n**= time unit; Δ**t**= time interval between two successive power consumptions; **n₁, n₂** = starting and ending discrete time points of consumption recording
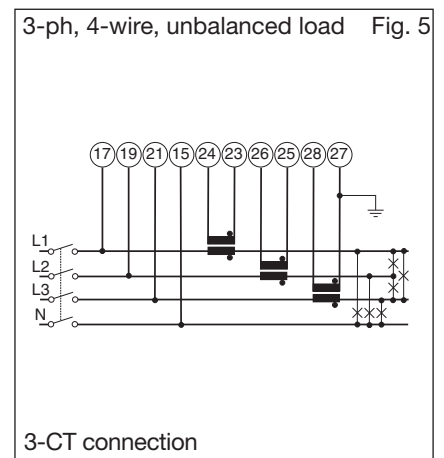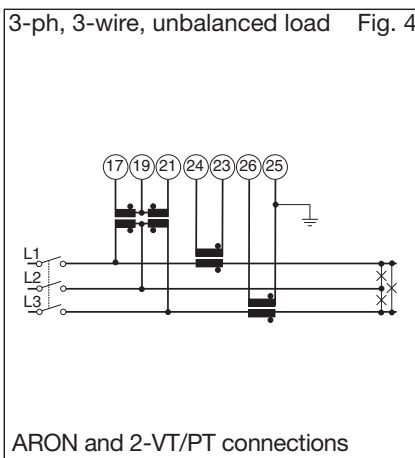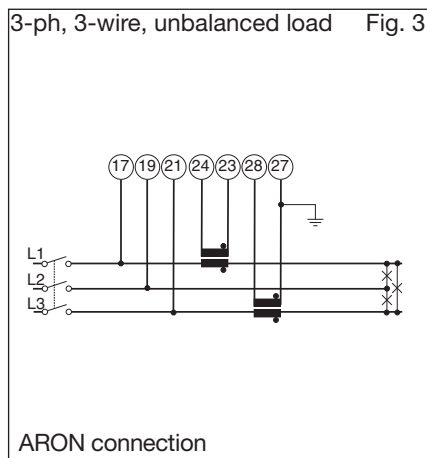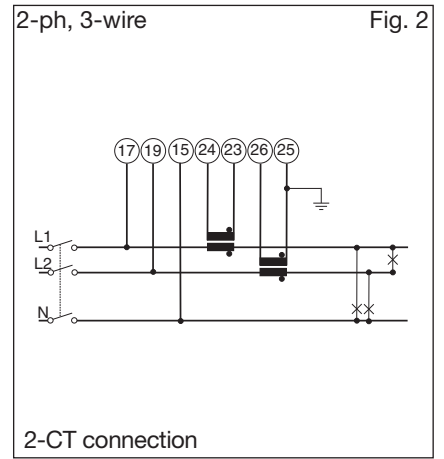
Harmonic Analysis

Analysis principle	FFT	Display of harmonic values	THD %
Harmonic measurement		**Others**	The harmonic distortion can be measured in both 3-wire or 4-wire systems.
Current	Up to 15th harmonic		
Voltage	Up to 15th harmonic		
Type of harmonics	THD (V$_L$1)		
	THD (V$_L$2)		
	THD (V$_L$3)		
	THD (A$_L$1)		
	THD (A$_L$2)		
	THD (A$_L$3)		

Wiring diagrams

When the CT is connected to earth, a leakage current from 0 to 1.8mA max is generated, whose value depends on the input impedance values of the instrument, on the type of connection and on the line voltage measured by the instrument.

1-ph, 2-wire   Fig. 1

1-CT connection

2-ph, 3-wire   Fig. 2

2-CT connection

3-ph, 3-wire, unbalanced load   Fig. 3

ARON connection

3-ph, 3-wire, unbalanced load   Fig. 4

ARON and 2-VT/PT connections

3-ph, 4-wire, unbalanced load   Fig. 5

3-CT connection

NOTE: the current inputs can be connected to the mains ONLY by means of current transformers. The direct connection is not allowed.

CARLO GAVAZZI
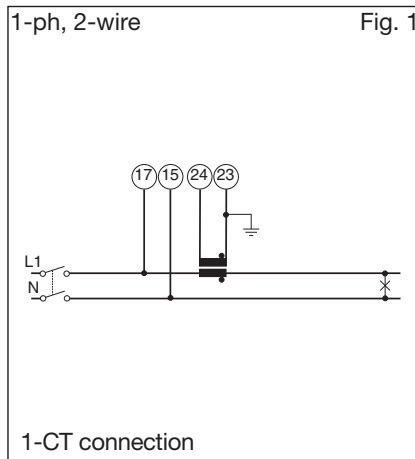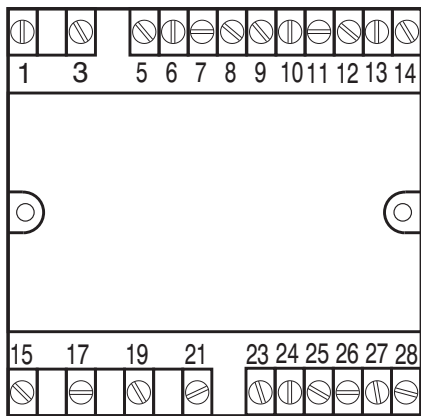
Wiring diagrams

When the CT is connected to earth, a leakage current from 0 to 1.8mA max is generated, whose value depends on the input impedance values of the instrument, on the type of connection and on the line voltage measured by the instrument.

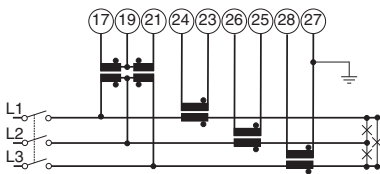
3-ph, 4-wire, unbalanced load   Fig. 6
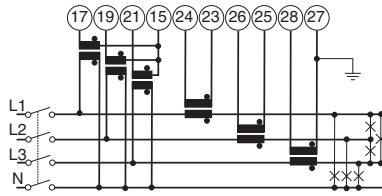
3-CT and 3-VT/PT connections
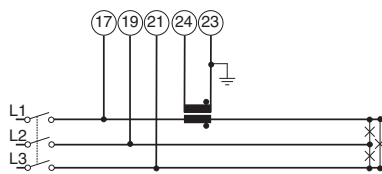

3-ph, 3-wire, unbalanced load   Fig. 7
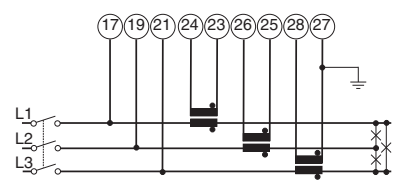
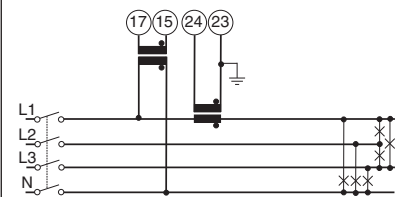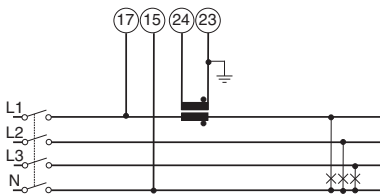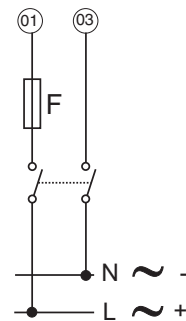3-CT connection

3-ph, 3-wire, unbalanced load   Fig. 8

3-CT and 2-VT/PT connections

3-ph, 3-wire, balanced load   Fig. 9

1-CT connection

3-ph, 4-wire balanced load   Fig. 10

1-CT and 1-VT/PT connections

3-ph, 4-wire, balanced load   Fig. 11

1-CT connection

Fig. 12

Power supply connection

NOTE: the current inputs can be connected to the mains ONLY by means of current transformers. The direct connection is not allowed.
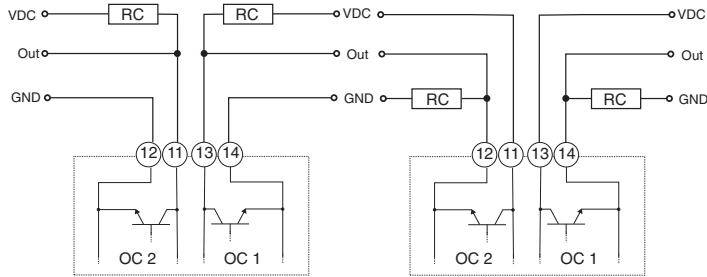
Output connections

Fig. 13

Fig. 14

Relay out.

Fig. 15

RS485 port

Fig.16

Fig. 17

Open collector outputs: The load resistance (Rc) 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: external power supply voltage. Out: positive output contact (open collector transistor). GND: ground output contact (open collector transistor).
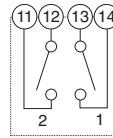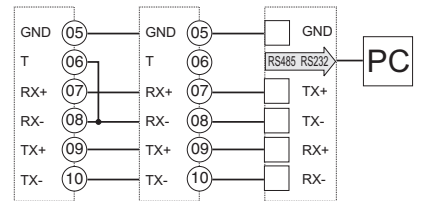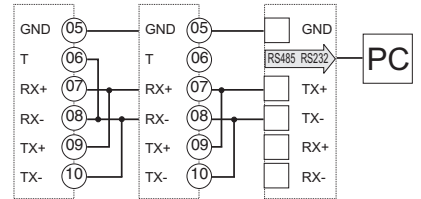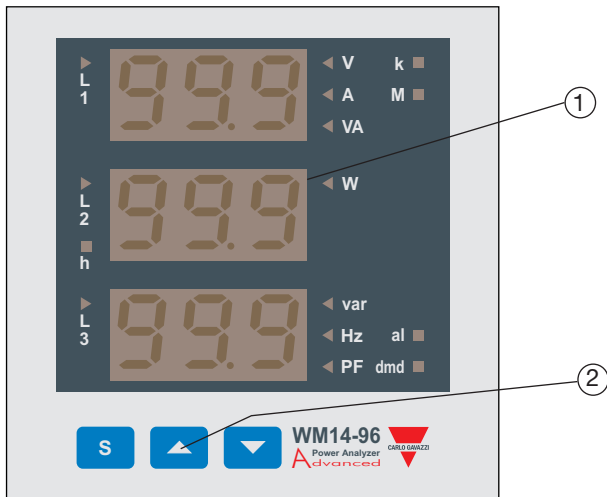
Front Panel Description

1. **Display**
   LED-type with alphanumeric indications to:
   - display configuration parameters;
   - display all the measured variables.

2. **Key-pad**
   To program the configuration parameters and the display of the variables.

   S
   Key to enter programming and confirm selections;

   ▲ ▼
   Keys to:
   - programme values;
   - select functions;
   - display measuring pages.

Dimensions and Panel Cut-out

96mm

96mm

96mm

61.4mm   15.4mm

☐ 91mm