Energy Management
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

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
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
Neutral current: 0.09A to 6A

System

3 : 1, 2 or 3 phase, balanced/unbalanced load, with or without neutral

Power supply

L: 18 to 60 VAC/VDC
H: 90 to 260 VAC/VDC

Output 1

R2: 2-relay outputs
O2: 2-open collector outputs

Output 2

XX: None
S1: RS485/RS422 port

Options

AX: advanced functions

Input specifications

Rated inputs Current Voltage	System type: 3 - phase 3 (By shunts) 4
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
Current	0.25 to 6A: ±(0.5% FS +1DGT) 0.03A to 0.25A: ±(0.5% FS +7DGT)
Neutral current	0.25 to 6A: ±(1.5% FS +1DGT) 0.09A to 0.25A: ±(1.5% FS +7DGT)
Phase-phase voltage	±(1.5% FS +1 DGT)
Phase-neutral voltage	±(0.5% FS + 1 DGT)
Active and Apparent power,	0.25 to 6A: ±(1% FS +1DGT); 0.03A to 0.25A: ±(1% FS +5DGT)
Reactive power	0.25 to 6A: ±(2% FS +1DGT); 0.03A to 0.25A: ±(2% FS +5DGT)
Active energy	Class 1 (start up current: 30mA)
Reactive energy	Class 2 (start up current: 30mA)
Frequency	±0.1Hz (48 to 62Hz)
Harmonic distortion	±3% F.S. (up to 15th harmonic) (F.S.: 100%)

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Input specifications (cont.)

Additional errors	
Humidity	≤0.3% FS, 60% to 90% RH
Temperature drift	≤ 200ppm/°C
Sampling rate	1600 samples/s @ 50Hz 1900 samples/s @ 60Hz
Display refresh time	200ms (FFT off) 500ms (FFT on)
Display	
Type	LED, 14mm
Read-out for instant. var.	3x3 DGT
Read-out for energies	3+3+3 DGT (Max indication: 999 999 99.9)
Read-out for hour counter	1+3+3 DGT (Max. indication: 9 999 9.99)

Measurements	Current, voltage, power, power factor, frequency
Type	TRMS measurement of distorted waves.
Coupling type	Direct
Crest factor	< 3, max 10A peak
Input impedance	
380/660V_{L-L} (AV5)	1.6 MW ±5%
120/208V_{L-L} (AV6)	1.6 MW ±5%
Current	≤ 0.02Ω
Frequency	48 to 62 Hz
Overload protection	(max values)
Continuous: voltage/current	AV5: 460V_{LN}, 800V_{LL}/6A AV6: 145V_{LN}, 250V_{LL}/6A
For 500ms: voltage/current	AV5: 800V_{LN}, 1380V_{LL}/36A AV6: 240V_{LN}, 416V_{LL}/36A

Output Specifications

Digital outputs	
Pulse type	
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
Alarm type	
Number of outputs	Up to 2, independent
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")
Set-point adjustment	From 0 to 100% of the display scale
Hysteresis	From 0 to full scale
On-time delay	0 to 255s
Output status	Selectable; normally de-energized and normally energized
Min. response time	≤400ms, filters excluded, With FFT off; ≤1s, with FFT on. (With Set-point on-time delay: "0 s")
Remote control	The digital outputs status can be managed by means of serial communication RS485 if programmed as "rEm"
Note	The 2 digital outputs can also work as pulse output and alarm output.
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.

Relay outputs	
Purpose	For alarm outputs or for pulse outputs
Type	Relay, SPST type AC 1-5A @ 250VAC DC 12-5A @ 24VDC AC 15-1.5A @ 250VAC DC 13-1.5A @ 24VDC
Mecanical life	≥30x10^6 operations
Electrical life	≥10^5 operations (@ 5A, 250V, PF1)
Insulation	4000 V_{RMS} output to measuring input, 4000 V_{RMS} output to supply input.
RS422/RS485	(on request) Multidrop bidirectional (static and dynamic variables)
Connections	2 or 4 wires, max. distance 1000m, termination directly on the instrument
Addresses	From 1 to 255, selectable
Protocol	MODBUS/JBUS (RTU)
Data (bidirectional)	
Dynamic (reading only)	System and phase variables: see table "List of variables..."
Static (reading and writing)	All the configuration parameters.
Data format	1 start bit, 8 data bit, no parity,1 stop bit
Baud-rate	4800, 9600,19200, 38400bits/s
Insulation	By means of optocouplers, 2.5 K V_{RMS} output to measuring input 2.5 K V_{RMS} 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 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 (4-wire) "1CT+1VT" 3-phase (3-wire) "1CT+2VT" 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": Admd 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	-30 to +60°C (-22 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, cULus
		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 Emissions	 EN61000-6-3 residential environment, commerce and light industry	**Protection degree**	Front: IP65 (standard), NEMA4x, NEMA12 Connections: IP20
		Weight	Approx. 400 g (pack. incl.)

Insulation between inputs and outputs

	Measuring Inputs V	Measuring Inputs A	Relay outputs	Open collector out-puts	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.

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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	H
27	PF L2	o	x	x	x	o	o	H
28	PF L3	o	o	x	x	o	o	H
29	PF sys	o	x	x	x	x	x	Sys = system
30	Hz	x	x	x	x	x	x	
31	Phase seq.	o	o	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).
(H) 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 (+).
(#) These variables are available also for the MAX values, which have not been stored in the EEPROM at power down.
(∆) These variables are available also for the MIN values, which have not been stored in the EEPROM at power down.

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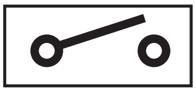
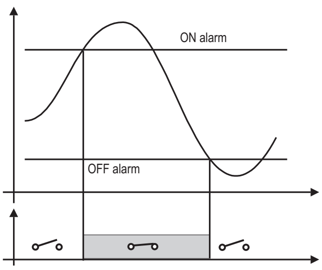
Alarm parameters and logic



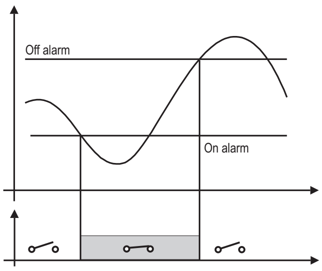
- Block enable.
- Controlled variable (VLN, ...).
- Alarm type (up, down, in window, out window).
- Activation function.

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

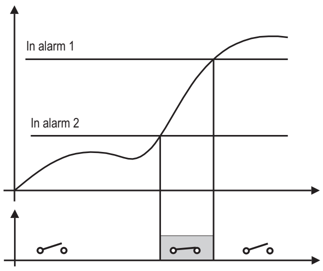
A, B, C... up to 16 parameter control blocks.



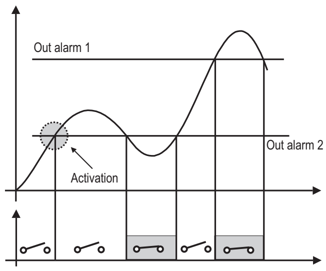
Up alarm
On alarm > Off alarm



Down alarm
On alarm < Off alarm



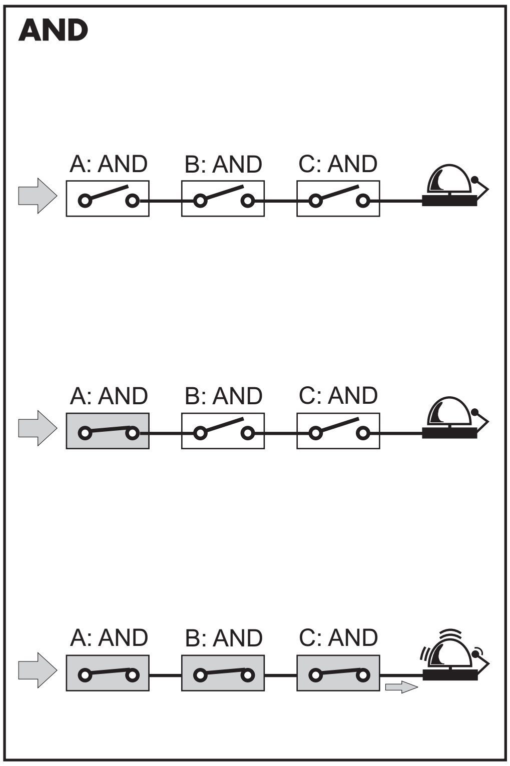
In window alarm

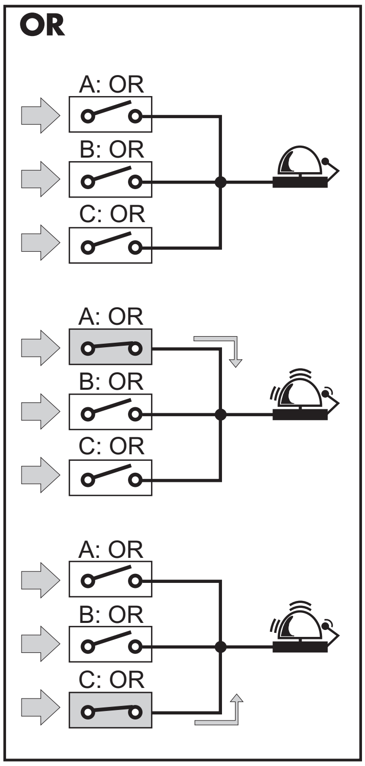


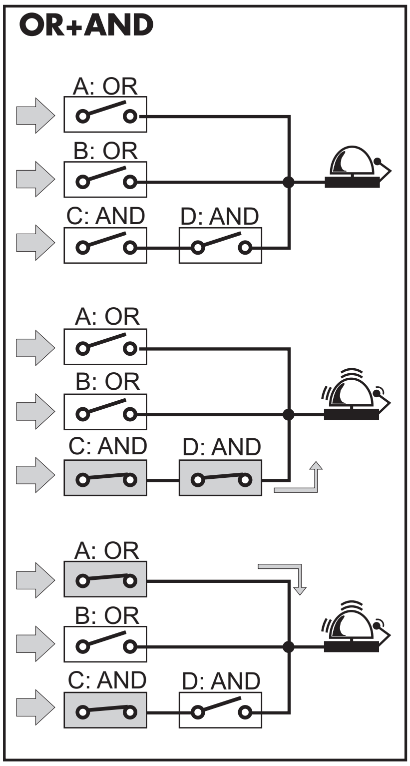
Out window alarm with start up deactivation

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:





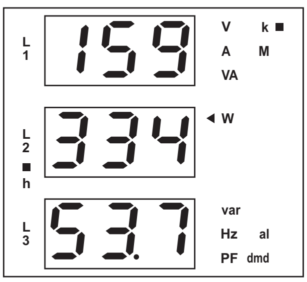


Display pages

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

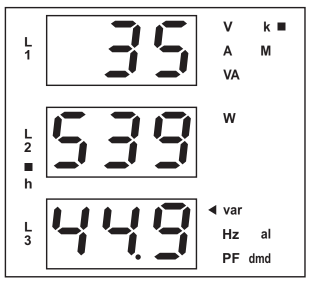


1) Example of kWh visualization:

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

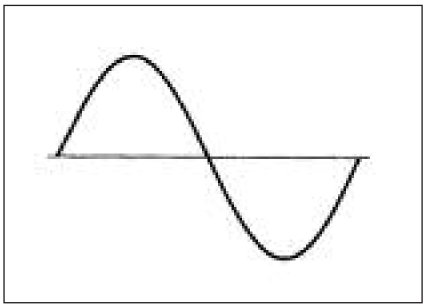


Figure A
Sine wave, undistorted
Fundamental content 100%
Harmonic content 0%
A_{rms} = 1.1107 | A |

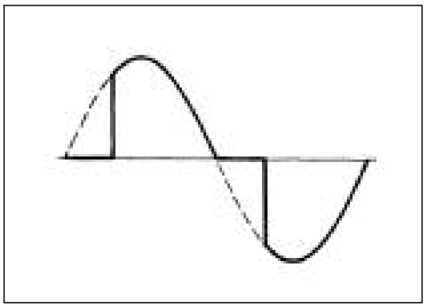


Figure B
Sine wave, indented
Fundamental content 10...100%
Harmonic content 0...90%
Frequency spectrum: 3rd to 16th harmonic
Additional error: <1% FS

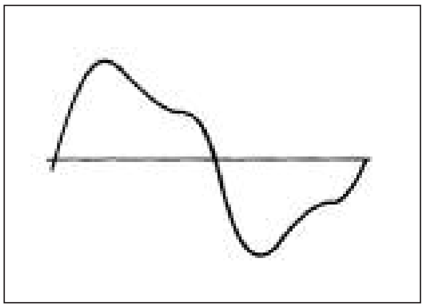
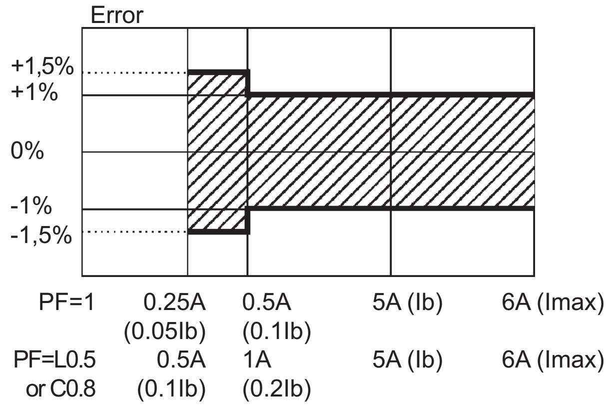


Figure C
Sine wave, distorted
Fundamental content 70...90%
Harmonic content 10...30%
Frequency spectrum: 3rd to 16th harmonic
Additional error: <0.5% FS

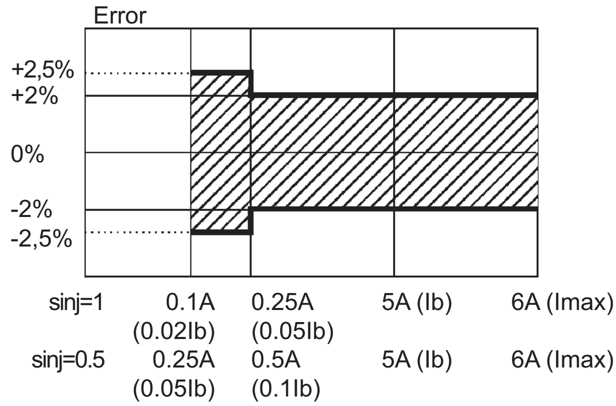
Accuracy

Wh, accuracy (RDG) depending on the current



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

varh, accuracy (RDG) depending on the current



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

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

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

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

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

Where:

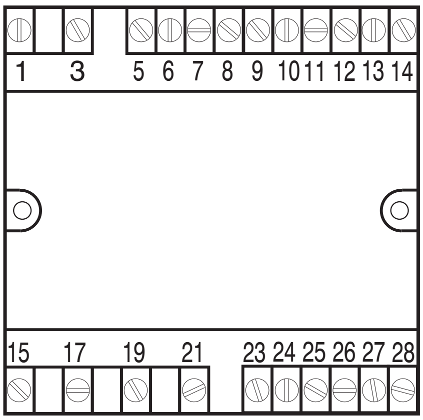
i= considered phase (L1, L2 or L3)
P= active power; **Q**= reactive power;
t_1, t_2 =starting and ending time points of consumption recording; **n**= time unit;**Δt**= time interval between two successive power consumptions;
n_1, n_2 = starting and ending discrete time points of consumption recording

Harmonic Analysis

Analysis principle	FFT
Harmonic measurement	
Current	Up to 15th harmonic
Voltage	Up to 15th harmonic
Type of harmonics	THD (VL1) THD (VL2) THD (VL3) THD (AL1) THD (AL2) THD (AL3)
Display of harmonic values	THD %
Others	The harmonic distortion can be measured in both 3-wire or 4-wire systems.

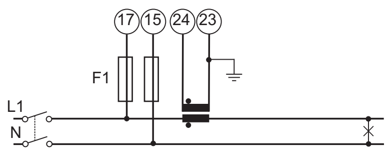
Wiring diagrams

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.



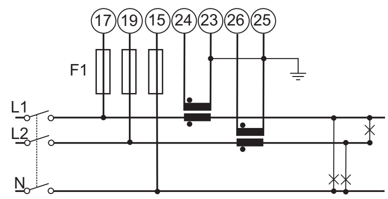
F1= 315mA

1-ph, 2-wire Fig. 1



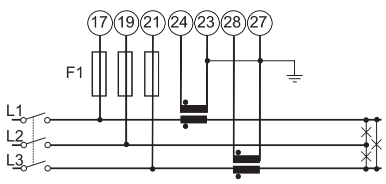
1-CT connection

2-ph, 3-wire Fig. 2



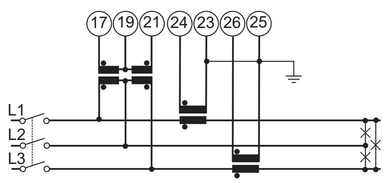
2-CT connection

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



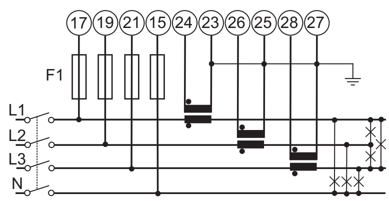
ARON connection

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



ARON and 2-VT/PT connections

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

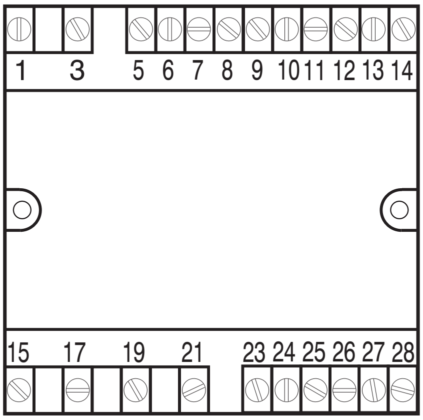


3-CT connection

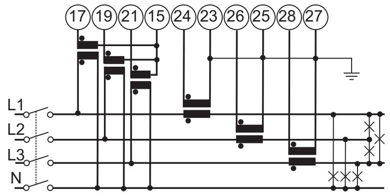
NOTE: the current inputs can be connected to the mains ONLY by means of current transformers. The direct connection is not allowed.

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.

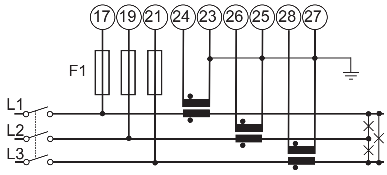


3-ph, 4-wire, unbalanced load Fig. 6



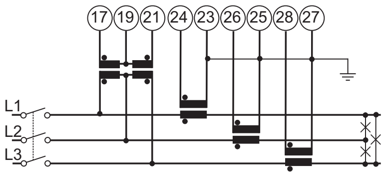
3-CT and 3-VT/PT connections

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



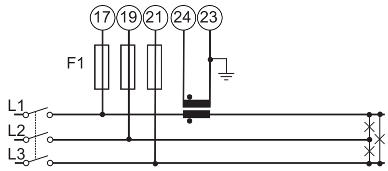
3-CT connection

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



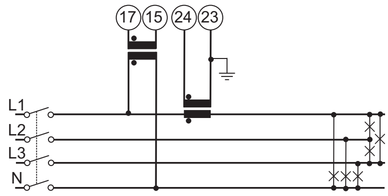
3-CT and 2-VT/PT connections

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



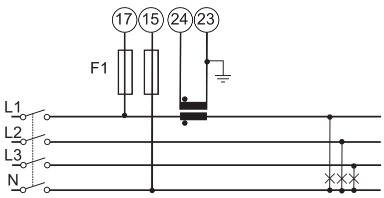
1-CT connection

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



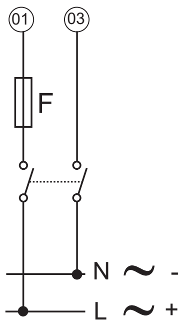
1-CT and 1-VT/PT connections

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.

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Output connections

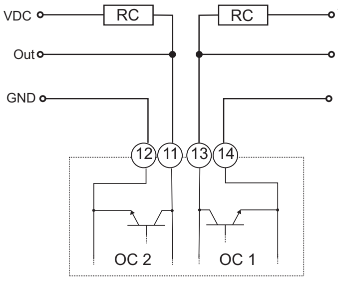


Fig. 13

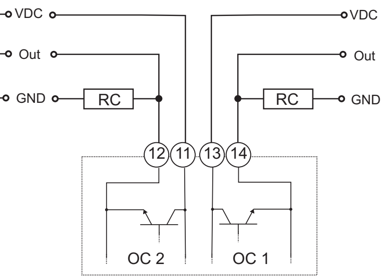


Fig. 14

Relay out.

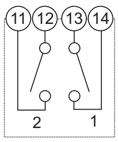


Fig. 15

RS485 port

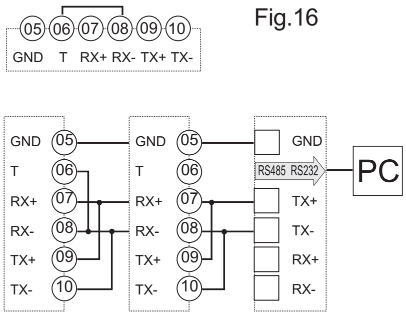


Fig.16

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).

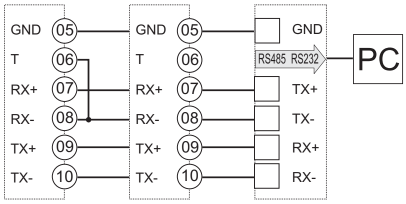
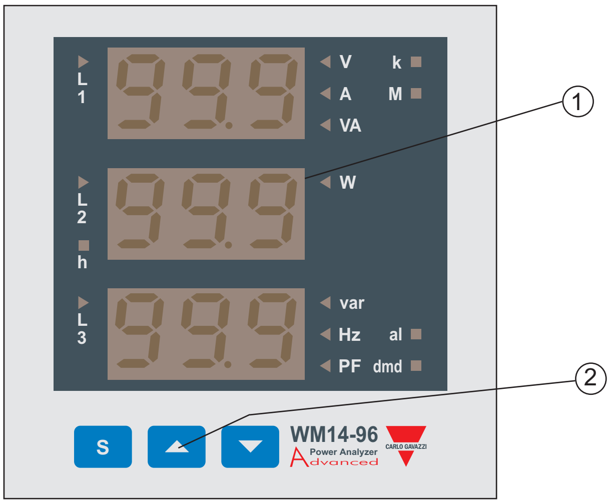


Fig. 17

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