

Energy Management Modular Power Quality Analyzer Type WM23-96



- Accuracy ± 0.5 F.S. (current/voltage)
- Three-phase modular power analyzer
- Backlighted LCD 4x3 1/2 DGT Display
- Front size: 96x96 mm
- Measurements of phase and system variables: W, W_{dmd} , var, VA, VA_{dmd} , PF, V_{L-N} , V_{L-L} , A, An, Hz, THD-A, THD-V
- TRMS measurement of distorted waves (voltages/currents)
- Measurement of MAX values: W L1, W L2, W L3, W_{Σ} , W_{dmd}
- Measurement of MIN values: PF L1, PF L2, PF L3, PF_{Σ}
- Harmonic analysis (FFT) up to the 16th harmonic (current and voltage)
- Instantaneous variables read-out: 4x3 1/2 digit
- Up to 2 optional relay or open collector outputs
- 1 optional analogue output

- Phases asymmetry control
- Optional RS 232 serial port
- Optional RS 422/485 serial port

- MODBUS, JBUS Protocol
- Protection degree (front): IP 65
- Universal power supply: 18-60VAC/VDC, 90-260 VAC/VDC

Product Description

μ P-based three-phase modular power quality analyzer with built-in programming key-pad. Particularly recommended for

a detailed analysis of the electrical variables and of the power quality. Housing for panel mounting and IP65 (front) protection degree.

Ordering Key

WM23-96AV53H XX XX XX XX X



Type selection

| Range code | Slot A (signal retransmission) | Slot B (communication) | Slot C (redundant output or digital inputs) |
|---|--|---|---|
| AV4: 208VLL/5(6)AAC -20% \leq Un \leq +20% | XX: None | XX: None | XX: None |
| AV5: 400VLL/5(6)AAC -20% \leq Un \leq +15% | A1: Single analogue output, 20mADC | S1: Serial port, RS485 multidrop, bidirectional | R1: Single relay output (AC1-8AAC, 250VAC) |
| AV6: 100VLL/5(6)AAC -20% \leq Un \leq +15% | A2: Single analogue output, ± 5 mADC | NOTE: max. digital output (alarms and/or pulses): 2, any exceeding output is redundant. | R2: Dual relay output (AC1-8AAC, 250VAC) |
| AV7: 660VLL/5(6)AAC -30% \leq Un \leq +15% | A3: Single analogue output, ± 10 mADC | | O1: Single open collector output (30V/100mADC) |
| 50-60 Hz for all input modules. Module not removable. | A4: Single analogue output, ± 20 mADC | NOTE: the second analogue output is intended as redundant type only. | O2: Dual open collector output (30V/100mADC) |
| System | B1: Dual analogue output, 20mADC | | D1: 3 digital inputs |
| 3: Three-phase, unbalanced load, with or without neutral | B2: Dual analogue output, ± 5 mADC | NOTE: with the A, B, C, D types power supply, only an open collector module or a single relay output module can be used. The instrument can be fully equipped only with L and H type power supply. | D2: 3 digital inputs + aux output |
| Power supply | B3: Dual analogue output, ± 10 mADC | | Slot D (alarm output) |
| A: 24 VAC -15 +10% 50-60Hz | B4: Dual analogue output, ± 20 mADC | XX: None | R1: Single relay output, (AC1-8AAC, 250VAC) |
| B: 48 VAC -15 +10% 50-60Hz | V1: Single analogue output, 10VDC | R2: Dual relay output, (AC1-8AAC, 250VAC) | O1: Single open collector output (30V/100mADC) |
| C: 115VAC -15 +10% 50-60Hz | V2: Single analogue output, ± 1 VDC | O2: Dual open collector output (30V/100mADC) | Options |
| D: 230 VAC -15 +10% 50-60Hz | V3: Single analogue output, ± 5 VDC | X: None | S: RS232 serial port |
| L: 18 to 60VAC/VDC | V4: Single analogue output, ± 10 VDC | | |
| H: 90 to 260VAC/VDC | W1: Dual analogue output, 10VDC | | |
| | W2: Dual analogue output, ± 1 VDC | | |
| | W3: Dual analogue output, ± 5 VDC | | |
| | W4: Dual analogue output, ± 10 VDC | | |

Input Specifications

| | | | |
|---|--|---|--|
| Number of analogue inputs | | | |
| Current | 3 | Active power (@ 25°C ± 5°C, R.H. ≤ 60%) | ±(1% Pn +2DGT) |
| Voltage | 4 | Reactive Power (@ 25°C ± 5°C, R.H. ≤ 60%) | ±(2% Pn +2DGT) |
| Digital Inputs | | Apparent power (@ 25°C ± 5°C, R.H. ≤ 60%) | ±(1% Pn +2DGT) |
| AQ1038 | Number of inputs: 3 (voltage free) | Harmonic distortion (@ 25°C ± 5°C, R.H. ≤ 60%) | ±3% F.S. (up to 16 th harmonic) (F.S.: 100%) |
| Use | Synchronization of the W-VAdmd measurements Input 1: lock of programming Inputs 2 and 3: W-VA dmd measurements synchronization | Additional errors | |
| Reading voltage AQ1042 | 24VDC/1mA Number of inputs: 3 + inputs power supply | Humidity | ≤0.3% F.S. from 60% to 90% H.R. |
| Input frequency | Max 20Hz, duty cycle 50% | Temperature drift | ≤200ppm/°C |
| Output voltage | 16V<+Aux<24VDC | Display | Back-lighted LCD 4x3 ¹ / ₂ digit 70 x 38mm |
| Output current | Max 15mA | Sampling rate | 700ms |
| Open contact resistance | Min 100kΩ | Measurements | Current, voltage, power, power factor, frequency, harmonic distortion. TRMS measurement of a distorted wave. |
| Insulation | 4000VRMS | Coupling type | Direct |
| Accuracy (display, RS232, RS485) | In=5A; Pn= In* Un Un: F.S. range AV4-5-6-7 | Input impedance | |
| Current | ±(0.5% In +2DGT) | 208VLL 5(6)AAC (AV4): | >200 kΩ |
| Phase-neutral voltage | ±(0.5% Un +2DGT) | 400VLL 5(6)AAC (AV5): | >900 kΩ |
| Phase-phase voltage | ±(1% Un +2DGT) | 100VLL 5(6)AAC (AV6): | >200 kΩ |
| Frequency | ±0.1Hz | 660VLL 5(6)AAC (AV7): | >900 kΩ |

Output Specifications

| | | |
|-------------------------|---|--|
| Analogue Outputs | (on request) | measuring input |
| Number of outputs | Up to 1 (+1 redundant) | 4000 V _{RMS} output to supply input |
| Accuracy | ±0.2% f.s. (@ 25°C ±5°C, R.H. ≤60%) | |
| Range | 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 | RS422/RS485 |
| Scaling factor: | Programmable within the whole range of retransmission; it allows the retransmission management of all values from: 0 and 20 mADC, | (on request) Multidrop bidirectional (static and dynamic variables) |
| Response time | ≤ 900 ms typical (filter excluded, FFT excluded) | Connections 2 or 4 wires, max. distance 1200m, termination directly on the instrument |
| Ripple | ≤1% acc. to IEC 60688-1, EN 60688-1 | Addresses Protocol Data (bidirectional) Dynamic (reading only) |
| Total temperature drift | ≤ 500 ppm/°C | Static (writing only) |
| Load: | 20 mADC ≤ 600 Ω | Data format |
| ±20 mADC | ≤ 550 Ω | Baud-rate |
| ±10 mADC | ≤ 1100 Ω | Insulation |
| ± 5 mADC | ≤ 2200 Ω | By means of optocouplers, 4000 V _{RMS} output to measuring input 4000 V _{RMS} output to supply input |
| 10 VDC | ≥ 10 kΩ | RS232 |
| ±10 VDC | ≥ 10 kΩ | (on request) bidirectional (static and dynamic variables) |
| ± 5 VDC | ≥ 10 kΩ | Connections |
| ± 1 VDC | ≥ 10 kΩ | Data format |
| Insulation | By means of optocouplers, 4000 V _{RMS} output to | Baud-rate |

Output Specifications (cont.)

| | | | |
|--|--|--------------------|--|
| Protocol other data | MODBUS/JBUS (RTU) as per RS422/485 | Output type | Relay, SPDT type AC 1-8A @ 250VAC DC 12-5A @ 24VDC AC 15-2.5A @ 250VAC DC 13-2.5A @ 24VDC |
| Digital outputs | (on request) To be used as alarms or remote control. | Min. response time | ≤ 150 ms, filter excluded, FFT excluded, setpoint on-time delay: "0 s" |
| Alarm outputs Number of outputs Alarm type Variables to be controlled Set-point adjustment Hysteresis On-time delay Relay status | (on request) up to 2, independent Up alarm, down alarm see the "List of the variables that can be connected..." from 0 to 100% of the electrical scale from 0 to 100% of the electrical scale 0 to 255s Selectable, normally de-energized and normally energized | Insulation | By means of optocouplers, 4000 V _{RMS} output to measuring input, 4000 V _{RMS} output to supply input. |
| | | Note | The outputs can be either relay type or open collector type (V _{ON} 1.2VDC/Max. 100mA, V _{OFF} 30VDC Max.). Insulation like relay outputs. |

Software Functions

| | | |
|---|---|---|
| Password 1st level 2nd level | Numeric code of max 4 digits; 2 protection levels of the programming data Password "0", no protection Password from 1 to 1000, all data are protected. | Page 5: PF L1 (min), PF L2 (min), PF L3 (min) Page 6: W L1, W L2, W L3 Page 7: W L1 (max), W L2 (max), W L3 (max) |
| Transformer ratio | CT from 1 to 5000 VT from 1.0 to 1999, where CT x VT ≤ 10000 | Page 8: var L1, var L2, var L3 Page 9: VA L1, VA L2, VA L3 Page 10: AL1 (alarm 1) Page 11: AL2 (alarm 2) Page 12: W _Σ , PF _Σ , var _Σ , Hz Page 13: W _Σ , PF _Σ , VA _Σ , Hz Page 14: W _Σ (max), PF _Σ (min) Page 15: W dmd, VA dmd, r.t. Page 16: W dmd (max), VA dmd (max) Page 17: THD VL1, THD VL2, THD VL3 Page 17: THD AL1, THD AL2, THD AL3 |
| Power demand (dmd) Integration time | Programmable from 1 to 30 min | |
| Filter Filter operating range Filtering coefficient Filter action | From 0 to 99.9% of the input electrical scale 1 to 16 Measurements, alarms, serial port (fundamental variables: V, A, W and their derived ones). | |
| Page Variables Three-phase system with neutral | Up to 4 by page Page 1: V L1, V L2, V L3, V LN _Σ Page 2: V L12, V L13, V L31, V _Σ Page 3: A L1, A L2, AL3, An Page 4: PF L1, PF L2, PF L3, PF _Σ | |

Supply Specifications

| | | |
|-------------------|--|---|
| AC voltage | 90 to 260 VDC/VAC 18 to 60VDC/VAC 24 VAC -15+10% 50-60Hz 48 VAC -15+10% 50-60Hz | 115VAC -15+10% 50-60Hz 230 VAC -15+10% 50-60Hz |
| | 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) | Immunity | light industry environment EN 61000-6-2 (class A) industrial environment |
| Storage temperature | -10 to +60°C (14 to 140°F) (R.H. < 90% non condensing) | Other standards | |
| Installation category | Cat. III (IEC 60664) | Safety | IEC 61010-1, EN 61010-1 |
| Pollution degree | 2 | Product | IEC 60688-1, EN 60688-1 |
| Key-pad lock | by means of a rotary switch placed behind the display or by means of a contact (in case of presence of the digital inputs module) | Approvals | CE |
| Insulation | 4000 V _{RMS} between all inputs/outputs to ground | Connections 5(6)A | Screw-type, max 2.5 mm ² wires (2 x 1.5mm ²) |
| Dielectric strength | 4000 V _{RMS} for 1 minute | Housing | |
| EMC | | Dimensions | 96x96x140 mm |
| Emissions | EN50082-1 (class A) residential, commercial and | Material | ABS, NORYL, PC (front) self-extinguishing: UL 94 V-0 |
| | | Protection degree | Front: IP65 Connections: IP20 |
| | | Weight | Approx. 400 g (packing incl.) |

Function Description

Input/analogue output scaling capability

Working of the analogue output (Y) versus the input variable (X) - (input/output scaling capability)

Figure A

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

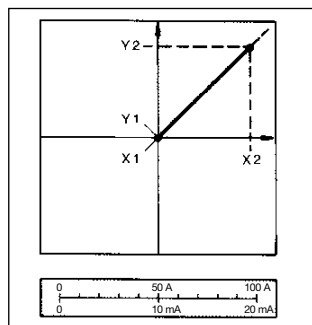


Figure D

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

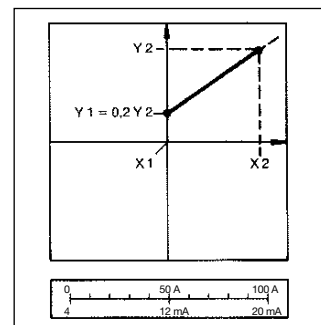


Figure B

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

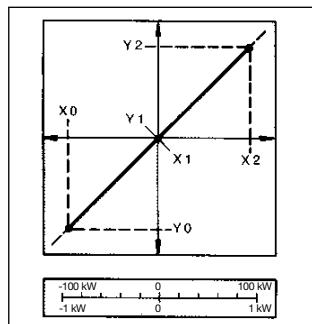


Figure E

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

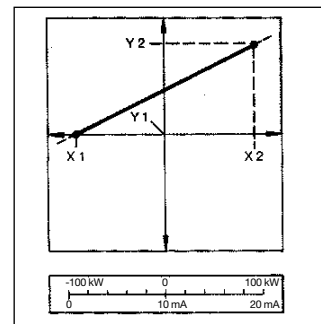


Figure C

The sign of measured quantity and output quantity remains the same. From X0 to X1, the output variable is 0. The range X1...X2 is delineated on the entire output range.

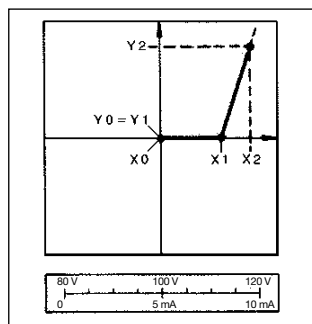
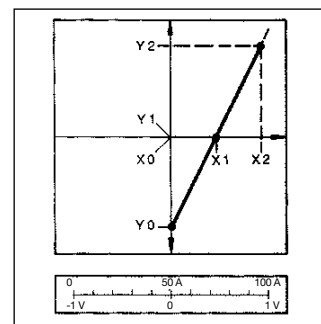


Figure F

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.



Mode of operation

Waveform of the signals that can be measured

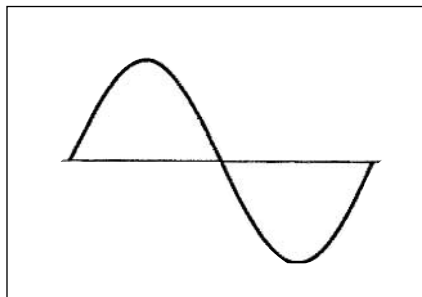


Figure G

Sinewave, undistorted

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

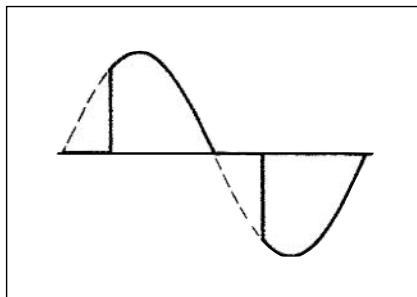


Figure H

Sinewave, indented

Fundamental content 10...100%
 Harmonic content 0...90%
 Frequency spectrum: 3rd to 16th harmonic

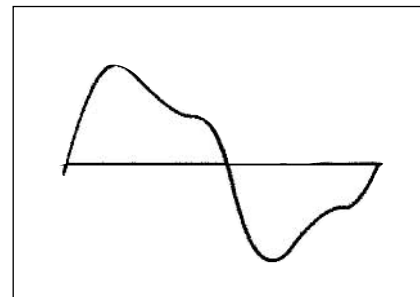


Figure I

Sinewave, distorted

Fundamental content 70...90%
 Harmonic content 10...30%
 Frequency spectrum: 3rd to 16th harmonic

Harmonic Analysis

| Analysis principle | FFT | Display pages | THD % |
|---|--|---------------|---|
| Harmonic measurement Current Voltage | Up to 16th harmonic Up to 16th harmonic | Others | The harmonic distortion can be measured in both 3-wire or 4-wire systems. |
| Type of harmonics | THD (V _{L1}) THD (V _{L2}) THD (V _{L3}) THD (A _{L1}) THD (A _{L2}) THD (A _{L3}) | | |

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 | Notes |
|----|--------------|--------------|--------------|----------------|--|
| 1 | V L1 | V L2 | V L3 | V LN Σ | Σ = system |
| 2 | V L1-2 | V L2-3 | V L3-1 | V Σ | Σ = system |
| 3 | A L1 | A L2 | A L3 | A _n | A _n = neutral current |
| 4 | PF L1 | PF L2 | PF L3 | PF Σ | Σ = system |
| 5 | PF L1 (min) | PF L2 (min) | PF L3 (min) | | |
| 6 | W L1 | W L2 | W L3 | | |
| 7 | W L1 (max) | W L2 (max) | W L3 (max) | | |
| 8 | var L1 | var L2 | var L3 | | |
| 9 | VA L1 | VA L2 | VA L3 | | |
| 10 | AL 1 | | | | variable connected to alarm 1 |
| 11 | AL 2 | | | | variable connected to alarm 2 |
| 12 | W Σ | PF Σ | var Σ | Hz | Σ = system |
| 13 | W Σ | PF Σ | VA Σ | Hz | Σ = system |
| 14 | W Σ (max) | PF Σ (min) | | | Σ = system |
| 15 | W dmd | VA dmd | r.t. | | r.t.= symbol of communication Rx/Tx on the serial port |
| 16 | W dmd (max) | VA dmd (max) | | | |
| 17 | THD V L1 | THD V L2 | THD V L3 | | total harmonic distortion |
| 18 | THD A L1 | THD A L2 | THD A L3 | | total harmonic distortion |



Used Calculation Formula

Phase Variables

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

Instantaneous effective current $A_1 = \sqrt{\frac{1}{n} \cdot \sum_1^n (A_{1i})^2}$

Instantaneous active power $W_1 = \frac{1}{n} \cdot \sum_1^n (V_{INi}) \cdot (A_{1i})$

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

Instantaneous apparent power $VA_1 = V_{IN} \cdot A_1$

Instantaneous power factor $\cos\phi_1 = \frac{W_1}{VA_1}$

System variables

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

Total harmonic distortion $THD_i = \frac{\sqrt{\sum_{n=2}^{\infty} I_n^2}}{I_1}$

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

Where:
 i = considered phase (L1, L2 or L3)
 T = considered variable (V or A)
 n = harmonic order

List of the variables that can be connected to:

- Alarm outputs
- Analogue outputs

| N° | Variable | 3-phase + neutral | 3-phase no neutral | Note |
|----|-----------------|-------------------|--------------------|---------------------|
| 1 | $V_{L-N\Sigma}$ | x | x | Σ = system |
| 2 | $V_{L-L\Sigma}$ | x | x | Σ = system |
| 3 | $W\Sigma$ | x | x | Σ = system |
| 4 | $var\Sigma$ | x | x | Σ = system |
| 5 | $VA\Sigma$ | x | x | Σ = system |
| 6 | $PF\Sigma$ | x | x | Σ = system |
| 7 | THD V (1) | x | x | if FFT is activated |
| 8 | THD A (1) | x | x | if FFT is activated |
| 9 | A n | x | x | |
| 10 | VA dmd | x | x | |
| 11 | W dmd | x | x | |
| 12 | ASY | x | x | asymmetry |

(1) The highest value among the three phases
 (2) The RS232 communication port works as alternative of the RS485 module.

The possible module combinations

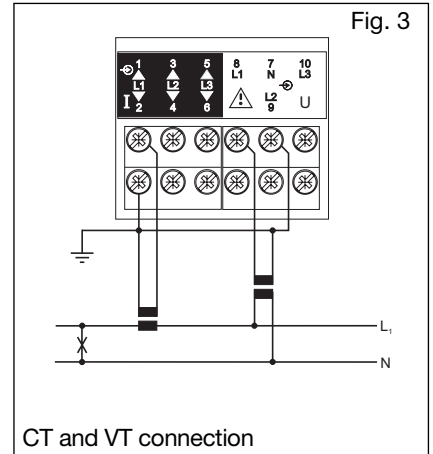
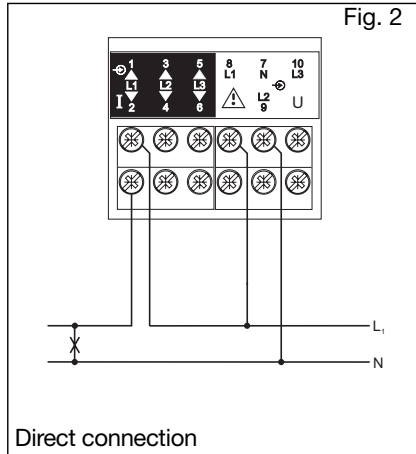
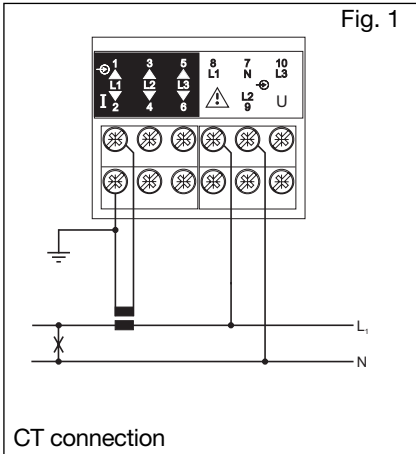
| Basic unit | Slot A | Slot B | Slot C | Slot D |
|------------------------------|--------|--------|--------|--------|
| Single analogue output | ● | | | |
| Dual analogue output | ● | | | |
| RS485 port | | ● | | |
| Single relay output | | | ● | |
| Single open collector output | | | ● | |
| Dual relay output | | | ● | ● |
| Dual open collector output | | | ● | ● |
| 3 digital inputs | | | ● | |
| 3 digital inputs + AUX | | | ● | |
| Basic unit | Slot E | | | |
| RS232 port | | ● | | |

The available modules

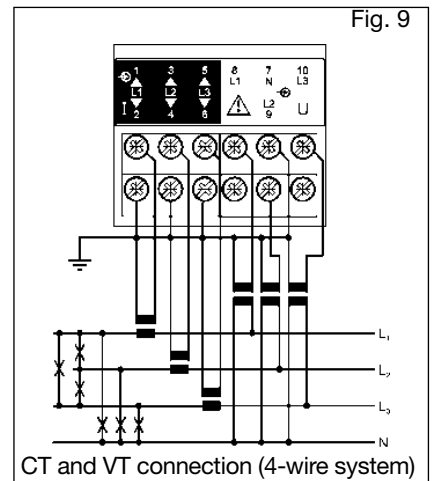
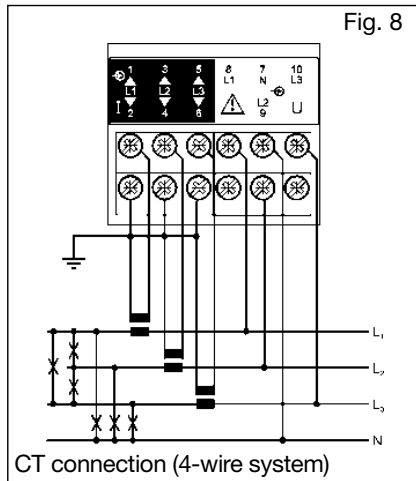
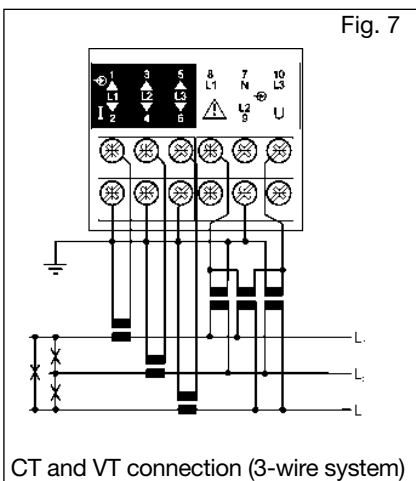
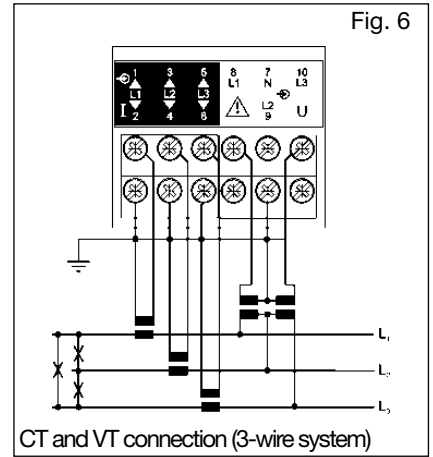
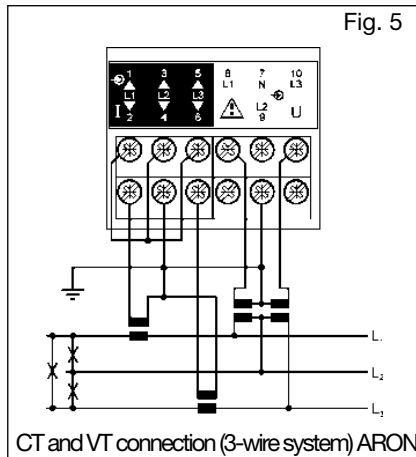
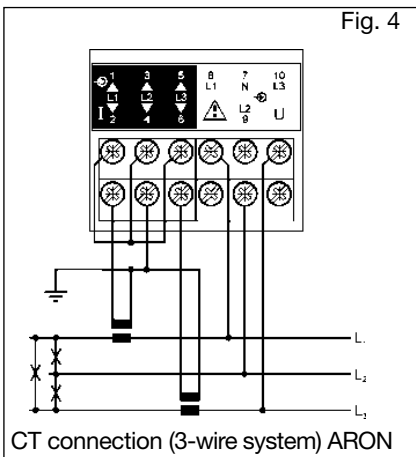
| Type | N. of channels | Ordering Code |
|----------------------------|----------------|---------------|
| WM23-96 400V L-L 5A (base) | | AH2300 |
| WM23-96 208V L-L 5A (base) | | AH2301 |
| WM23-96 100V L-L 5A (base) | | AH2302 |
| WM23-96 660V L-L 5A (base) | | AH2303 |
| 24VAC power supply | | AP1025 |
| 48VAC power supply | | AP1024 |
| 115VAC power supply | | AP1023 |
| 230VAC power supply | | AP1022 |
| 18-60VAC/DC power supply | | AP1021 |
| 90-260VAC/DC power supply | | AP1020 |
| 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 |
| Relay output | 1 | AO1058 |
| Relay output | 2 | AO1035 |
| Open collector output | 1 | AO1059 |
| Open collector output | 2 | AO1036 |
| Digital inputs | 3 | AQ1038 |
| Digital inputs + AUX | 3 | AQ1042 |
| RS485 serial port (2) | 1 | AR1034 |
| RS232 serial port (2) | 1 | AR1039 |

Wiring Diagrams

Single phase

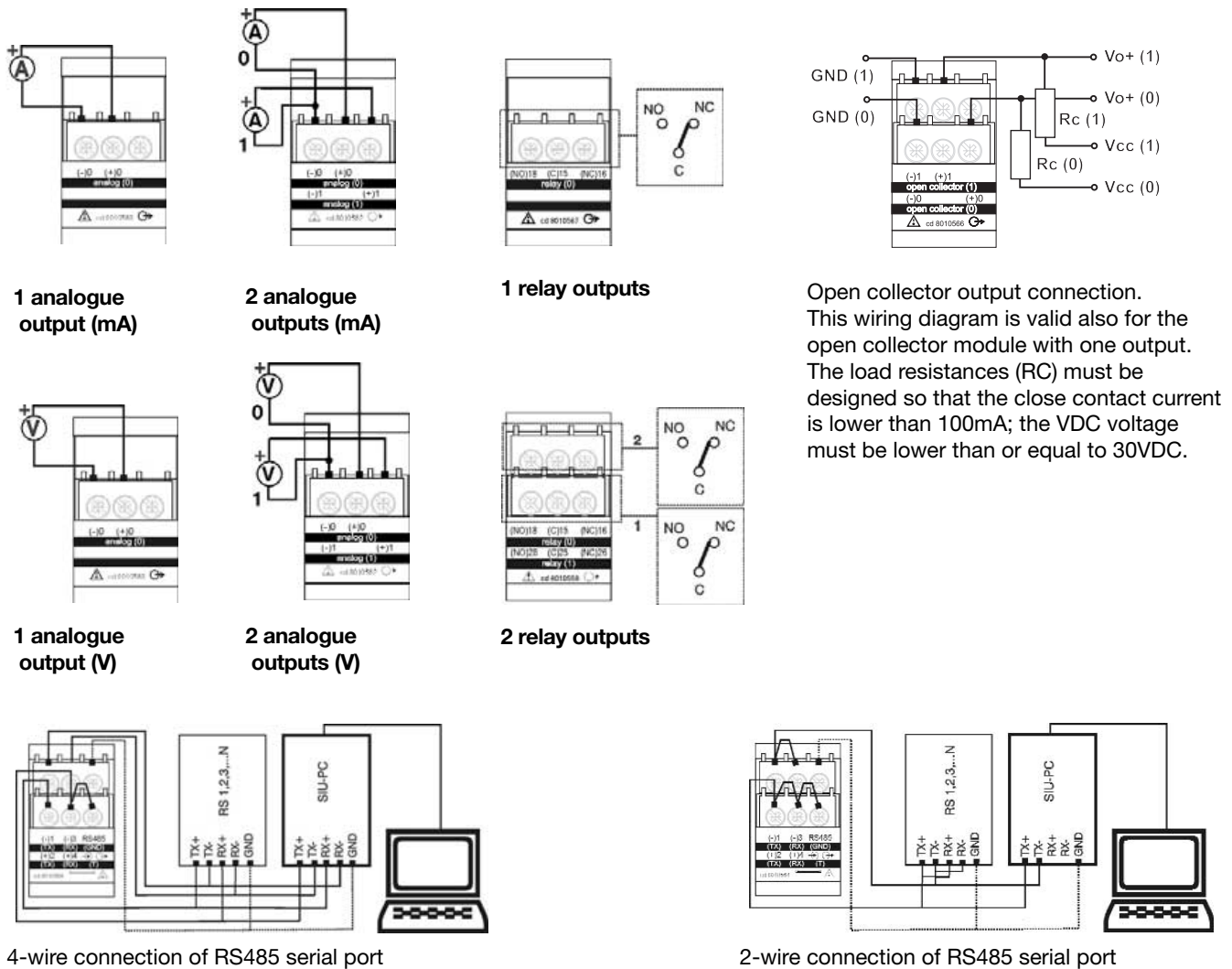


Three-phase - Unbalanced load

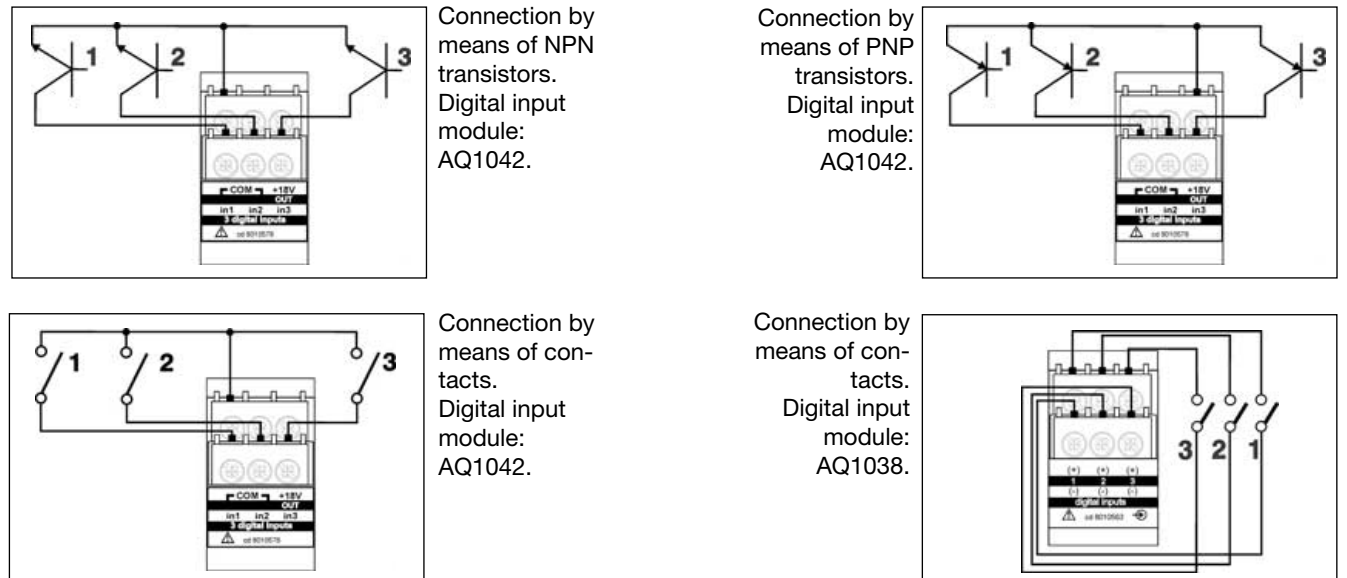




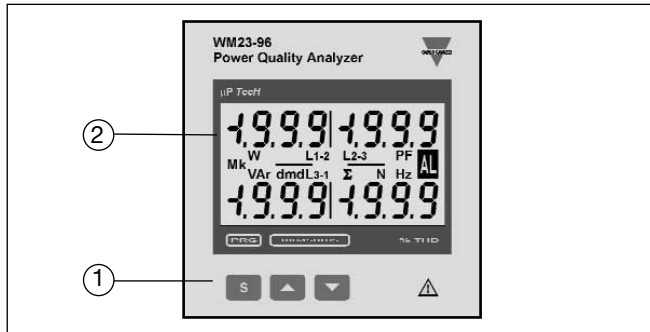
Wiring diagrams (optional modules)



Wiring diagrams: digital input modules



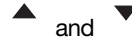
Front Panel Description



1. Key-pad

The programming of configuration parameters and the display are easily controlled by means of the 3 push buttons:

- "S" to enter into the programming phase and to confirm the password



- for value programming
- for function selections
- for page scrolling

2. Display

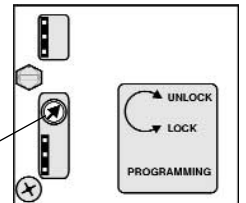
- Instantaneous measurements:
- 4x3 1/2 digit (maximum read-out 1999)

Alphanumeric indications by means of LCD display for:

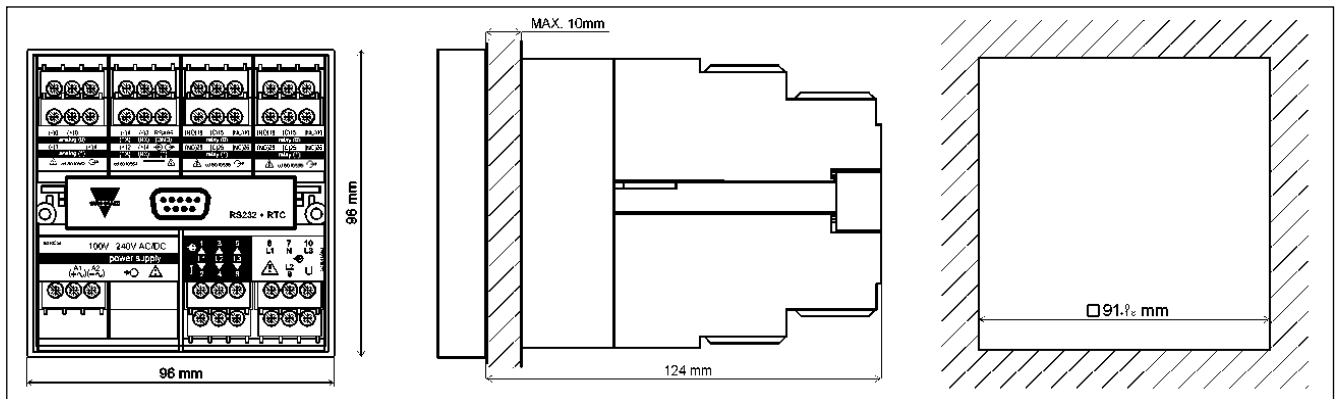
- Displaying the configuration parameters
- Displaying all the measured variables.

3. Programming lock

It's possible to lock the programming key-pad by means of a rotary switch located behind the instrument in the power supply slot. Turn counterclockwise the switch to lock the programming key-pad.



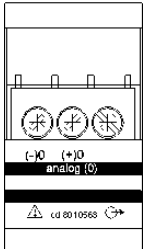
Dimensions





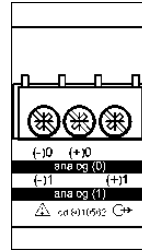
Terminal boards

Single analogue output modules



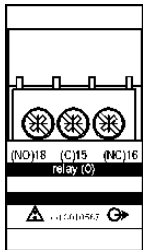
- AO1050** (20mADC)
- AO1051** (10VDC)
- AO1052** (± 5 mADC)
- AO1053** (± 10 mADC)
- AO1054** (± 20 mADC)
- AO1055** (± 1 VDC)
- AO1056** (± 5 VDC)
- AO1057** (± 10 VDC)

Dual analogue output modules

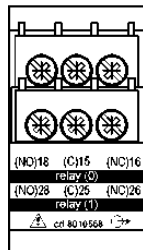


- AO1026** (20mADC)
- AO1027** (10VDC)
- AO1028** (± 5 mADC)
- AO1029** (± 10 mADC)
- AO1030** (± 20 mADC)
- AO1031** (± 1 VDC)
- AO1032** (± 5 VDC)
- AO1033** (± 10 VDC)

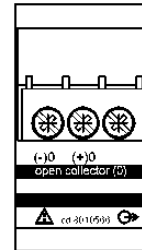
Digital output modules



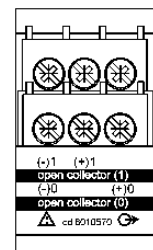
AO1058
Single relay output



AO1035
Dual relay output

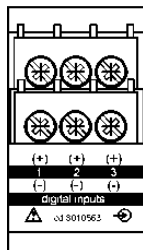


AO1059
Single open collector output

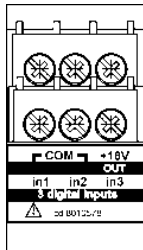


AO1036
Dual open collector output

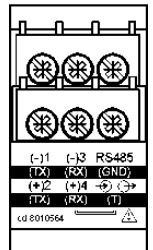
Other input/output modules



AQ1038
3 digital inputs



AQ1042
3 digital inputs + aux

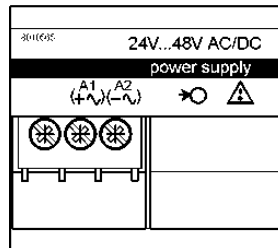


AR1034
RS422/485 communication port



AR1039
RS232 communication port

Power supply modules



- AP1021** 18-60 VAC/DC power supply
- AP1020** 90-260 VAC/DC power supply
- AP1025** 24VAC power supply
- AP1024** 48VAC power supply
- AP1023** 115VCA power supply
- AP1022** 230VCA power supply