Energy Management
Modular Universal Utility Meter and Power Analyzer
Type WM24-96

- Class 1 (active energy)
- Class 2 (reactive energy)
- Accuracy 0.5% RDG (current/voltage)
- Universal utility meter and power analyzer
- Backlighted LCD display
- Front size: 96x96 mm
- Measurements of phase and system variables: W, W_{dmd}, var, VA, VA_{dmd}, PF, V_{L-N}, A, Hz
- Measurements of total energies: kWh, kvarh C+/C-, kvarh L+/L-
- Measurements of partial energies: kWh, kvarh C+/C-, kvarh L+/L-
- Measurements according to EN61036 and EN61268
- Time periods (t1, t2, t3, t4) management by means of input contacts
- Measurements of $m^3 H_2O$ and $m^3 GAS$ by means of input contacts

- Up to 2 pulse outputs and up to 2 alarm outputs
- Up to 3 digital inputs for the time period and H_2O and GAS meters management
- MODBUS/JBUS (RTU) Protocol
- Optional RS232, RS422/485 serial ports

- TRMS measurement of distorted waves (currents/voltages)
- Universal power supply: 18-60VAC/VDC, 90-260 VAC/VDC
- Instantaneous variables read-out: 4x3 1/2 digit
- Energies, water, gas, variables read-out: 1x7 1/2 digit
- Protection degree (front): IP 65

Product Description

µP-based modular universal utility meter and power analyzer with built-in programming key-pad.
Particularly recommended for the analysis of the electtrical variables, for the multi time periods (t1, t2, t3, t4) energy metering and water/gas metering. Housing for panel mounting and IP65 (front) protection degree.

Ordering Key   WM24-96AV53H XX XX XX XX X

Model
Range Code
System
Power Supply
Slot A
Slot B
Slot C
Slot D
Options

Type selection

Range code		Power supply		Slot B (communication)		Slot D (alarm output)	
AV4:	208VLL/1/5(6)AAC -20% ≤ Un ≤+20%	**A:**	24 VAC -15 +10% 50-60Hz	**XX:**	None	**XX:**	None
AV5:	400VLL/1/5(6)AAC -20% ≤ Un ≤+15%	**B:**	48 VAC -15 +10% 50-60Hz	**S1:**	Serial port, RS485 multidrop, bidirectional	**R1:**	Single relay output, (AC1-8AAC, 250VAC)
AV6:	100VLL/1/5(6)AAC -20% ≤ Un ≤+15%	**C:**	115VAC -15 +10% 50-60Hz			**R2:**	Dual relay output, (AC1-8AAC, 250VAC)
AV7:	660VLL/1/5(6)AAC -30% ≤ Un ≤+15%	**D:**	230 VAC -15 +10% 50-60Hz	**Slot C (redundant output or digital inputs)**		**O1:**	Single open collector output (30V/100mADC)
50-60 Hz for all input modules. Module not removable.		**L:**	18 to 60VAC/VDC			**O2:**	Dual open collector output (30V/100mADC)
		H:	90 to 260VAC/VDC	**XX:**	None		
				R1:	Single relay output (AC1-8AAC, 250VAC)		
System		**Slot A**		**R2:**	Dual relay output (AC1-8AAC, 250VAC)		
				O1:	Single open collector output (30V/100mADC)	**Options**	
3:	Three-phase, unbalanced load, with or without neutral	**XX:**	None	**O2:**	Dual open collector output (30V/100mADC)	**X:**	None
				D1:	3 digital inputs	**S:**	RS232 serial port
				D2:	3 digital inputs + aux output		

NOTE: max digital output (alarms and/or pulses): 2, any exceeding output is redundant.
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.

Input Specifications

Number of measure inputs	
Current	3
Voltage	4

Digital inputs	(on request)
AQ1038	Number of inputs: 3 (voltage free)
Reading voltage	24VDC/1mA
Input frequency	Max. 20Hz, dutycycle 50%
Contact 1 purpose	key-pad programming lock (when the contact is closed).
Contact 2-3 purpose	To be used in 3 different ways:
	• time period selection (t1-t2-t3-t4) and W_{dmd}, VA_{dmd} synchronization;
	• Gas total meter, and night and day tariffs selections
	• GAS and WATER, total meters;
AQ1042	Number of inputs: 3+excitation output (AUX) (16V<Aux<24VDC, max 15mA) other characteristics like AQ1038

Accuracy (display, RS232, RS485)	Ib:5A; Pn= Ib* Un
Current (@ 25°C ± 5°C, R.H. ≤ 60%)	0.003Ib to 0.2Ib: ±(0.5% RDG + 3DGT); 0,2Ib to Imax: ±(0.5 RDG + 1DGT)
Phase-neutral voltage (@ 25°C ± 5°C, R.H. ≤ 60%)	Range Un: ±(0.5% RDG + 1DGT)
Frequency	±0.1 Hz
Active power/energy (@ 25°C ± 5°C, R.H. ≤ 60%)	Class 1 according to EN61036 (I start-up: 20mA)
Reactive power/energy (@ 25°C ± 5°C, R.H. ≤ 60%)	Class 2 according to EN61268 (I start-up: 20mA)

Apparent power (@ 25°C ± 5°C, R.H. ≤ 60%)	±(1% Pn +2DGT) Ib:1A; Pn= Ib* Un
Current (@ 25°C ± 5°C, R.H. ≤ 60%)	0.02Ib to Ib: ±(0.5%RDG + 3DGT); Range Un:
Phase-neutral voltage (@ 25°C ± 5°C, R.H. ≤ 60%)	±(0.5% RDG +1DGT)
Frequency	±0.1 Hz
Active power (@ 25°C ± 5°C, R.H. ≤ 60%)	0.5Ib to Ib: ±(1%RDG +1DGT) 0.02Ib to 0.5Ib: ±(1.5%RDG +3DGT)
Reactive power (@ 25°C ± 5°C, R.H. ≤ 60%)	0.5Ib to Ib: ±(2%RDG +1DGT) 0.02Ib to 0.5Ib: ±(3%RDG +3DGT)

Temperature drift	≤200ppm/°C
Display	Back-lighted LCD 4x3½ digits (instantaneous variables) or 1x7 ½ digits (energy, gas, water) 70 x 38mm
Display refresh time	700ms
Measurements	Current, voltage, power, power factor, frequency, energy. TRMS measurement of a distorted wave.
Coupling type	Direct

Input impedance	
208VLL 5(6)AAC (AV4):	>200 kΩ
400VLL 5(6)AAC (AV5):	>900 kΩ
100VLL 5(6)AAC (AV6):	>200 kΩ
660VLL 5(6)AAC (AV7):	>900 kΩ

Output Specifications

RS422/RS485	(on request) Multidrop bidirectional (static and dynamic variables)
Connections	2 or 4 wires, max. distance 1200m, termination directly on the instrument
Addresses	255, selectable by key-pad
Protocol	MODBUS/JBUS (RTU)
Data (bidirectional)	
Dynamic (reading only)	System and phase variables: see table "display pages"
Static (writing only)	All the configuration parameters, activation of the static output.
Data format	1 start bit, 8 data bit, no parity,1 stop bit
Baud-rate	9600 bauds
Insulation	By means of optocouplers, 4000 V_{RMS} output to measuring input 4000 V_{RMS} output to supply input

RS232	(on request) bidirectional (static and dynamic variables)
Connections	3 wires, max. distance 15m,
Data format	1 start bit, 8 data bit

	no parity, 1 stop bit
Baud-rate	9600 bauds
Protocol	MODBUS/JBUS (RTU)
other characteristics	as per RS422/485

Pulse outputs (on request)	
Number of outputs	up to 2
Type	programmable from 1 to 1000 pulses V_{ON} 1.2 VDC/ max. 100 mA V_{OFF} 30 VDC max. Outputs conectable to the total and/or partial energy meters
Pulse duration	220 ms (ON), ≥ 220 ms (OFF) according to DIN43864
Insulation	By means of optocuplers, 4000 V_{RMS} output to measuring inputs, 4000 V_{RMS} output to power supply input.
Notes	The outputs can be either open collector type or relay type (for the relay outputs refer to the specifications described in the "alarm outputs").

Output Specifications (cont.)

Alarm outputs	(on request)		DC 12-5A @ 24VDC
Number of outputs	up to 2, independent		AC 15-2.5A @ 250VAC
Alarm type	Up alarm, down alarm		DC 13-2.5A @ 24VDC
Variables to be controlled	see the "List of the variables that can be connected..."	Min. response time	≤150ms, filters escluded, Set-point on-time delay: "0 s"
Set-point adjustment	from 0 to 100% of the electrical scale	Insulation	By means of optocouplers, 4000 V_{RMS} output to measuring input, 4000 V_{RMS} output to supply input.
Hysteresis	from 0 to 100% of the electrical scale		
On-time delay	0 to 255s	Note	The outputs can be either relay type or open collector type (for the open collector output refer to the specifications described in the "pulse outputs")
Relay status	Selectable; normally de-energized and normally energized		
Output type	Relay, SPDT type AC 1-8A @ 250VAC		

Software Functions

Password	Numeric code of max 4 digits; 2 protection levels of the programming data	**Page Variables**	Up to 4 by page
		Three-phase system with neutral	Page 1: V L1, V L2, V L3, V LN∑
1st level	Password "0", no protection		Page 2: AL1, AL2, AL3
2nd level	Password from 1 to 1000, all data are protected.		Page 3: W L1, W L2, W L3
			Page 4: VA L1, VA L2 VA L3
Transformer ratio	CT from 1 to 5000 VT from 1.0 to 1999, where CT x VT ≤ 10000		Page 5: var L1, var L2, var L3
			Page 6: PF L1, PF 2, PF L3, PF ∑
Power demand (dmd)			Page 7: W ∑, var ∑, PF ∑, Hz
Integration time	Programmable from 1 to 30 min		Page 8: W ∑, VA ∑, PF ∑, Hz
Filter			Page 9: W dmd, VA dmd
Filter operating range	From 0 to 100% of the input electrical scale	Energy, gas, water, meter pages	See "Energy, gas, water meter settings" table
Filtering coefficient	1 to 16		
Filter action	Measurements, alarms, serial port (fundamental variables: V, A, W and their derived ones).		

Supply Specifications

AC voltage	90 to 260 VDC/VAC		115VAC -15+10% 50-60Hz
	18 to 60VDC/VAC		230 VAC -15+10% 50-60Hz
	24 VAC -15+10% 50-60Hz	**Power consumption**	≤ 30VA/12W (90 to 260V)
	48 VAC -15+10% 50-60Hz		≤ 20VA/12W (18 to 60V)

General Specifications

Operating temperature	0 to +50°C (32 to 122°F) (R.H. < 90% non-condensing)	Immunity	residential, commercial and 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** Safety Product	IEC 61010-1, EN 61010-1 IEC 60688-1, EN 60688-1
Installation category	Cat. III (IEC 60664)	**Approvals**	CE, UL, CSA
Pollution degree	2	**Connections 5(6)A**	Screw-type, max 2.5 mm² wires (2 x 1.5mm²)
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 modules)	**Housing** Dimensions Material	96x96x140 mm ABS, NORYL, PC (front) self-extinguishing: UL 94 V-0
Insulation	4000 V$_{RMS}$ between all inputs/outputs to ground	**Protection degree**	Front: IP65, NEMA4X, NEMA12 Connections: IP20
Dielectric strength	4000 V$_{RMS}$ for 1 minute	**Weight**	Approx. 400 g (packing incl.)
EMC Emissions	EN50082-1 (class A)		

Mode of operation

Waveform of the signals that can be measured
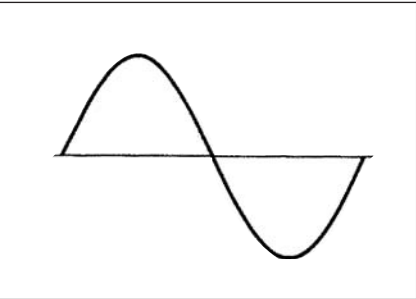
Figure G
Sinewave, undistorted

Fundamental content	100%
Harmonic content	0%
A$_{rms}$ =	1.1107	$\overline{A}$	
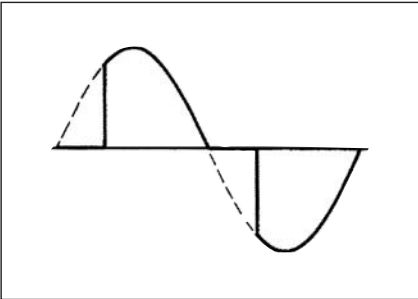
Figure H
Sinewave, indented

Fundamental content	10...100%
Harmonic content	0...90%
Frequency spectrum:	3rd to 16th harmonic
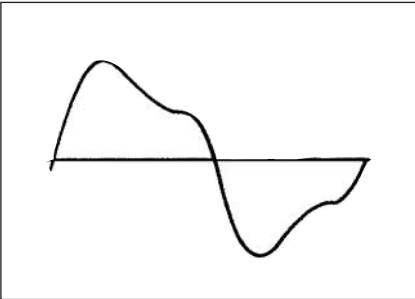
Figure I
Sinewave, distorted

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

Accuracy

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)

EN 61036/ IEC 61036 limits (Active energy)
5(6A) Start-up current: 20mA

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)

EN 61268/ IEC 61268 limits (Reactive energy)
5(6A) Start-up current: 20mA
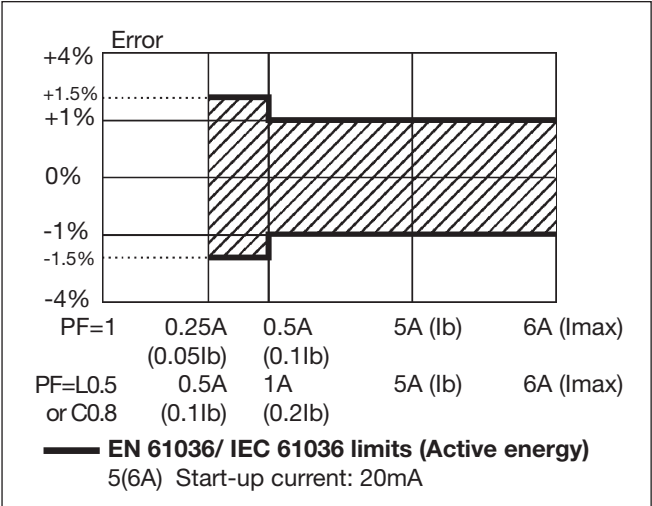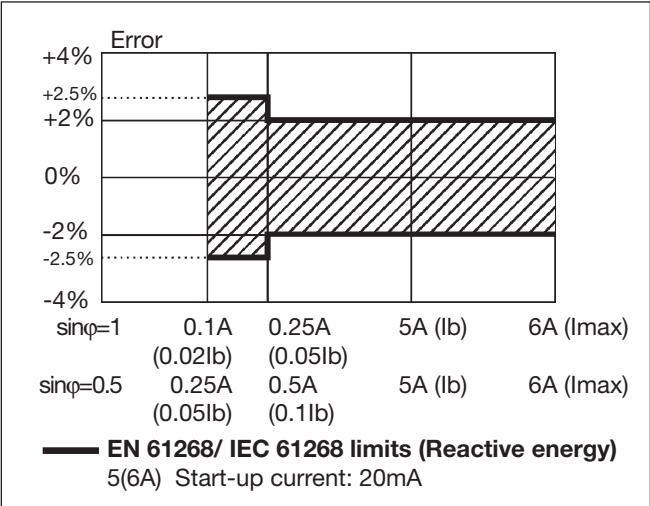
Display pages

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

No	1st variable	2st variable	3st variable	4th variable	Notes
1	V L1-N	V L2-N	V L3-N	V Σ	Σ = system
2	A L1	A L2	A L3		
3	W L1	W L2	W L3		
4	VA L1	VA L2	VA L3		
5	var L1	var L2	var L3		
6	PF L1	PF L2	PF L3	PF Σ	Σ = system
7	W Σ	PF Σ	PF Σ	Hz	Σ = system
8	W Σ	PF Σ	VA Σ	Hz	Σ = system
9	W dmd	VA dmd	r.t.		r.t.= symbol of communication Rx/Tx on the serial port
10	Wh+ (total)				It depends on the instrument configuration (see also "Energy, gas, water settings")
11	Wh- (total)				
12	Wh (total)				
13	varh (total)				
14	varh L+ (total)				
15	varh L- (total)				
16	varh C+ (total)				
17	varh C- (total)				
18	m3 GAS (day)				
19	m3 GAS (night)				
20	m3 GAS (total)				
21	m3 ACQUA (total)				
22	Wh (tariff 1)				
23	Wh (tariff 2)				
24	Wh (tariff 3)				
25	Wh (tariff 4)				
26	varh (tariff 1)				
27	varh (tariff 2)				
28	varh (tariff 3)				
29	varh (tariff 4)				

Energy, gas, water meter settings

The instrument can be configured with four different ways of management of the meters as explained in the table below.

Set 1 (total)	Set 2 (total and tariffs)	Set 3 (total and gas)	Set 4 (total, gas and water)
Wh+ (total)	Wh (total)	Wh+ (total)	Wh+ (total)
Wh- (total)	varh (total)	Wh- (total)	Wh- (total)
varh C+ (total)	Wh t1 (partial)	varh C+ (total)	varh C+ (total)
varh C- (total)	varh t1 (partial)	varh C- (total)	varh C- (total)
varh L+ (total)	Wh t2 (partial)	varh L+ (total)	varh L+ (total)
varh L- (total)	varh t2 (partial)	varh L- (total)	varh L- (total)
	Wh t3 (partial)	m^3 GAS (day tariff)	m^3 GAS (total)
	varh t3 (partial)	m^3 GAS (night tariff)	m^3 WATER (total)
	Wh t4 (partial)		
	varh t4 (partial)		

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

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

Istantaneous power factor

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

Istantaneous 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 system voltage

$$V_\Sigma = \frac{V_1 + V_2 + V_3}{3} * \sqrt{3}$$

System reactive power

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

System active power

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

System apparent power

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

System power factor

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

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

t_1, t_2 = starting and ending time points of consumption recording

n = time unit

Δt = time interval between two successive power consumption

n_1, n_2 = starting and ending discrete time points of consumption recording

The possible module combinations

Base unit	Slot A	Slot B	Slot C	Slot D
RS485 port		●		
Single relay output			●	●
Single open coll. output			●	●
Dual relay output			●	●
Dual open coll. output			●	●
3 digital inputs			●	
3 digital inputs + AUX			●	
Base unit	**Slot E**			
RS232 port	●			

The available modules

Type	N. of channels	Ordering code
WM24-96 400V L-L 5A (base)		AJ2400
WM24-96 208V L-L 5A (base)		AJ2401
WM24-96 100V L-L 5A (base)		AJ2402
WM24-96 660V L-L 5A (base)		AJ2403
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
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 (1)	1	AR1034
RS232 serial port (1)	1	AR1039

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

List of the variables that can be connected to:

• **Alarm outputs**

N°	Variable	3-phase + neutral	3-phase no neutral	Note
1	$V_{L-N} \Sigma$	x		Σ = system
2	$W \Sigma$	x	x	Σ = system
3	$var \Sigma$	x	x	Σ = system
4	$VA \Sigma$	x	x	Σ = system
5	$PF \Sigma$	x	x	Σ = system
6	VA_{dmd}	x	x	
7	W_{dmd}	x	x	
8	ASY	x	x	asymmetry

Wiring Diagrams

Single phase

Fig. 1
CT connection

Fig. 2
Direct connection

Fig. 3
CT and VT connection

Three-phase - Unbalanced load

Fig. 4
CT connection (3-wire system) ARON

Fig. 5
CT and VT connection (3-wire system) ARON

Fig. 6
CT and VT connection (3-wire system)

Fig. 7
CT and VT connection (3-wire system)

Fig. 8
CT connection (4-wire system)

Fig. 9
CT and VT connection (4-wire system)
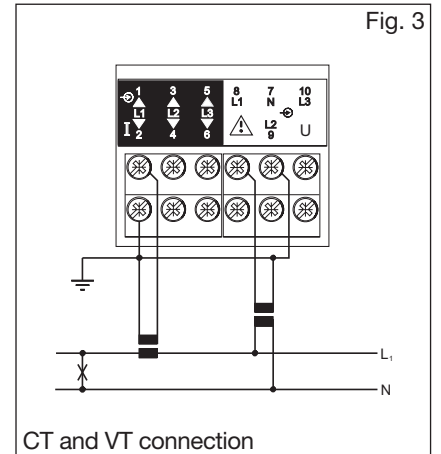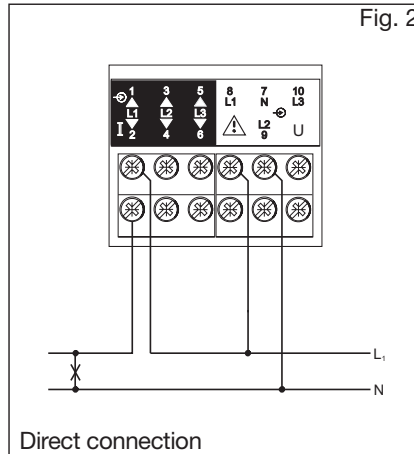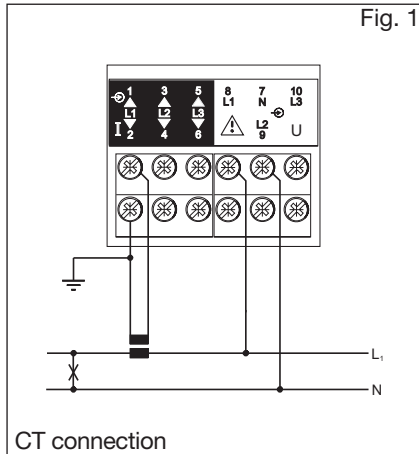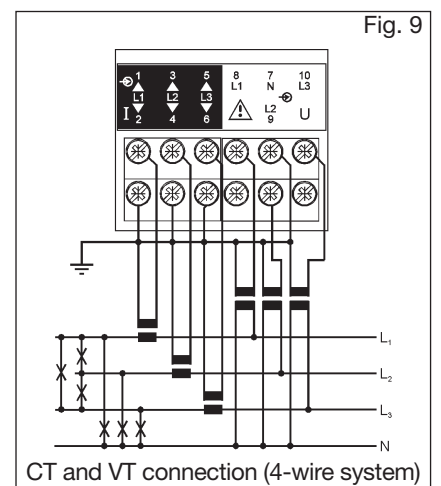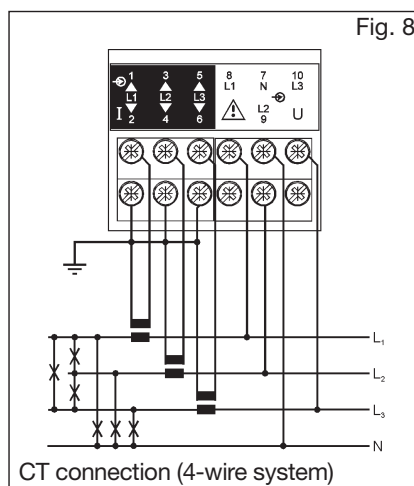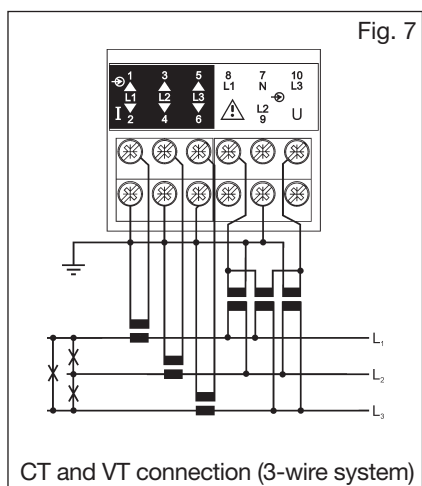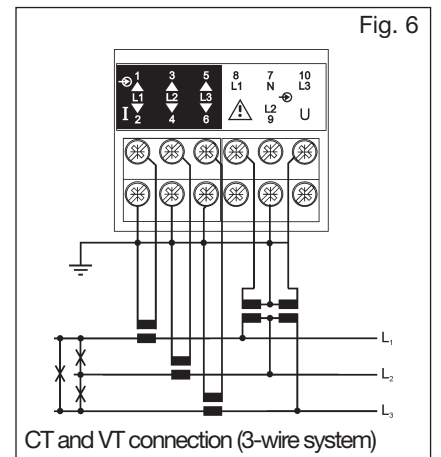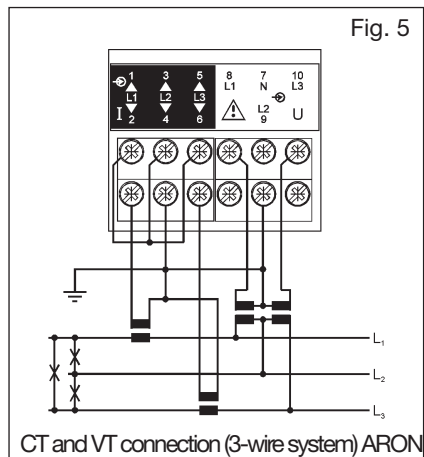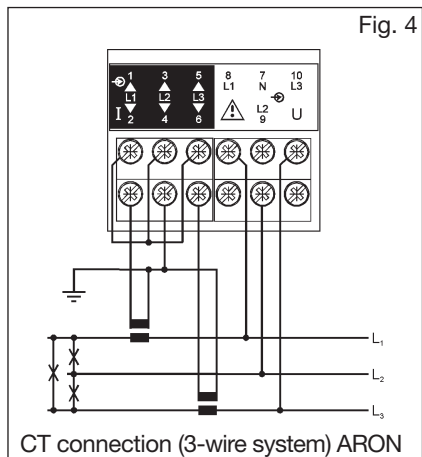
Wiring diagrams (optional modules)
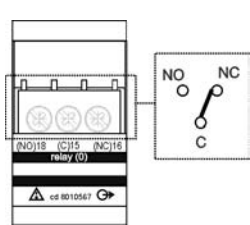
1 relay output
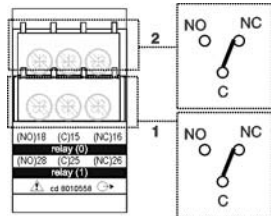
2 relay outputs
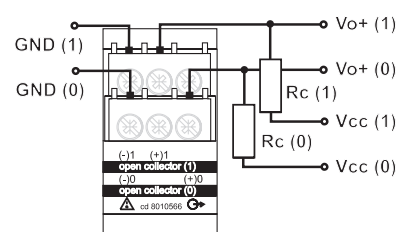
Open collector output connection.
This wiring diagram is valid also for the
open collector module with one output.
The load resistances (RC) must be
designed so that the close contact current
is lower than 100mA; the VDC voltage
must be lower than or equal to 30VDC.
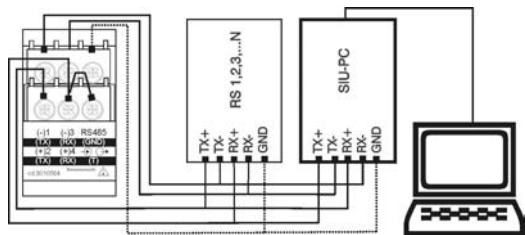
4-wire connection of RS485 serial port
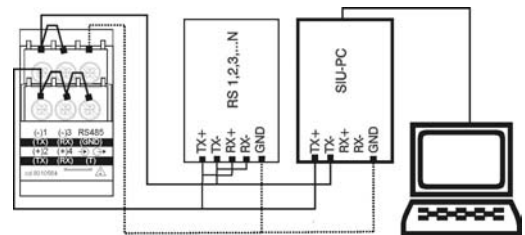
2-wire connection of RS485 serial port

Wiring diagrams: digital input modules
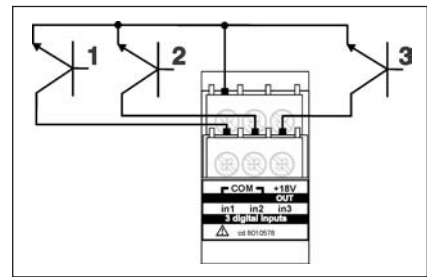
Connection by
means of NPN
transistors.
Digital input
module:
AQ1042.

Connection by
means of PNP
transistors.
Digital input
module:
AQ1042.
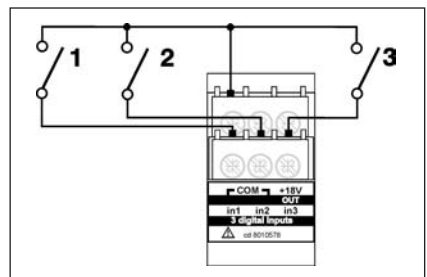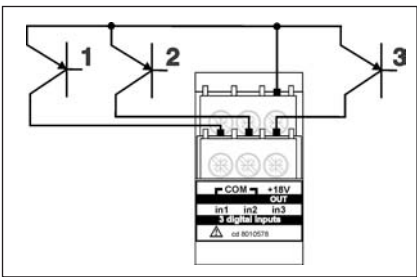
Connection by
means of con-
tacts.
Digital input
module:
AQ1042.

Connection by
means of con-
tacts.
Digital input
module:
AQ1038.
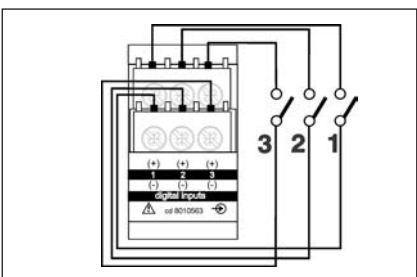
Front Panel Description
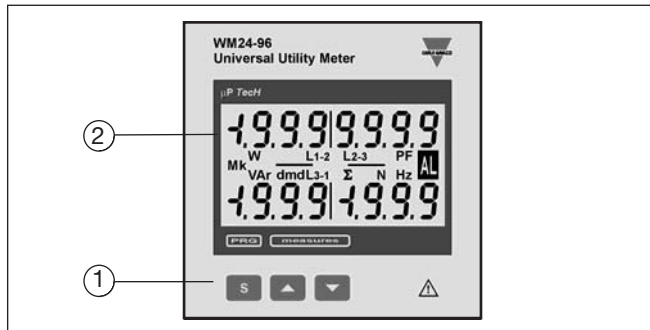
1. Key-pad

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

▲ and ▼
- for value programming
- for function selections
- for page scrolling

2. Display

Instantaneous measurements:
- 4x 3 1/2 digit (maximum read-out 1999)
Energies, gas and water:
- 1x 7 1/2 digit (maximum read-out 19.999.999).
Alphanumeric indications by means of LCD display for:
- Displaying 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 into the power supply slot. Turn counterclockwise the switch to lock the programming key-pad.
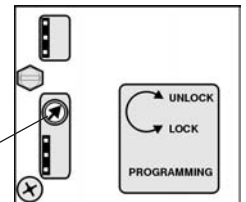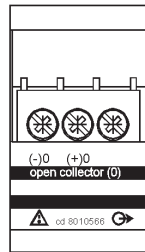
Dimensions
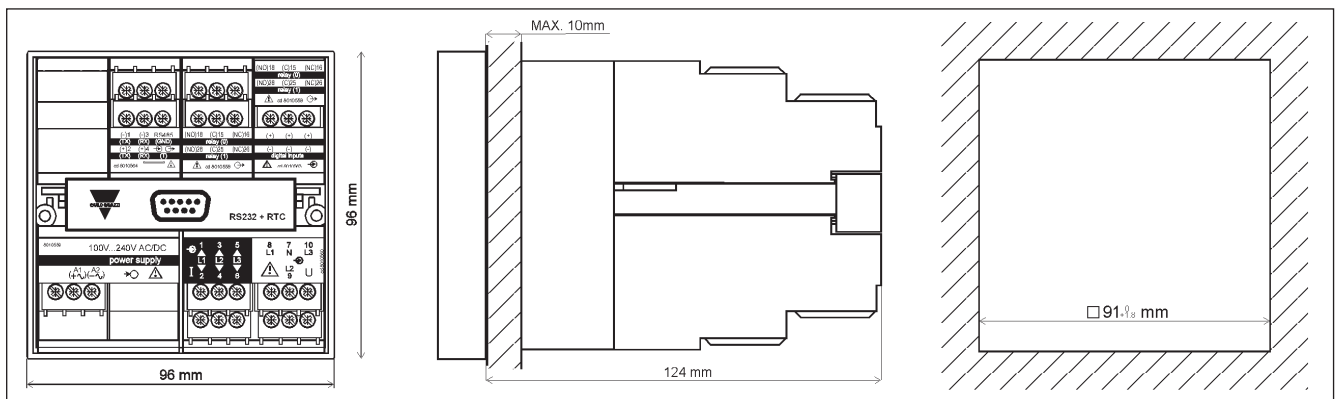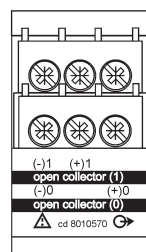
Terminal boards

Digital output modules
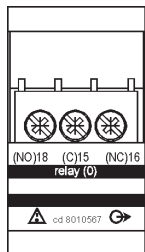
AO1058
Single relay output
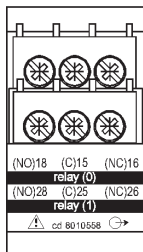
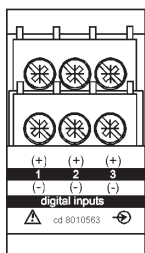**AO1035**
Dual relay output

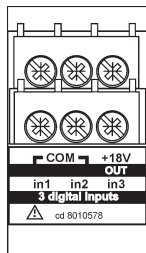**AO1059**
Single open collector
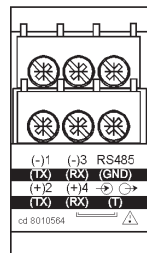output

AO1036
Dual open collector
output

Other input/output modules

AQ1038
3 digital inputs

AQ1042
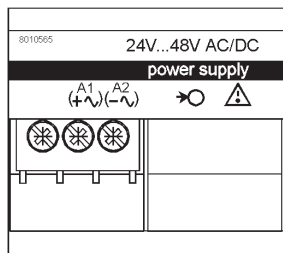3 digital inputs + aux

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