Energy Management
Modular Smart Power Quality Analyzer
Type WM5-96

- MODBUS RTU, JBUS protocol, iFIX SCADA compatibility
- Real time clock function (without back-up)
- Up to 12 optional digital inputs (sync function, remote digital input control)
- Up to 16 optional digital outputs (pulse, alarm, remote control)
- 16 freely configurable alarms with OR/AND logic linkable with up to 4 relay outputs and up to 16 open collector outputs
- Up to 8 optional analogue outputs (+20mA, +10VDC, +/- 5mA)
- Universal power supply: 18-60VAC/VDC, 90-260 VAC/VDC
- Front protection degree: IP 65 (NEMA4x)
- Class 0.2 (current/voltage)
- ARM® powered
- Back-lighted graph display (128x64 dots)
- Bargraph indication of instantaneous power (kW)
- Front size: 96x96 mm
- Measurement of single phase and system instantaneous variables: W, var, VA, PF, VLL, VLN, A_L, A_n, Hz, THD, ASY VLL, ASY VLN (for all measurements max, min, dmd/AVG and max dmd/AVG values)
- Measured energies (imported/exported): kWh and kvarh
- Current and voltage inputs with autoranging capability
- 4x4 DGT instantaneous variable read-out
- 4x9 DGT total energies read-out
- 4x9 DGT partial energies read-out
- Energy measurements according to ANSI C12.20, CA 0.5, EN62053-22 CL 0.5S and ANSI C12.1, EN62053-23 CL 2
- 4 total 3-phase, 48 partial 3-phase and 12 total single phase independent energy meters to be used as single, dual, multi-time tariff management
- Display refresh rate: 10 samples/s
- Harmonic distortion analysis (FFT) up to the 63rd harmonic with graphic and numeric indication (current and voltage)
- Harmonics source detection
- Data stamping of up to 10,000 events: alarm, min, max, digital input status, digital output status as remote control, resets
- 3 independent communication ports:
  optical front communication port (ANSI C12.18)
  optional RS 422/485 serial port
  optional RS232 + real time clock function

Product Description

3-phase utility grade power quality analyzer. Particularly recommended for the measurement of the main electrical variables.
Housing for panel mounting, with optical communication port (according to the ANSI standards), RS485/RS232 communication ports, pulse and alarm outputs. Parameters programming and data reading by means of Wm5Soft.

How to order

WM5-96 see next page

How to order

Wm5Soft

Parameters programming and data reading by means of Wm5Soft.

Modules Combination

Description	Part N.	Slot A	Slot B	Slot C	Slot D	Slot E
WM5-96 base with ANSI local port	AD2001					
WM5-96 base without local port	AD2000					
Power supply (18-60VAC/DC)	AP1021					
Power supply (90-260VAC/DC)	AP1020					
Measuring input (AV5: 400/690VL-L)	AQ2030					
Measuring input (AV6: 120/208VL-L)	AQ2031					
RS485 port (9 600 bps)	AR1034		1-port			
RS485 port (115,200 bps)	AR2040		1-port			
Analogue output (20mA DC)	AO2050	2-out	2-out			
Analogue output (10V DC)	AO2051	2-out	2-out	2-out	2-out	
Analogue output (+/-5mA DC)	AO2052	2-out	2-out	2-out	2-out	
Relay output	AO1058	1-out	1-out	1-out	1-out	
Relay output	AO1035			2-out	2-out	
Open collector output	AO1059	1-out	1-out	1-out	1-out	
Open collector output	AO1036	2-out	2-out	2-out	2-out	
Open collector output	AO1037	4-out	4-out	4-out	4-out	
Digital inputs	AQ1038	3-in	3-in	3-in	3-in	
Digital inputs + Aux	AQ1042	3-in	3-in	3-in	3-in	
RS232 port + RTC (9 600 bps)	AR1039					1-port

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How to order WM5 96

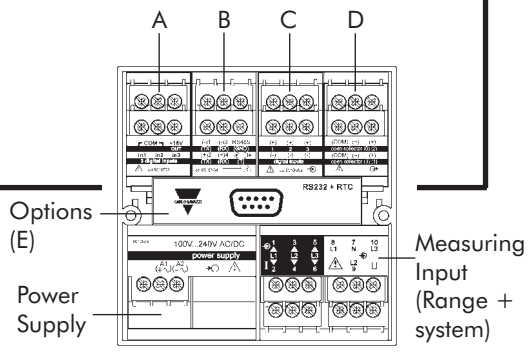
Minimum modules for a basic unit on grey background
Ordering key (fully assembled instrument):

WM5 96 AV53 H XX XX XX XX XX

Description	Ch	Part No.	Legend
Model			
WM5-96 with optical port ANSI C12.18 type		AD2001	WM5 96
WM5-96 without optical port		AD2000	WM5 96
Range code + system (measuring inputs)			
400/690VL-L 1/5A (10A)		AQ2030	AV5.3
120/208VL-L 1/5A (10A)		AQ2031	AV6.3
Power supply			
18-60VAC/DC power supply		AP1021	L
90-260VAC/DC power supply		AP1020	H
None			XX
Digital inputs	3	AQ1038	D1
Digital inputs + aux	3	AQ1042	D2
Open collector output	4	AO1037	O4
Open collector output	2	AO1036	O2
Open collector output	1	AO1059	O1
Relay output	1	AO1058	R1
Analogue output 20mADC	2	AO2050	B1
Analogue output 10VDC	2	AO2051	W1
Analogue output +/-5mA	2	AO2052	B2
SLOT A			
None			XX
Digital inputs	3	AQ1038	D1
Digital inputs + aux	3	AQ1042	D2
Open collector output	4	AO1037	O4
Open collector output	2	AO1036	O2
Open collector output	1	AO1059	O1
Relay output	1	AO1058	R1
Analogue output 20mADC	2	AO2050	B1
Analogue output 10VDC	2	AO2051	W1
Analogue output +/-5mA	2	AO2052	B2
RS485 9600bps	1	AR1034	S1
RS485 115200bps	1	AR2040	S2
SLOT B			
None			XX
Digital inputs	3	AQ1038	D1
Digital inputs + aux	3	AQ1042	D2
Open collector output	4	AO1037	O4
Open collector output	2	AO1036	O2
Open collector output	1	AO1059	O1
Relay output	1	AO1058	R1
Relay output	2	AO1035	R2
Analogue output 10VDC	2	AO2051	W1
Analogue output +/-5mA	2	AO2052	xx
SLOT C			
None			XX
Digital inputs	3	AQ1038	D1
Digital inputs + aux	3	AQ1042	D2
Open collector output	4	AO1037	O4
Open collector output	2	AO1036	O2
Open collector output	1	AO1059	O1
Relay output	1	AO1058	R1
Relay output	2	AO1035	R2
Analogue output 10VDC	2	AO2051	W1
Analogue output +/-5mA	2	AO2052	B2
SLOT D			
Utility grade with optical port			XX
RS232 + RTC (utility grade)	1	AR1039	SX
Revenue approval. An "instrument setting" form must be properly filled up by the user.			XU
RS232+RTC + "XU" option	1	AR1039	SU
Utility grade without optical port			YY
RS232 + RTC (utility grade) without optical port	1	AR1039	SY
OPTIONS SLOT E			

Example of which modules to order for:
WM5-96 AV53 H B1 S1 R2 O2 SX

Bill of material	Ordering No.
WM5 96	AD2001
AV53 measuring inputs (400/690VL-L)	AQ2030
90-260VAC/DC power supply	AP1020
Analogue output 20mA (2 channels)	AO2050
RS485 serial port 9600 bps	AR1034
Relay output (2 channels)	AO1035
Open collector (2 channels)	AO1036
RS232 port+RTC	AR1039



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Input specifications

Number of analogue inputs	
Current	1 (1-phase; system code: 3) 3 (3-phase; system code: 3)
Voltage	1 (1-phase; system code: 3) 4 (3-phase; system code: 3)
Digital inputs (on request)	Up to 12
AQ1038	No. of inputs: 3 (voltage-free)
Purpose	"dmd" measurements synchronisation. Tariff selection: energy. Contact status reading. Clock synchronisation.
Contact measuring current	<8mA/ 17.5 to 25VDC
AQ1042	Number of inputs: 3 + excitation output
Purpose	"dmd" measurements synchronisation. Tariff selection: energy. Contact status reading. Clock synchronisation.
Excitation output	16V<+Aux<24VDC Max 15mA
Contact measuring current	15mA
Common characteristics	
Close contact resistance	Max 1kΩ
Open contact resistance	Min 100kΩ
Insulation	see "Insulation between inputs and outputs" table
Accuracy (display, RS232, RS485)	In: 5A, If.s.: 10A Un: see voltage ranges below
Current (A_{L1}, A_{L2}, A_{L3}) (@20°C ±5°C, R.H. ≤75%)	from 0.05In to Imax: ±(0.2%RDG+2DGT) from 0.01In to 0.05In: ±(0.5%RDG+2DGT)
Current (A_n)	±0.5% RDG (0.2 to 2 In) @ 40 to 100 Hz
Voltage (@20°C±5°C,R.H.≤75%) range AV5:	400/690V_{L-L} AC V_{L-N}: 185 V to 460 V V_{L-L}: 320 V to 800 V ±(0.2%RDG+1DGT)
range AV6:	120/208V_{L-L} AC V_{L-N}: 45 V to 145 V V_{L-L}: 78 V to 250 V ±(0.2%RDG+1DGT)
	Includes also: frequency, power supply and output load influences
Frequency	±0.1% RDG (40 to 440 Hz)
Active power and apparent power (@ 20°C ± 5°C, R.H. ≤ 75%)	0.05In to Imax, PF 1: ±(0.5%RDG+1DGT) 0.01In to 0.05In, PF 1: ±(1%RDG+1DGT) 0.1In to Imax, PF0.5L, PF 0.8C: ±(0.6%RDG+1DGT) 0.02In to 0.1In,PF0.5L, PF 0.8C: ±(1%RDG+1DGT)
Reactive power (@ 20°C ± 5°C, R.H. ≤ 75%)	0.1In to Imax, senφ 0.5L/C: ±(2%RDG+1DGT) 0.05In to 0.1In, senφ 0.5L/C: ±(2.5%RDG+1DGT) 0.05In to Imax, senφ 1: ±(2%RDG+1DGT) 0.02In to 0.05In, senφ 1: ±(2.5%RDG+1DGT)
Energies (@ 20°C ± 5°C, R.H. ≤ 75%)	Active: class 0.5 according to EN62053-22, ANSI C12.20 Reactive: class 2 according to EN62053-23, ANSI C12.1 In: 5A, Imax: 10A 0.1In: 500mA, Start-up current: 5mA Un: 400/690V_{L-L} (AV5) Un: 120/208V_{L-L} (AV6)
Harmonic distortion (@ 20°C ± 5°C, R.H. ≤ 75%)	1% FS (FS: 100%) phase: ±2°; Imin: 5mA_{RMS}; Imax: 15Ap; Umin: 30V_{RMS}; Umax: 500Vp
Temperature drift	≤ 200ppm/°C (A/V), ≤300ppm/°C (all the other measurements)
Sampling rate	6400 samples/s @ 50Hz 7680 samples/s @ 60Hz
Display	Graph LCD backlighted (128x64 dots). Read-out for the instantaneous variables: 4x4 digit Total energies: 4x9 digit; Partial energies: 4x9 digit
Display refresh time	100ms
Max. and min. indication	Max. 9999 (999,999,999), Min. -9999 (–999,999,999)
Front LED	Red Blinking light in case of virtual alarm Fixed light in case of digital output activation (alarm)
Measurements	Current, voltage, power, energy, power factor, frequency, harmonic distortion (see "Display Pages"). TRMS measurement of a distorted wave (voltage/current) .
Coupling type	Direct.
Crest factor	< 3, max 10A peak
Input impedance	
400/690V_{L-L} (AV5)	1.77 MΩ ±5%
120/208V_{L-L} (AV6)	885 kΩ ±5%
Current	≤ 0.01Ω
Frequency	40 to 440 Hz
Overload protection	(max values)
Continuous voltage/current	AV5: 460V_{LN}, 800V_{LL}/10A AV6: 145V_{LN}, 250V_{LL}/10A
For 500ms: voltage/current	AV5: 800V_{LN}, 1380V_{LL}/36A AV6: 240V_{LN}, 416V_{LL}/36A

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Output specifications

Analogue Outputs (on request)	
Number of outputs	Up to 8 (max 4 x 20mA + 4 x 10VDC or 4 x 20mA + 4 x ±5mA or 8 x 10VDC or 8 x ±5mA)
Accuracy (@ 25°C ±5°C, R.H. ≤60%)	±0.1%FS (20mA or 10VDC) ±0.3%FS (±5mA), FS=10mA
Range	0 to 20mA or 0 to 10 VDC or ±5mA
Scaling factor:	Programmable within the whole range of retransmission; it allows the retransmission management of all values from: 0 and 20 mA, 0 and 10VDC, or -5mA and +5mA
Response time	≤ 400 ms typical (filter excluded)
Ripple	≤1% (according to IEC 60688-1, EN 60688-1)
Total temperature drift	≤ 500 ppm/°C
Load: 20 mADC	≤ 350 Ω
10 VDC	≥ 10kΩ
±5 mA	≤ 1400Ω
Insulation	see "Insulation between inputs and outputs" table
Optical communication port	According to ANSI C12.18
RS422/RS485 port (on request)	Multidrop bidirectional (static and dynamic variables)
Connections	2 or 4 wires, max. distance 1000m, termination directly on the module
Addresses	1 to 247, selectable by key-pad
Protocol	MODBUS RTU /JBUS,
Data (bidirectional)	
Dynamic (reading only)	All display variables (see also the table, "List of the variables that can be connected to"...)
Static (writing only)	All configuration parameters, reset of energy, activation of digital output
	Stored energy (EEPROM) max. 999.999.999 kWh/kvarh
Data format	1-start bit, 8-data bit, no parity/even parity, odd parity, 1 stop bit
Baud-rate	9.6k, 19.2k, 38.4k, 115.2k bit/s selectable bauds
Insulation	see "Insulation between inputs and outputs" table
RS232 output (on request)	Bidirectional (static and dynamic variables)
Connections	3 wires, max. distance 15m,
Data format	1-start bit, 8-data bit, no parity, even parity, odd parity, 1 stop bit
Baud-rate	9.6k bit/s
Protocol	MODBUS RTU /JBUS
Other data	as for RS422/485
Digital outputs (on request)	
Pulse type	
Number of outputs	Up to 16
Type	Programmable from 0.001 to 1000 pulses per kWh/kvarh (total and partial) Outputs connectable to the total and/or partial energy meters (Wh/varh)
Pulse duration	≥ 100ms, < 120msec (ON), ≥ 100ms (OFF) according to EN62053-31
Alarm type	
Number of outputs	up to 16, independent
Alarm modes	Up alarm, down alarm, in window alarm, out window alarm. All of them can be used with start up deactivation function and/or latch. All the alarms can be connected to all variables (see the table "List of the variables that can be connected to").
Set-point adjustment	from 0 to 100% of the electrical scale
Hysteresis	from 0 to full scale
On-time delay	0 to 255s
Output status	Selectable; normally de-energised and normally energised
Min. response time	≤200ms, filters excluded, Set-point on-time delay: "0 s"
Note	The 16 digital outputs can also work as combination of pulse outputs and alarm outputs.
Static (digital) outputs	**(on request)**
Purpose	For pulse outputs or for alarm outputs
Signal	V_{ON} 1.2 VDC/ max. 100 mA V_{OFF} 30 VDC max.
Insulation	see "Insulation between inputs and outputs" table
Relay (digital) outputs	**(on request)**
Purpose	For alarm outputs or for pulse outputs
Output type	Relay SPDT AC 1-8A, 250VAC DC 12-5A, 24VDC AC 15-2.5A, 250VAC DC 13-2.5A, 24VDC
Insulation	see "Insulation between inputs and outputs" table

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Software functions

Password	Numeric code of max 4 digits from 0 to 1000; 2 protection levels of the programming data
1st level	Password “0”: no protection
2nd level	Password from 1 to 1000: all data are protected.
System selection	
System 1	1-phase (2 wires)
System 2, unbalanced	2-phase (3 wires)
System 3, balanced	3-phase (3 wires+1CT)
System 3, unbalanced	3-phase (3 wires) 3-phase (4 wires)
Transformer ratio	CT up to 60 kA (6000 max) VT (PT) up to 600 kV (6000 max)
Filters	
Filter operating range	0.1 to 100% of the input electrical scale.
Filtering coefficient	1 to 255
Filter action	Display, alarms, serial outputs (fundamental variables: V, A, W and their derived ones).
Alarms	
Working mode	“OR” or “AND” or “OR+AND” functions (see “Alarm parameter and logic” page). Freely programmable on up to 16 alarms. 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 the key-pad or of the configuration software, it is possible to reset the following data: - all the min, max, dmd, dmd-max values. - total and partial counters. - latch alarms. - all the events.

Data stamping	
Type of data	Alarm, min, max, digital input status, digital output status as remote control, resets. All events are stored with date (dd:MM:yy) and hour (hh:mm:ss) reference
Number of events	Up to 10,000
Data management type:	FIFO
Data storage type	Data flash
Displaying	4 variables per page 1 page that can be laid out by the user Up to 36 pages
Energy meters	Up to 28 pages depending on the selected tariff mode. Displaying of the consumed energy of the previous 12 months.
Stored events	10,000 events.
Display language	Selectable: English, Italian, French, German, Spanish

Wm5Soft parameter programming and variable reading software

Wm5Soft	Multi-language software (Italian, English, French, German, Spanish) for variable reading, instrument calibration and parameters programming. The program runs under Windows /98/98SE/2000/NT/XP.
Working mode	Three different working modes can be selected:

	- management of local RS232 (MODBUS); - management of local optical port (MODBUS); - management of a local RS485 network (MODBUS);
Data Storing	In pre-formatted XLS files (Excel data base).
Data Transfer	Manual or automatic at programmable timings.

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Time period management

Meters	
Total	4 (9-digit)
Partial and multitariff	48 (9-digit)
Tariffs	Up to 12
Time periods	
Number of periods	Up to 24 per day Up to 100 different days per year
Pulse output	Connectable to total and/or partial meters (multitariff)
Energy meter recording	Consumption history by recording of the monthly energy meters (12 previous months). Recording of total and partial energy meters. Energy meter recording (EEPROM) Max.999,999,999kWh/kvarh.

Energy Meters	
Total energy meters	4 (+kWh, +kvarh, -kWh, -kvarh) It is possible to divide each energy meter here above listed in 3 additional energy meters (1 for each phase "L1-L2-L3")
Monthly energy meters	48 (energy meters for each month: "+kWh, +kvarh, -kWh, -kvarh")
Partial energy meters	16 (using digital inputs: max 4 tariffs). 48 (using the internal clock: max 12 tariffs)

Harmonic distortion analysis

Analysis principle	FFT
Harmonic measurement	
Current	Up to the 63rd harmonic
Voltage	Up to the 63rd harmonic
Type of harmonics	THD (V_{L1} and V_{L1-N}) THD odd (V_{L1} and V_{L1-N}) THD even (V_{L1} and V_{L1-N}) The same for the other phases: L2, L3. THD (A_{L1}) THD odd (A_{L1}) THD even (A_{L1}) The same for the other phases: L2, L3.
Harmonic phase angle	The instrument measures the angle between the single harmonic of "V" and the single harmonic of "I" of the same order. According to the value of the electrical angle, it is possible to know if the distortion is absorbed or generated. Note: if the system has 3 wires the angle cannot be measured.
Harmonic details	The harmonic contents is displayed as a graph showing the whole harmonic spectrum. This value is also given as a numerical information: THD % / RMS value THD even % / RMS value THD odd% / RMS value single harmonics in % / RMS value
System	The harmonic distortion can be measured in single-phase, 3-wire or 4-wire systems. Tw: 0.02 sec@50Hz without filter

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General Specifications

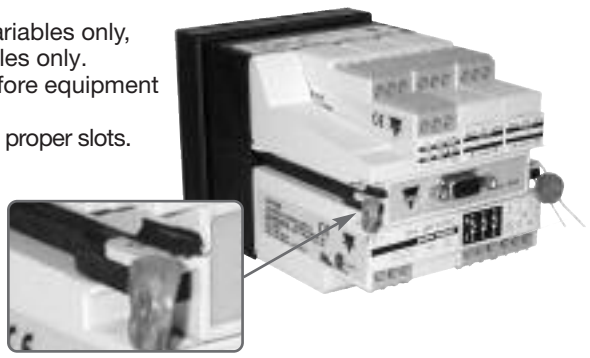
Operating temperature	-10° to +45°C (14° to 113°F) (R.H. < 90% non-condensing)
Limit range of operating temp.	-20° to +55°C (-4° to 131°F) (R.H. <90% non-condensing)
Storage temperature	-30° to +60°C (-4° to 140°F) (R.H. < 90% non-condensing)
Installation category	III
Pollution degree	2
Altitude	up to 2000m (6560 feet) above sea-level
Insulation reference voltage	300 V_{RMS} to ground (AV5 input)
Dielectric strength	4kVAC$_{RMS}$ (for 1 min)
Noise Rejection CMRR	100 dB, 48 to 62 Hz
EMC Emissions	EN61000-6-3, EN60688 residential environment, commerce and light industry
Immunity	EN61000-6-2 industrial environment. ANSI/IEEE C37.90-1989 (surge, withstand and fast transient test)
Pulse voltage (1.2/50µs)	EN61000-4-5
Safety standards	IEC60664, IEC61010-1 EN60664, EN61010-1
Measurement standards	IEC60688, EN60688, EN62053-22, EN62053-23, ANSI C12.20, ANSI C12.1
Approvals	CE, cURus and CSA
Connections 5(6) A	Screw-type max. 2.5 mm^2 wires (2x 1.5mm^2)
Housing Dimensions Material	96x96x140 mm ABS, self-extinguishing: UL 94 V-0
Protection degree	Front: IP65 / NEMA 4x
Weight	Approx. 600 g (packing included)

Supply specifications

AC/DC voltage	90 to 260V (standard) 18 to 60V (on request)
Power consumption	≤ 30VA/12W (90 to 260V) ≤ 20VA/12W (18 to 60V)

Revenue approval settings

- The access to the programming parameters via front key pad and/or serial communication ports is locked.
- The front key pad (up and down keys) allows the displaying of the variables only, while the communication ports allows the transmission of the variables only.
- A proper “instrument settings” form must be filled up by the user before equipment supplying.
- WM5-96 is supplied with the desired modules plugged and sealed in the proper slots.
- WM5-96 fulfils: the ANSI/IEEE C12.20-1998 requirements;
  the CAN3-C17-M84 requirements;
  and can be certified according to:
  C12.20-1998, class 0.5 (independent labs);
  AE-0924 Industry Canada Approval.



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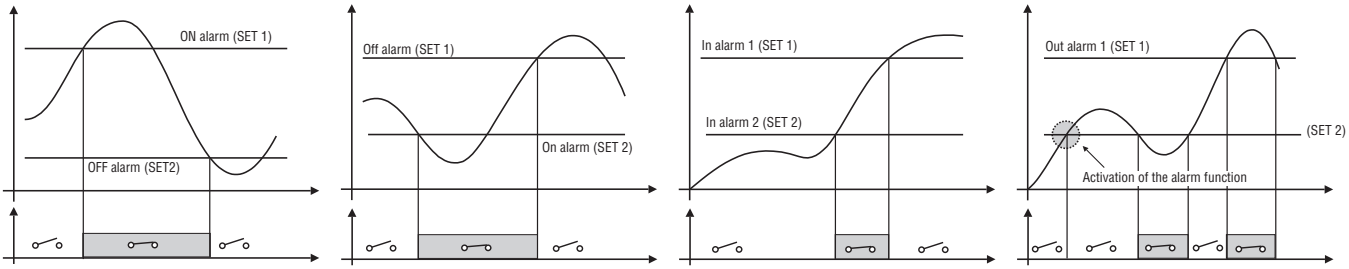
Alarm parameters and logic

- Block enable.
- Controlled variable (VLN, ...).
- Alarm type (up, down, window int, window ext).
- Activation function.
- Latch
- SET 1.
- SET 2.
- ON delay.
- OFF delay
- Logical function (AND, OR).
- Digital output (1 to 16).

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



Up alarm
SET 1 > SET 2

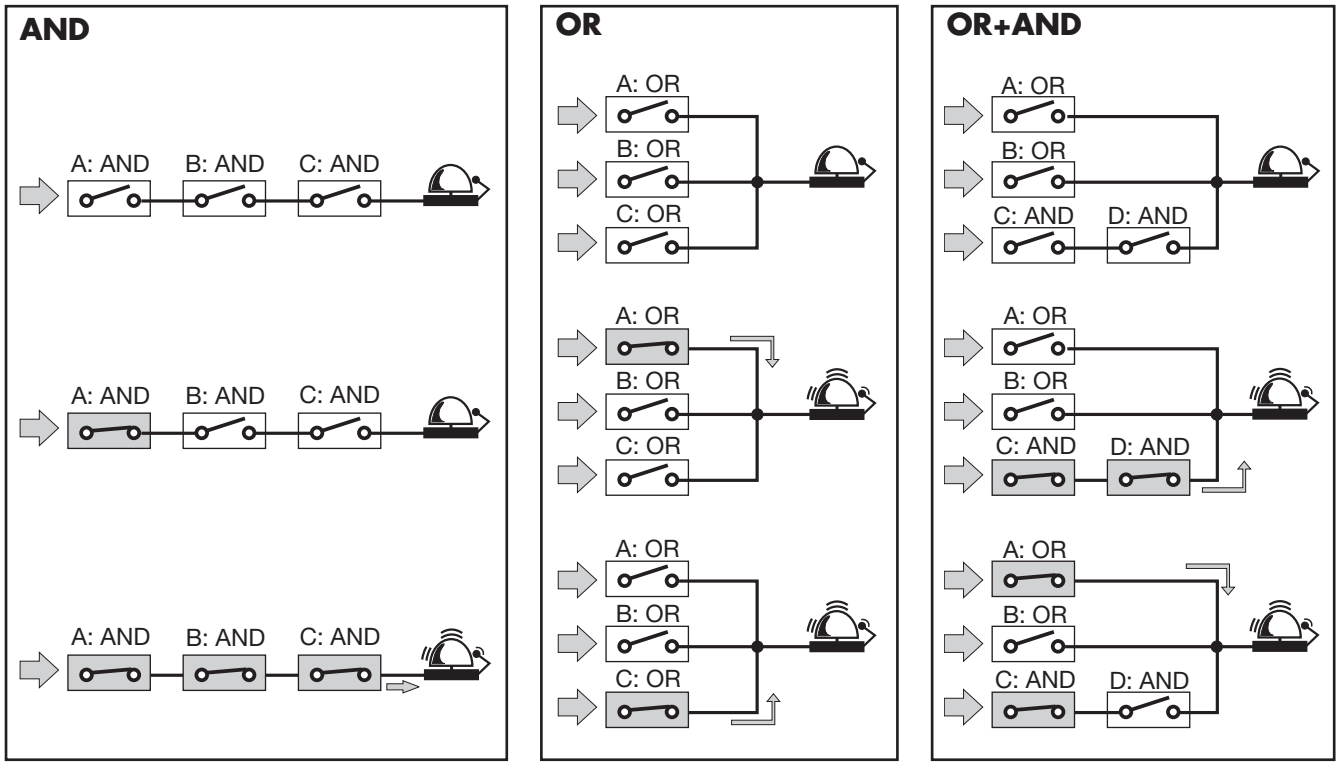
Down alarm
SET 2 < SET 1

In windows alarm
In alarm between
SET 1 and SET 2

Out windows alarm with
start up deactivation
In alarm over SET 1 and
below SET 2

Note: any alarm working mode can be linked to the “Activation” function which disables only the first alarm at the power on of the instrument. All the alarms can be used with the latch function.

AND/OR logical alarm examples:



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Function Description

Input and output scaling capability. Working of the analogue outputs (y) versus input variables (x)

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

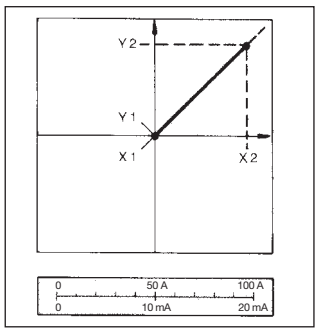


Figure B
The sign of measured quantity and output quantity changes simultaneously. The output quantity is proportional to the measured quantity.

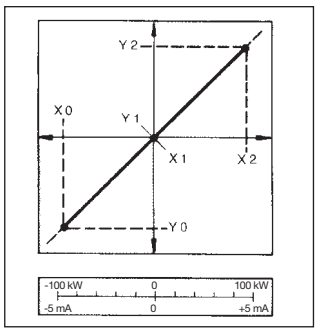


Figure C
The sign of measured quantity and output quantity remains the same. On the range X0...X1, the output quantity is zero. The range X1...X2 is delineated on the entire output range Y0 = Y1...Y2 and thus presented in strongly expanded form.

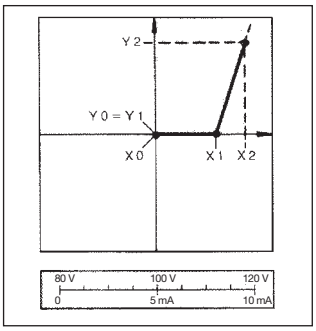


Figure D
The sign of measured quantity and output quantity remains the same. With the measured quantity being zero, the output quantity already has the value Y1 = 0.2 Y2.
Live zero output.

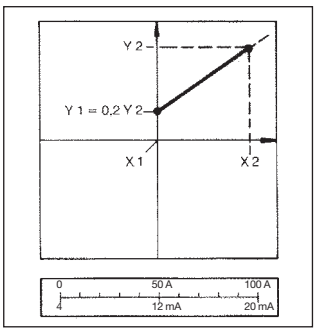


Figure E
The sign of the measured quantity changes but the one of the output quantity remains the same. The output quantity steadily increases from value X1 to value X2 of the measured quantity.

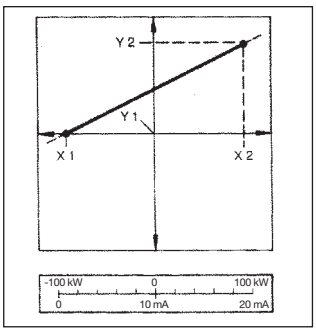
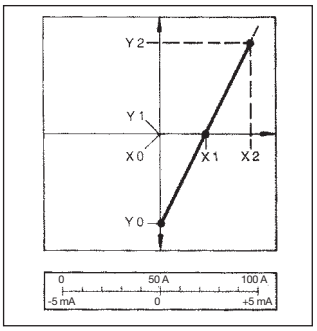


Figure F
The sign of the measured quantity remains the same, the one of the output quantity changes as the measured quantity leaves range X0...X1 and passes to range X1...X2 and vice versa.



Insulation between inputs and outputs

	Meas. /digital inputs	Relay output	Open collector output	Analogue out. 10V, 20mA	Analogue out. ±5mA	AR1034	AR2040	AR1039	Power Supply 90-260VAC/DC	Power Supply 18-60VAC/DC
Meas. /digital inputs	-	4kV	4kV	2kV	2kV	4kV	2kV	4kV	4kV	4kV
Relay output	4kV	4kV (*)	4kV	4kV	4kV	4kV	4kV	4kV	4kV	4kV
Open coll.out.	4kV	4kV	4kV (*)	4kV	4kV	4kV	4kV	4kV	4kV	4kV
Analogue out. 10V, 20mA	2kV	4kV	4kV	4kV (*)	4kV	4kV	4kV	4kV	4kV	4kV
Analogue out. ±5mA	2kV	4kV	4kV	4kV	200V (**)	4kV	4kV	4kV	4kV	4kV
AR1034	4kV	4kV	4kV	4kV	4kV	-	-	4kV	4kV	4kV
AR2040	2kV	4kV	4kV	4kV	4kV	-	-	4kV	4kV	4kV
AR1039	4kV	4kV	4kV	4kV	4kV	4kV	4kV	-	4kV	4kV
90-260VAC/DC	4kV	4kV	4kV	4kV	4kV	4kV	4kV	4kV	-	-
18-60VAC/DC	4kV	4kV	4kV	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.
(*) The given insulation is granted among outputs plugged in different slots. The modules equipped with two or four outputs have therefore non insulation among the outputs. **(**)** Insulation between the 2 outputs of the same module is 200V for 1 min.

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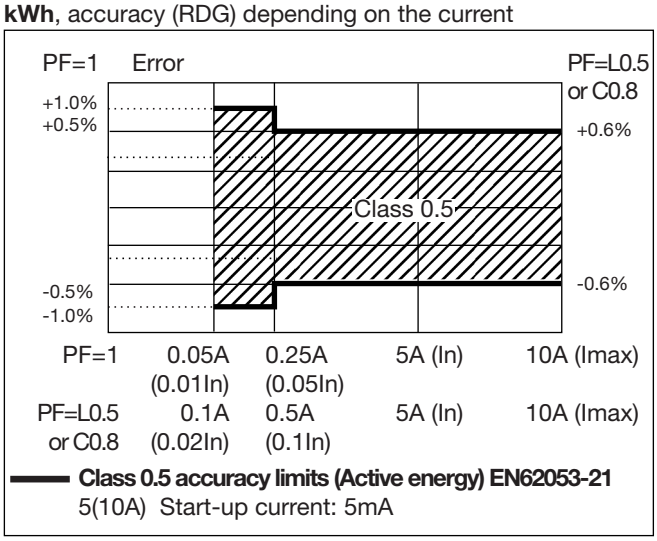
Digital outputs important note

Code	Description	Slot A				Slot B				Slot C				Slot D			
AO1058	1 relay output	A0				B0				C0				D0			
AO1059	1 open coll. output	A0				B0				C0				D0			
AO1035	2 relay outputs	A0	A1			B0	B1			C0	C1			D0	D1		
AO1036	2 open coll. outputs	A0	A1			B0	B1			C0	C1			D0	D1		
AO1037	4 open coll. outputs	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4

The grey-marked digital outputs are activated for a while during the instrument start-up, therefore they are not suggested for pulse output purpose.

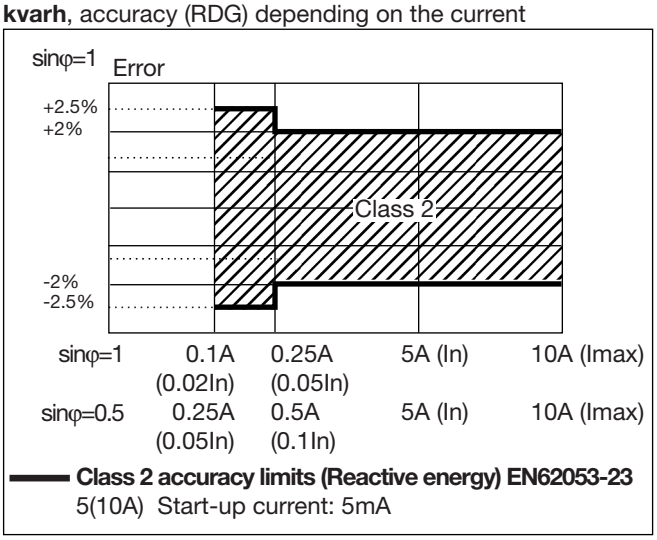
Accuracy

kWh, accuracy (RDG) depending on the current



Class 0.5 accuracy limits (Active energy) EN62053-21
5(10A) Start-up current: 5mA

kvarh, accuracy (RDG) depending on the current



Class 2 accuracy limits (Reactive energy) EN62053-23
5(10A) Start-up current: 5mA

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 (TPF)

$$\cos\phi_\Sigma = \frac{W_\Sigma}{VA_\Sigma}$$

Energy metering

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

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

Where:

i= considered phase (L1, L2 or L3)
P= active power; **Q**= reactive power;
$\mathbf{t_1}$, $\mathbf{t_2}$ =starting and ending time points of consumption recording; **n**= time unit;Δ**t**= time interval between two successive power measurements;
$\mathbf{n_1}$, $\mathbf{n_2}$ = starting and ending discrete time points of power recording

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List of the variables that can be connected to:

Analogue outputs (all listed variables with the only exception of energies), alarm outputs (all listed variables with the only exception of energies), pulse outputs (only energies), communication (all listed variables).

No	Variable	1-phase system	2-ph. 3-wire system	3-ph. 4-wire bal. (1 CT)	3-ph. 3-wire unbal. sys.	3-ph. 4-wire unbal. sys.	Notes
1	V L1	x	x	x	o	x	
2	V L2	o	x	x	o	x	
3	V L3	o	o	x	o	x	
4	V L-N sys	o	x	x	o	x	Sys = system = Σ
5	V L1-2	o	x	x	x	x	
6	V L2-3	o	o	x	x	x	
7	V L3-1	o	o	x	x	x	
8	V L-L sys	o	o	x	x	x	Sys = system = Σ
9	A L1	x	x	x	x	x	
10	A L2	o	x	x	x	x	
11	A L3	o	o	x	x	x	
12	An	o	x	x	o	x	An=neutral current
13	W L1	x	x	x	x	x	
14	W L2	o	x	x	x	x	
15	W L3	o	o	x	x	x	
16	W sys	o	x	x	x	x	
17	var L1	x	x	x	x	x	
18	var L2	o	x	x	x	x	
19	var L3	o	o	x	x	x	
20	var sys	o	x	x	x	x	Sys = system = Σ
21	VA L1	x	x	x	x	x	
22	VA L2	o	x	x	x	x	
23	VA L3	o	o	x	x	x	
24	VA sys	o	x	x	x	x	Sys = system = Σ
25	PF L1	x	x	x	x	x	
26	PF L2	o	x	x	x	x	
27	PF L3	o	o	x	x	x	
28	PF sys	o	x	x	x	x	Sys = system = Σ
29	Hz	x	x	x	x	x	
30	ASY VL-N	o	x	x	o	x	Asymmetry of phase-neutral
31	ASY VL-L	o	o	x	x	x	Asymmetry of phase-phase
32	THD V1	x	x	x	o	x	
33	THD V2	o	x	x	o	x	
34	THD V3	o	o	x	o	x	
35	THD V1-2	o	x	x	x	x	
36	THD V2-3	o	o	x	x	x	
37	THD V3-1	o	o	x	x	x	
38	THD A1	x	x	x	x	x	
39	THD A2	o	x	x	x	x	
40	THD A3	o	o	x	x	x	
41	THDo V1	x	x	x	o	x	
42	THDo V2	o	x	x	o	x	
43	THDo V3	o	o	x	o	x	
44	THDo V1-2	o	x	x	x	x	
45	THDo V2-3	o	o	x	x	x	
46	THDo V3-1	o	o	x	x	x	
47	THDo A1	x	x	x	x	x	
48	THDo A2	o	x	x	x	x	
49	THDo A3	o	o	x	x	x	
50	THDe V1	x	x	x	o	x	
51	THDe V2	o	x	x	o	x	
52	THDe V3	o	o	x	o	x	
53	THDe V1-2	o	x	x	x	x	
54	THDe V2-3	o	o	x	x	x	
55	THDe V3-1	o	o	x	x	x	
56	THDe A1	x	x	x	x	x	
57	THDe A2	o	x	x	x	x	
58	THDe A3	o	o	x	x	x	
59	Phase seq.	o	o	x	x	x	Phase sequence

(x) = available (o) = not available

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Display pages

Display variables in three-phase systems, 4-wire connections

No	1st variable	2nd variable	3rd variable	4th variable	Note
0	Selectable	Selectable	Selectable	See note	kWh + kvarh meters + W% bargraph
1	V L1	V L2	V L3	V L-N sys	instant.-min-max-dmd-max dmd
2	V L1-2	V L2-3	V L3-1	V L-L sys	instant.-min-max-dmd-max dmd
3	A L1	A L2	A L3	An	instant.-min-max-dmd-max dmd
4	W L1	W L2	W L3	W sys	instant.-min-max-dmd-max dmd
5	var L1	var L2	var L3	var sys	instant.-min-max-dmd-max dmd
6	VA L1	VA L2	VA L3	VA sys	instant.-min-max-dmd-max dmd
7	PF L1	PF L2	PF L3	PF sys	instant.-min-max-dmd-max dmd
8	V L1	A L1	PF L1	W L1	instant.-min-max-dmd-max dmd
9	V L2	A L2	PF L2	W L2	instant.-min-max-dmd-max dmd
10	V L3	A L3	PF L3	W L3	instant.-min-max-dmd-max dmd
11	V L-L sys	ASY V L-L	Hz	An	instant.-min-max-dmd-max dmd
12	V L-N sys	ASY V L-N	Hz	An	instant.-min-max-dmd-max dmd
13	W sys	var sys	PF sys	VA sys	instant.-min-max-dmd-max dmd
14	THD VL1 tot	THD VL2 tot	THD VL3 tot		instant.-min-max-dmd-max dmd
15	THD VL1 odd	THD VL2 odd	THD VL3 odd		instant.-min-max-dmd-max dmd
16	THD VL1 even	THD VL2 even	THD VL3 even		instant.-min-max-dmd-max dmd
17	THD VL1-2 tot	THD VL2-3 tot	THD VL3-1 tot		instant.-min-max-dmd-max dmd
18	THD VL1-2 odd	THD VL2-3 odd	THD VL3-1 odd		instant.-min-max-dmd-max dmd
19	THD VL1-2 even	THD VL2-3 even	THD VL3-1 even		instant.-min-max-dmd-max dmd
20	THD AL1 tot	THD AL2 tot	THD AL3 tot		instant.-min-max-dmd-max dmd
21	THD AL1 odd	THD AL2 odd	THD AL3 odd		instant.-min-max-dmd-max dmd
22	THD AL1 even	THD AL2 even	THD AL3 even		instant.-min-max-dmd-max dmd
23	Histogram FFT V1 (THD, THDo, THDe, Single harmonic)				
24	Histogram FFT V2 (THD, THDo, THDe, Single harmonic)				
25	Histogram FFT V3 (THD, THDo, THDe, Single harmonic)				
26	Histogram FFT V1-2 (THD, THDo, THDe, Single harmonic)				
27	Histogram FFT V2-3 (THD, THDo, THDe, Single harmonic)				
28	Histogram FFT V3-1 (THD, THDo, THDe, Single harmonic)				
29	Histogram FFT A1 (THD, THDo, THDe, Single harmonic)				
30	Histogram FFT A2 (THD, THDo, THDe, Single harmonic)				
31	Histogram FFT A3 (THD, THDo, THDe, Single harmonic)				
32	Digital input status				
33	Digital output status				
34	Energy meters				
35	Events				
36	Alarms status				
37	Info				
38	Info				
39	Info				

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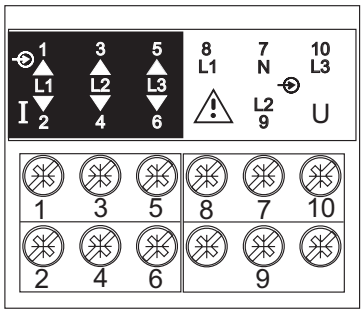
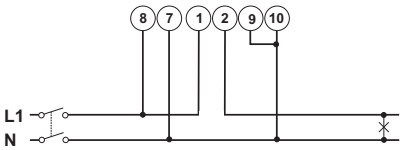
Wiring diagrams



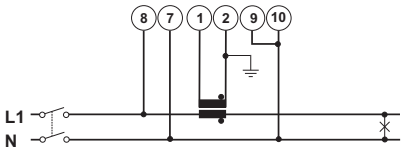
1-phase, 2-wire input connections (1P)

Fig. 1



Direct connection

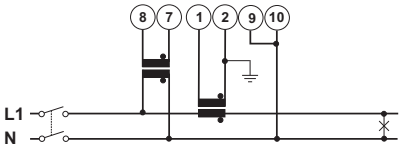
Fig. 2



CT connection

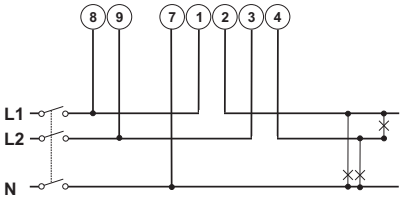
2-phase, 3-wire input connections (2P)

Fig. 3



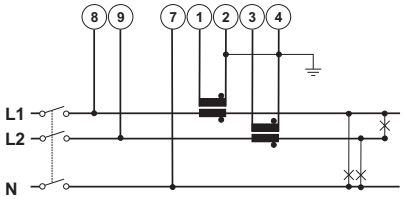
CT and VT connections

Fig. 4



Direct connection

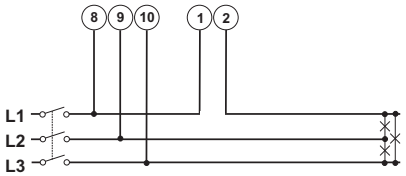
Fig. 5



CT connection

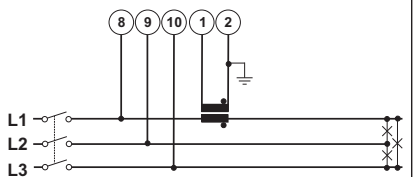
3-phase, 3 and 4-wire input connections - Balanced load (3P)

Fig. 6



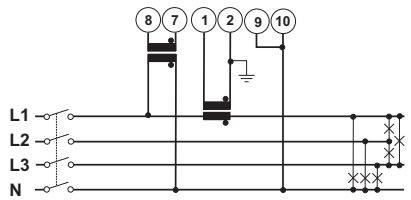
Direct connection (3-wire system)

Fig. 7



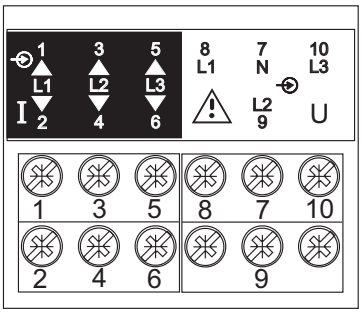
CT and VT connections (3-wire system)

Fig. 8



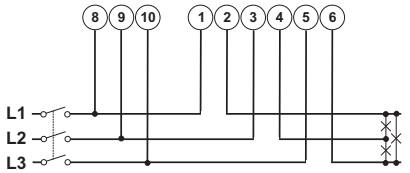
CT and VT connections (4-wire system)

Wiring diagrams (cont.)



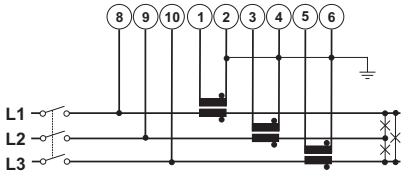
3-phase, 3-wire input connections - Unbalanced load (3P)

Fig. 9



Direct connection (3-wire system)

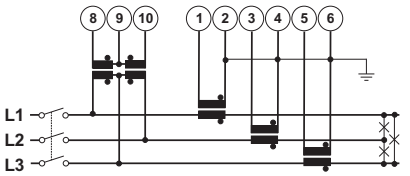
Fig. 10



CT connection (3-wire system)

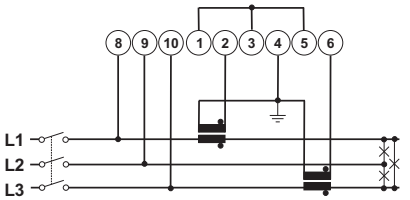
3-phase, 3-wire input connections ARON (3P)

Fig. 11



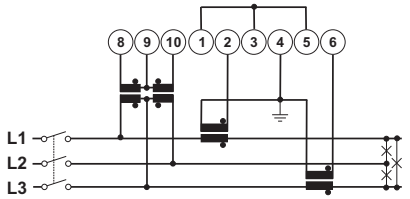
CT and VT connections (3-wire system)

Fig. 12



ARON connection (3-wire system)

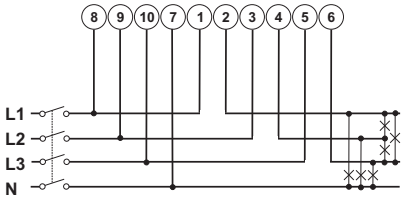
Fig. 13



ARON and VT connections (3-wire system)

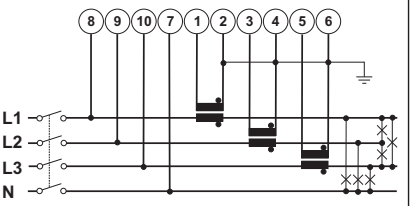
3-phase, 4 wires input connections - Unbalanced load (3p+N)

Fig. 14



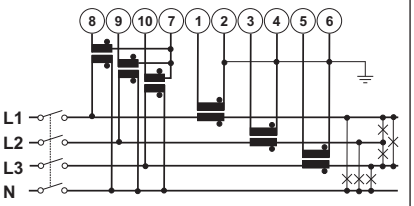
Direct connection (4-wire system)

Fig. 15



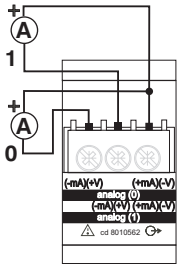
CT connection (4-wire system)

Fig. 16

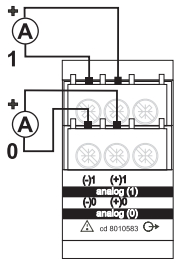


CT and VT connections (4-wire system)

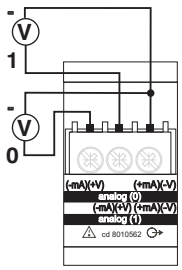
Wiring diagrams (optional modules)



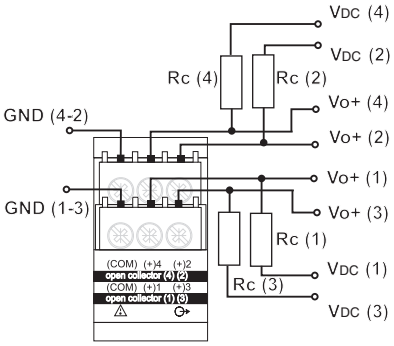
AO2050
2 analogue outputs (0-20mA)



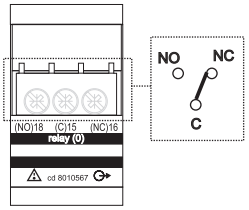
AO2052
2 analogue outputs (+/-5mA)



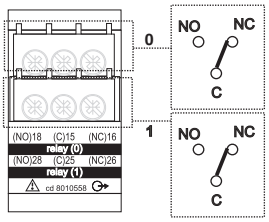
AO1051
2 analogue outputs (10V)



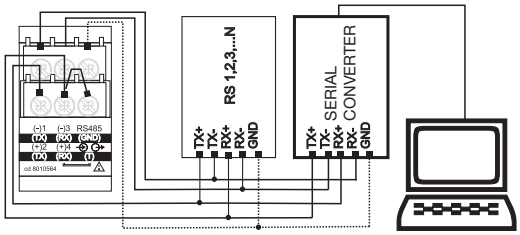
AO1037 4-open collector output connection:
This wiring diagram is valid also for the open collector module with one or two outputs.
The load resistances (RC) must be designed so that the close contact current is lower than 100mA; the VDC voltage must be lower than or equal to 30VDC.



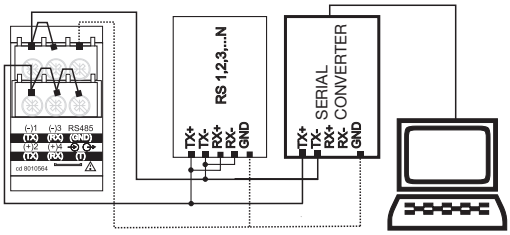
AO1058
1 relay output



AO1035
2 relay outputs



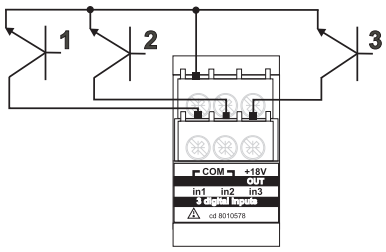
AR1034/AR2040
4-wire connection of RS485 serial port



AR1034/AR2040
2-wire connection of RS485 serial port

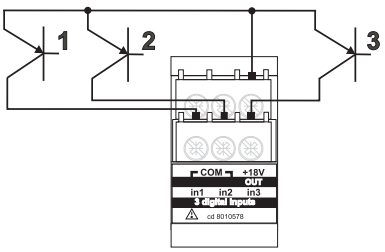
RS422/485 NOTE: additional devices provided with RS422/485 (that is RS 1, 2, 3...N) are connected in parallel. The termination of the serial output is carried out only on the last instrument of the network, by means of a jumper between (RX+) and (T).

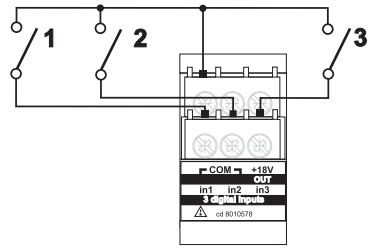
Wiring diagrams: digital input modules



AQ1042
Connection by means of NPN transistors.

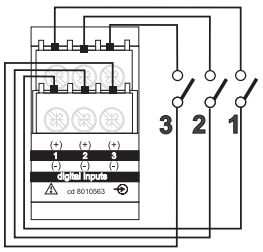
AQ1042
Connection by means of PNP transistors.



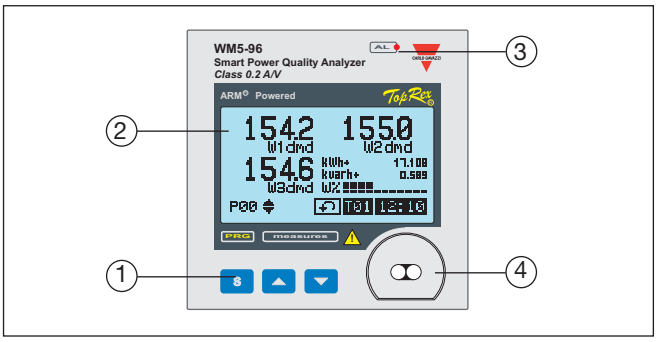


AQ1042
Connection by means of contacts.

AQ1038
Connection by means of contacts.

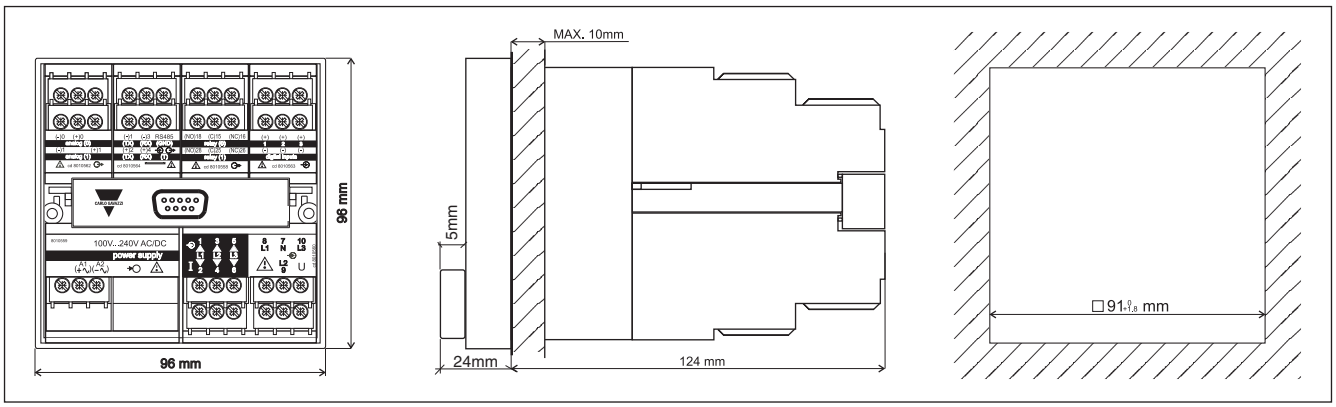


Front panel description



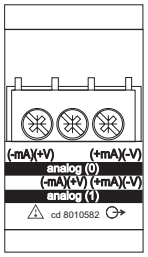
1. **Key-pad**
   Set-up, programming and display parameters are easily controlled by the 3 push-buttons.
   - S to enter programming and to confirm password.
   - ▲ and ▼
   - to program values
   - to select functions
   - to scroll display pages
2. **Display**
   Instantaneous measurements:
   - 4 digits (max display 9999)
   Energies:
   - 9 digits (max display 999 999 999).
   Alphanumeric indications by means of LCD display for:
   - Display of configuration parameters
   - All measuring variables.
3. **LED**
   Alarm LED.
4. **Optical Port**
   For data reading and programming (or pulse output).

Dimensions

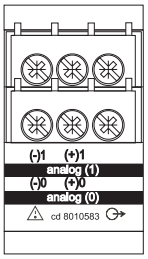


Modules

Dual analogue output modules

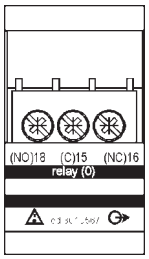


AO2050 (20mADC)
AO2051 (10VDC)

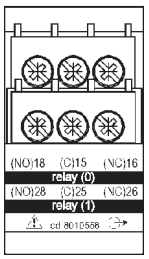


AO2052 (+/-5mADC)

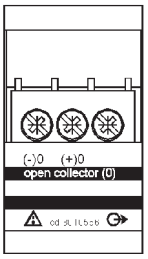
Digital output modules



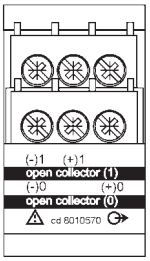
AO1058
Single relay output



AO1035
Dual relay output

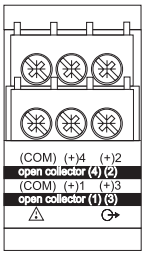


AO1059
Single open collector output

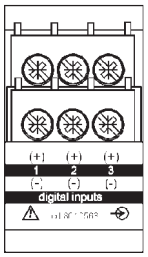


AO1036
Dual open collector output

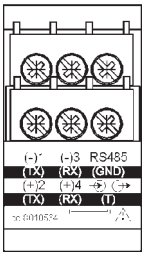
Other input/output modules



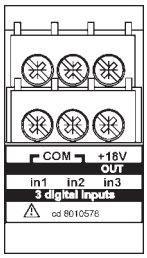
AO1037
4 open collector outputs



AQ1038
3 digital inputs

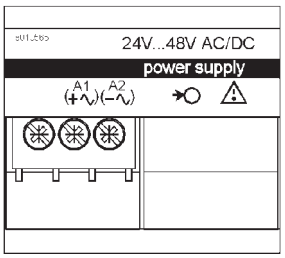


AR1034
AR2040
RS485 port

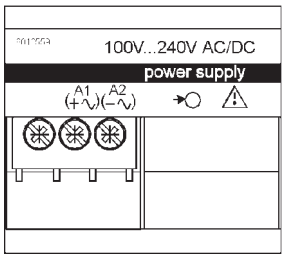


AQ1042
3 digital inputs + aux

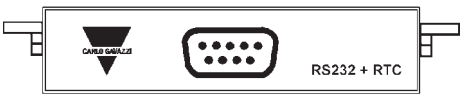
Power supply modules



AP1021
18-60VAC/DC power supply



AP1020
90-260 VAC/DC power supply



AR1039
RS232 port + RTC