

# Energy Management

## Three-phase energy meter with output modules

### Type EM4-DIN

CARLO GAVAZZI



- Front dimensions: 9 DIN modules
- RS 422/485 Serial port by means of optional module
- Dual pulse output by means of optional module
- Digital inputs for the management of the time periods and of the H<sub>2</sub>O and GAS meters

- Class 1 (active energy)
- Class 2 (reactive energy)
- Three-phase multi-function energy meter
- Back-lighted LCD display
- 4 x 3<sup>1</sup>/<sub>2</sub> DGT instantaneous variables read-out
- 8 DGT + 7<sup>1</sup>/<sub>2</sub> DGT energy read-out
- Measurements of system and phase variables: W, Wdmd
- Measurements of total energies: kWh, kvarh
- Measurements of partial energies: kWh, kvarh
- Energy measurements according to EN61036 and EN61268
- Energy measurements by time periods (t1-t2-t3-t4) selectable by input contacts
- Measurements of m<sup>3</sup> H<sub>2</sub>O and m<sup>3</sup> GAS by means of input contacts

- TRMS measurements of distorted wave forms (voltages/currents)
- Two basic models: direct connection 20(90)AAC, CT 5(10)AAC and VT connection
- Self power supply (available for some models only) or auxiliary power supply: 24V, 48V, 115V, 230V, 50-60Hz
- Degree of protection (front): IP 40

## Product description

Three-phase energy meter with built-in configuration key-pad; particularly indicated for the metering and the management of the energy in addition to the metering and the management of the signals coming from the water and gas meters. Housing for DIN-rail or wall-mounting, IP40 (front) protection degree. Completely sealable housing. In case of direct connection up to 90A, the measuring

input terminals are suitable for cables with a cross-section area from 6 to 35 mm<sup>2</sup>. The special design of the instrument's housing allows to add at any time the interface modules, even when the instrument is already installed. The following modules are available:

- for all versions: pulse output;
- only for the versions with auxiliary power supply: digital inputs, RS485 serial port.

## How to order EM4-DIN AV5 3 X X XX

Model \_\_\_\_\_  
 Range code \_\_\_\_\_  
 System \_\_\_\_\_  
 Power supply \_\_\_\_\_  
 Slot A \_\_\_\_\_  
 Slot B \_\_\_\_\_

## Type selection

Range Code	Power supply	Slot A (retransmission)	Slot B (retransmission)
<b>Auxiliary Power Supply:</b> <b>AV0:</b> 208V <sub>L-L</sub> /20(90)AAC [1] <b>AV1:</b> 400V <sub>L-L</sub> /20(90)AAC [1] <b>AV3:</b> 660V <sub>L-L</sub> /20(90)AAC [2] <b>AV4:</b> 208V <sub>L-L</sub> /5(10)AAC [1] <b>AV5:</b> 400V <sub>L-L</sub> /5(10)AAC [1] <b>AV6:</b> 100V <sub>L-L</sub> /5(10)AAC [3] <b>AV7:</b> 660V <sub>L-L</sub> /5(10)AAC [2]			
<b>Self Power Supply:</b> <b>AV8:</b> 208V <sub>L-L</sub> /20(90)AAC [1] <b>AV9:</b> 400V <sub>L-L</sub> /20(90)AAC [1]			
<b>System</b> <b>3 :</b> Three-phase, balanced and unbalanced load with or without neutral			
	<b>For all versions</b> <b>A:</b> 24VAC -15+10%, 50-60Hz <b>B:</b> 48VAC -15+10%, 50-60Hz <b>C:</b> 115VAC -15+10%, 50-60Hz <b>D:</b> 230VAC -15+10%, 50-60Hz	<b>X:</b> None <b>O:</b> AO2900 module Dual open collector output. Two operating modes: • two pulse outputs (kWh and kvarh); • one output remotely controlled by a serial port and one pulse output (kWh or kvarh) <b>D:</b> AO2940 module Two digital inputs for the management of water and gas meters	<b>Only with A-B-C-D power supply</b> <b>XX:</b> None <b>S0:</b> AR2950 module RS422/485 serial port
	<b>Only for AV8 and AV9 versions</b> <b>X:</b> Self Power Supply 400V <sub>L-L</sub> -20+15%, 50-60Hz 208V <sub>L-L</sub> -20+15%, 50-60Hz		

[1] Un: -20+15% [2] Un: -30+15% [3] Un: -20+20%

Specifications are subject to change without notice

## Input specifications

<b>Number of inputs</b>		<b>Temperature drift</b>	≤ 200ppm/°C
Current	3	<b>Sampling rate</b>	1000 samplings/s @ 50Hz
Voltage	4	<b>Display</b>	
<b>Accuracy</b> (display, RS485)	Ib: 5A, I <sub>max</sub> : 10A Ib: 20A, I <sub>max</sub> : 90A Un: see "Range code" on previous page	Type	Back-lighted LCD
Current	from 0.003Ib to 0.2Ib: ±(0.5%RDG + 3DGT) from 0.2Ib to I <sub>max</sub> : ±(0.5%RDG + 1DGT)	Instantan. variables read-out	4x3½ DGT
Voltage	in the range Un: ±(0.5% RDG + 1DGT)	Energies	Total: 8 DGT + 7½ DGT; Partial: 8 DGT + 7½ DGT;
Frequency	±0.1% RDG (50 to 60 Hz)	<b>Max. and Min. indication</b>	Max. 1999 (99999999), Min. 0
Active power (@ 25°C ± 5°C, R.H. ≤ 90%)	±1% RDG ±1DGT (PF 1, 0.1Ib to I <sub>max</sub> , in the Un range; PF 0.5L, PF 0.8C, 0.2Ib to I <sub>max</sub> , in the Un range)	<b>Measurements</b>	Power, energy. TRMS measurements of distorted wave forms. Direct
Energies (@ 25°C ± 5°C, R.H. ≤ 90%)	Class 1 acc. to EN61036 Class 2 acc. to EN61268 Ib: 5A, I <sub>max</sub> : 10A 0.1Ib: 500mA, Start up current: 20mA Un: see table "range code" Ib: 20A, I <sub>max</sub> : 90A 0.1Ib: 2A, Start up current: 80mA Un: see table "range code"	Coupling type	
<b>Additional errors</b>	Acc. to EN61036, EN61268	<b>Crest factor</b>	
Wave form	<1% (3 <sup>rd</sup> harmonic: 10%)	Ib 5A	≤3 (15A max. peak)
Voltage asymmetry	< 0.5% (referred to Un)	Ib 20A	≤6 (127A max. peak)
Magnetic induction	0 (up to 0.5 mT)	<b>Current overload</b>	
HF Electromagnetic fields	< 1%	5(10) A, for 10ms	300A max, @ 50Hz
Operation of accessories	0	5(10) A, for 500ms	200A max, @ 50Hz
		5(10) A, permanent	10A, @ 50Hz
		20(90) A, for 10ms	2700A max, @ 50Hz
		20(90) A, permanent	90A, @ 50Hz
		<b>Voltage overload</b>	
		Permanent	1.2 Un
		For 1s	2 Un
		<b>Input impedance</b>	
		400V <sub>L-L</sub> (AV1-AV5-AV9)	> 720KΩ
		208V <sub>L-L</sub> (AV0-AV4-AV8)	> 720KΩ
		660V <sub>L-L</sub> (AV3-AV7)	> 1.97MΩ
		100V <sub>L-L</sub> (AV6)	> 400KΩ
		5(10) A (AV4-AV5-AV6-AV7)	< 0.3VA
		20(90) A (AV0-AV1-AV3-AV8-AV9)	< 4VA
		<b>Frequency</b>	50 to 60 Hz

## Interface module specifications

<b>RS422/RS485</b> (on request)	AR2950 module	2000 V <sub>RMS</sub> output to measuring inputs
Type	Multidrop	2000 V <sub>RMS</sub> output to supply input
Connections	bidirectional (static and dynamic variables) 2 or 4 wires, max. distance 1200m, termination directly on the module	<b>Pulse outputs</b> (on request)
Addresses	255, selectable by key-pad	AO2900 module
Protocol	MODBUS/JBUS	To be used as energy retransmission, water and gas or remote static outputs.
Data (bidirectional)		Two working modes are selectable:
Dynamic (reading only)	Phase and system variables: see table "Display pages"	• two pulse outputs (kWh and kvarh);
Static (writing only)	All the programming data, reset of energy, activation of static output.	• one output remotely con- trolled by means of the serial port and one pulse output (kWh or kvarh)
Data format	Stored energy (EEPROM) max. 99.999.999 kWh/kvarh	Number of outputs
Baud-rate	1 start bit, 8 data bit, no parity, 1 stop bit	Number of pulses
Insulation	9600 bit/s	
	By means of optocouplers,	

## Interface module specifications (cont.)

Output type	Open collector (NPN transistor) $V_{ON}$ 1.2 VDC / max. 100 mA $V_{OFF}$ 30 VDC max.		
Pulse duration	220 ms (ON), $\geq$ 220 ms (OFF)		
Insulation	According to DIN43864 By means of optocouplers, 2000 $V_{RMS}$ outputs to measuring inputs, 2000 $V_{RMS}$ output to supply input. Insulation between the two outputs: functional	Number of inputs Input frequency Duty cycle Contact measur. voltage	“day-time/night” GAS meter; • total energy meters (kWh, kvarh), GAS and WATER meters;
<b>Digital inputs</b> (on request)	AO2900 module Four working modes are selectable: • total and partial energy meters (kWh and kvarh) without the use of digital inputs • total and partial energy meters (kWh and kvarh) managed by time periods ( $t_1$ - $t_2$ - $t_3$ - $t_4$ ); • total energy meters (kWh, kvarh) and total	Contact measur. current Input impedance Contact resistance  Insulation	2 20Hz max. 50% 12V < +Aux < 24VDC Logic status: OFF < 2V ON > 10V 15mA max 1k $\Omega$ $\leq$ 1k $\Omega$ , close contact $\geq$ 100k $\Omega$ , open contact By means of optocouplers, 2000 $V_{RMS}$ digital inputs to measuring inputs, 2000 $V_{RMS}$ digital inputs to supply input.

## Software functions

<b>Password</b>	Numeric code of max. 3 digits 2 protection levels of the programming data Password “0”, no protection Password from 1 to 1000, all data are protected	<b>Display</b> Variables	Up to 4 variables per page Page 1: kWh-kvarh Page 2a: kWh ( $t_1$ - $t_2$ - $t_3$ - $t_4$ ) kvarh ( $t_1$ - $t_2$ - $t_3$ - $t_4$ ) Page 2b: GAS m <sup>3</sup> day-time tariff, GAS m <sup>3</sup> night tariff Page 2c: H <sub>2</sub> O m <sup>3</sup> , GAS m <sup>3</sup> Page 3: $W_{L1}$ Page 4: $W_{L2}$ Page 5: $W_{L3}$ Page 6: $W_{dmd}$
<b>System selection</b>	Three-phase with neutral Three-phase without neutral		
<b>Transformer ratio</b> CT VT	1 to 5000 1.0 to 199.9 and 200 to 1999 Note: The CT ratio * VT ratio must never exceed the value 5000. The current measuring inputs can manage CT's with a secondary of 1A and 5A (accuracy always refers to 5A)	Errors	Phase sequence, serial communication status, wrong connection of current measuring inputs.

## Supply specifications

<b>Self supplied version</b>	400V <sub>L-L</sub> -20% +15%, 50-60Hz 208V <sub>L-L</sub> -20% +15% , 50-60Hz		115V AC -15 +10%, 50-60Hz 48VAC -15 +10%, 50-60Hz 24VAC -15 +10%, 50-60Hz
<b>Auxiliary power supply</b>	230V AC -15 +10%, 50-60Hz	<b>Energy consumption</b>	$\leq$ 7VA

## General Specifications

<b>Operating temperature</b>	0 to +55°C (R.H. < 90% non-condensing 40°C)	<b>Pulse voltage (1.2/50µs)</b>	8kV (EN61000-4-5)
<b>Storage temperature</b>	-20 to +60°C (R.H. < 90% non-condensing 40°C)	<b>Standards</b> Safety Metrology	IEC664-1 Energy measurements: EN61036, EN61268. DIN43864
<b>Installation category</b>	Cat. III (IEC 664)	Pulse output	
<b>Insulation</b>	2000 VRMS between all inputs / outputs to earth	<b>Approvals</b>	CE
<b>Dielectric strength</b>	4000 VRMS for 1 minute	<b>Connections 5(10) A</b> Cable cross-section area	Screw-type, 4 mm <sup>2</sup>
<b>Noise rejection</b> CMRR	100 dB, 48 to 62 Hz	<b>Connections 20(90) A</b> Min./Max. cable cross-section area Min./Max. screws tightening torque	Screw-type, 6 mm <sup>2</sup> / 35 mm <sup>2</sup> 2 Nm / 6 Nm (90A inputs)
<b>EMC</b> Burst Immunity to irradiated electromagnetic fields Electrostatic discharges Radio frequency emissions	4kV/level 4 (EN61000-4-4)  10V/m 26-1000MHz (EN61000-4-3) 15kV (EN61000-4-2) according to CISPR 14 and CISPR 22	<b>Housing</b> Dimensions Material	162.5 x 90 x 63 mm ABS, NORYL, PC self-extinguishing: UL 94 V-0
		<b>Mounting</b>	DIN-rail and wall
		<b>Degree of protection</b>	Front: IP40 Connections: IP20
		<b>Weight</b>	800 g approx. (packing included)

## Display pages

### Variables that can be displayed

No	1 <sup>st</sup> variable	2 <sup>nd</sup> variable	Notes
1	kWh	kvarh	
2a	kWh (t <sub>1</sub> or t <sub>1</sub> -t <sub>2</sub> -t <sub>3</sub> -t <sub>4</sub> )	kvarh (t <sub>1</sub> or t <sub>1</sub> -t <sub>2</sub> -t <sub>3</sub> -t <sub>4</sub> )	Depending on the type of selection you have chosen.
2b	Day-time GAS m <sub>3</sub>	Night GAS m <sub>3</sub>	For the energy it is possible to choose the following operating mode: t <sub>1</sub> partial meters or t <sub>1</sub> -t <sub>2</sub> -t <sub>3</sub> -t <sub>4</sub> multitariff selection
2c	H <sub>2</sub> O m <sub>3</sub>	GAS m <sub>3</sub>	
3	W <sub>L1</sub>		
4	W <sub>L2</sub>		
5	W <sub>L3</sub>		
6	W <sub>dmd</sub>		dmd = demand (integration time selectable from 1 to 30 min.)
7	Display of the serial communication status, phase sequence, wrong connection of current measuring inputs		

### Used calculation formulas

#### Phase variables

Instantaneous effective voltage

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

Instantaneous active power

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

Instantaneous power factor

$$\cos \phi_1 = \frac{W_1}{V_{IN} \cdot A_1}$$

Instantaneous effective current

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

Instantaneous apparent power

$$VA_1 = V_{IN} \cdot A_1$$

Instantaneous reactive power

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

**Note:** serial communication of “dynamic data”. In addition to the variables displayed in the table above also the variables mentioned in the table “Displayed pages” of WM22-DIN are transmitted with the only exclusion of: THD<sub>A</sub>, THD<sub>V</sub>, A max, W<sub>dmd</sub> max, e VA<sub>dmd</sub> max.

#### System variables

Equivalent system voltage

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

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

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

#### Consumption recording

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

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

Note:

i = phase (L1, L2 or L3)

P = active power

Q = reactive power

t<sub>1</sub>, t<sub>2</sub> = starting and ending time points of consumption recording

n = time unit

Δt = time interval of consumption recording

n<sub>1</sub>, n<sub>2</sub> = starting and ending discrete time points of consumption recording

## Available models

Type	Inputs	Power supply	Ordering code
EM4-DIN AV9.3.X.	400V <sub>L-L</sub> , 20(90)A	Self power supply	AG2200
EM4-DIN AV8.3.X.	208V <sub>L-L</sub> , 20(90)A	Self power supply	AG2201
EM4-DIN AV1.3.D.	400V <sub>L-L</sub> , 20(90)A	230VAC, 50-60Hz	AG2202
EM4-DIN AV0.3.D.	208V <sub>L-L</sub> , 20(90)A	230VAC, 50-60Hz	AG2203
EM4-DIN AV3.3.D.	660V <sub>L-L</sub> , 20(90)A	230VAC, 50-60Hz	AG2204
EM4-DIN AV1.3.C.	400V <sub>L-L</sub> , 20(90)A	115VAC, 50-60Hz	AG2205
EM4-DIN AV0.3.C.	208V <sub>L-L</sub> , 20(90)A	115VAC, 50-60Hz	AG2206
EM4-DIN AV3.3.C.	660V <sub>L-L</sub> , 20(90)A	115VAC, 50-60Hz	AG2207
EM4-DIN AV1.3.B.	400V <sub>L-L</sub> , 20(90)A	48VAC, 50-60Hz	AG2208
EM4-DIN AV0.3.B.	208V <sub>L-L</sub> , 20(90)A	48VAC, 50-60Hz	AG2209
EM4-DIN AV3.3.B.	660V <sub>L-L</sub> , 20(90)A	48VAC, 50-60Hz	AG2210
EM4-DIN AV1.3.A.	400V <sub>L-L</sub> , 20(90)A	24VAC, 50-60Hz	AG2211
EM4-DIN AV0.3.A.	208V <sub>L-L</sub> , 20(90)A	24VAC, 50-60Hz	AG2212
EM4-DIN AV3.3.A.	660V <sub>L-L</sub> , 20(90)A	24VAC, 50-60Hz	AG2213
EM4-DIN AV5.3.D.	400V <sub>L-L</sub> , 5(10)A	230VAC, 50-60Hz	AG2214
EM4-DIN AV4.3.D.	208V <sub>L-L</sub> , 5(10)A	230VAC, 50-60Hz	AG2215
EM4-DIN AV7.3.D.	660V <sub>L-L</sub> , 5(10)A	230VAC, 50-60Hz	AG2216
EM4-DIN AV5.3.C.	400V <sub>L-L</sub> , 5(10)A	115VAC, 50-60Hz	AG2217
EM4-DIN AV4.3.C.	208V <sub>L-L</sub> , 5(10)A	115VAC, 50-60Hz	AG2218
EM4-DIN AV7.3.C.	660V <sub>L-L</sub> , 5(10)A	115VAC, 50-60Hz	AG2219
EM4-DIN AV5.3.B.	400V <sub>L-L</sub> , 5(10)A	48VAC, 50-60Hz	AG2220
EM4-DIN AV4.3.B.	208V <sub>L-L</sub> , 5(10)A	48VAC, 50-60Hz	AG2221
EM4-DIN AV7.3.B.	660V <sub>L-L</sub> , 5(10)A	48VAC, 50-60Hz	AG2222
EM4-DIN AV5.3.A.	400V <sub>L-L</sub> , 5(10)A	24VAC, 50-60Hz	AG2223
EM4-DIN AV4.3.A.	208V <sub>L-L</sub> , 5(10)A	24VAC, 50-60Hz	AG2224
EM4-DIN AV7.3.A.	660V <sub>L-L</sub> , 5(10)A	24VAC, 50-60Hz	AG2225
EM4-DIN AV6.3.D.	100V <sub>L-L</sub> , 5(10)A	230VAC, 50-60Hz	AG2226
EM4-DIN AV6.3.C.	100V <sub>L-L</sub> , 5(10)A	115VAC, 50-60Hz	AG2227
EM4-DIN AV6.3.B.	100V <sub>L-L</sub> , 5(10)A	48VAC, 50-60Hz	AG2228
EM4-DIN AV6.3.A.	100V <sub>L-L</sub> , 5(10)A	24VAC, 50-60Hz	AG2229

## Available modules

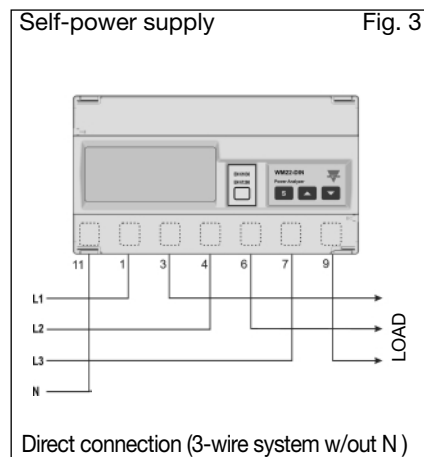
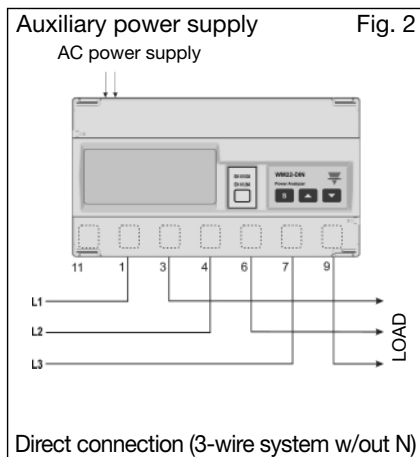
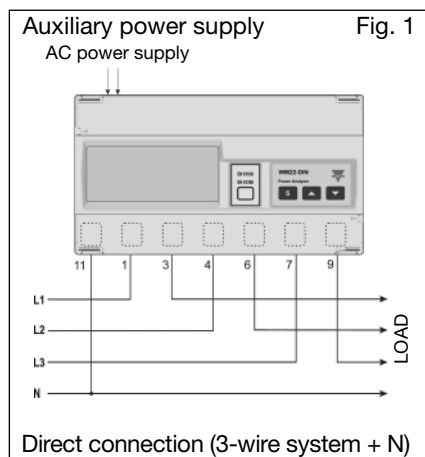
Type	Channels	Code	Type	Channels	Code
Open collector output	2	AO2900	RS485 Serial Output	1	AR2950
Digital inputs	2	AO2940			

## Possible module combinations

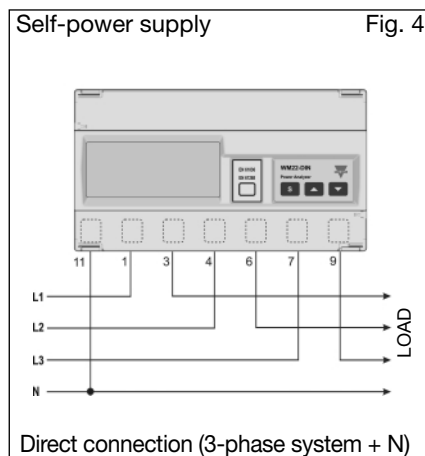
Power supply	Self p.s.		Auxiliary p.s.		Power supply	Self p.s.		Auxiliary p.s.	
Basic unit	Slot A	Slot B	Slot A	Slot B	Basic unit	Slot A	Slot B	Slot A	Slot B
Open collector output	●		●		RS485 Serial Output				●
Digital inputs			●						

## Wiring diagrams

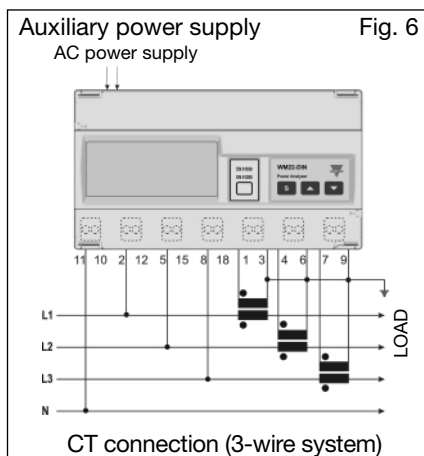
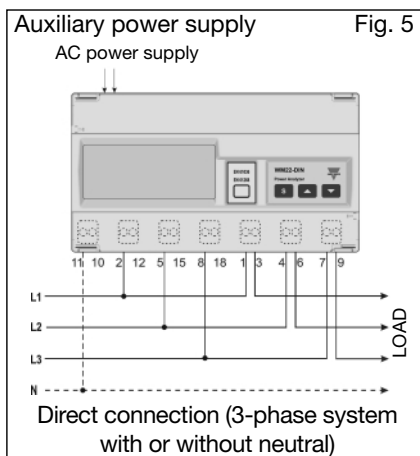
### 20(90)A model: three-phase unbalanced load



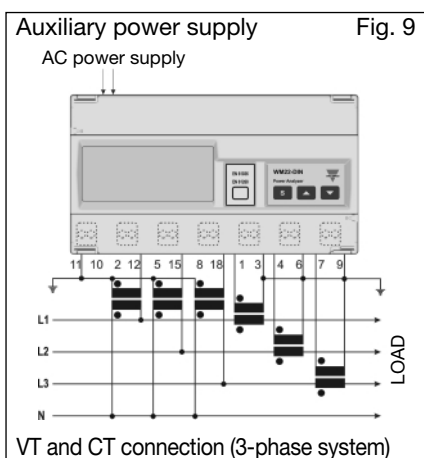
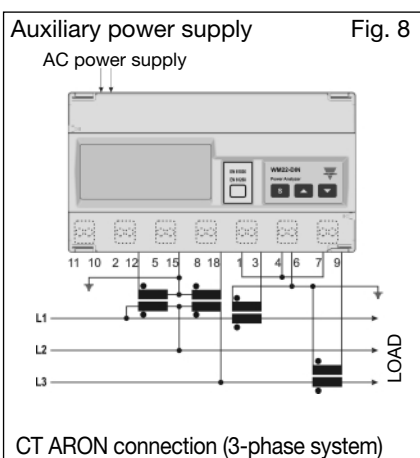
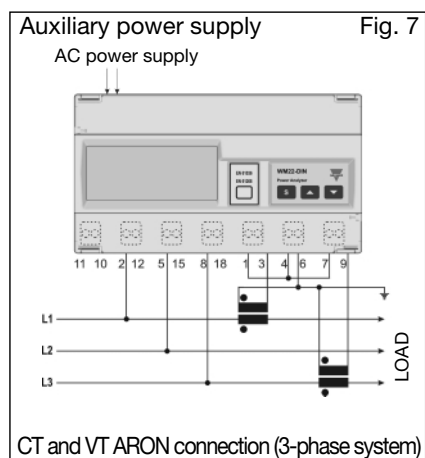
### 20(90)A model: three-phase unbalanced load



### 5(10)A model: three-phase unbalanced load



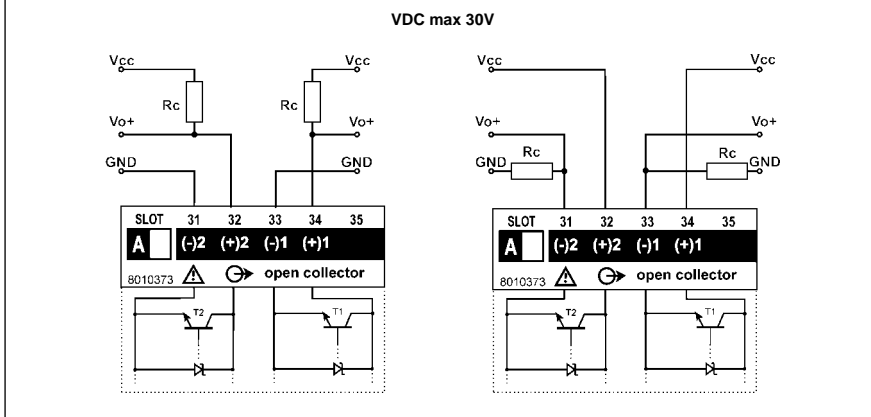
### 5(10)A model: three-phase unbalanced load



## Wiring diagrams (optional modules)

Open collector output

Fig.10



The grounds of the outputs are separated, and therefore it's possible to carry out, for the same module, two different connections. The load resistance ( $R_c$ ) must be designed so that the closed contact current is lower than 100mA; the VDC voltage must be lower than or equal to 30V.

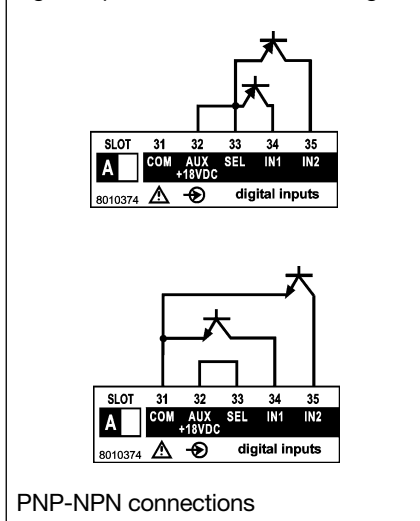
VDC: power supply voltage output.

Vo+: positive output contact (open collector transistor).

GND: ground output contact (open collector transistor).

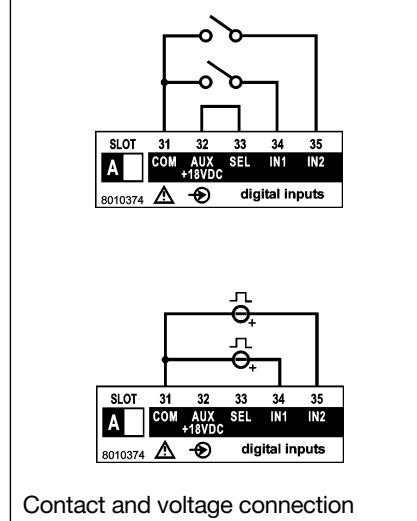
Digital inputs

Fig. 11



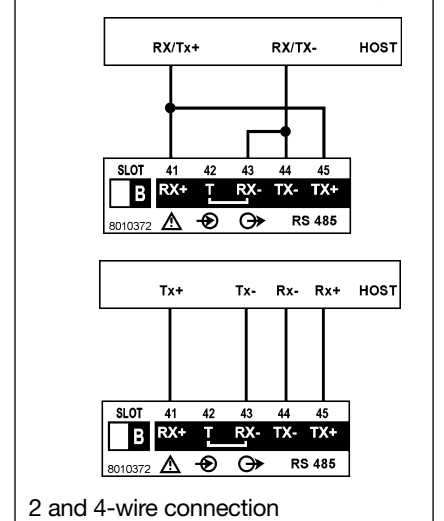
Digital inputs

Fig. 12

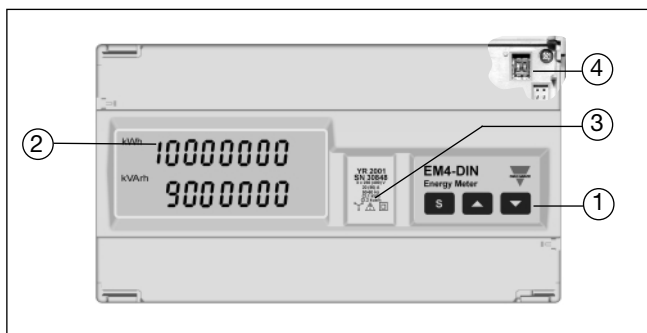


RS485 Serial output

Fig. 13



## Front panel description



### 1. Key-pad

To program configuration parameters and to display variables.

**S** S-key to enter programming and confirm selections;

**▲ ▼** Keys for:  
- values programming;

- function selection;
- displaying the measuring pages.

### 2. Display

LCD with alphanumeric indications to:

- display configuration parameters;
- display all the measured variables.

### 3. Removable label

It shows the following information:

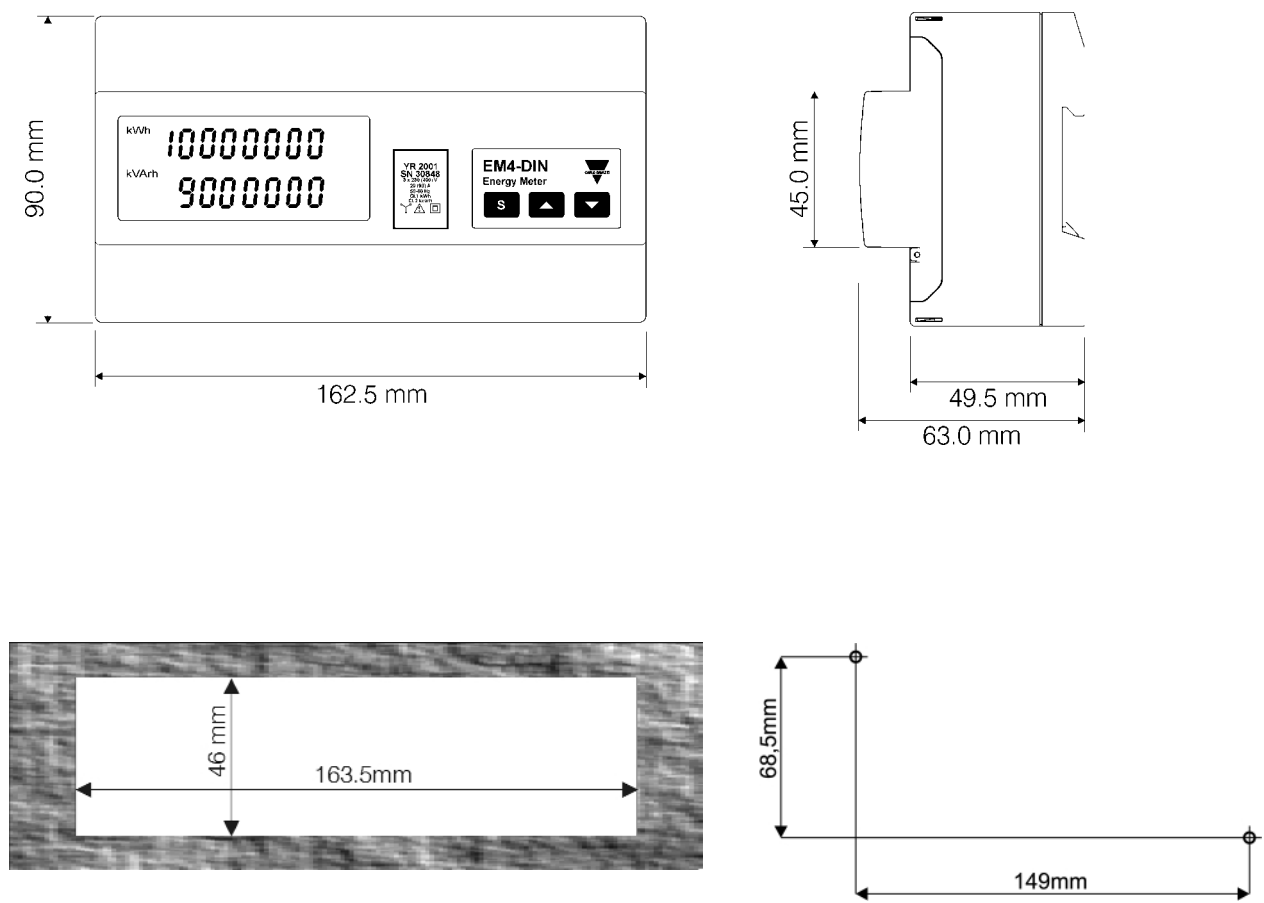
- year of manufacturing
- serial number
- input voltages and currents
- operating frequency
- kWh measuring class
- kvarh measuring class
- symbols: electric system, attention and dual insulation.

### 4. Hidden dip-switch

Enable/disable the access to the programming procedure.

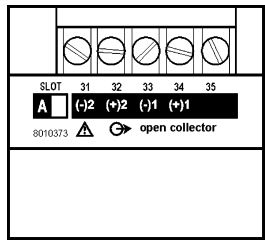


Dimensions and panel cut-out



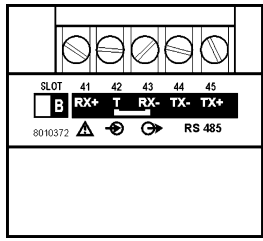
Terminal boards

Open collector dual output module



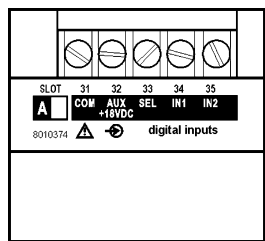
AO 2900

RS485 Serial output module



AR 2950

Digital inputs module



AO 2940