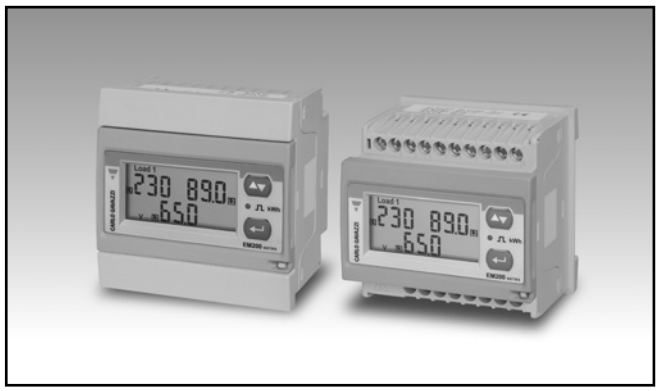
Energy Management
Energy Analyzer
Type EM210

CARLO GAVAZZI



- **Easy connections management**
- **Detachable display**
- **Multi-use housing: for both DIN-rail and panel mounting applications**

- **Class B (kWh) according to EN50470-3**
- **Class 1 (kWh) according to EN62053-21**
- **Class 2 (kvarh) according to EN62053-23**
- **Accuracy ±0.5 RDG (current/voltage)**
- **Energy meter**
- **Instantaneous variables readout: 3 DGT**
- **Energies readout: 7 DGT**
- **System variables: W, var, PF, Hz, Phase-sequence.**
- **Single phase variables: VLL, VLN, A, PF, THD (A,V, up to the 15th harmonic)**
- **Energy measurements: total kWh (imported and exported); kvarh**
- **TRMS measurements of distorted sine waves (voltages/currents)**
- **Self power supply**
- **Dimensions: 4-DIN modules and 72x72mm**
- **Protection degree (front): IP40**
- **Application adaptable display and programming procedure (Easyprog function)**

Product description

Three-phase energy meter with removable front LCD display unit. The same unit can be used either as a DIN-rail mounting or a panel mounting energy meter. This general purpose three-phase energy meter is suitable for both active and reactive energy metering for cost allocation but also for main electrical parameter measurement and retransmission (transducer function). Possibility to display also exported active energy (e.g. in case of regenerated energy in lifts or similar applications) harmonic distortion information are available for the voltages and the currents, up to the 15th harmonic. An hourcounter meter is available to link the energy consumption to the relevant working hours and a hourcounter to link the exported energy to production hours. Housing for DIN-rail mounting with IP40 (front) protection degree. Current measurements carried out by means of external current transformers and voltage measurements carried out either by means of direct connection or by means of potential transformers. EM210 is provided, as standard, with a pulsating output for active energy retransmission. In addition a 2-wire RS485 communication port is available as an option.

How to order

EM210 72D AV5 3 X O X X

Model
Range code
System
Power supply
Output 1
Output 2
Option

Type Selection

Range code

AV5: 230/400VLL AC, 5(6) A or 1(6)A **(*)** (CT connection)

AV6: 120/230VLL AC 5(6)A or 1(6)A (*) (VT/PT and CT connections)

MV5: 230/400VLL AC, 0.333V (current sensor connection)

MV6: 120/230VLL AC, 0.333V (VT/PT and current sensor connection)

System

3: balanced and unbalanced load: 3-phase, 4-wire; 3-phase, 3-wire (without N connection); 2-phase, 3-wire; 1-phase, 2-wire

Power supply

X: Self power supply from 40V to 480VAC LL, 45 to 65 Hz (connection VL2-VL3)

Options

X: none

Output 1

O: Single static output (opto-mosfet)

Output 2

X: None

S: RS485 port

(*) the range 1(6)A is available but not in compliance with the EN50470-3 standard.

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Input specification

Rated Input	System type: 3
Current type	Not isolated (shunt inputs). Note: the external current transformers can be connected to earth individually.
Current range AV5, AV6	In: primary current corresponding to 5 A secondary output. Imax: 1.2 In (6A secondary).Note:The “1(6) A” range is available but not in compliance with the EN50470-3 standard.
Current range MV5, MV6	In: primary current corresponding to 0.333 V secondary output. Imax: 1.2 In (0.4V secondary).
Voltage (direct or by VT/PT)	AV5, MV5: 230/400VLL; 6A; Un: 160 to 240VLN (277 to 415VLL). AV6, MV6: 120/230VLL; 6A; Un: 57.7 to 144VLN (100 to 230VLL).
Accuracy (Display + RS485) (@25°C ±5°C, R.H. ≤60%, 50Hz)	In: see below, Un: see below
Current AV5, AV6 models	From 0.002In to 0.2In: ±(0.5% RDG +3DGT). From 0.2In to Imax: ±(0.5% RDG +1DGT).
Current MV5, MV6 models	From 0.002In to 0.2In: ±(1% RDG +3DGT). From 0.2In to Imax: ±(0.5% RDG +1DGT).
Phase-neutral voltage	In the range Un: ±(0,5% RDG +1DGT).
Phase-phase voltage	In the range Un: ±(1% RDG +1DGT).
Frequency	Range: 45 to 65Hz; resolution: ±1Hz
Active power	±(1%RDG +2DGT).
Power Factor	±[0.001+1%(1.000 - “PF RDG”)].
Reactive power	±(2%RDG +2DGT).
Active energy	class B according to EN50470-1-3; class 1 according to EN62053-21.
Reactive energy	class 2 according to EN62053-23. Start up current: 10mA.
Energy additional errors	
Influence quantities	According to EN62053-21, EN50470-1-3, EN62053-23
Temperature drift	≤200ppm/°C.
Sampling rate	1600 samples/s @ 50Hz, 1900 samples/s @ 60Hz

Display refresh time	1 second
Display	2 lines 1st line: 7-DGT or 3-DGT+3-DGT 2nd line: 3-DGT
Type	LCD, h 7mm.
Instantaneous variables read-out	3-DGT.
Energies	Total: 5+2, 6+1 or 7DGT
Overload status	EEE indication when the value being measured is exceeding the “Continuous inputs overload” (maximum measurement capacity)
Max. and Min. indication	Max. instantaneous variables: 999; energies: 9 999 999. Min. instantaneous variables: 0; energies 0.00.
LEDs	
Red LED (Energy consumption)	
AV5, AV6	0.001 kWh by pulse if CT ratio x VT ratio is <7; 0.01 kWh by pulse if CT ratio x VT ratio is ≥ 7.0 < 70.0; 0.1 kWh by pulse if CT ratio x VT ratio is ≥ 70.0 < 700.0; 1 kWh by pulse if CT ratio x VT ratio is ≥ 700.0.
Red LED (Energy consumption)	
MV5, MV6	0.001kWh/pulse if VT ratio by In < 35.0 0.01kWh/pulse if VT ratio by In ≥35.0 and <350.0 0.1kWh/pulse if VT ratio by In ≥ 350.0 and <3500.0 1kWh/pulse if VT ratio by In ≥ 3500.0
Max frequency	16Hz, according to EN50470-3. Green LED (on the terminal blocks side) for power on (steady) and communication status: RX-TX (in case of RS485 option only) blinking.
Measurements	See “List of the variables that can be connected to:”
Method	TRMS measurements of distorted wave forms.
Coupling type	By means of external CT’s.
Crest factor	AV5, AV6: ≤3 (15A max. peak).MV5, MV6: 1.414 @ Imax (Imax=1.2 In = 0.4V). In any case: Vpeak max = 0.565V.

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Input specification (cont.)

Current Overloads	
Continuous	1.2In, @ 50Hz.
For 500ms	20In, @ 50Hz.
Voltage Overloads	
Continuous	1.2 Un
For 500ms	2 Un
Current input impedance	
AV5, AV6	< 0.3VA
MV5, MV6	>100 kΩ
Voltage input impedance	
Self-power supply	Power Consumption: < 2VA

Frequency	45 to 65 Hz.
Keypad	Two push buttons for variable selection and programming of the instrument working parameters.

Output specifications

Pulse output	
Number of outputs	1
Type	Programmable from 0.01 to 9.99 kWh per pulses. Output connectable to the energy meter (+kWh)
Pulse duration	TOFF ≥120ms, according to EN62052-31. TON selectable (30 ms or 100 ms) according to EN62053-31
Output	Static: opto-mosfet.
Load	VON 2.5 VAC/DC, 70 mA max. VOFF 260 VAC/DC max.
Insulation	By means of optocouplers, 4000 VRMS output to measuring inputs.
RS485	
Type	Multidrop, bidirectional (static and dynamic variables)

Connections	2-wire max. distance 1000m, termination directly on the instrument.
Addresses	247, selectable by means of the front keypad
Protocol	MODBUS/JBUS (RTU)
Data (bidirectional)	
Dynamic (reading only)	System and phase variables: see table “List of variables...”
Static (reading and writing)	All the configuration parameters.
Data format	1 start bit, 8 data bit, and even parity,1 or 2 stop bit.
Baud-rate	9.6, 19.2, 38.4, 57.6, 115.2 kbps.
Driver input capability	1/5 unit load. Maximum 160 transceiver on the same bus.
Insulation	By means of optocouplers, 4000 VRMS output to measuring input.

Software functions

Password	Numeric code of max. 3 DGT; 2 protection levels of the programming data:
1st level	Password “0”, no protection;
2nd level	Password from 1 to 999, all data are protected
Programming lock	By means of potentiometer (back-side of the display module) it is possible to lock the access to all the configuration parameters.
System selection	
System 3-Ph.n unbalanced load	3-phase (4-wire) 3-phase (3-wire) without neutral connection.
System 3-Ph.1 balanced load	• 3-phase (3-wire) one current and 3-phase to phase voltage measurements. • 3-phase (4-wire) one current and 3-phase to neutral voltage measurements.
System 2-Ph	2-phase (3-wire)
System 1-Ph	1-phase (2-wire)

Transformer ratio	
VT (PT) ratio	1.0 to 99.9 / 100 to 999
CT (AV5, AV6)	1.0 to 99.9 / 100 to 999 The max CTxVT product for AV5 models is 1187 (X option), for AV6 models is 2421 (X option). Primary current 10 to 10000.
Displaying	Up to 3 variables per page. 6 different set of variables available.
Reset	By means of the front keypad: total energies (kWh, kvarh).
Easy connection function	Wrong phase detection and displaying. For all the display selections (except “D” and “E”) the current, power and energy measurement are independent on the current direction.

General specifications

Operating temperature	-25°C to +55°C (-13°F to 131°F) (R.H. from 0 to 90% non-condensing) according to EN62053-21 and EN62053-23.
Storage temperature	-30°C to +70°C (-22°F to 158°F) (R.H. < 90% non-condensing) according to EN62053-21 and EN62053-23)
Overvoltage category	Cat. III
Insulation (for 1 minute)	4000 VRMS between measuring inputs and digital output.
Dielectric strength	4000VAC RMS for 1 minute
Noise rejection CMRR	100 dB, 48 to 62 Hz
EMC	According to EN62052-11
Electrostatic discharges	15kV air discharge.
Immunity to irradiated electromagnetic fields	Test with current: 10V/m from 80 to 2000MHz Test without any current: 30V/m from 80 to 2000MHz;
Burst	On current and voltage measuring inputs circuit: 4kV
Immunity to conducted disturbances	10V/m from 150kHz to 80Mhz
Surge	On current and voltage measuring inputs circuit: 6kV;
Radio frequency suppression	According to CISPR 22

Standard compliance	
Safety	EC60664, IEC61010-1 EN60664, EN61010-1 EN62052-11
Metrology	EN62053-21, EN62053-23, EN50470-3
Pulse output	DIN43864, IEC62053-31
Approvals	CE, cULus listed (only AV)
Connections	Screw type
Cable cross-section area	2.4 x 3.5 mm Min./Max. screws tightening torque: 0.4 Nm / 0.8 Nm
Housing	
Dimensions (WxHxD)	72 x 72 x 65 mm
Material	Noryl, PA66 self-extinguishing: UL 94 V-0
Mounting	Panel and DIN-rail
Protection degree	
Front	IP40
Screw terminals	IP20
Weight	Approx. 400g (packing included)

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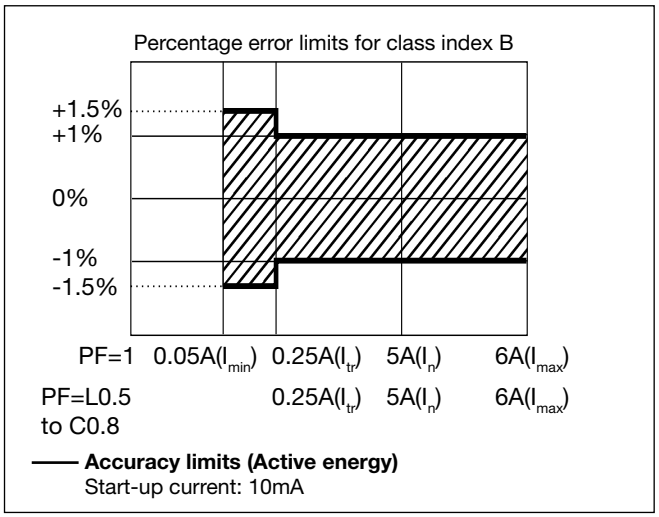
Power supply specifications

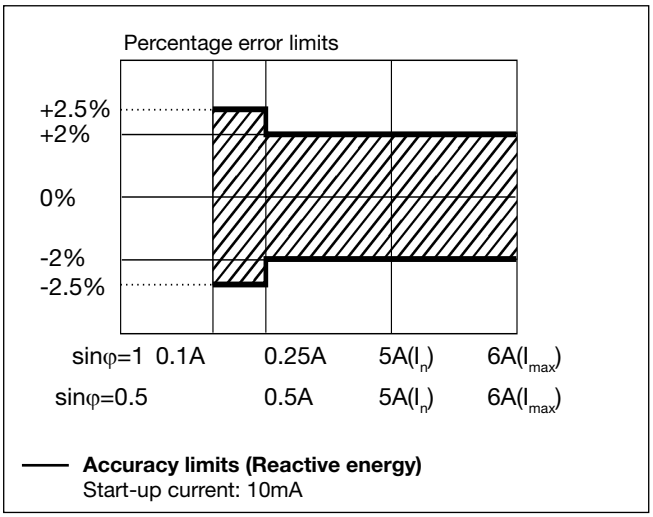
Self power supply	40 to 480VAC (45-65Hz). Across input “VL2” and “VL3”	**Power consumption**	≤2VA/1W

Accuracy AV5, AV6 (According to EN50470-3 and EN62053-23)

kWh, accuracy (RDG) depending on the current

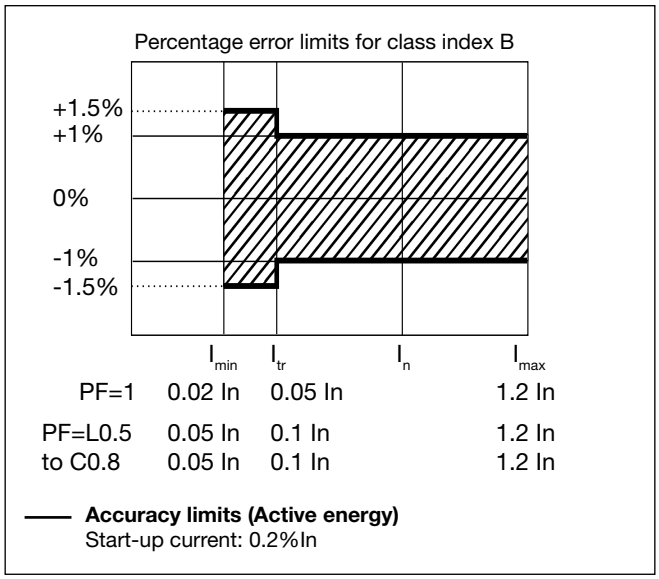


kvarh, accuracy (RDG) depending on the current

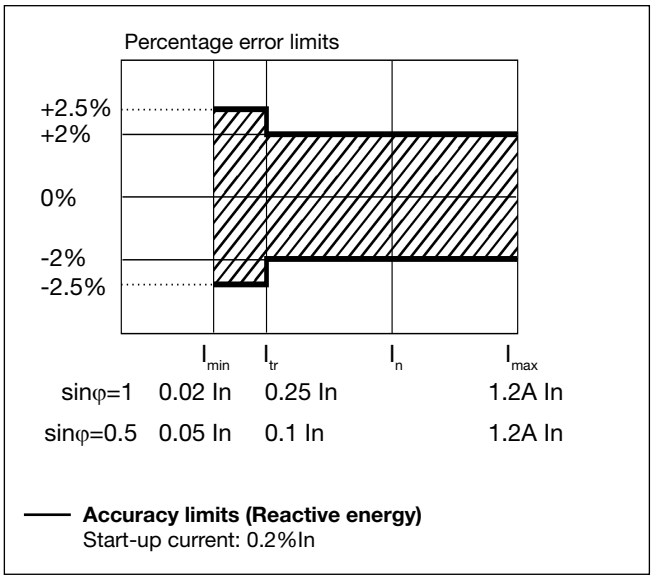


Accuracy MV5, MV6 (According to EN50470-3 and EN62053-23)

kWh, accuracy (RDG) depending on the current



kvarh, accuracy (RDG) depending on the current



Insulation between inputs and outputs

	Measuring input	Opto-Mosfet output	Communication port	Self power supply
Measuring inputs	-	4kV	4kV	0kV
Opto-Mosfet output	4kV	-	-	4kV
Communication port	4kV	-	-	4kV
Self power supply	0kV	4kV	4kV	-

NOTE: all the models have, mandatorily, to be connected to external current transformers.

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

$$\cos\varphi_1 = \frac{W_1}{VA_1}$$

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

$$\mathrm{var}_1 = \sqrt{(VA_1)^2 - (W_1)^2}$$

System variables

Equivalent three-phase voltage

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

Voltage asymmetry

Three-phase active power

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

Three-phase apparent power

$$VA_\Sigma = \sqrt{W_\Sigma^2 + \mathrm{var}_\Sigma^2}$$

Three-phase power factor

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

Energy metering

$$k\,\mathrm{var}hi = \int_{t1}^{t2} Qi(t)dt \cong \Delta t \sum_{n1}^{n2} Qnj$$

$$kWhi = \int_{t1}^{t2} Pi(t)dt \cong \Delta t \sum_{n1}^{n2} Pnj$$

Where:
i= considered phase (L1, L2 or L3)
P= active power; **Q**= reactive power;
t1, t2 =starting and ending time points of consumption recording; **n**= time unit; Δ **t**= time interval between two successive power consumptions;
n1, n2 = starting and ending discrete time points of consumption recording

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List of the variables that can be connected to:

- RS485 communication port
- Pulse outputs (only “energies”)

N°	Variable	1-ph. sys.	2-ph. sys.	3-ph. 4-wire balanced system	3-ph. 4-wire unbalanced system	3-ph. 3-wire balanced system	3-ph. 3-wire unbalanced system	Notes
1	kWh	x	x	x	x	x	x	Total (2)
2	kvarh	x	x	x	x	x	x	Total (3)
3	V L-N sys (1)	o	x	x	x	x	x	sys=system (Σ)
4	V L1	x	x	x	x	x	x	
5	V L2	o	x	x	x	x	x	
6	V L3	o	o	x	x	x	x	
7	V L-L sys (1)	o	x	x	x	x	x	sys=system (Σ)
8	V L1-2	o	x	x	x	x	x	
9	V L2-3	o	o	x	x	x	x	
10	V L3-1	o	o	x	x	x	x	
11	A L1	x	x	x	x	x	x	
12	A L2	o	x	x	x	x	x	
13	A L3	o	o	x	x	x	x	
14	VA sys (1)	x	x	x	x	x	x	sys=system (Σ)
15	VA L1 (1)	x	x	x	x	x	x	
16	VA L2 (1)	o	x	x	x	x	x	
17	VA L3 (1)	o	o	x	x	x	x	
18	var sys	x	x	x	x	x	x	sys=system (Σ)
19	var L1 (1)	x	x	x	x	x	x	
20	var L2 (1)	o	x	x	x	x	x	
21	var L3 (1)	o	o	x	x	x	x	
22	W sys	x	x	x	x	x	x	sys=system (Σ)
23	W L1 (1)	x	x	x	x	x	x	
24	W L2 (1)	o	x	x	x	x	x	
25	W L3 (1)	o	o	x	x	x	x	
26	PF sys	x	x	x	x	x	x	sys=system (Σ)
27	PF L1	x	x	x	x	x	x	
28	PF L2	o	x	x	x	x	x	
29	PF L3	o	o	x	x	x	x	
30	Hz	x	x	x	x	x	x	
31	Phase sequence	o	o	x	x	x	x	
32	THD VL1N	X	X	X	X	O	O	only if THD enabled
33	THD VL2N	O	X	X	X	O	O	only if THD enabled
34	THD VL3N	O	O	X	X	O	O	only if THD enabled
35	THD A L1	X	X	X	X	X	X	only if THD enabled
36	THD A L2	O	X	X	X	X	X	only if THD enabled
37	THD A L3	O	O	X	X	X	X	only if THD enabled
38	THD V L1-2	O	X	X	X	X	X	only if THD enabled
39	THD V L2-3	O	O	X	X	X	X	only if THD enabled
40	THD V L3-1	O	O	X	X	X	X	only if THD enabled
41	A n	O	X	O	X	O	O	

(x) = available
(o) = not available (zero indication on the display)
(1) = Variable available only through the serial communication port RS485
(2) = also kWh- (exported) with application E (see next table)
(3) = sum (not algebraic) of kvarh imported and exported with application F (see next table)

Display pages

No	1st variable (1st half-line)	2nd variable (2nd half-line)	3rd variable (2nd line)	Note	Applications					
					A	B	C	D	E	F
	Phase sequence			The phase sequence triangle appears in any page only if there is a phase reverse	x	x	x	x	x	x
1	Total kWh		W sys		x	x	x	x	x	x
1b	Total kWh (-)		"NEG"	Exported active energy					+	
2	Total kvarh		kvar sys			+	+	+	+	T
3		PF sys	Hz	Indication of C, -C, L, -L depending on the quadrant		x	x	x	x	x
4	PF L1	PF L2	PF L3	Indication of C, -C, L, -L depending on the quadrant			x	x	x	x
5	A L1	A L2	A L3				x	x	x	x
6	V L1-2	V L2-3	V L3-1				x	x	x	
7	V L1	V L2	V L3				x	x		
8	"thd"	"L1"	THD VL1-N			x	x	x	x	x
9	"thd"	"L2"	THD VL2-N			x	x	x	x	x
10	"thd"	"L3"	THD VL3-N			x	x	x	x	x
11	"thd"	"L1"	THD A L1			x	x	x	x	x
12	"thd"	"L2"	THD A L2			x	x	x	x	x
13	"thd"	"L3"	THD A L3			x	x	x	x	x
14	"thd"	"L1"	THD VL1-2			x	x	x	x	x
15	"thd"	"L2"	THD VL2-3			x	x	x	x	x
16	"thd"	"L3"	THD VL3-1			x	x	x	x	x
17	"A n"		A n			x	x	x	x	x
18	"working hours"(rel. to kWh+)		h				x	x	x	x
19	"working hours"(re. to kWh-)		h-						x	

Notes: x = available
+ = only positive kvarh is measured (kvar sys is the algebraic sum of the phase kvar)
T = positive and negative kvarh are summed and measured in the same kvarh meter
(kvarsys is the sum of the absolute values of each phase kvar). The phase kvar are displayed with the correct sign.

Additional available information on the display

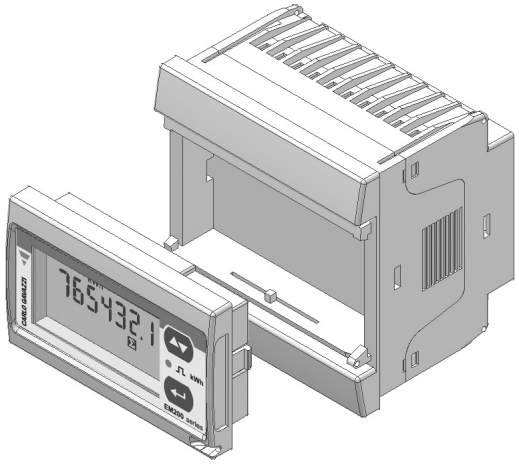
Type	1st line	2nd line	Note
Meter information 1	Y. 2007	r.A0	Year of production and firmware release
Meter information 2	value	LEd (kWh)	KWh per pulse of the LED
Meter information 3	SYS [3P.n]	value	System type and connection type
Meter information 4	Ct rAt.	value	Current transformer ratio
Meter information 5	Ut rAt.	value	Voltage transformer ratio
Meter information 6	PuLSE (kWh)	value	Pulse output: kWh per pulse
Meter information 7	Add	value	Serial communication address
Meter information 8	value	Sn	Secondary address (M-bus protocol)

List of selectable applications

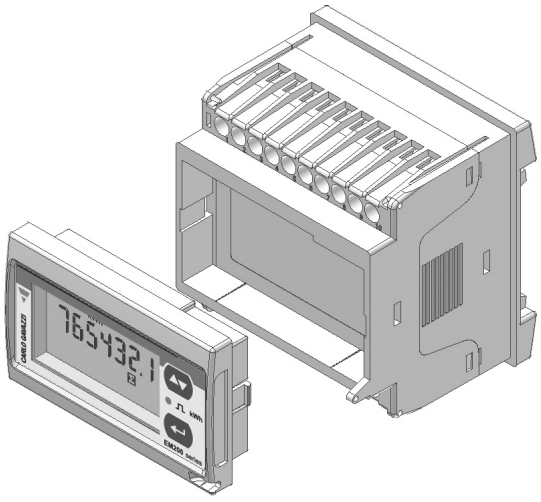
	Description	Notes
A	Active energy meter	Active energy measurement with some minor parameters
B	Active and reactive energy meter	Active and reactive energy measurement with some minor parameters
C	Full set of variables	Full set of available variables can be displayed (default selection)
D	Full set of variables +	Full set of available variables can be displayed +
E	Full set of variables +	Full set of variables with exported (negative) kWh meter
F	Full set of variables	Full set of variables with imported and exported kWh meters

Notes:
+ Only in “D” and “E” applications the actual direction of the current is considered.

One instrument with double mounting capability



By means of the patented detachable display it is possible to configure the same instrument either as a panel mounting meter or...



... as DIN-rail mounting meter.

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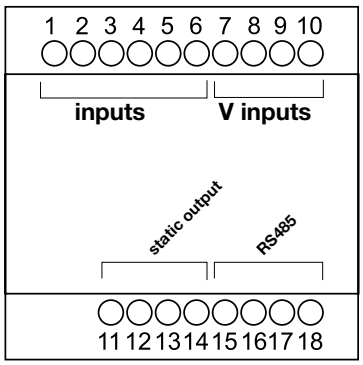
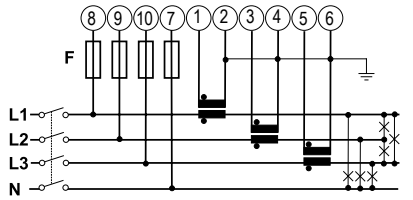
Wiring diagrams



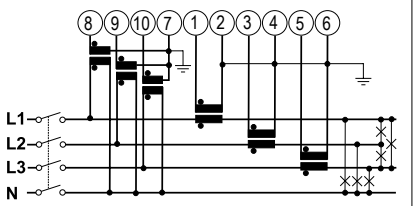
(6A) Self power supply, system type selection: 3P.n

3-ph, 4-wire, unbalanced load **Fig.1**



3-CT connection

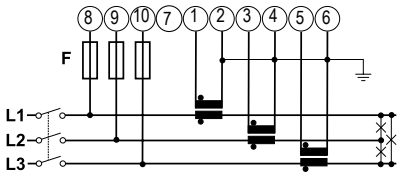
3-ph, 4-wire, unbalanced load **Fig.2**



3-CT and 3-VT/PT connections

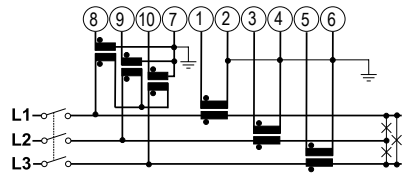
(6A) System type selection: 3P

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



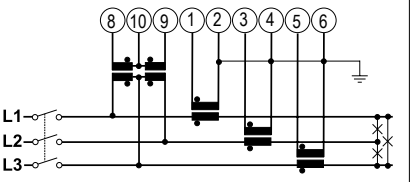
3-CT connection

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



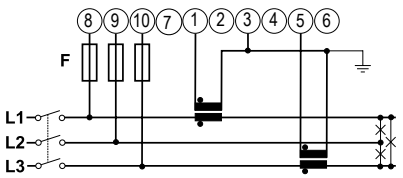
3-CT and 3-VT/PT connections

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



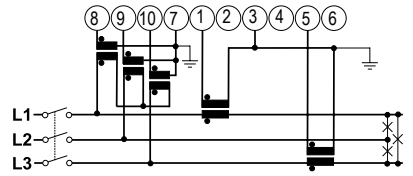
3-CT and 2-VT/PT connections

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



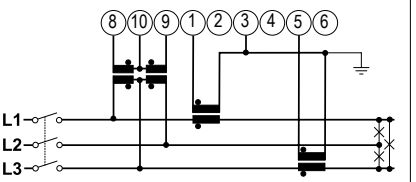
2-CT connections (ARON)

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



2-CT and 3-VT/PT connections ARON

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



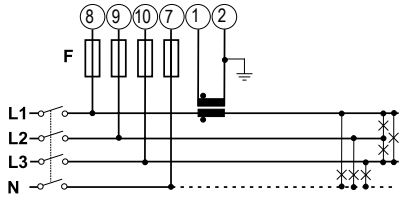
2-CT and 2-VT/PT connections ARON

CARLO GAVAZZI

Wiring diagrams

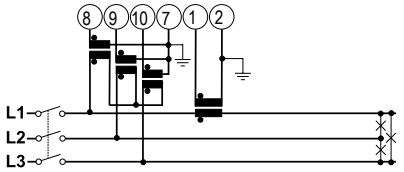
(6A) Self power supply, system type selection: 3P.1

3-ph, 3/4-wire, balanced load 1-CT connection **Fig.9**



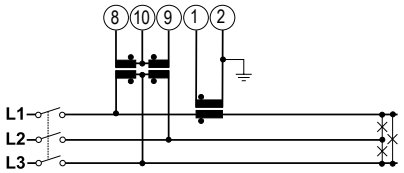
N connection is optional.
NOTE: in the calculations, it is considered only the voltage relevant to L1

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



1-CT and 3-VT/PT connections

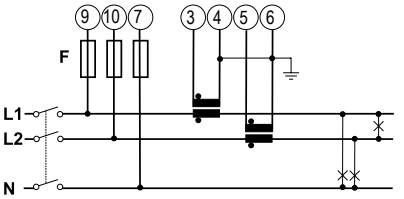
3-ph, 3-wire, balanced load **Fig.11**



1-CT and 2-VT/PT connections

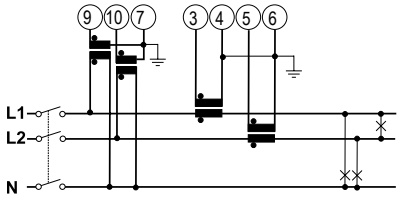
(6A) System type selection: 2P

2-ph, 3-wire **Fig.12**



2-CT connection

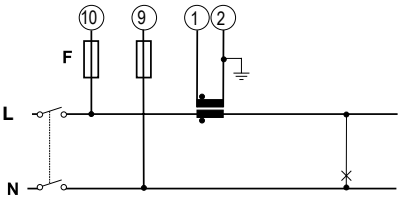
2-ph, 3-wire **Fig.13**



2-CT and 2-VT/PT connections

(6A) System type selection: 1P

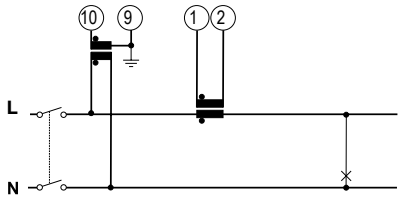
1-ph, 2-wire **Fig.14**



1-CT connection

(6A) System type selection: 1P

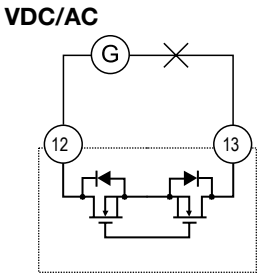
1-ph, 2-wire **Fig.15**



1-CT and 1-VT connections

Static output wiring diagram

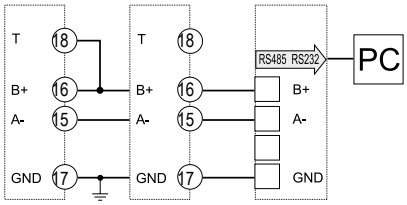
Opto-mosfet



VDC/AC supply

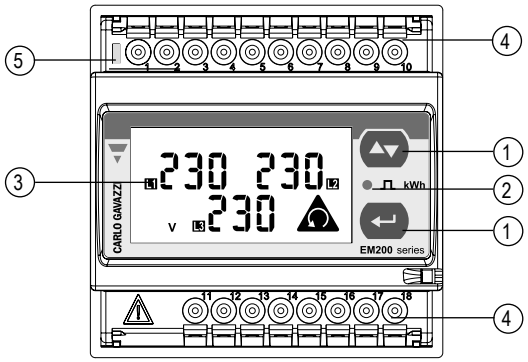
RS485 port wiring diagram

RS485 port



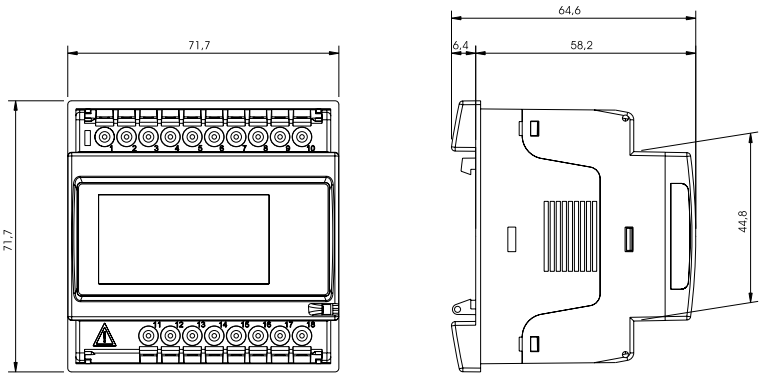
RS485 NOTE: additional devices provided with RS485 are connected as per the picture above. The termination of the serial output is carried out only on the last instrument of the network, by means of a jumper between (B+) and (T).

Front panel description



1. **Keypad**
   To program the configuration parameters and scroll the variables on the display.
2. **Pulse output LED**
   Red LED blinking proportional to the energy being measured.
3. **Display**
   LCD-type with alphanumeric indications to display all the measured variables.
4. **Connections**
   Screw terminal blocks for instrument wiring.
5. **Green LED**
   Lit when power supply is available.

Dimensions (DIN configuration)



Dimensions and panel cut out (72x72 panel mounting configuration)