

# Energy Management Energy Meter Type EM21 72R "Retro-Fit"

CARLO GAVAZZI



- Including 3 miniature split-core current sensors
- 10mm (90A), 16mm (150A) and 24mm (250A) diameter holes

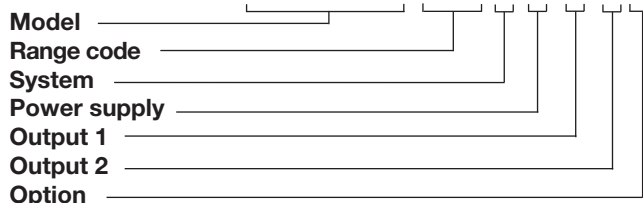
- Class A (kWh) according to EN50470-3
- Class 2 (kWh) according to EN62053-21
- Accuracy  $\pm 0.5\%$  RDG (voltage),  $\pm 1\%$  RDG (current)
- Energy meter
- Instantaneous variables readout: 3 DGT
- Energies readout: 6+1 DGT
- System variables: W, var, PF, Hz, Phase-sequence.
- Single phase variables:  $V_{LL}$ ,  $V_{LN}$ , A, PF
- Energy measurements: total kWh and 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)
- Easy connections management
- Detachable display
- Multi-use housing: for both DIN-rail and panel mounting applications

## 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). Housing for DIN-rail mounting with IP40

(front) protection degree. Current measurements carried out by means of external miniature split-core current sensors (included) and voltage measurements carried out either by means of direct connection or by means of potential transformers. EM21-72R 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 EM21 72R VV5 3 X O X X



## Type Selection

Range codes	System	Power supply	Output 1
<b>VV2 (*)</b> : 400V <sub>LL</sub> AC, 90A (by current sensor) <b>VV3 (**)</b> : 400V <sub>LL</sub> AC, 150A (by current sensor) <b>VV5 (**)</b> : 400V <sub>LL</sub> AC, 250A (by current sensor)	<b>3 (*)</b> : balanced and unbalanced load: 3-phase, 4-wire; 3-phase, 3-wire; 2-phase, 3-wire; 1-phase, 2-wire	<b>X (*)</b> : Self power supply from 18V to 260VAC VLN, 45 to 65 Hz (connection VL1-N)	<b>O (*)</b> : Single static output (opto-mosfet)
<b>Output 2</b> <b>X (*)</b> : None <b>S (**)</b> : RS485 port	<b>Options</b> <b>X (*)</b> : None	(*) as standard. (**) on request.	

## Input specifications

<b>Rated inputs</b>	System type: 3 Not isolated (by CT). Note: the external current transformers can be connected to earth individually.	<b>Overload status</b>	EEE indication when the value being measured is exceeding the "Continuous inputs overload" (maximum measurement capacity)
Current type			
Current range (by current sensors)	VV2: 90A VV3: 150A VV5: 250A VVx: 400VLL	Max. and Min. indication	Max. instantaneous variables: 999; energies: 999 999.9 or 9 999 999. Min. instantaneous variables: 0; energies 0.0.
Voltage (direct or by VT/PT)			
<b>Accuracy</b> (Display + RS485)	Iref: see below; Un: see below	<b>LEDs</b>	Red LED (Energy consumption) 0.01 kWh by pulse if VT ratio is <4 (VV2) or <2 (VV3 or VV5) 0.1 kWh by pulse if VT ratio is <40 (VV2) or <23 (VV3 or VV5) 1kWh by pulse if VT ratio is >40 (VV2) or >23 (VV3 or VV5)
(@25°C ±5°C, R.H. ≤60%, 48 to 62 Hz)			
Voltage range VVx model	Un: 160 to 260VLN (277 to 450VLL).	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.
Current range VV2 model	Iref: 15A, Imax: 90A		
VV3 model	Iref: 20A, Imax: 150A	<b>Measurements</b>	See "List of the variables that can be connected to:"
VV5 model	Iref: 20A, Imax: 250A	Method	TRMS measurements of distorted wave forms.
Current	From 0,05Iref to 0,1Iref: ±(1% RDG + 3DGT) From 0,1Iref to Imax: ±(1% RDG + 1DGT)	Coupling type	By means of external CT's.
Phase-neutral voltage	In the range Un: ±(0.5% RDG + 1DGT).	<b>Crest factor</b>	≤3 (VV2: 230A max. peak)
Phase-phase voltage	In the range Un: ±(1% RDG + 1DGT).	<b>Current Overloads</b>	Without valid measurement
Frequency	Range: 45 to 65Hz; resolution: ±1Hz	Continuous	VV2: 120A VV3: 300A VV5: 360A
Active power	±(2%RDG + 2DGT).	<b>Voltage Overloads</b>	
Power Factor	±[0.001+2%(1.000 - "PF RDG")].	Continuous	1.2 Un
Reactive power	±(3%RDG + 2DGT).	For 500ms	2 Un
Active energy	class A according to EN50470-3; class 2 according to EN62053-21.	<b>Voltage input impedance</b>	
Start up current	VV2: 75mA. VV3, VV5: 100mA	Self-power supply	Power consumption: <2VA.
<b>Temperature drift</b>	≤200ppm/°C @ PF=1 Phase error: ≤0.05/°C	<b>Frequency</b>	45 to 65 Hz.
<b>Sampling rate</b>	1600 samples/s @ 50Hz, 1900 samples/s @ 60Hz	<b>Key-pad</b>	Two push buttons for variable selection and programming of the instrument working parameters.
<b>Display refresh time</b>	1 second		
<b>Display</b>	2 lines 1 <sup>st</sup> line: 7-DGT, 2 <sup>nd</sup> line: 3-DGT or 1 <sup>st</sup> line: 3-DGT + 3-DGT, 2 <sup>nd</sup> line: 3-DGT. LCD, h 7mm.		
Type	3-DGT.		
Instantaneous variables read-out	Imported Total: 6+1DGT or 7DGT		
Energies			

## Output specifications

<b>Pulse output</b>			
Number of outputs	1	Addresses	247, selectable by means of the front keypad
Type	Programmable from 0.01 to 9.99 kWh per pulses. Output connectable to the energy meters (kWh)	Protocol	MODBUS/JBUS (RTU)
Pulse duration	≥100ms < 120ms (ON), ≥120ms (OFF), according to EN62052-31.	Data (bidirectional)	System and phase variables: see table "List of variables..."
Output Load	Static: opto-mosfet. V <sub>ON</sub> 2.5 VAC/DC max. 70 mA, V <sub>OFF</sub> 260 VAC/DC max.	Dynamic (reading only)	All the configuration parameters.
Insulation	By means of optocouplers, 4000 VRMS output to measuring inputs.	Static (reading and writing)	1 start bit, 8 data bit, no parity, 1 stop bit.
<b>RS485</b>		Data format	9600 bits/s.
Type	Multidrop, bidirectional (static and dynamic variables)	Baud-rate	1/5 unit load. Maximum 160 transceiver on the same bus.
Connections	2-wire. Max. distance 1000m, termination directly on the instrument.	Driver input capability	By means of optocouplers, 4000 VRMS output to measuring input.
		Insulation	

## Software functions

<b>Password</b>		System 2-Ph	2-phase (3-wire)
1st level	Numeric code of max. 3 digits; 2 protection levels of the programming data: Password "0", no protection;	System 1-Ph	1-phase (2-wire)
2nd level	Password from 1 to 999, all data are protected	<b>Transformer ratio</b>	
Programming lock	By means of potentiometer (back-side of the display module) it is possible to lock the access to all the configuration parameters.	VT (PT)	1.0 to 99.9 / 100 to 999 / 1.00k to 6.00k
<b>System selection</b>		CT	Fixed primary: 90, 150 or 250A. The maximum power being measured cannot exceed 210 MW calculated as maximum input voltage and current, (see the "Accuracy" paragraph).
System 3-Ph.n unbalanced load	3-phase (4-wire) 3-phase (3-wire)	<b>Displaying</b>	Up to 3 variables per page. See « Display pages », 3 different set of variables available (see « Display pages ») according to the metering function being selected.
System 3-Ph.1 balanced load	<ul style="list-style-type: none"> <li>3-phase (3-wire) one current and 3-phase to phase voltage measurements. Note: the phase to phase voltage is calculated multiplying by 1.73 the virtual phase to neutral voltage.</li> <li>3-phase (4-wire) one current and 3-phase to neutral voltage measurements. Note: the phase to phase voltage is calculated multiplying by 1.73 the virtual phase to neutral voltage.</li> <li>3-phase (2-wire) one current and 1-phase (L1) to neutral voltage measurement.</li> </ul>	<b>Reset</b>	By means of the front keypad: total energies (kWh, kvarh).
		<b>Easy connection function</b>	Wrong phase detection and displaying. For all the display selections, both energy measurements are dependent from the current direction, both power measurements are independent from the current direction. The power measurements are always positive.

## General specifications

<b>Operating temperature</b>	-20°C to +50°C (-13°F to 131°F) (R.H. from 0 to 90% non-condensing @ 40°C)	<b>Standard compliance</b>	IEC60664, IEC61010-1 EN60664, EN61010-1 EN62052-11 EN62053-21, EN62053-23, EN50470-3 DIN43864, IEC62053-31 CE
<b>Storage temperature</b>	-30°C to +70°C (-22°F to 158°F) (R.H. < 90% non-condensing @ 40°C)	<b>Safety</b>	
<b>Installation category</b>	Cat. III (IEC60664, EN60664).	<b>Metrology</b>	
<b>Insulation (for 1 minute)</b>	4000 VRMS between measuring inputs and digital output.	<b>Pulse output Approvals</b>	
<b>Dielectric strength</b>	4000 VRMS for 1 minute.	<b>Connections</b>	Screw-type 2.4 x 3.5 mm Min./Max. screws tightening torque: 0.4 Nm / 0.8 Nm
<b>Noise rejection CMRR</b>	100 dB, 48 to 62 Hz.	<b>Cable cross-section area</b>	
<b>EMC</b>	According to EN62052-11	<b>Housing</b>	72 x 72 x 65 mm Noryl PA66, self-extinguishing: UL 94 V-0 Panel and DIN-rail
Electrostatic discharges	15kV air discharge; Test with current: 10V/m from 80 to 2000MHz;	<b>Dimensions (WxHxD)</b>	
Immunity to irradiated	Test without any current: 30V/m from 80 to 2000MHz;	<b>Material</b>	
Electromagnetic fields	On current and voltage measuring inputs circuit: 4kV	<b>Mounting</b>	
Burst	10V/m from 150KHz to 80MHz	<b>Protection degree</b>	IP40 IP20
Immunity to conducted disturbances	On current and voltage measuring inputs circuit: 6kV;	<b>Front Screw terminals</b>	
Surge	According to CISPR 22	<b>Weight</b>	Approx. 400 g (packing included)
Radio frequency suppression			

## Power supply specifications

<b>Self power supply</b>	18 to 260VAC (48-62Hz). Across input "VL1" and "N"	<b>Power consumption</b>	≤2VA/1W
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## Insulation between inputs and outputs

	Measuring Inputs	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

$$V_{IN} = \sqrt{\frac{1}{n} \cdot \sum_1^n (V_{IN})_i^2}$$

Instantaneous active power

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

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

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

Instantaneous reactive power

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

### System variables

Equivalent three-phase voltage

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

Voltage asymmetry

$$ASY_{LL} = \frac{(V_{LL \max} - V_{LL \min})}{V_{LL \Sigma}}$$

$$ASY_{LN} = \frac{(V_{LN \max} - V_{LN \min})}{V_{LN \Sigma}}$$

Three-phase active power

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

Three-phase apparent power

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

Three-phase power factor

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

### Energy metering

$$k \text{ var hi} = \int_{t_1}^{t_2} Q_i(t) dt \cong \Delta t \sum_{n_1}^{n_2} Q_{nj}$$

$$k \text{ Whi} = \int_{t_1}^{t_2} P_i(t) dt \cong \Delta t \sum_{n_1}^{n_2} P_{nj}$$

Where:

**i**= considered 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; **t**= time interval between two successive power consumptions;  
**n<sub>1</sub>, n<sub>2</sub>** = starting and ending discrete time points of consumption recording



## List of the variables that can be connected to:

- RS485 communication port
- Pulse outputs (only "energies")

No	Variable	1-ph. sys.	2-ph. sys.	3-ph. 4-wire balanced system	3-ph. 3-wir balanced system	3-ph. 4-wire unbalanced system	3-ph. 3-wir unbalanced system	Notes
1	kWh	x	x	x	x	x	x	Total
2	kvarh	x	x	x	x	x	x	Total
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	

(x) = available

(o) = not available (zero indication on the display)

(1) = Variable available only through the serial communication port RS485

## Display pages

No	1st variable (1 <sup>st</sup> half-line)	2nd variable (2 <sup>nd</sup> half-line)	3rd variable (2nd line)	Note	Applications		
					A	B	C
	Phase sequence			The phase sequence triangle appears in any page only if there is a phase reverse	x	x	x
1	Total kWh		W sys		x	x	x
2	Total kvarh		kvar sys			x	x
3		PF sys	Hz	Indication of C, -C, L, -L depending on the quadrant	x	x	x
4	PF L1	PF L2	PF L3	Indication of C, -C, L, -L depending on the quadrant			x
5	A L1	A L2	A L3				x
6	V L1-2	V L2-3	V L3-1				x
7	V L1	V L2	V L3				x

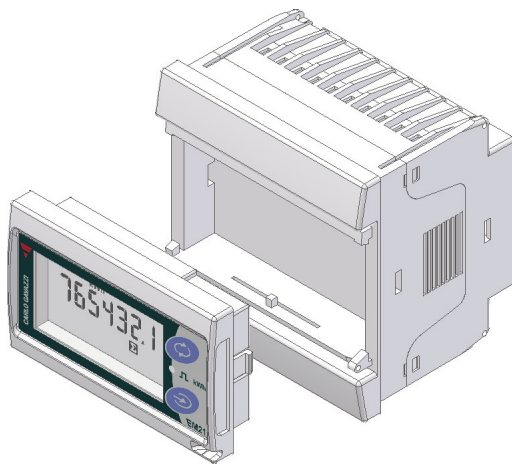
## Additional available information on the display

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 Prin	value	Primary current transformer value
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

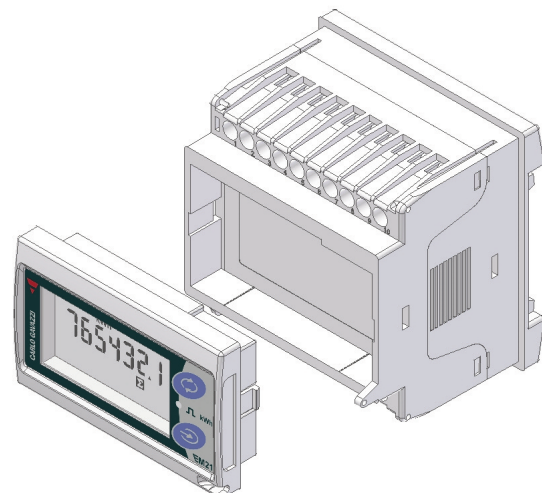
## List of selectable applications

	Description	Notes
<b>A</b>	Active energy meter	Active energy measurement with some minor parameters
<b>B</b>	Active and reactive energy meter	Active and reactive energy measurement with some minor parameters
<b>C</b>	Full set of variables	Full set of available variables can be displayed

## One instrument with double mounting capability



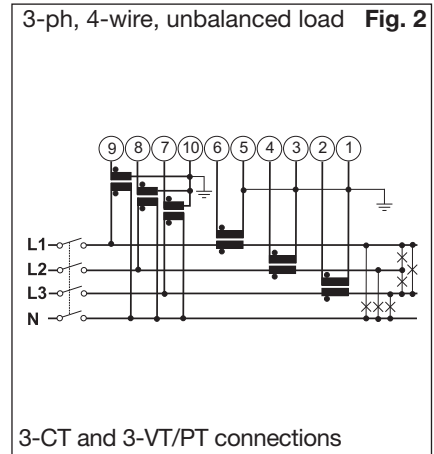
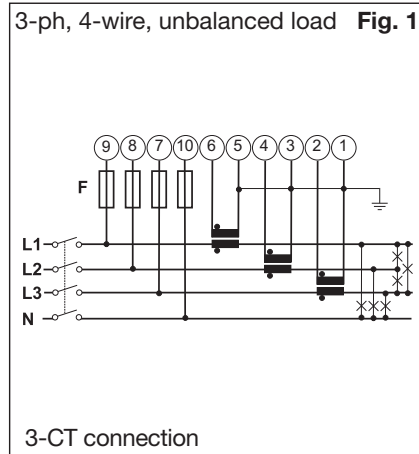
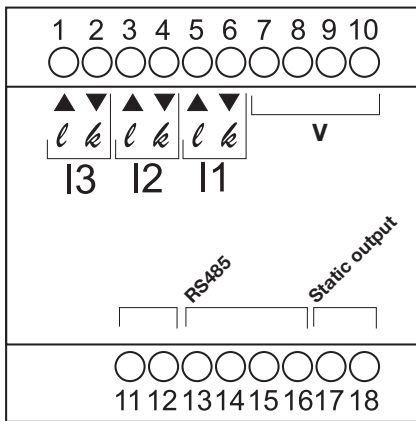
By means of the patented detachable display it is possible to configure the same instrument either as a panel mounting meter or...



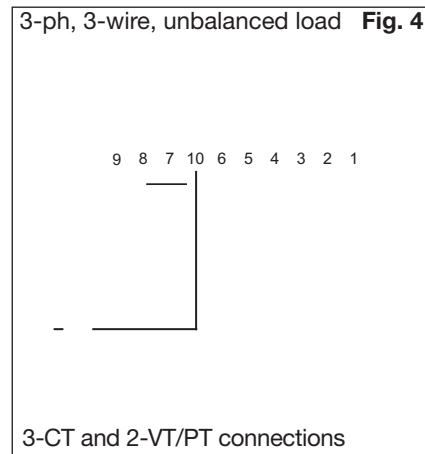
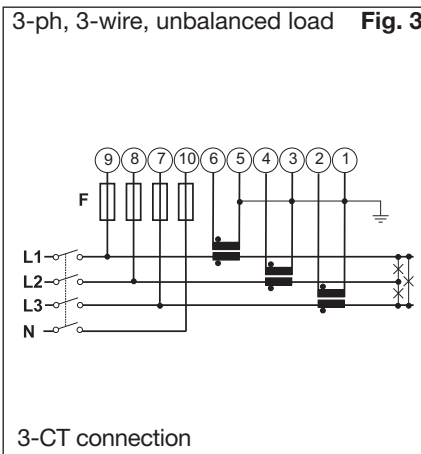
... as DIN-rail mounting meter.

# Wiring diagrams

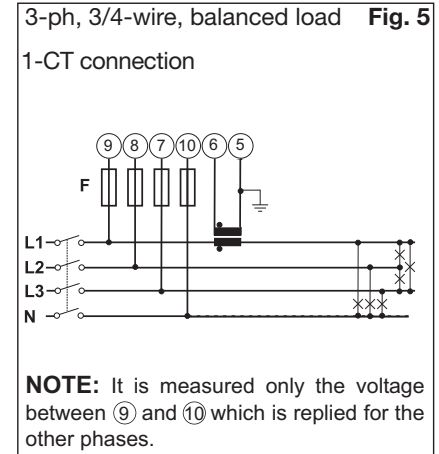
## Self power supply, system type selection: 3P.n



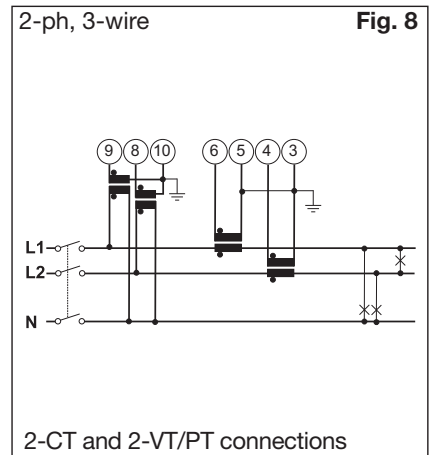
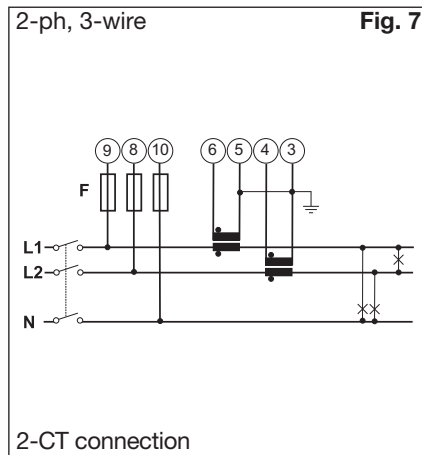
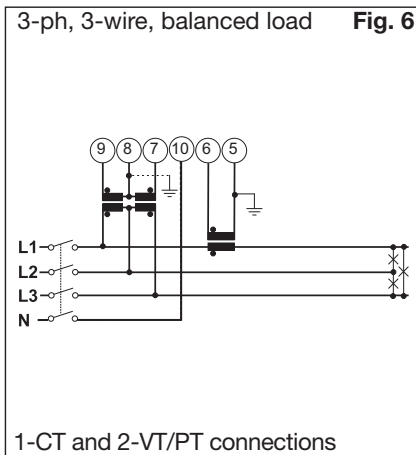
## System type selection: 3P.n



## Self power supply, system type selection: 3P.1



## System type selection: 2P

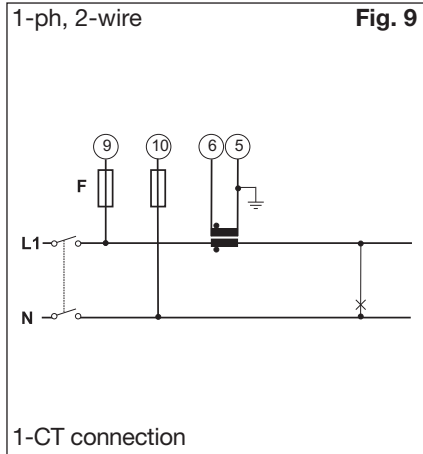


(\*) **NOTE:** For a correct power supply of the instrument, the neutral must always be connected.

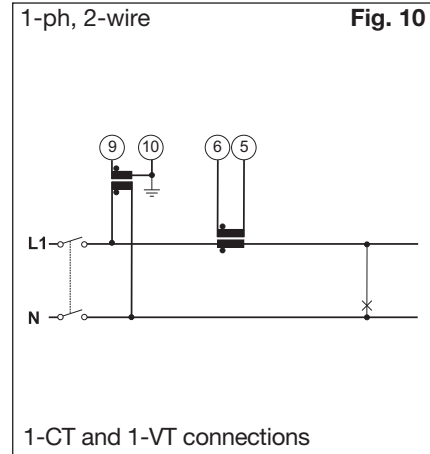


## Wiring diagrams

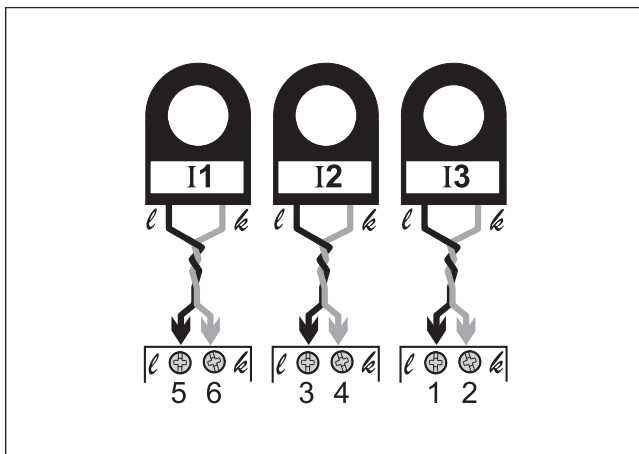
### System type selection: 1P



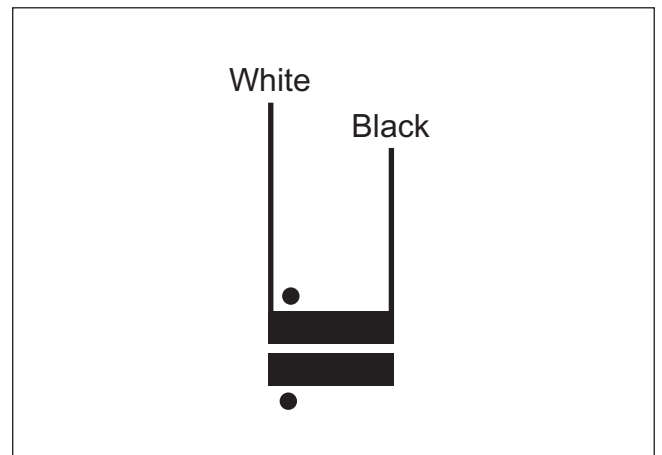
### System type selection: 1P



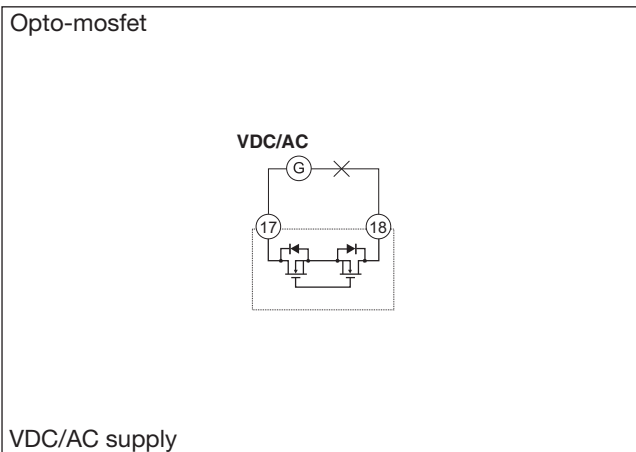
## CT connections



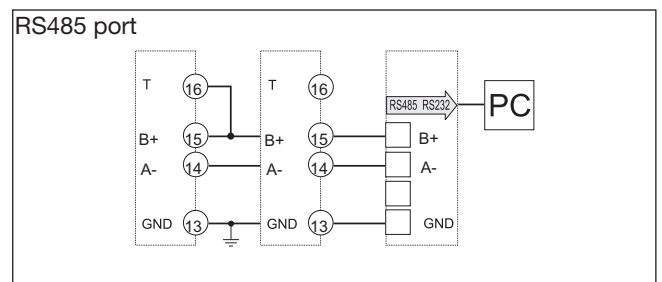
## Secondary wiring diagram



## Static output wiring diagram

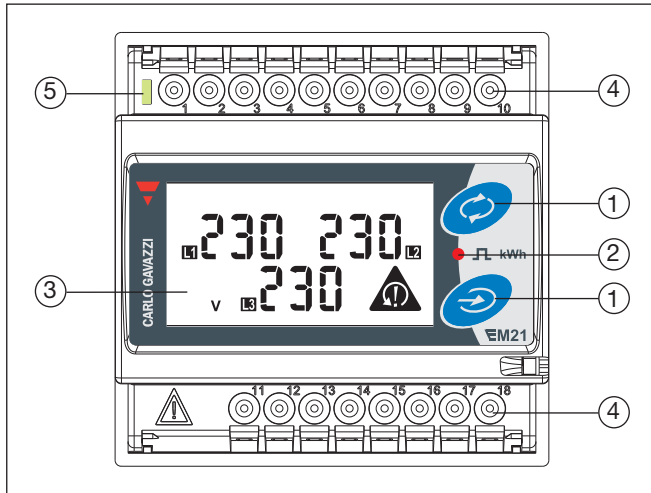


## RS485 port wiring diagram



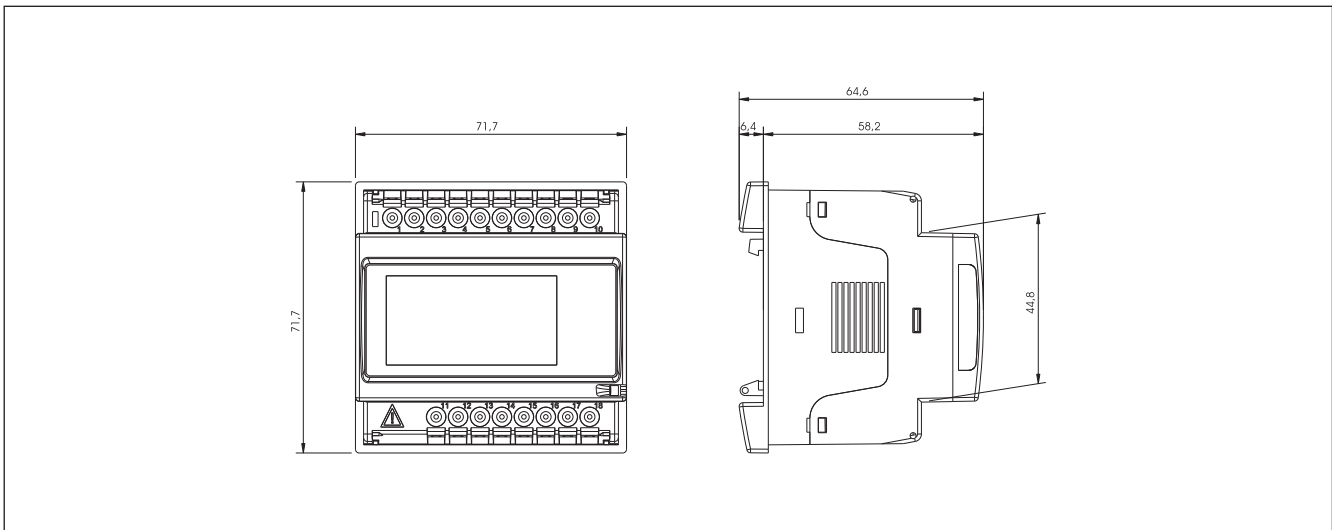
**RS485 NOTE:** additional devices provided with RS485 are connected as per the picture above. The termination of the serial output is carried out only on the last instrument of the network, by means of a jumper between (B+) and (T).

## Front panel description

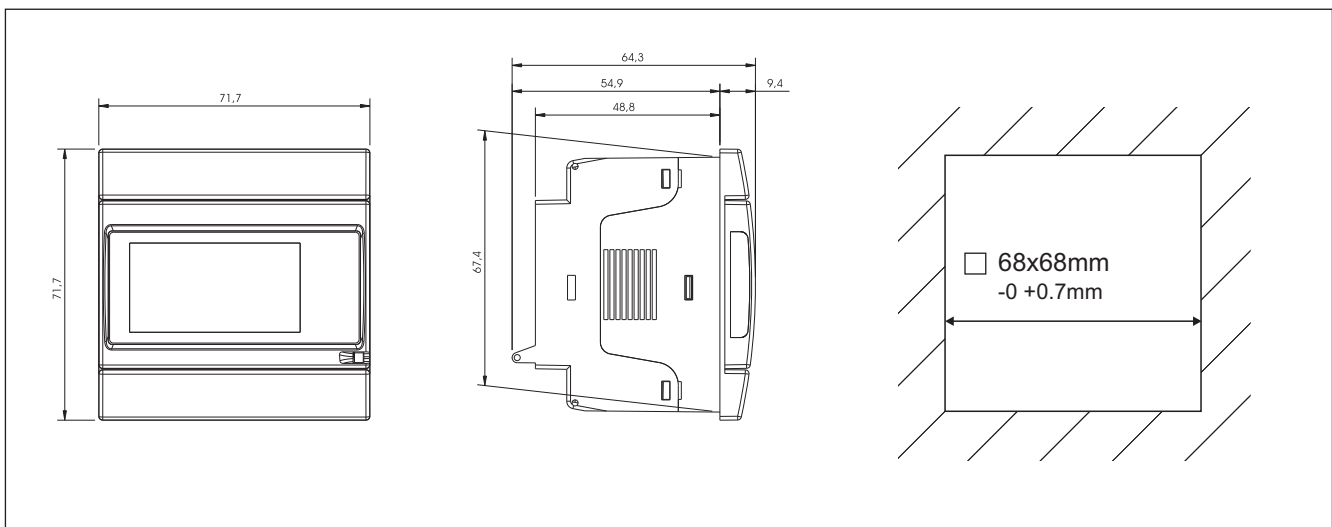


1. **Keypad**  
To program the configuration parameters and scroll the variables on the display.
2. **Pulse output LED**  
Red LED blinking proportional to the energy being measured.
3. **Display**  
LCD-type with alphanumeric indications to display all the measured variables.
4. **Connections**  
Screw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

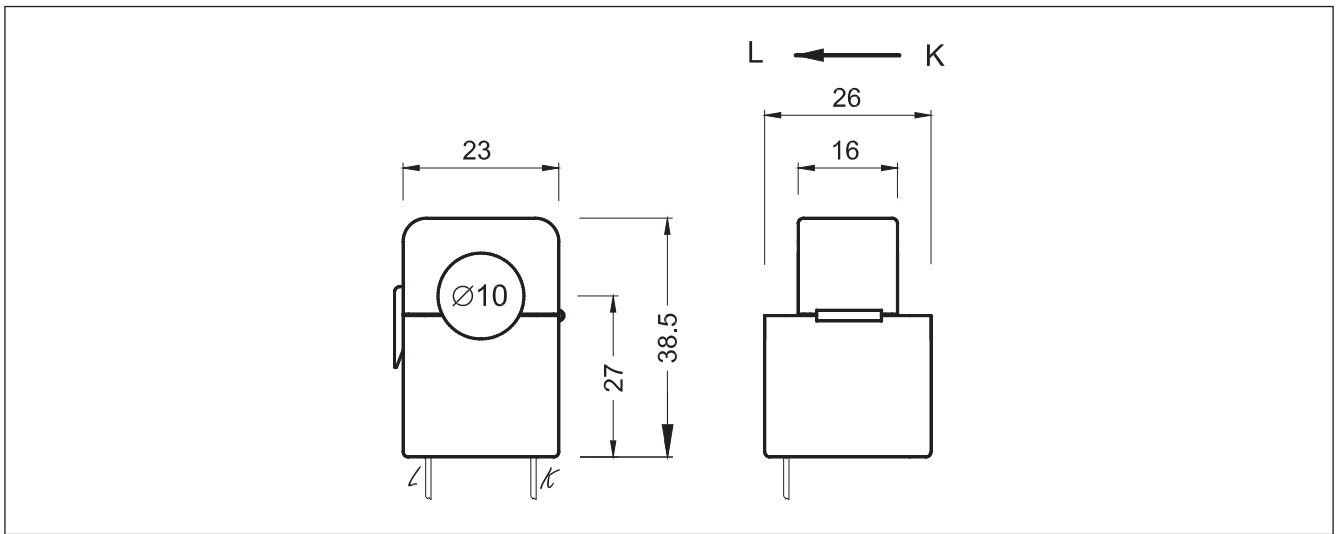
## Dimensions (DIN configuration)



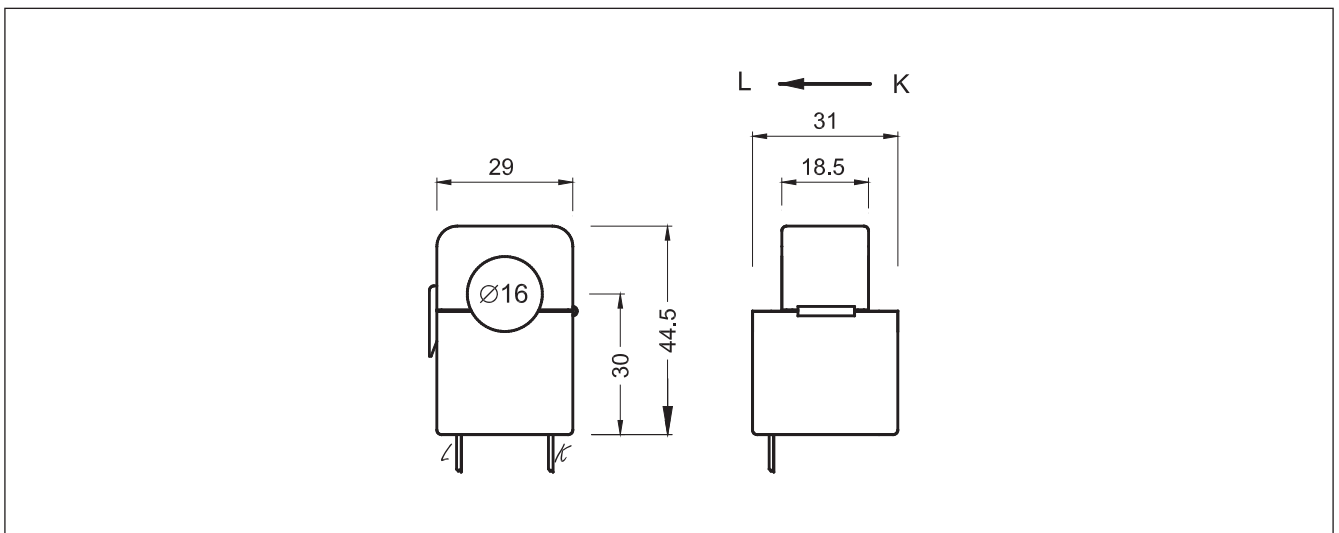
## Dimensions and panel cut out (72x72 panel mounting configuration)



### 90A CT Dimensions



### 150A CT Dimensions



### 250A CT Dimensions

