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

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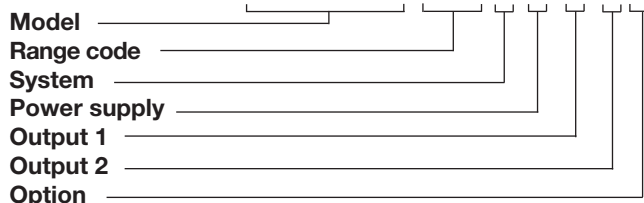- 10mm (90A), 16mm (150A) and 24mm (250A) diameter holes

- Class A (kWh) according to EN50470-3
- Class 2 (kWh) according to EN62053-21
- Accuracy ±0.5% RDG (voltage), ±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

Model							
Range code							
System							
Power supply							
Output 1							
Output 2							
Option							

Type Selection

Range codes	System	Power supply	Output 1
VV2 (*): 400V_{LL} AC, 90A (by current sensor)	**3 (*):** balanced and unbalanced load: 3-phase, 4-wire; 3-phase, 3-wire; 2-phase, 3-wire; 1-phase, 2-wire	**X (*):** Self power supply from 18V to 260VAC VLN, 45 to 65 Hz (connection VL1-N)	**O (*):** Single static output (opto-mosfet)
VV3 (**): 400V_{LL} AC, 150A (by current sensor)			
VV5 (**): 400V_{LL} AC, 250A (by current sensor)			

Output 2	Options	
X (*): None	**X (*):** None	**(*)** as standard.
S (**): RS485 port		**(**)** on request.

Input specifications

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

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Output specifications

Pulse output

Number of outputs	1
Type	Programmable from 0.01 to 9.99 kWh per pulses. Output connectable to the energy meters (kWh)
Pulse duration	≥100ms < 120ms (ON), ≥120ms (OFF), according to EN62052-31.
Output	Static: opto-mosfet.
Load	V_{ON} 2.5 VAC/DC max. 70 mA, V_{OFF} 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, no parity,1 stop bit.
Baud-rate	9600 bits/s.
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 digits; 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)
System 3-Ph.1 balanced load	• 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. • 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. • 3-phase (2-wire) one current and 1-phase (L1) to neutral voltage measurement.

System 2-Ph	2-phase (3-wire)
System 1-Ph	1-phase (2-wire)
Transformer ratio	
VT (PT)	1.0 to 99.9 / 100 to 999 / 1.00k to 6.00k
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).
Displaying	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.
Reset	By means of the front keypad: total energies (kWh, kvarh).
Easy connection function	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.

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General specifications

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

Power supply specifications

Self power supply	18 to 260VAC (48-62Hz). Across input "VL1" and "N"	**Power consumption**	≤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

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

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

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

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

Three-phase active power

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

Three-phase apparent power

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

Three-phase power factor

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

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; **t**= time interval between two successive power consumptions;
n₁, n₂ = 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 ($\sum$)
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 ($\sum$)
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 ($\sum$)
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 ($\sum$)
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 ($\sum$)
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 ($\sum$)
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 (1st half-line)	2nd variable (2nd 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
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

One instrument with double mounting capability
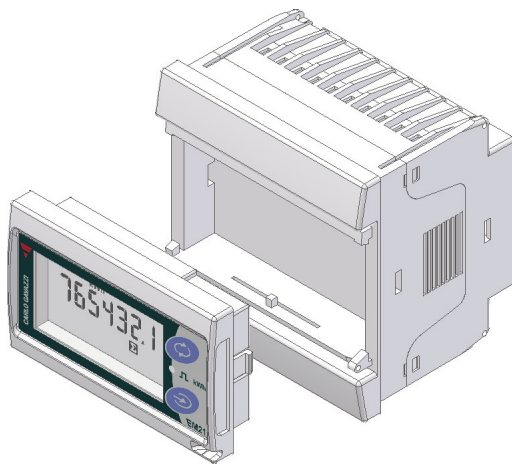
By means of the patented detachable display it is possible to configure the same instrument either as a panel mounting meter or...
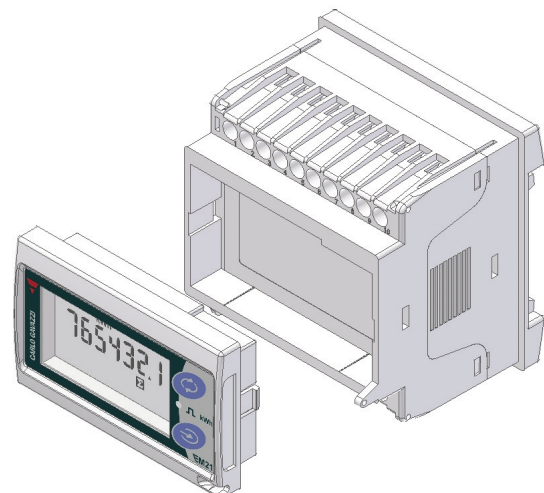
... as DIN-rail mounting meter.

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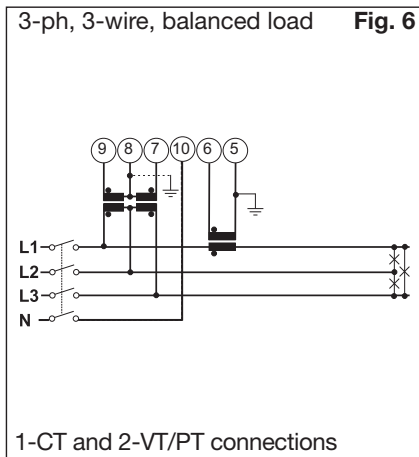
Wiring diagrams

Self power supply, system type selection: 3P.n
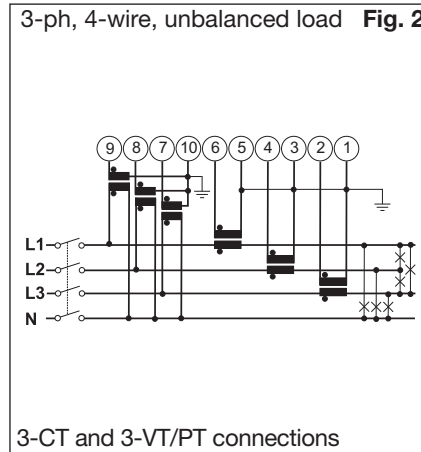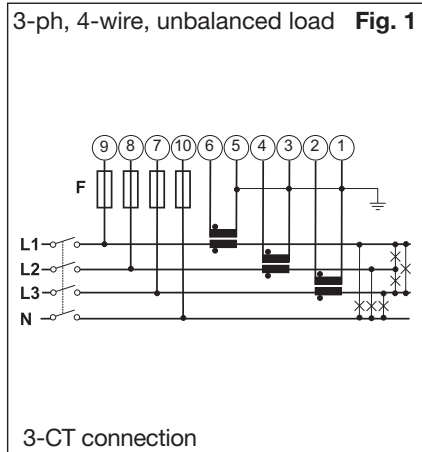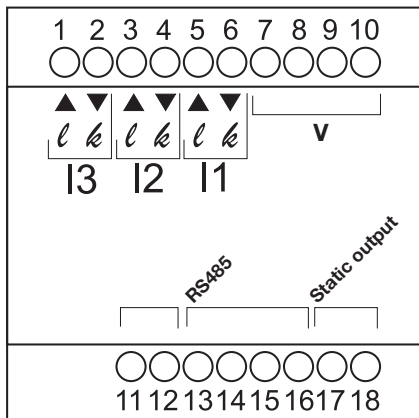
3-ph, 4-wire, unbalanced load **Fig. 1**
3-CT connection

3-ph, 4-wire, unbalanced load **Fig. 2**
3-CT and 3-VT/PT connections

System type selection: 3P.n

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

3-ph, 3-wire, unbalanced load **Fig. 4**
3-CT and 2-VT/PT connections

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

3-ph, 3/4-wire, balanced load **Fig. 5**
1-CT connection

NOTE: It is measured only the voltage between ⑨ and ⑩ which is replied for the other phases.

System type selection: 2P

3-ph, 3-wire, balanced load **Fig. 6**
1-CT and 2-VT/PT connections

2-ph, 3-wire **Fig. 7**
2-CT connection

2-ph, 3-wire **Fig. 8**
2-CT and 2-VT/PT connections
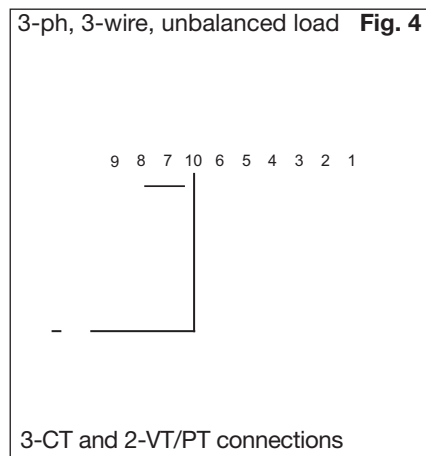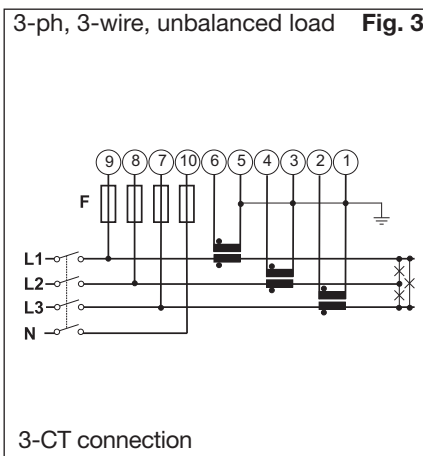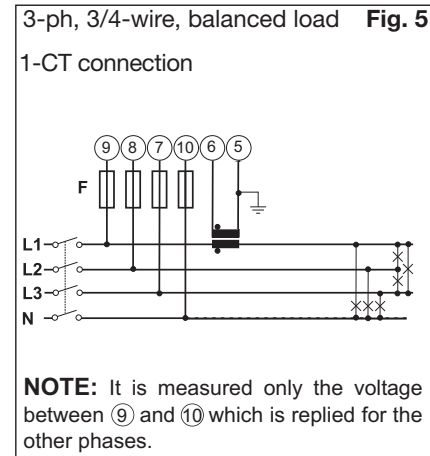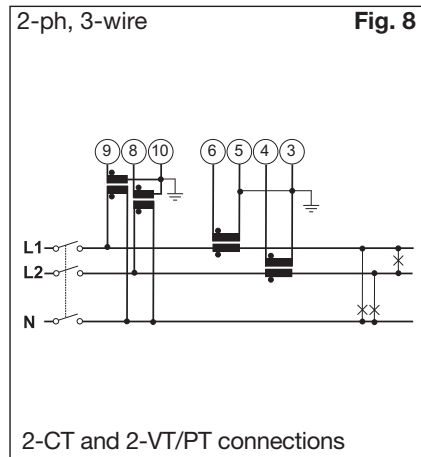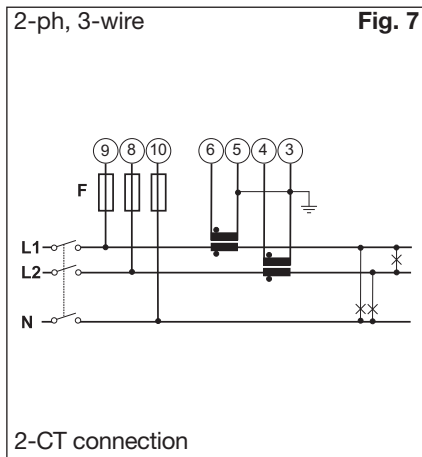
(*) NOTE: For a correct power supply of the instrument, the neutral must always be connected.

Wiring diagrams

System type selection: 1P

1-ph, 2-wire	**Fig. 9**

1-CT connection

System type selection: 1P

1-ph, 2-wire	**Fig. 10**

1-CT and 1-VT connections
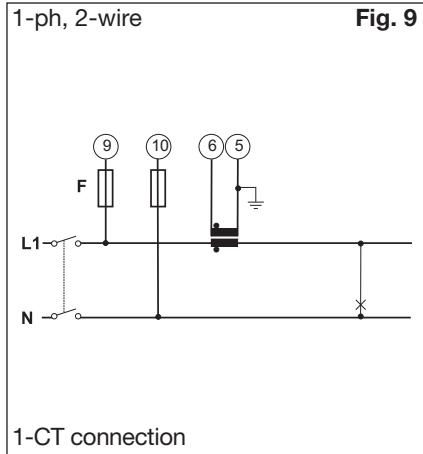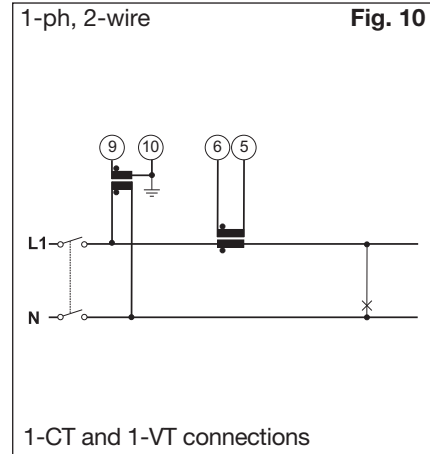
CT connections
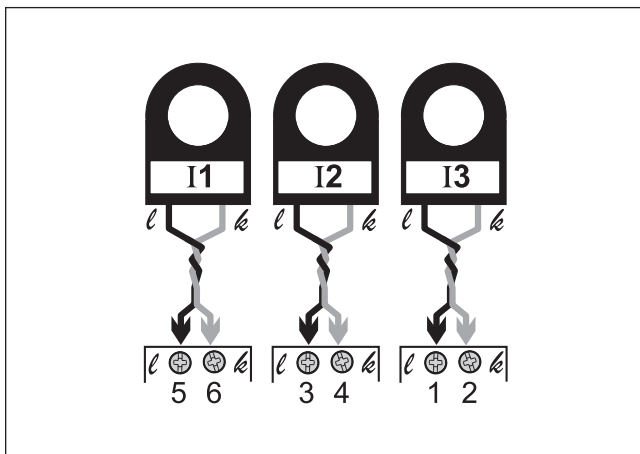
Secondary wiring diagram

White

Black
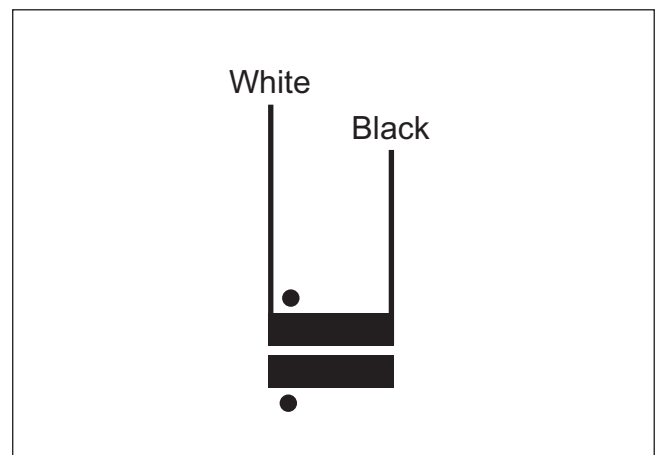
Static output wiring diagram

Opto-mosfet

VDC/AC

VDC/AC supply
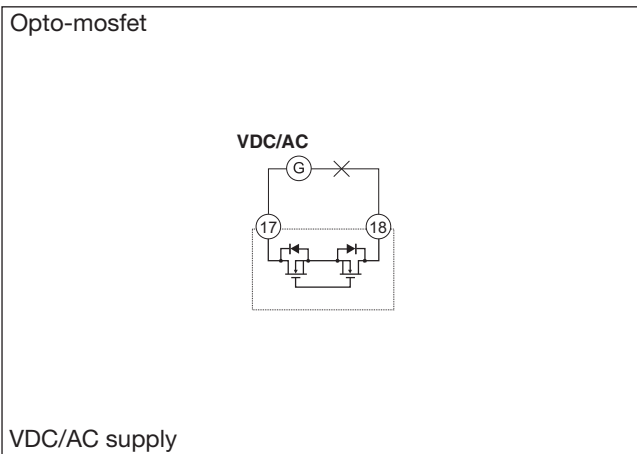
RS485 port wiring diagram

RS485 port
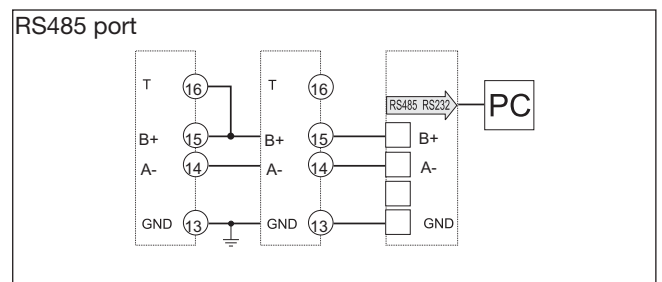
RS485 NOTE: additional devices provided with RS485 are connected as per the picture above. The termination of the serial output is carried out only on the last instrument of the network, by means of a jumper between (B+) and (T).
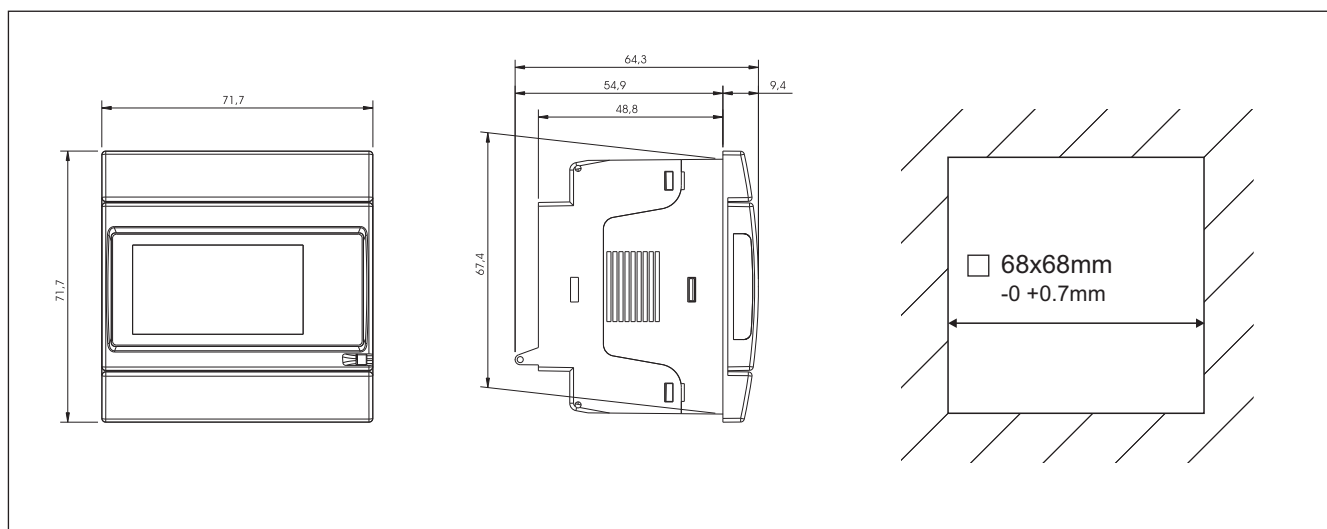
Front panel description
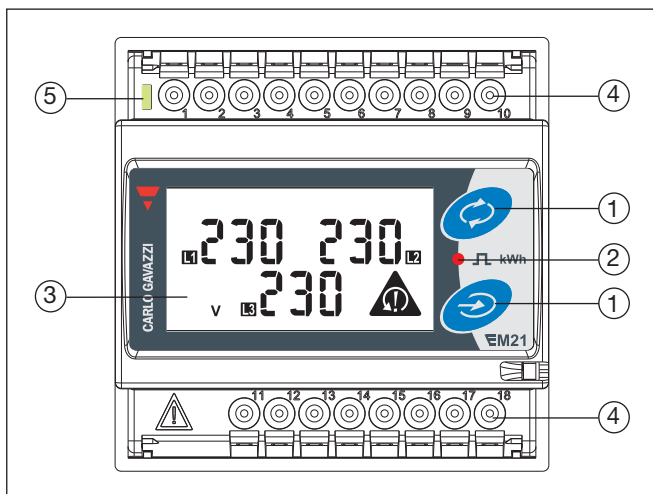
1. **Keypad**
   To program the configuration parameters and scroll the variables on the display.
2. **Pulse output LED**
   Red LED blinking proportional to the energy being measured.
3. **Display**
   LCD-type with alphanumeric indications to display all the measured variables.
4. **Connections**
   Screw terminal blocks for instrument wiring.
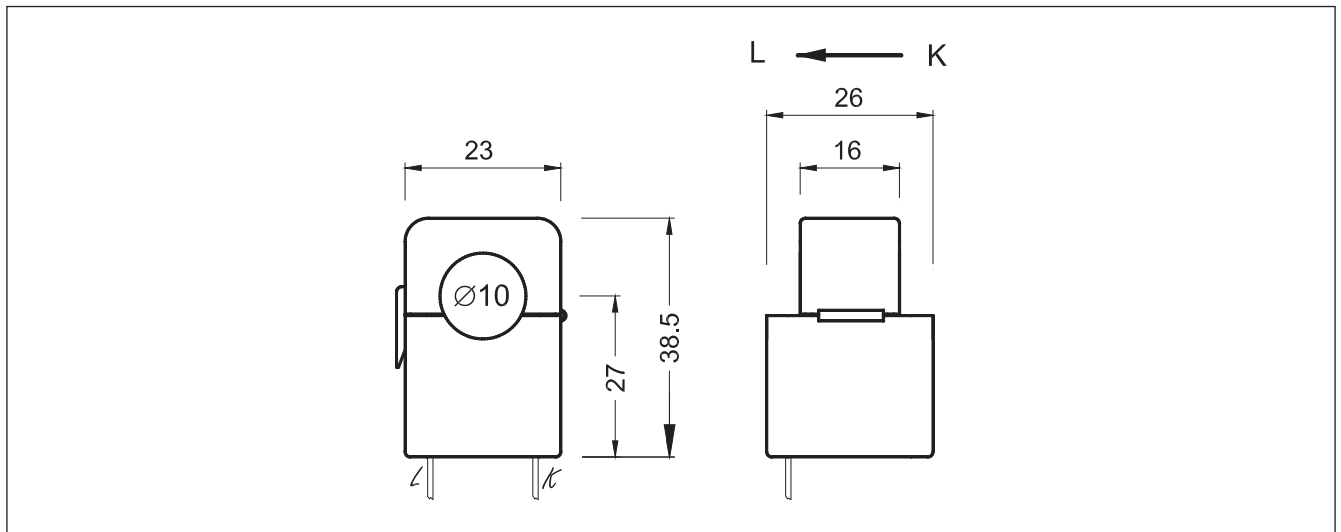5. **Green LED**
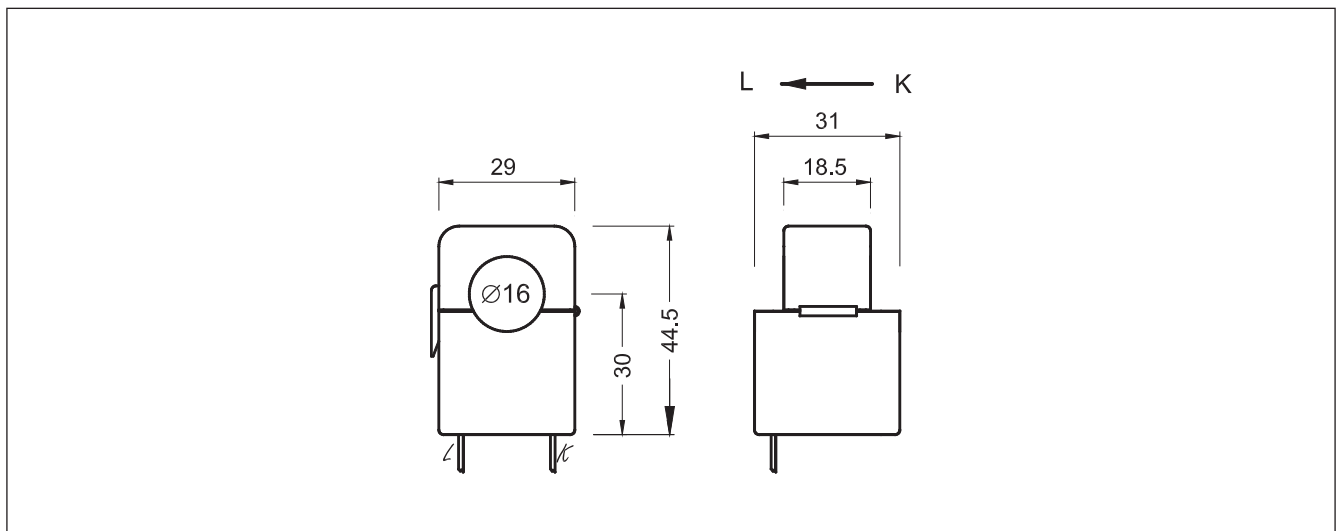   Lit when power supply is available

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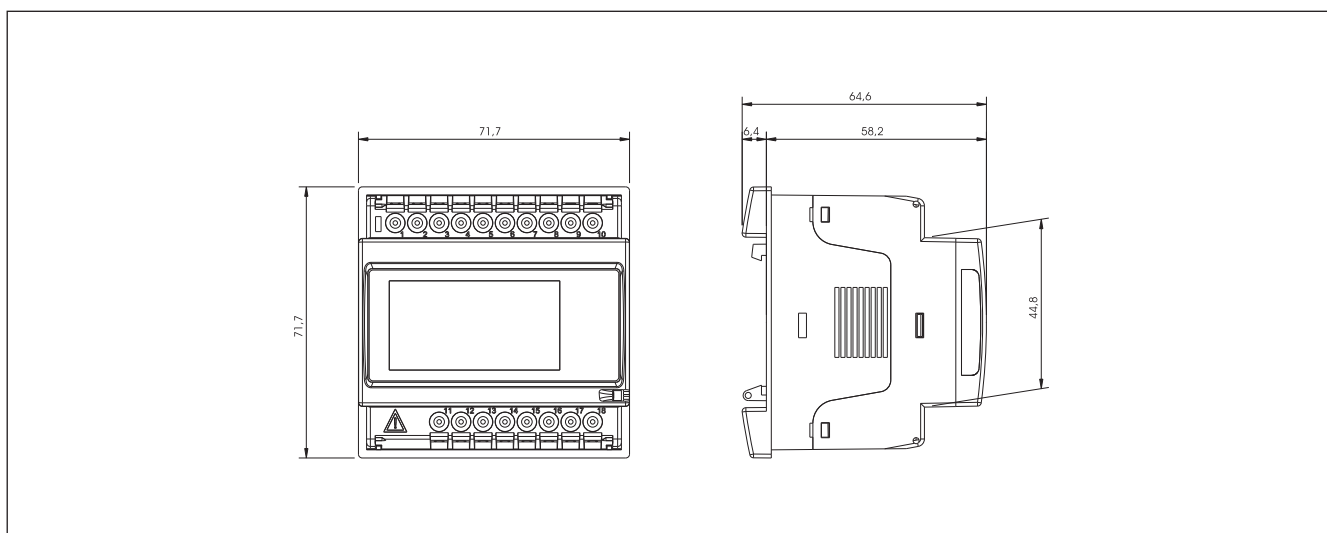
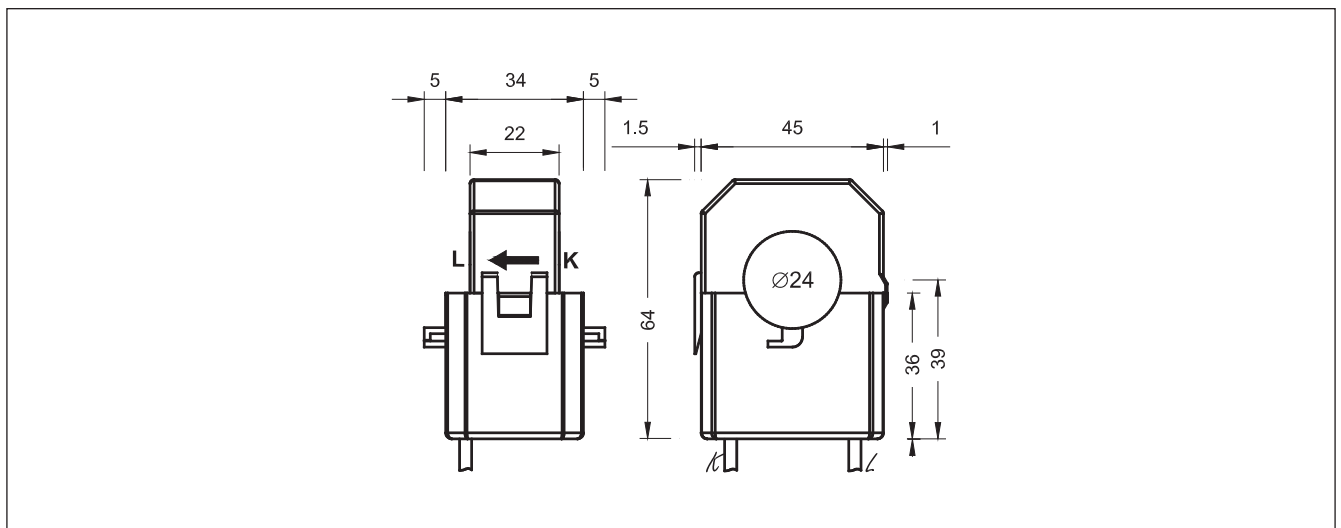# Dimensions and panel cut out (72x72 panel mounting configuration)

☐ 68x68mm
-0 +0.7mm

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90A CT Dimensions

L ← K

23

26

16

∅10

38.5

27

L   K

150A CT Dimensions

L ← K

29

31

18.5

∅16

44.5

30

L   K

250A CT Dimensions

5   34   5

22

1.5   45   1

L ← K

∅24

64

36   39

K   L

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