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

- **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): IP50**
- **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 IP50 (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

VV2 (*): 400V_{LL} AC, 90A (by current sensor)
VV3 (**): 400V_{LL} AC, 150A (by current sensor)
VV5 (**): 400V_{LL} AC, 250A (by current sensor)

System

3 (*): balanced and unbalanced load: 3-phase, 4-wire; 3-phase, 3-wire; 2-phase, 3-wire; 1-phase, 2-wire

Power supply

X (*): Self power supply from 18V to 260VAC VLN, 45 to 65 Hz (connection VL1-N)

Output 1

O (*): Single static output (opto-mosfet)

Output 2

X (*): None
S (**): RS485 port

Options

X (*): None

(*) as standard.
(**) on request.

CARLO GAVAZZI

Input specifications

Rated inputs	System type: 3
Current type	Not isolated (by CT). Note: the external current transformers can be connected to earth individually.
Current range (by current sensors)	VV2: 90A VV3: 150A VV5: 250A
Voltage (direct or by VT/PT)	VVx: 400VLL
Accuracy (Display + RS485) (@25°C ±5°C, R.H. ≤60%, 48 to 62 Hz)	Iref: see below; Un: see below
Voltage range	
VVx model	Un: 160 to 260VLN (277 to 450VLL).
Current range	
VV2 model	Iref: 15A, Imax: 90A
VV3 model	Iref: 20A, Imax: 150A
VV5 model	Iref: 20A, Imax: 250A
Current	From 0,05Iref to 0,1Iref: ± (1% RDG + 3DGT) From 0,1Iref to Imax: ± (1% 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	±(2%RDG +2DGT).
Power Factor	±[0.001+2%(1.000 - "PF RDG")].
Reactive power	±(3%RDG +2DGT).
Active energy	class A according to EN50470-3; class 2 according to EN62053-21.
Start up current	VV2: 75mA. VV3, VV5: 100mA
Temperature drift	≤200ppm/°C @ PF=1 Phase error: ≤0.05/°C
Sampling rate	1600 samples/s @ 50Hz, 1900 samples/s @ 60Hz
Display refresh time	1 second
Display	2 lines 1st line: 7-DGT, 2nd line: 3-DGT or 1st line: 3-DGT + 3-DGT, 2nd line: 3-DGT.
Type	LCD, h 7mm.
Instantaneous variables read-out	3-DGT.
Energies	Imported Total: 6+1DGT 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: 999 999.9 or 9 999 999. Min. instantaneous variables: 0; energies 0.0.
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)
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	≤3 (VV2: 230A max. peak)
Current Overloads	Without valid measurement
Continuous	VV2: 120A VV3: 300A VV5: 360A
Voltage Overloads	
Continuous	1.2 Un
For 500ms	2 Un
Voltage input impedance	
Self-power supply	Power consumption: <2VA.
Frequency	45 to 65 Hz.
Key-pad	Two push buttons for variable selection and programming of the instrument working parameters.

CARLO GAVAZZI

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.

CARLO GAVAZZI

General specifications

Operating temperature	-20°C to +50°C (-13°F to 131°F) (R.H. from 0 to 90% non-condensing @ 40°C)
Storage temperature	-30°C to +70°C (-22°F to 158°F) (R.H. < 90% non-condensing @ 40°C)
Installation category	Cat. III (IEC60664, EN60664).
Insulation (for 1 minute)	4000 VRMS between measuring inputs and digital output.
Dielectric strength	4000 VRMS 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	IEC60664, IEC61010-1 EN60664, EN61010-1 EN62052-11
Metrology	EN62053-21, EN62053-23, EN50470-3
Pulse output	DIN43864, IEC62053-31
Approvals	CE
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	IP50
Screw terminals	IP20
Weight	Approx. 400 g (packing included)

Power supply specifications

Self power supply	18 to 260VAC (48-62Hz). Across input “VL1” and “N”
Power consumption	≤2VA/1W

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 (TPF)

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

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;
$\mathbf{t_1}$, $\mathbf{t_2}$ =starting and ending time points of consumption recording; **n**= time unit;$\varnothing$**t**= time interval between two successive power consumptions;
$\mathbf{n_1}$, $\mathbf{n_2}$ = starting and ending discrete time points of consumption recording

CARLO GAVAZZI

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 (∑)
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 (∑)
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 (∑)
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 (∑)
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 (∑)
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 (∑)
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

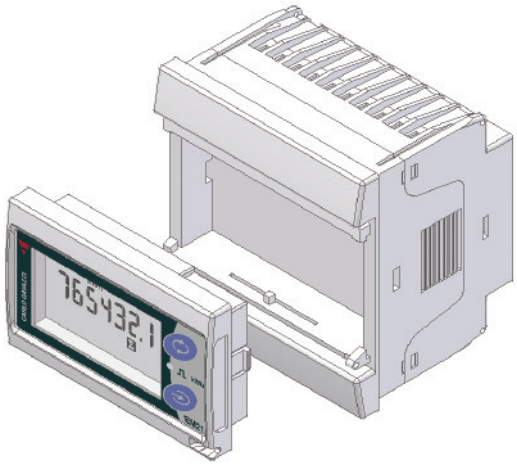
Additional available information on the display

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

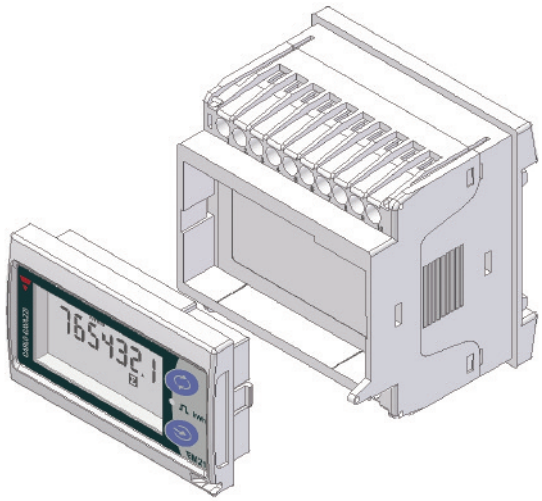
	Description	Notes
A	Active energy meter	Active energy measurement with some minor parameters
B	Active and reactive energy meter	Active and reactive energy measurement with some minor parameters
C	Full set of variables	Full set of available variables can be displayed

One instrument with double mounting capability



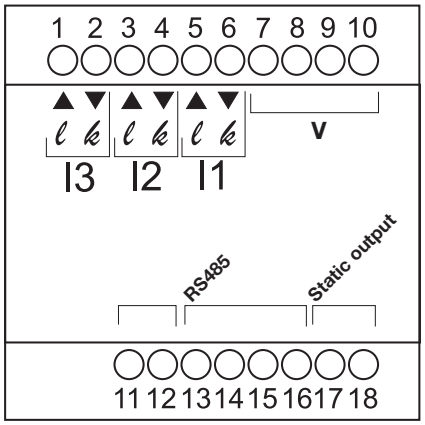
... as DIN-rail mounting meter.

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



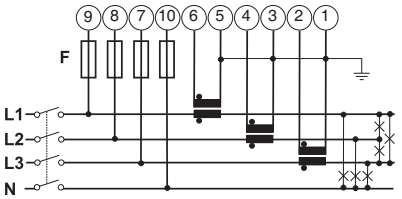
CARLO GAVAZZI

Wiring diagrams



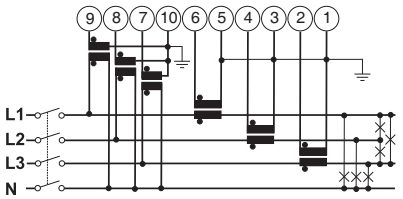
Self power supply, system type selection: 3P.n

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



3-CT connection

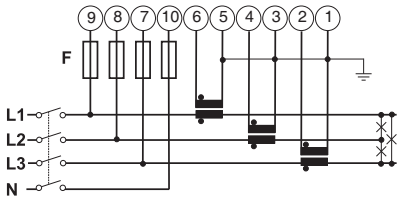
3-ph, 4-wire, unbalanced load **Fig. 2**



3-CT and 3-VT/PT connections

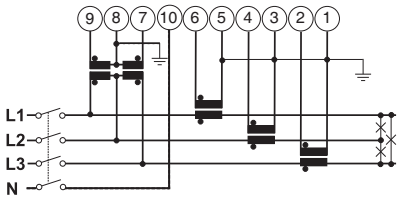
System type selection: 3P.n

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



3-CT connection

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

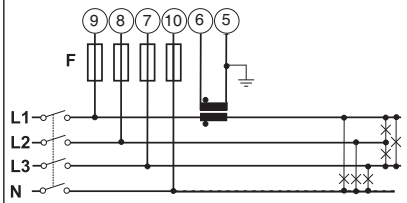


3-CT and 2-VT/PT connections

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

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

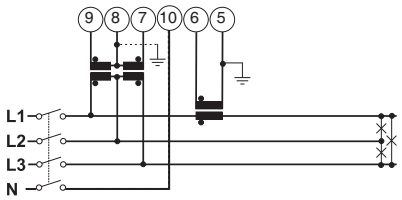
1-CT connection



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

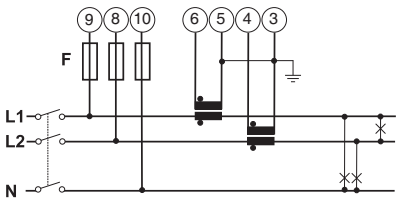
System type selection: 2P

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



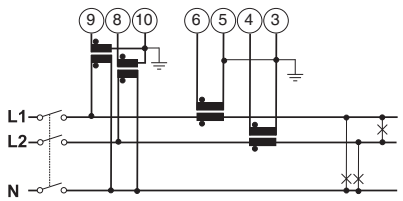
1-CT and 2-VT/PT connections

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



2-CT connection

2-ph, 3-wire **Fig. 8**



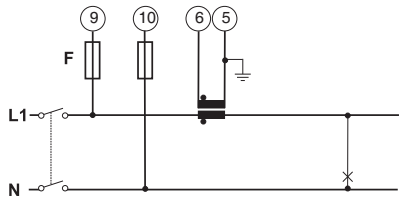
2-CT and 2-VT/PT connections

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

Wiring diagrams

System type selection: 1P

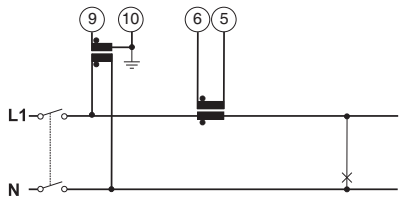
1-ph, 2-wire **Fig. 9**



1-CT connection

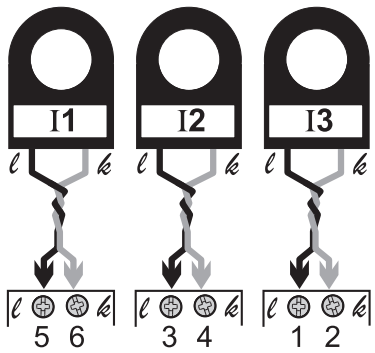
System type selection: 1P

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

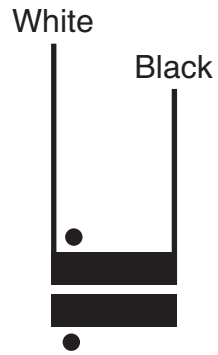


1-CT and 1-VT connections

CT connections

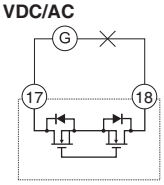


Secondary wiring diagram



Static output wiring diagram

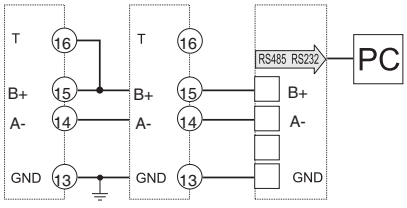
Opto-mosfet



VDC/AC supply

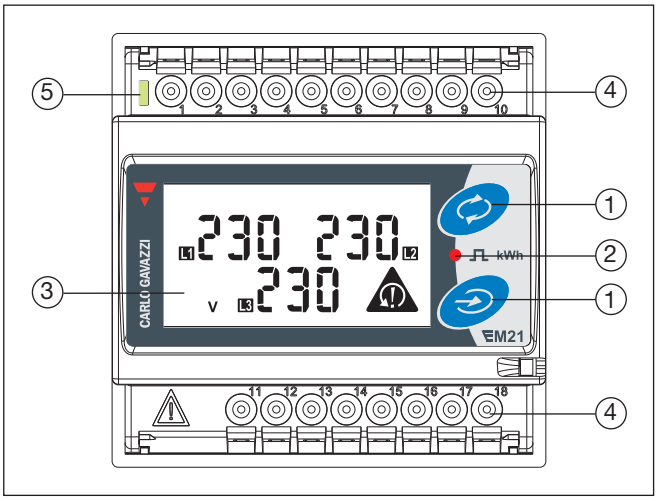
RS485 port wiring diagram

RS485 port



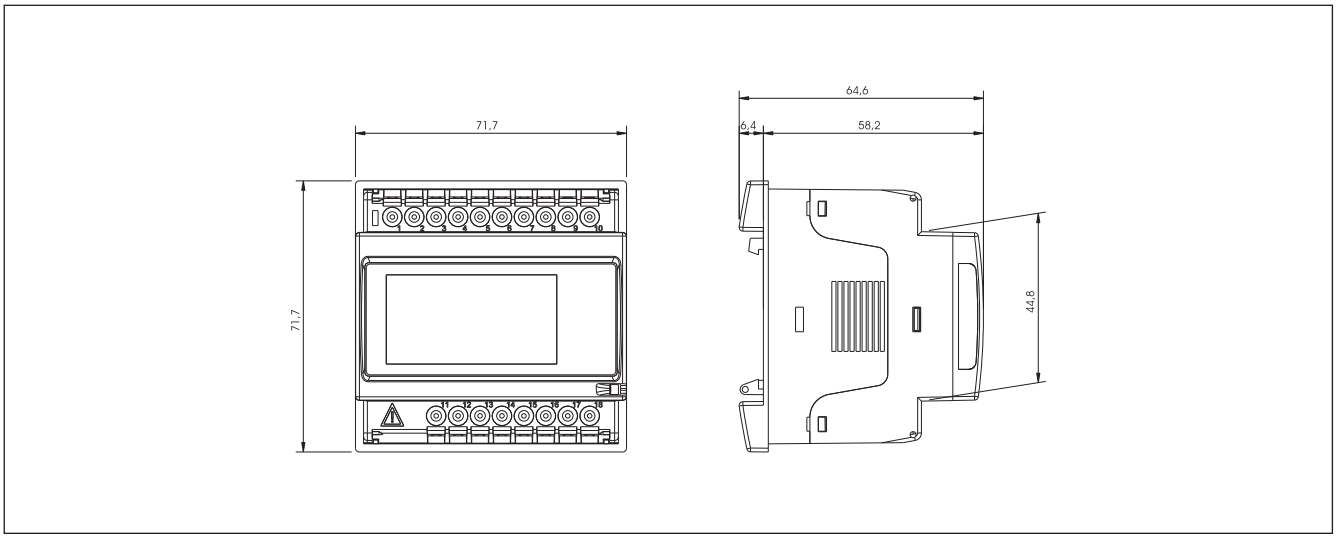
RS485 NOTE: additional devices provided with RS485 are connected as per the picture above. The termination of the serial output is carried out only on the last instrument of the network, by means of a jumper between (B+) and (T).

Front panel description

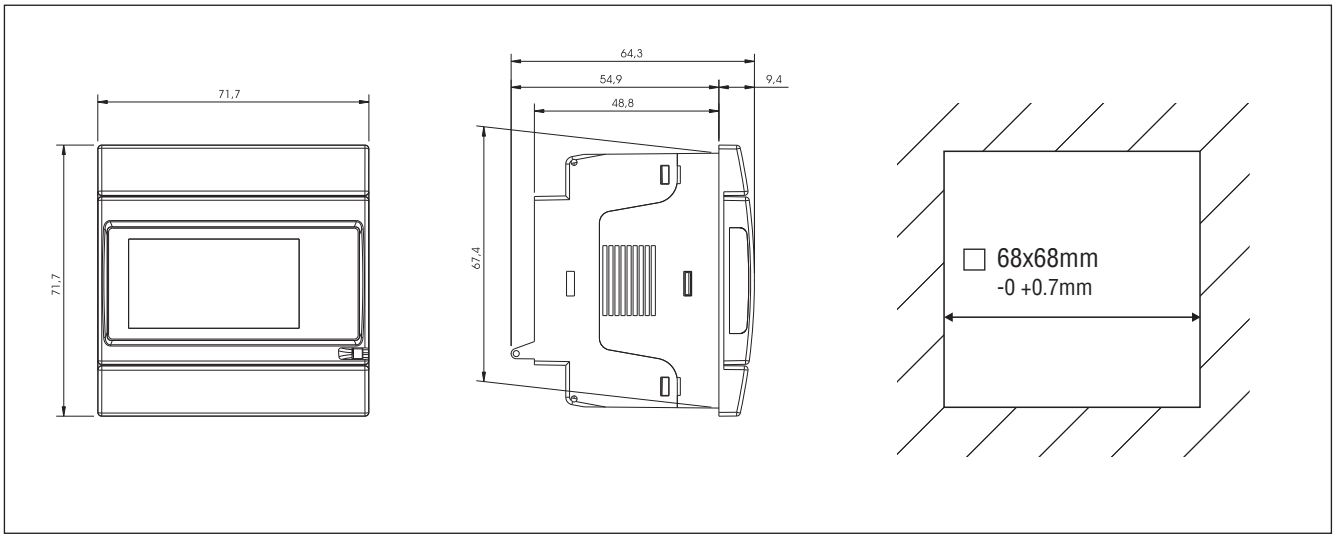


1. **Keypad**
   To program the configuration parameters and scroll the variables on the display.
2. **Pulse output LED**
   Red LED blinking proportional to the energy being measured.
3. **Display**
   LCD-type with alphanumeric indications to display all the measured variables.
4. **Connections**
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

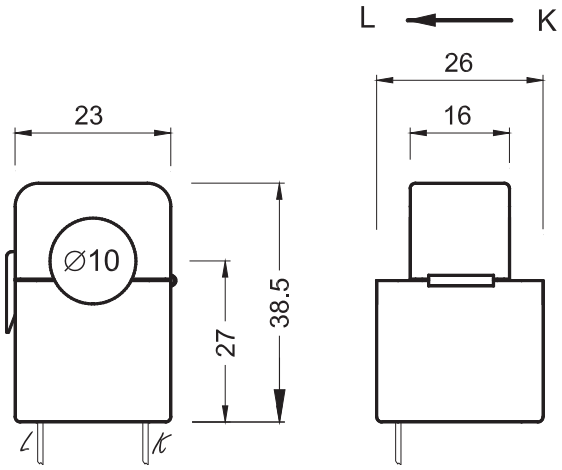
Dimensions (DIN configuration)



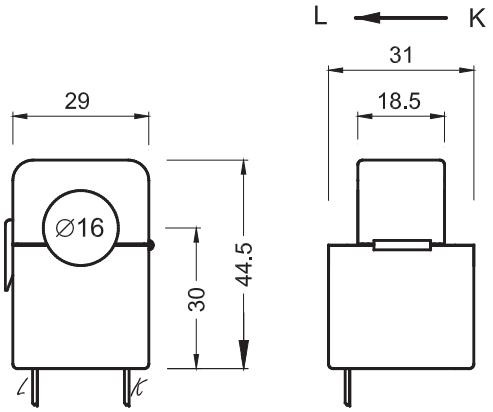
Dimensions and panel cut out (72x72 panel mounting configuration)



90A CT Dimensions



150A CT Dimensions



250A CT Dimensions