EM540

Energy analyzer for three-phase and two-phase systems

Description

EM540 is a direct connection energy analyser, for two- and three-phase systems up to 415 V L-L and current up to 65 A. In addition to a digital input, the unit can be equipped, according to the model, with a static output (pulse or alarm), a Modbus RTU communication port or an M-Bus communication port.

Benefits

- **Enhanced readability.** The backlit display ensures perfect visibility even in low light. The different size of the digits preceding and following the dot makes the displayed values easier to read, while the essential style of the units of measure allows you to readily understand the available variables.
- **Easy browsing.** Page configuration and browsing are very intuitive, thanks to the user interface with 3 mechanical keys. The slideshow function automatically displays the desired measurements in sequence, without having to use the keyboard; the page filter allows you to hide the unnecessary information.
- **Quick configuration.** The configuration wizard which runs when the system is started up for the first time allows you to commission the unit without errors in a matter of seconds. The UCS configuration software is available for download free of charge.
- **Accurate measuring.** EM540 complies with the precision international standard IEC/EN62053-21, and with the performance requirements (power and active energy) set out by IEC/EN61557-12.
- **Fiscal metrology.** The sliding terminal caps (patent application pending in EU, US, CA, AU), can be sealed to prevent any tampering with the connections, allowing the unit, thanks to the MID certification, to perform measurements for fiscal purposes and a reinforced protection toward the power terminals.
- **Flexible installation.** It can be installed in two-phase, three-phase with neutral, three-phase without neutral, and wild-leg three-phase low-voltage systems.

Applications

EM540 can be installed in any low-voltage switchboard with rated current up to 65 A, to monitor the energy consumption, the main electrical variables and the harmonic distortion.

If used to monitor a single machine, it provides all the main electrical variables to identify any possible malfunction in its early stage and can correlate the energy consumption with the hours of operation, to plan maintenance and prevent failures. The partial meter reset function, easily implementable by means of a digital input, allows you to monitor each individual machine cycle.

The MID-certified version can be used for fiscal metrology and can be installed in residential or commercial buildings to split the costs among the different units, or as a component of machines or equipment requiring measurement certification.

Thanks to the measurement refresh time and to the high resolution of the variables available through a Modbus RTU communication module, it can also be used as data source for control actions, such as avoiding feeding energy into the electricity grid in a photovoltaic joint installation with energy storage.

Main functions

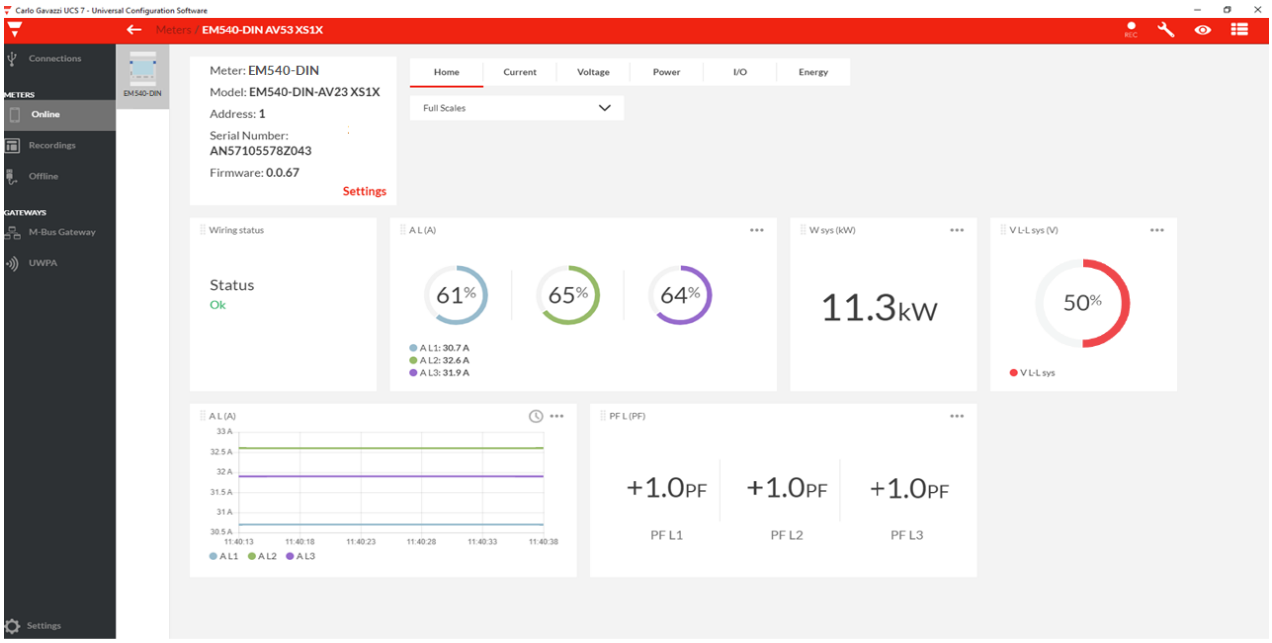
- Measure active, reactive and apparent energy
- Measure the main electrical variables
- Measure the load run hours and of the analyser
- Measure the total harmonic distortion (THD) of current and voltages
- Transmit data to other systems through Modbus RTU or M-Bus
- Manage a digital output for pulses or alarm transmission
- Visualize the measured variables on the display

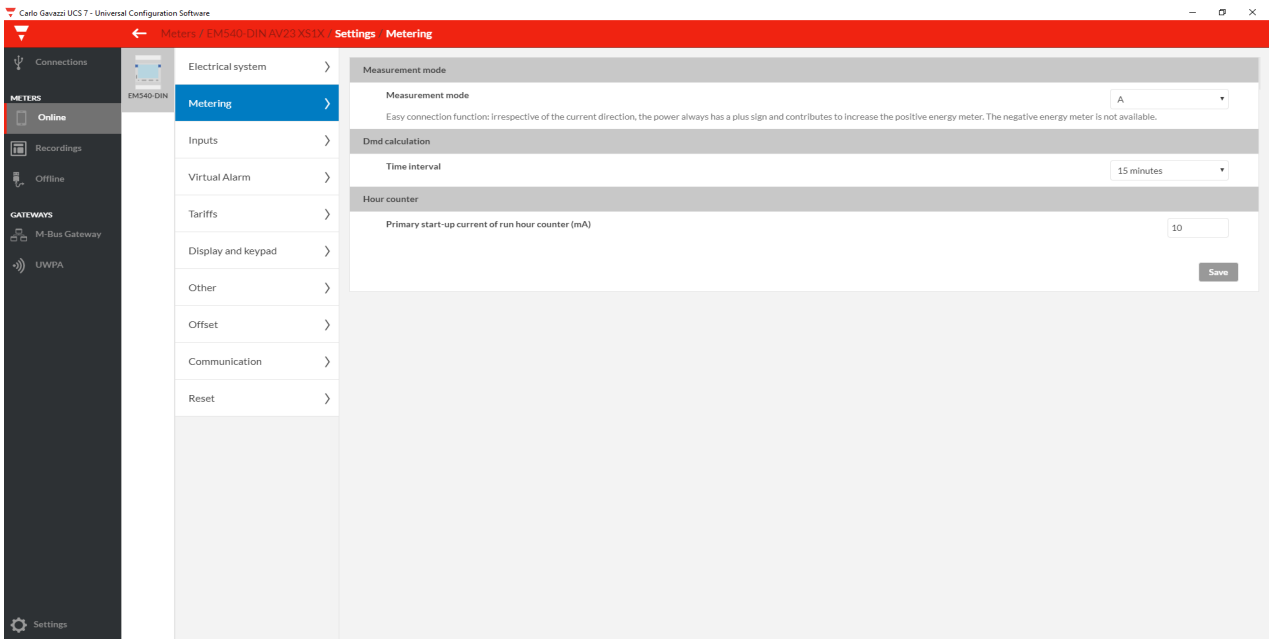
Main features

- System and phase variables (V L-L, V L-N, A, W/var, VA, PF, Hz)
- Displaying of the consumed active energy with a resolution of 0.001 kWh
- The frequency value is available via Modbus, with a resolution of 0.001 Hz
- Average value calculation (dmd) for current and power (kW / kVA)
- Streamlined user interface featuring 3 mechanical buttons
- Modbus RTU RS485 (data refresh every 100 ms)
- Continuous sampling of each voltage and current
- Backlit LCD display
- MID certified version
- MID-certified meter resolution 0.001 kWh
- cULus approved (UL 61010)
- Compliance with the performance requirements set out by IEC/EN61557-12 (power and active energy)

UCS software

- Free download from Carlo Gavazzi website
- Configuration through RS485 from PC or trough UWP3.0 via LAN or the web (UWP Secure Bridge function)
- Setups can be saved offline for serial programming with a single command
- Real time data view for testing and diagnostics
- Notification of possible wiring errors and display of the corrective steps, reassignment of the correct association of the phases or the direction of the currents via software control.





Structure

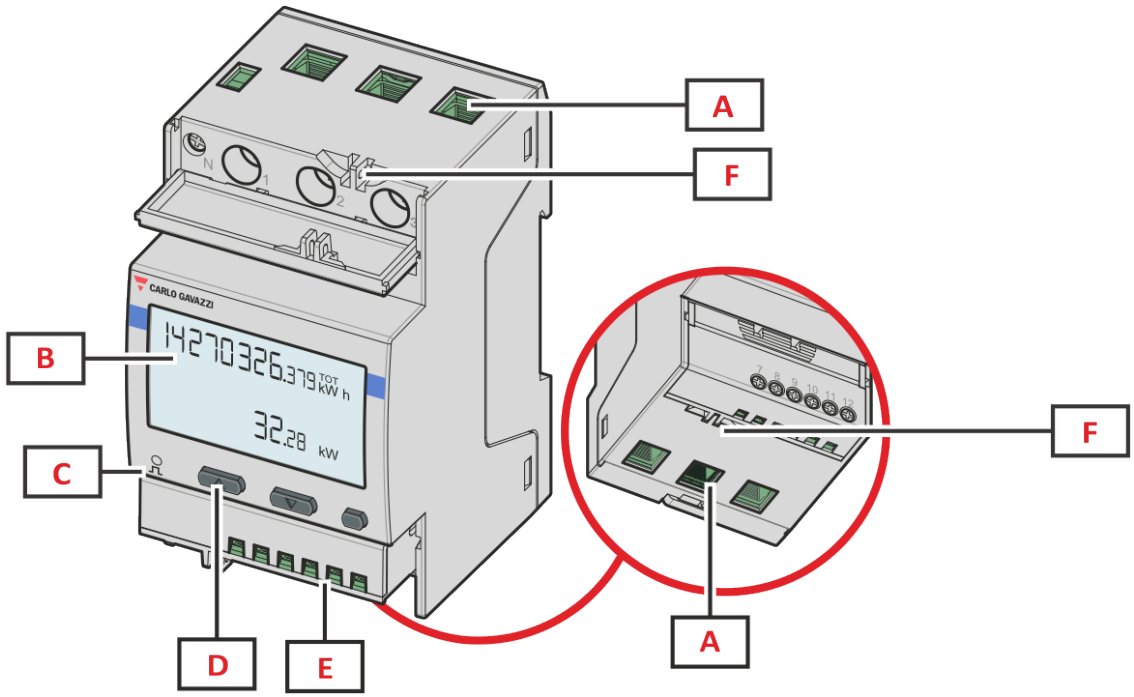


Fig. 1 *Front*

Area	Description
A	Voltage inputs/Current inputs
B	Display
C	LED
D	Browsing and configuration buttons
E	Digital input, digital output and communication connections
F	MID seal housings

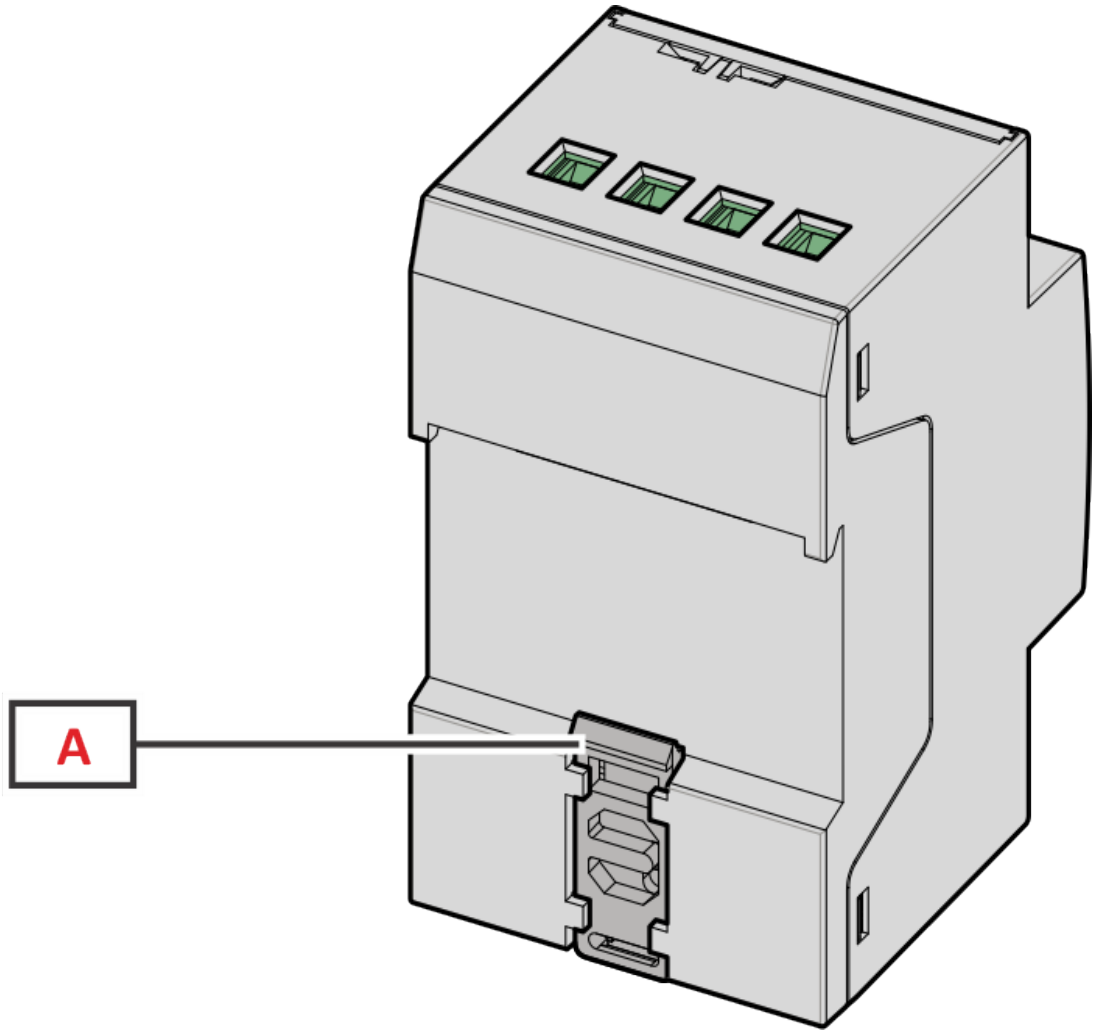


Fig. 2 *Back*

Area	Description
A	DIN rail mounting bracket

Features

General

Material	Housing: PBT Transparent cover: polycarbonate
Protection degree	Front: IP40 Terminals: IP20
Terminals	Measurement inputs (Phase 1,2, 3): min: 2.5 mm^2, max: 16 mm^2, 2.5 Nm max Neutral: min: 0.06 mm^2, max: 2.5 mm^2, 0.5 Nm max Inputs, outputs and communication: min: 0.2 mm^2, max: 1.5 mm^2, 0.4 Nm max
Overvoltage category	Cat. III
Pollution degree	2
Mounting	DIN rail
Weight	370 g (packaging included)
Dimensions	3-DIN modules

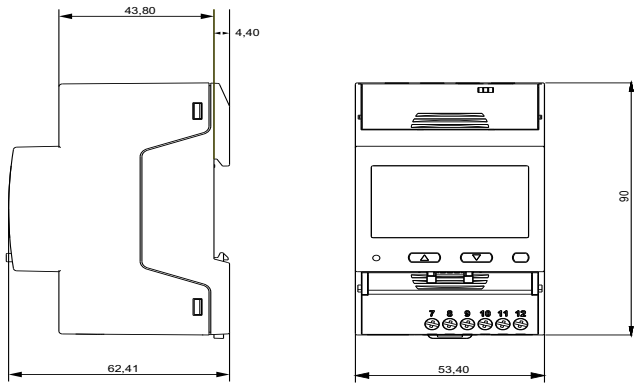


Fig. 3

Environmental specifications

Operating temperature	From -25 to +55 °C/from -13 to +131 °F
Storage temperature	From -25 to +70 °C/from -13 to 158 °F
Electromechanical environmental condition	E2
Mechanical environmental condition	M2

***Note**: R.H. < 90 % non-condensing @ 40 °C / 104 °F.*

Input and output insulation

Type	Measurement inputs	Digital input	Digital outputs	RS485 serial port	M-Bus serial port
Measurement inputs	-	Double/Reinforced	Double/Reinforced	Double/Reinforced	Double/Reinforced
Digital input	Double/Reinforced	-	none	none	none
Digital outputs	Double/Reinforced	none	-	-	-
RS485 serial port	Double/Reinforced	none	-	-	-
M-Bus serial port	Double/Reinforced	none	-	-	-

According to: EN 61010-1, EN 50470-1 (MID). Overvoltage category III. Pollution degree 2.

Compatibility and conformity

Directives	2014/32/EU (MID) 2014/35/EU (LVT - Low Voltage) 2014/30/EU (EMC - Electro Magnetic Compatibility) 2011/65/EU, 2015/863/EU (Electric-electronic equipment hazardous substances)
Standards	Electromagnetic compatibility (EMC) - emissions and immunity: EN 62052-11; EN 50470-1 (MID) Electrical safety: EN 61010-1, EN 50470-1 (MID) Metrology: EN62053-21, EN62053-23, IEC61557-12, EN 50470-3 (MID), IEC/EN61557-12 (active power and active energy, MID models only) Pulse output: IEC 62053-31
Approvals	CE c UL us LISTED UK CA

Electrical specifications

Electrical system	
Managed electrical system	Two-phase (3-wire) Three-phase with neutral (4-wire) Three-phase without neutral (3-wire) Wild leg system (three-phase, four-wire delta)
MID managed electrical system	Three-phase with neutral (4-wire) Three-phase without neutral (3-wire)

Voltage inputs - MID	
Voltage connection	Direct
Rated voltage L-N	120 to 230
Rated voltage L-L	208 to 400 V
Voltage tolerance	From 0.8 to 1.15 Un
Overload	Continuous: 1.5 Un max
Input impedance	Refer to “Power supply”
Frequency	50 Hz
Voltage inputs - Non MID models	
Voltage connection	Direct
Rated voltage L-N (from Un min to Un max)	120 to 240 V
Rated voltage L-L (from Un min to Un max)	208 to 415 V
Voltage tolerance	From 0.8 to 1.15 Un
Overload	Continuous: 1.5 Un max
Input impedance	Refer to “Power supply”
Frequency	From 45 to 65 Hz

***Note**: for MID versions the voltage range is limited to 3x120 (208)...3x230 (400) V, frequency to 50Hz.*
***Note**: EM540 can also be installed in a wild leg system (three phases, four delta wires), where one of the phase-neutral voltages is higher than the other two.*

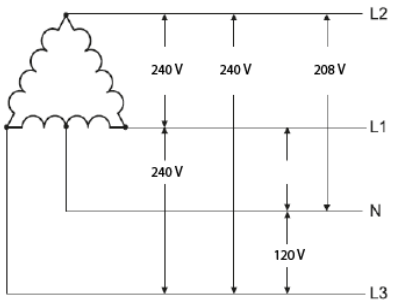


***Fig. 4** Two-phase system with neutral (3-wire)*

Current inputs	
Current connection	Direct
Base current (Ib)	5 A
Minimum current (Imin)	0.25 A
Maximum current (Imax)	65 A
Start-up current (Ist)	20 mA
Overload	For 10 ms: 30 Imax (1950 A)
Input impedance	< 3.4 VA
Crest factor	Crest factor: 4 (Imax peak 92A)

Power supply

Type	Self power supply
Consumption	< 1.3 W/2.6 VA
Frequency	50/60 Hz

Measurements

Method	TRMS measurements of distorted waveforms

Available measurements

Active energy	Unit	System	Phase
Imported (+) Total	kWh+	•	•
Imported (+) partial	kWh+	•	-
Exported (-) Total	kWh-	•	-
Exported (-) partial	kWh-	•	-
Imported (+) Total by tariff (t1, t2)	kWh+	•	-

Reactive energy	Unit	System	Phase
Imported (+) Total	kvarh+	•	-
Imported (+) partial	kvarh+	•	-
Exported (-) Total	kvarh-	•	-
Exported (-) partial	kvarh-	•	-

Apparent energy	Unit	System	Phase
Total	kVAh	•	-
Partial	kVAh	•	-

Run hour meter	Unit	System	Phase
Total (kWh+)	hh:mm	●	-
Partial (kWh+)	hh:mm	●	-
Total (kWh-)	hh:mm -	●	-
Partial (kWh-)	hh:mm -	●	-
Total ON time	hh:mm	●	-

Electrical variable	Unit	System	Phase
Voltage L-N	V	●	●
Voltage L-L	V	●	●
Current	A	●	●
DMD	A	-	●
DMD MAX	A	-	●
Neutral current	A	●	-
Active power	W	●	●
DMD	W	●	-
DMD MAX	W	●	-
Apparent power	VA	●	●
DMD	VA	●	-
DMD MAX	VA	●	-
Reactive power	Var	●	●
Power factor	PF	●	●
Frequency	Hz	●	-
THD Current*	THD A %	-	●
THD Voltage L-N*	THD L-N %	-	●
THD Voltage L-L*	THD L-L %	-	●

* Up to 15th harmonic

***Note**: the available variables depend on the type of system set.*
Total imported active energy (kWh TOT) is the only MID certified meter. Apparent energy, reactive energy and exported active energy are not MID certified. Partial meters are not MID certified.
All the variables calculated by the meter are referred to the primary current of the current transformer.

Energy metering

Energy metering depends on the measurement type you chose (selectable in non-MID models, according to the model in MID-certified models).

A measurement (MID PFA models)

Easy connection function: irrespective of the current direction, the power always has a plus sign and contributes to increase the positive energy meter. The negative energy meter is not available.

B measurement (MID PFB models)

For each measuring time interval, the individual phase energies with a plus sign are summed to increase the positive energy meter (kWh+), while the others increase the negative one (kWh-).

Example:
P L1= +2 kW, P L2= +2 kW, P L3= -3 kW
Integration time = 1 hour
kWh+ = (2+2) x1h = 4 kWh
kWh- = 3 x 1h= 3kWh

C measurement (MID PFC models)

For every measuring interval time, the energies of the single phases are summed; according to the sign of the result, the positive (kWh+) or negative totalizer (kWh-) is increased.

Example:
P L1= +2 kW, P L2= +2 kW, P L3= -3 kW
Integration time = 1 hour
kWh+=(+2+2-3)x1h=(+1)x1h=1 kWh
kWh- =0 kWh

Measurement accuracy

Current	
From 2 A to 65 A	± 0.5% rdg
From 0.5 A to 2 A	± 1% rdg

Phase-phase voltage	
From Un min -20% to Un max +15%	± 0.5% rdg

Phase-neutral voltage	
From Un min -20% to Un max +15%	± 0.5% rdg

Active and apparent power	
From 1.0 A to 65.0 A (PF=0.5L - 1 - 0.8C)	± 1% rdg
From 0.5 A to 1.0 A (PF=1)	± 1.5% rdg

Reactive power	
From 1.0 A to 2.0 A (sinϕ=0.5L - 0.5C) **From 0.5 A to 1.0 A (sinϕ=1)**	± 2% rdg
From 2.0 A to 65.0 A (sinϕ=0.5L - 0.5C) **From 1.0 A to 65.0 A (PF=1)**	± 2.5% rdg
Active energy	Class 1 EN62053-21, Class B EN50470-3 (MID)
Reactive energy	Class 2 (EN62053-23)

Frequency	
From 45 to 65 Hz	± 0.1% rdg

Measurement resolution

Variable	Display resolution	Resolution by serial communication
Energy	0.001 kWh/kvarh/kVAh	
Single phase energy	0.01 kWh	0.001 kWh
Power	0.01 kW/kvar/kVA	0.1 W/var/VA
Current	0.01 A	0.001 A
Voltage	0.1 V	
Frequency	0.01 Hz	0.001 Hz
THD	0.01 %	
Power factor	0.01	0.001

Display

Type	Segments
Refresh time	500 ms
Description	Backlit LCD
Variable readout	Instantaneous: 5+1 dgt or 5+2 dgt Power factor: 1+2 dgt Energy: 8+3 dgt

LED

Front	Red. Pulse weight: proportional to energy consumption: 0.001 kWh per pulse

Digital outputs/inputs

Digital inputs

Connection type	Screw terminals
Number of inputs	1
Type	Free contact
Function	Remote status Tariff management Partial meter start/pause Partial meter reset
Features	Open contact voltage: 5 Vdc +/- 5% Closed contact voltage: 5 mA max Input impedance: 11.6 k Ω Open contact resistance: ≥ 25 kΩ Closed contact resistance: ≤ 840 Ω Maximum voltage applicable with no damages: 30 V ac
Configuration parameters	Input function
Configuration mode	Via keypad or UCS software

***Note**: type S0, class B in accordance with EN62053-31*

Digital outputs

Digital ouput

Connection type	Screw terminals
Maximum number of outputs	1
Type	Opto-mosfet
Function	Pulse output or alarm output
Features	V_{ON} 2.5 V ac/dc, max 100 mA V_{OFF} 42 V ac/dc
Configuration parameters	Output function (pulse/alarm) Pulse weight (from 0.001 to 10 kWh per pulse) Pulse duration (30 or 100 ms) Output normal status (NO or NC)
Configuration mode	Via keypad

Communication ports

Modbus RTU

Protocol	Modbus RTU
Devices on the same bus	Max 247 (1/8 unit load)
Communication type	Multidrop, bidirectional
Connection type	2 wires
Configuration parameters	Modbus address (from 1 to 247) Baud rate (9.6 / 19.2 / 38.4 / 57.6 /115.2 kbps) Parity (None/ Even) Stop bit (1 or 2)
Refresh time	≤ 100 ms
Configuration mode	Via keypad or UCS software

M-Bus

Protocol	M-Bus according to EN13757-3:2013
Devices on the same bus	Max 250 (1 unit load)
Connection type	2 wires
Configuration parameters	Primary address (1 to 250) Baud rate (0.3/ 2.4 / 9.6 kbps)
Refresh time	≤ 100 ms
Configuration mode	Via keypad

Connection Diagrams

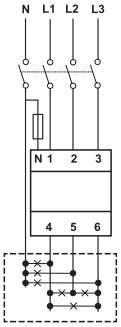


Fig. 5 *Three-phase with neutral (4-wire). MID*

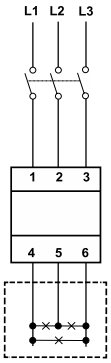


Fig. 6 *Three-phase without neutral (3-wire). MID*

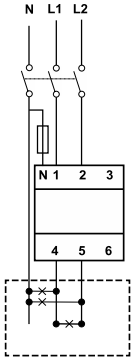


Fig. 7 *Two-phase (3-wire).*

Digital outputs/inputs

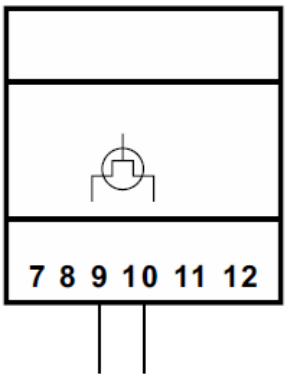


Fig. 8 *Output*

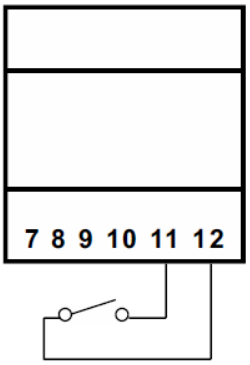


Fig. 9 *Input*

Communication

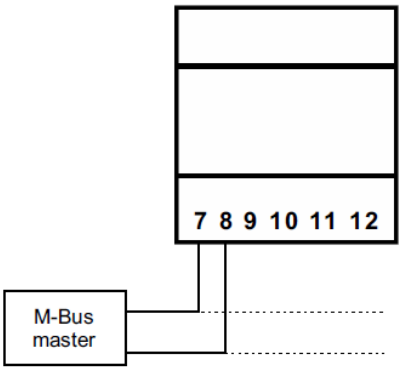


Fig. 10 *M-Bus*

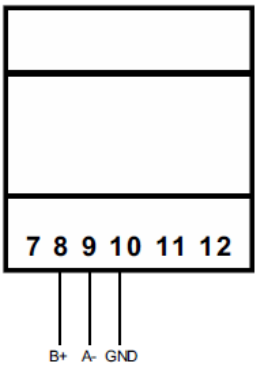


Fig. 11 *RS485 port*

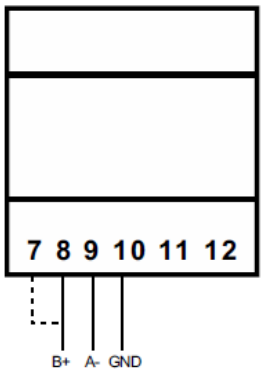


Fig. 12 *Last device on RS485*

References

Order code

EM540 DIN AV2 3X ☐☐

Enter the code option instead of ☐

Code	Options	Description
EM540 DIN AV2 3X	-	-
☐	O1	Digital output
	S1	RS485 Modbus RTU
	M1	M-Bus
☐	X	Non MID models
	PFA	MID models (3P, 3P.n)
	PFB	MID models (3P, 3P.n)
	PFC	MID models (3P, 3P.n)

- PFA: Easy connection, the total energy totalizer (kWh+) is certified according to MID;
- PFB: only the total positive totalizer (kWh+) is certified according to MID. The negative energy totalizer is available but not certified according to MID.

  Note: for each measuring time interval, the individual phase energies with a plus sign are summed up to increase the positive energy meter (kWh+), while the others increase the negative one (kWh-).

- PFC: only the positive totalizer (kWh+) is MID-certified. The negative energy totalizer is available but is not MID-certified.

  Note: for each measuring time interval, the energies of the individual phases are summed up; according to the sign of the result, the system increases the positive totalizer (kWh+) or the negative one (kWh-).