# EMS 1.0 MV5/AV5

## Description

EMS 1.0 is an all-in-one smart meter, gateway, web-server and controller. It is an energy analyser that can monitor one three phase load (or 3 single-phase loads), expandable to 10 three-phase loads via ESY bus add-ons.

EMS 1.0 is a gateway that supports several communication protocols including Modbus (TCP/IP and RTU), BACnet IP, FTP, FTPS, SFTP, Rest-API and MQTT which allow for rapid integration with third-party software and any other device connected to the network (e.g., building energy management systems and inverters or charging stations).

EMS 1.0 is a stand- alone controller: with two Ethernet ports, RS485 ports and Wi- Fi communication for a easy and simple programming via smart- phone; energy data readings can be pushed to external servers/Cloud and can be stored in the internal memory of the device.

EMS 1.0 is a web server: for data analytics presented via dashboards, charts and reports.

By combining accurate metering, a powerful linux powered CPU in a small case, EMS is really a complete Energy Management System in a box.

Compatible with any 333 mV current transformer.

## Benefits

- **All-in-one Energy Management System**: fully integrated smart meter, data logger, gateway, web server and controller.
- **High measurement accuracy**.
- **User-friendly installation and set up**: the start-up and each function can be managed and configured by a unique web app (compatible with PC and smart-phones).
- **Real-time data acquisition.**
- **Accurate and reliable 3- phase energy measurement for consumption and feed-in.**
- **0.333V CT connection** (current sensor CTV series or any standard 333 mV CT).
- **Scalability**: it is easy to scale up the system thanks to additional ESY accessories.
- **Interoperability**. By leveraging its automation-server functions, it is easy to exchange data with other systems via FTP, SFTP, FTPS, SMTP, Rest- API, MQTT, Modbus and BACnet.
- **Powered by MAIA Cloud**: secure and reliable system for remotely managing, setting and operating EMS 1.0 units Worldwide.
- **Optimised user interface and data management**. Improved user experience for fast commissioning and easy daily operation thanks to a multi-user system.
- **Fleet management**. It is possible to update the EMS modules or fleets of modules thanks to MAIA Cloud.
- **Quick configuration**. The configuration wizard that runs when the system is started for the first time allows you to put the unit into operation without errors and in few seconds.
- **Cybersecurity (IoT Security Rating)**: Security Capabilities Verified by UL to Level SILVER for EMS 1.0 (Security Enhancement).
- **Optional Open-EM system**: for allowing third party software modules to be embedded into EMS 1.0 so to build custom solutions for specific applications.

# References

## How to order

**EMS10 □□□**

Enter the code option instead of □

| Code | Options | Description |
|---|---|---|
| EMS10 | - | - |
| □ | AV5 | 5 A CT connection |
| | MV5 | 333 mV CT connection |
| □ | O1 | Digital output |
| | S1 | RS485 Modbus RTU |
| □ | X | - |

## MAIA Cloud licences

| Information | Description | Document |
|---|---|---|
| EMS-LICENCE-M01B | MAIA PLUS LICENCE-12 MONTHS VPN | MAIA Licence A4 pdf<br>Licence Code EIM pdf |
| EMS-LICENCE-M02B | MAIA PLUS LICENCE-24 MONTHS VPN | |
| EMS-LICENCE-M04B | MAIA PLUS LICENCE-48 MONTHS VPN | |
| EMS-LICENCE-M05B | MAIA PLUS LICENCE-60 MONTHS VPN | |
| EMS-LICENCE-M25B | MAIA PLUS LICENCE-300 MONTHS VPN | |
| EMS-ACTIVATION-KEY | MAIA ACTIVATION LICENCE | MAIA Activation A4 pdf<br>Activation Key EIM pdf |

## Accessory modules

| Module code | Connectable CT | Size |
|---|---|---|
| ESY3XMV | 3 x 333 mV | 1 DIN |
| ESY3XAV5 | 3 x 5 A | |

## Main metering functions

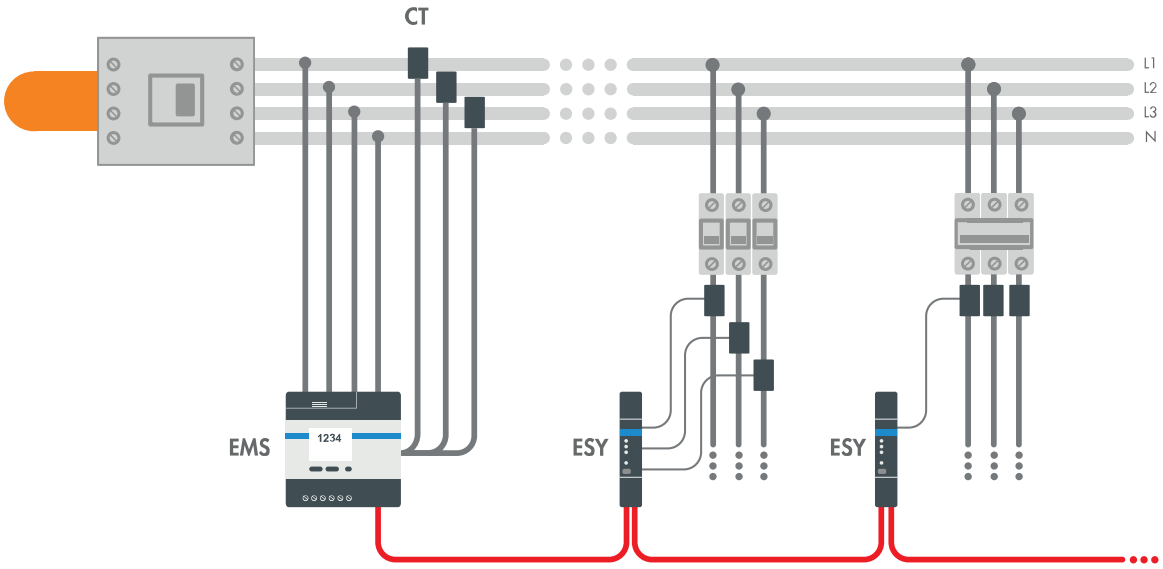
- Measure active, reactive and apparent energy
- Measure the main electrical variables
- Measure the load/analyser run hours
- Measure the total harmonic distortion (THD) of current and voltages
- Multi Load monitoring via plug'n play ESY BUS add-on modules

## Main IoT features

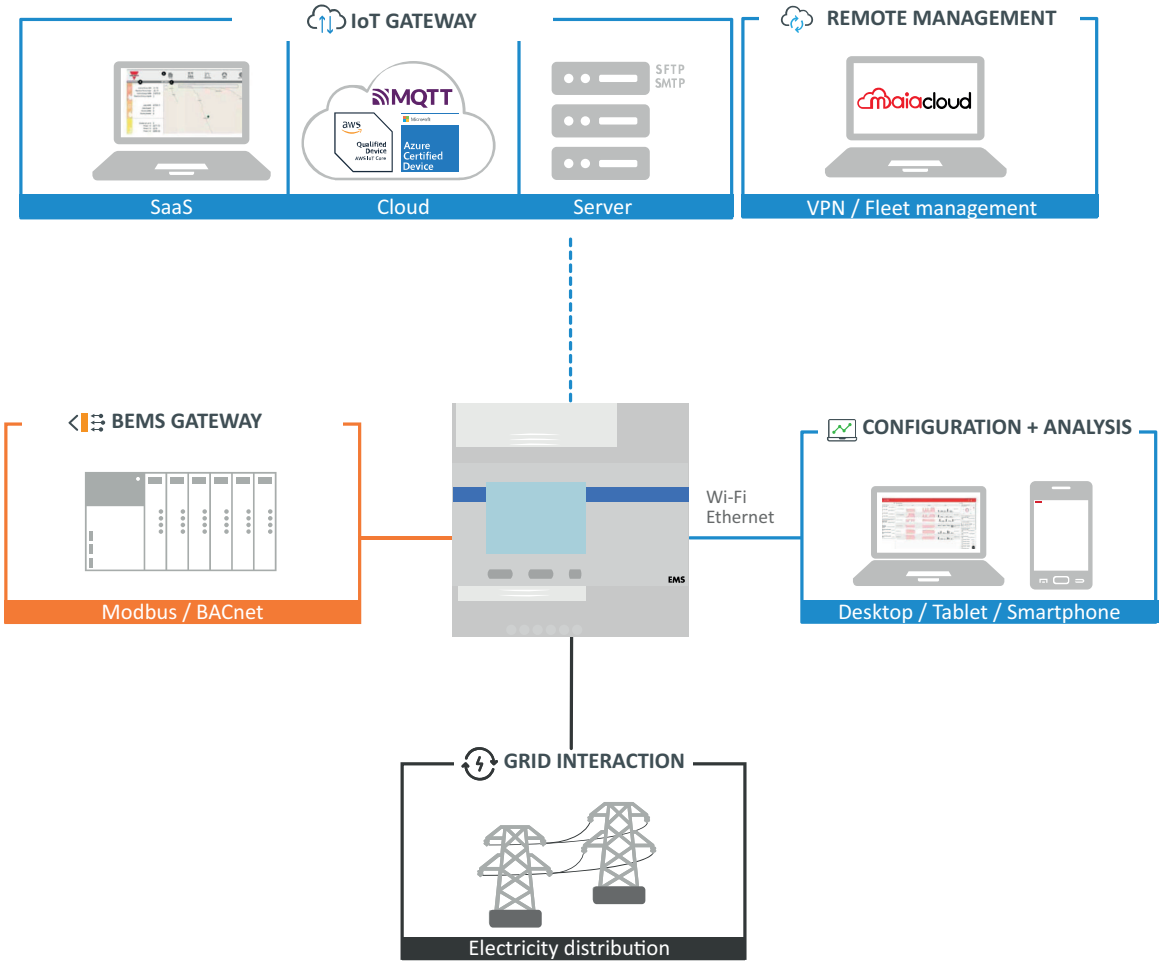
- Self power supply via voltage inputs
- Data transmission via Modbus BACnet, MQTT, FTP, SFTP, FTPS, Rest-API
- Embedded Wi-Fi for easy programming/data analysis
- Reliable data storage within the embedded database
- Data analytics organized in dashboards and widgets
- Display analytics based on the stored data via the embedded web server
- Embedded reporting system (scheduled or on-demand reports)
- Secure multi-user access either local (embedded web app) or remote (MAIA Cloud)
- Remote access and firmware update via MAIA Cloud (commissioning and troubleshooting)
- Two Ethernet ports (switch mode for easy cascading of connected devices)
- BTL certified
- IoT certification for Amazon AWS and Microsoft Azure
- Embedded display for diagnostics and variables

# Architecture

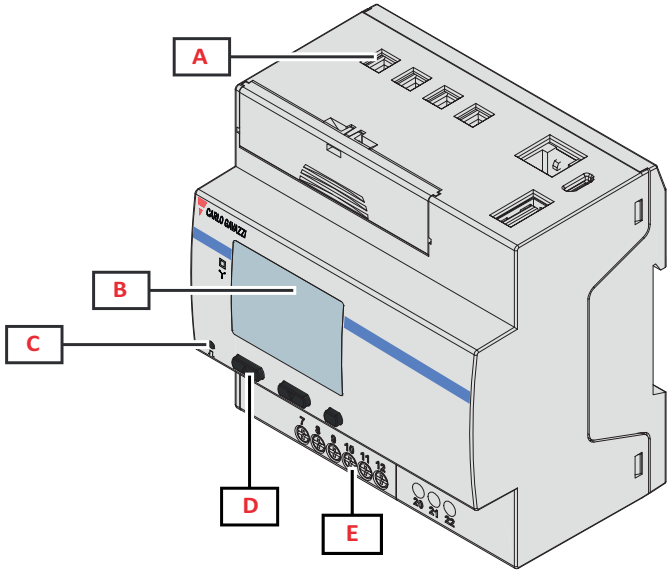
## Electrical connection



## Connectivity



# Structure

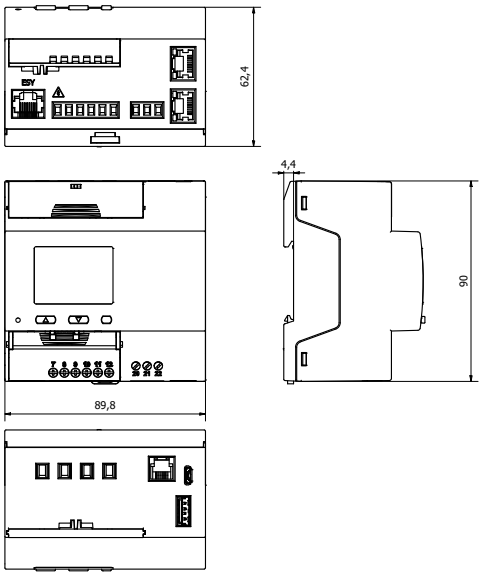



| Area | Description |
|---|---|
| **A** | Voltage inputs |
| **B** | Display |
| **C** | LED |
| **D** | Browsing and configuration buttons |
| **E** | Digital input, digital output and communication connections |

# Features

## General

| | |
|---|---|
| **Material** | Housing: PBT<br>Transparent cover: polycarbonate<br>Compliant with UL and CE marks |
| **Dimensions** | 5-DIN module |
| **Weight** | Approx. 500 g |
| **Protection degree** | Front: IP40; Screw terminals: IP20 |
| **Terminals** | **AV5/MV5 voltage input (four terminals):**<br>• Screw type: Combo head<br>• Wire size: min. 0.2 $mm^2$, max. 2.5 $mm^2$ (stranded or solid)<br>• Torque: 0.45 Nm max.<br>• Sealable, pitch 10 mm<br>**AV5/MV5 current input (six terminals):**<br>• Screw type: Combo head<br>• Wire size: min. 0.2 $mm^2$, max. 2.5 $mm^2$ (stranded or solid)<br>• Torque: 0.45 Nm max.<br>• Sealable, pitch 5 mm<br>**RS485 Modbus Master port:**<br>• Screw type: Combo head<br>• Wire size: min. 0.2 $mm^2$, max. 2.5 $mm^2$ (stranded or solid)<br>• Torque: 0.45 Nm max.<br>• Sealable, pitch 5 mm<br>**Auxiliary Input/Output (six or four terminals):**<br>• Screw type: Combo head<br>• Wire size: min. 0.2 $mm^2$, max. 1.5 $mm^2$ (stranded or solid)<br>• Torque: 0.4 Nm max.<br>• Sealable, pitch 4.6 mm |
| **Mounting** | DIN rail |
| **Overvoltage category** | III |
| **Pollution degree** | 2 |




## Environmental

| | |
|---|---|
| **Operating temperature** | From -25 to +70 °C / from -13 to +158 °F |
| **Storage temperature** | From -30 to +70 °C / from -22 to 158 °F |

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

## Power Supply

| | |
|---|---|
| **Type** | Self power supply |
| **Frequency** | 50/60 Hz |
| **Consumption** | 10 W / 24 VA |

## Compatibility and conformity

| | |
|---|---|
| **Directives** | **RED** 2014/53/EU<br>**RoHS** 2011/65/EU |
| **Standards** | **Radio**: EN 300 328 V2.2.2<br>**EMC (Electro Magnetic Compatibility)**: EN 301 489-1 V2.2.3, EN 301 489-17 V3.2.4, EN 62052-11.2021<br>**Safety**: EN IEC 61010-1<br>**Health**: EN 62311:2020<br>**Metrology**: EN IEC 62053-22, EN IEC 62053-23<br>**FCC (USA) Radio Emission**: FCC CFR title 47 Part 15C, FCC CFR title 47 Part 2.1091<br>**IC (canadian) radio emission**: ISED RSS-247 Issue 3;<br>ISED RSS-102 Issue 5 |
| **Approvals** | |

# Electrical specifications

| Electrical system | |
|---|---|
| **Managed electrical system** | Single-phase (2-wire)<br>Two-phase (3-wire)<br>Three-phase with neutral (4-wire)<br>Three-phase without neutral (3-wire)<br>Wild-leg system (three-phase, four-wire Delta) |

| Voltage inputs | |
|---|---|
| **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 |

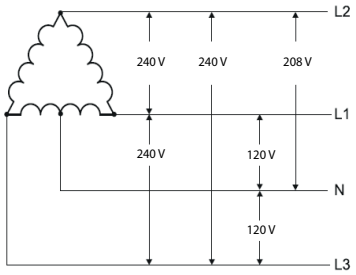



***Fig. 1*** *Two-phase system with neutral (3-wire)*

| Current inputs | AV5 | MV5 |
|---|---|---|
| **Current connection** | Via CT | Via 333 mV current sensor |
| **CT transformation ratio** | 2000 max. | - |
| **Primary current** | 10 kA max. | 10 kA max. |

| Current inputs | AV5 | MV5 |
|---|---|---|
| **Rated current ($I_n$) input** | 5 A | 333 mV |
| **Minimum current ($I_{min}$)** | 0.05 A | 0.01 $I_n$ (0.03 V) |
| **Maximum current ($I_{max}$)** | 6 A | 1.2 $I_n$ (0.4 V) |
| **Start-up current ($I_{st}$)** | 10 mA | 0.001 $I_n$ (0.003 V) |
| **Threshold current ($I_{tr}$)** | 0.05 $I_n$ | 0.05 $I_n$ |
| **Overload** | For 500 ms: 20 $I_{max}$ (120 A) | For 500 ms: 20 $I_{max}$ |
| **Input impedance** | < 0.3 VA | 100 kΩ |
| **Crest factor** | 3 | 1.414 @ $I_{max}$ |
| **Measurement type** | by means of internal shunts | with external current sensors |

# Measurements

| | |
|---|---|
| **Method** | TRMS measurements of distorted waveforms |

## Measurement accuracy

| **Current AV5** | |
|---|---|
| **From 0.05 $I_n$ to $I_{max}$** | ± 0.3% rdg |
| **From 0.01 $I_n$ to 0.05 $I_n$** | ± 0.6% rdg |

| **Current MV5** | |
|---|---|
| **From $I_{min}$ to 0.05 $I_n$ (PF=1)** | ± 1% rdg |
| **From 0.05 $I_n$ to $I_{max}$ (PF=1)** | ± 0.5% rdg |
| **From 0.05 $I_n$ to 0.1 $I_n$ (PF=0.5L - 0.8C)** | ± 1% rdg |
| **From 0.1 $I_n$ to $I_{max}$ (PF=0.5L - 0.8C)** | ± 0.6% rdg |

| **Phase-phase voltage** | |
|---|---|
| **From Un min. -20% to Un max. +15%** | ± 0.2% rdg |

| **Phase-neutral voltage** | |
|---|---|
| **From Un min. -20% to Un max. +15%** | ± 0.2% rdg |

| Active and apparent power | AV5 | MV5 |
|---|---|---|
| From 0.05 $I_n$ to $I_{max}$ (PF=1) | ± 0.5% rdg | |
| From 0.01 $I_n$ to 0.05 $I_n$ (PF=1) | ± 1% rdg | |
| From 0.1 $I_n$ to $I_{max}$ (PF=0.5 L - 0.8 C) | ± 0.6% rdg | |
| From 0.02 $I_n$ to 0.1 $I_n$ (PF=0.5 L - 0.8 C) | ± 1% rdg | |
| Active energy | Class 0.5S EN IEC 62053-22 | Equivalent to class 0.5 EN IEC 62053-22 |

| Reactive power | AV5 | MV5 |
|---|---|---|
| From 0.1 $I_n$ to $I_{max}$ (sinϕ=0.5 L - 0.5 C)<br>From 0.05 $I_n$ to $I_{max}$ (sinϕ=1) | ± 2% rdg | |
| From 0.05 $I_n$ to 0.1 $I_n$ (sinϕ=0.5 L - 0.5 C)<br>From 0.02 $I_n$ to 0.05 $I_n$ (PF=1) | ± 2.5% rdg | |
| Active energy | Class 2 (EN IEC 62053-23) | Equivalent to class 2 (EN IEC 62053-23) |

| 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** | N.A. | 0.001 kWh |
| **Power** | 0.001 kW/kvar/kVA | 0.1 W/var/VA |
| **Current*** | 0.001 A | 0.001 A |
| **Voltage** | 0.1 V | |
| **Frequency** | N.A. | 0.001 Hz |
| **THD** | 0.01 % | |
| **Power factor** | 0.01 | 0.001 |

***(*)Note**: value referred to CT ratio =1.*

# Digital outputs/inputs

## Digital inputs

| | |
|---|---|
| **Connection type** | Screw terminals |
| **Number of inputs** | 1 |
| **Type** | Free contact |
| **Function** | Remote status<br>Tariff management<br>Partial meter start/pause<br>Partial meter reset |
| **Features** | Open contact voltage: 5 V DC +/- 5%<br>Closed contact voltage: 5 mA max<br>Input impedance: 11.6 k Ω<br>Open contact resistance: ≥ 25 kΩ<br>Closed contact resistance: ≤ 840 Ω<br>Maximum voltage applicable with no damages: 30 V AC |
| **Configuration parameters** | Input function |
| **Configuration mode** | Via web app |

## Digital ouput

| | |
|---|---|
| **Connection type** | Screw terminals |
| **Maximum number of outputs** | 1 |
| **Type** | Opto-mosfet |
| **Function** | Remote output, alarm |
| **Features** | $V_{ON}$ 2.5 V AC/DC, max 100 mA<br>$V_{OFF}$ 42 V AC/DC |
| **Configuration parameters** | Output function (remote/alarm)<br>Output normal status (NO or NC) |
| **Configuration mode** | Via web app |

# Input and output insulation

| Type | Measurement inputs | Digital input | Digital outputs | RS485 serial port |
|---|---|---|---|---|
| **Measurement inputs** | - | Double/Reinforced | Double/Reinforced | Double/Reinforced |
| **Digital input** | Double/Reinforced | - | none | none |
| **Digital outputs** | Double/Reinforced | none | - | - |
| **RS485 serial port** | Double/Reinforced | none | - | - |

According to EN IEC 61010-1. Overvoltage category III. Pollution degree 2.

# Display

| | |
|---|---|
| **Type** | Graphical matrix display |
| **Refresh time** | 500 ms |
| **Description** | 128 x 96 backlit LCD |
| **Variable readout** | Instantaneous: 5+1 dgt or 5+3 dgt<br>Energy: 8+3 dgt |

# LED

## AV5

The LED is Red coloured. Pulse weight: proportional to energy consumption and depending on the CT ratio, 16 Hz maximum frequency.

| Weight (kWh per pulse) | CT ratio |
|---|---|
| 0.001 | ≤ 7 |
| 0.01 | 7 < CT ≤ 70 |
| 0.1 | 70 < CT ≤ 700 |
| 1 | 700 < CT ≤ 2000 |

## MV5

The LED is Red coloured. Pulse weight: proportional to energy consumption and depending on Primary current ($I_n$), 16Hz maximum frequency.

| Weight (kWh per pulse) | Primary current ($I_n$) |
|---|---|
| 0.001 | ≤ 35 |
| 0.01 | 35 < $I_n$ ≤ 350 |
| 0.1 | 350 < $I_n$ ≤ 3500 |
| 1 | > 3500 |

# Ports

## Ethernet

| | |
|---|---|
| **Number of ports** | 2 |
| **Standard** | ISO9847 |
| **LAN configuration** | Static or DHCP<br>IP Address; Net Mask; Default Gateway, DNS (primary, secondary) |
| **Protocols** | HTTP, HTTPS, FTP, FTPS, SFTP, Modbus TCP/IP, SMTP, NTP, Azure IoT Hub, AWS IoT, BACnet IP, Rest-API, Multicast DNS (mDNS) |
| **Connection type** | 2 x RJ45 connector (10 Base-T, 100 Base-TX)<br>Maximum distance: 100 m<br>Integrated switch function to connect another Ethernet device |

## RS485

| | |
|---|---|
| **Number of ports** | 2 |
| **Function** | 1 Modbus slave and 1 Modbus master |
| **Protocol** | Modbus RTU |

## RJ11

| | |
|---|---|
| **Number of ports** | 1 |
| **Function** | P1 port for reading smart meter |

## ESY bus

| | |
|---|---|
| **Number of ports** | 1 |
| **Function** | Connection with ESY bus accessories |
| **Cable type** | Min. Cat. 5E, not crossed |
| **Cable length** | Max. 100 m |
| **Bus type** | Daisy chain (refer to standard Modbus RTU requirements) |
| **Number of ESY extension modules** | Max. 10 units |

## USB micro bus

| | |
|---|---|
| **Type** | High-speed USB 2.0 micro-B |
| **Mode** | Device |
| **Speed** | 60 MB/s |
| **Function** | RNDIS (virtual Ethernet)<br>Network access via IP: 192.168.254.254 |

## USB type A port

| | |
|---|---|
| **Type** | High-speed 2.0 Type-A |
| **Mode** | Host |
| **Communication speed** | 60 MB/s |
| **Function** | Modem communications |
| **Supported devices** | USB modem/router can be directly connected |
| **Supported file system** | USB mass storage not supported |

# 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+ | ● | - |
| **Quadrant I, II, III, IV** | kWh | ● | - |

| Reactive energy | Unit | System | Phase |
|---|---|---|---|
| **Imported (+) Total** | kvarh+ | ● | ● |
| **Imported (+) partial** | kvarh+ | ● | - |
| **Exported (-) Total** | kvarh- | ● | ● |
| **Exported (-) partial** | kvarh- | ● | - |
| **Quadrant I, II, III, IV** | kvarh | ● | - |

| Apparent energy | Unit | System | Phase |
|---|---|---|---|
| **Total** | kVAh | ● | - |
| **Partial** | kVAh | ● | - |
| **Quadrant I, II, III, IV** | 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 | ● | ● |
| **Neutral current** | A | ● | - |

| Electrical variable | Unit | System | Phase |
|---|---|---|---|
| **Active power** | W | ● | ● |
| **Apparent power** | 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 31$^{th}$ harmonic