Iskra®

User 's Manual

EN

Three-phase electrical energy meters for charging stations

WM3M4 & WM3M4C

October 2020 • Version 1.07

Three-phase electrical energy meters for charging stations

WM3M4 & WM3M4C

User and Installation manual

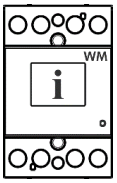
Security Advices and Warnings

Please read this chapter carefully and examine the equipment carefully for potential damages which might arise during transport and to become familiar with it before continue to install, energize and work with *the WM3M4 & WM3M4C three-phase energy meters*.

This chapter deals with important information and warnings that should be considered for safe installation and handling with a device in order to assure its correct use and continuous operation.

Everyone using the product should become familiar with the contents of chapter »Security Advices and Warnings«.

If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.



PLEASE NOTE

This booklet contains instructions for installation and use of a three-phase energy meters WM3M4 & WM3M4C. Installation and use of a device also includes handling with dangerous currents and voltages therefore should be installed, operated, serviced and maintained by qualified personnel only. ISKRA Company assumes no responsibility in connection with installation and use of the product. If there is any doubt regarding installation and use of the system in which the device is used for measuring or supervision, please contact a person who is responsible for installation of such system.

Before installing

Check the following before installing:

- Nominal voltage.
- Terminals integrity.
- Protection fuse for voltage inputs (recommended maximum external fuse size is 40 A).
- External switch or circuit breaker must be included in the installation for disconnection of the devices' power supply. It must be suitably located and properly marked for reliable disconnection of the device when needed.
- Proper connection of communication terminals.

Used symbols on devices' housing and labels

SYMBOL	EXPLANATION
	**DANGER** Indicates proximity of hazardous high voltage, which might result in serious injury or death if not handled with care.
	**WARNING** Indicates situations where careful reading of this manual is required and following requested steps to avoid potential injury is advised.
	Compliance of the product with directive 2002/96/EC, as first priority, the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment.
	Compliance of the product with European CE directives.

Disposal

It is strongly recommended that electrical and electronic equipment (WEEE) is not deposit as municipal waste. The manufacturer or provider shall take waste electrical and electronic equipment free of charge. The complete procedure after lifetime should comply with the Directive 2002/96/EC about restriction on the use of certain hazardous substances in electrical and electronic equipment.

Table of contents

1 BASIC DESCRIPTION AND OPERATION

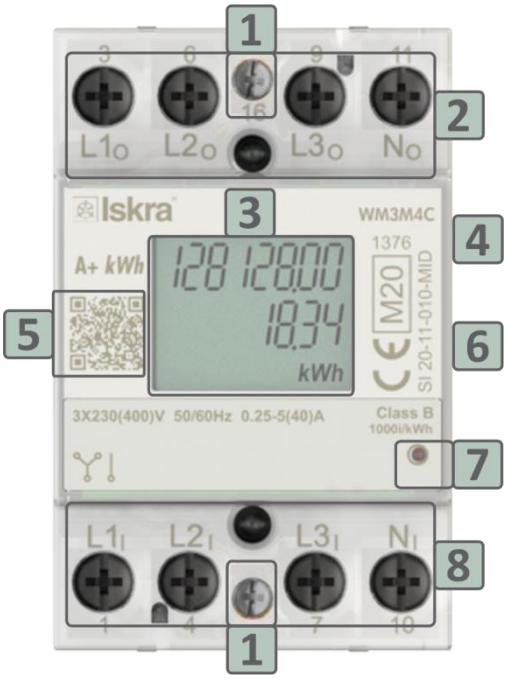
The following chapter presents basic information about *WM3M4 & WM3M4C three-phase energy meters* required to understand its purpose, applicability and basic features connected to its operation. In this chapter you will find:

1.1 Description of the device

1.1.1 Functionality of WM3M4 & WM3M4C

The *WM3M4 & WM3M4C energy meters* are MID certified meters, intended for energy measurements in the three-phase and single-phase electrical charger stations. The WM3M4C energy meter features high temperature operation and digital signing for a charging event, whereas WM3M4 features only high temperature operation. Both meters measure energy directly in 4-wire networks according to the principle of fast sampling of voltage and current signals. A built-in microprocessor calculates power, energy, current, voltage, power factor, power angle, frequency, harmonics of THD voltage and THD current harmonics. WM3M4C meter can detect and log events relevant for charging via RS485 communication. Thus the meter can produce relevant digital signature for charging event.

1.1.2 Appearance



1. **RS485 terminals**
2. **Current terminals – to load**
3. **LCD display**
4. **IR COMM PORT – on side**
5. **QR code** (valid only for WM3M4C)
6. **DIN-Rail fitting**
7. **LED indicator (1000 imp/kWh)**
8. **Current terminal – source (max 40 A)**

LCD

Number of digits:	8 (6+2)
Height of digits:	6.52 mm

LED

Colour:	red
Pulse rate:	1000 imp/kWh
LED on:	no load indication

Figure 1: *Appearance of a three-phase electrical energy meter WM3M4C*

The energy meters have a built-in optical (IR) communication port on the side as a standard. A special WM-USB adapter (size 1 DIN module) can easily be attached to it. It can be used for direct communication with a PC to change settings of devices without any communication installed.

On the housing there are two terminals, A(16) and B(15) for RS485 communication.

Terminals can be sealed with a protective cover to prevent unauthorized access. They are fixed in accordance with EN 60715.

1.2 Hardware description

The whole system of the *WM3M4 & WM3M4C energy meters* is equipped with the following units:

- Stand-alone unit.
- Power supply unit.
- Process unit (MCU microcontroller) with IR communication, LED display, LCD support, and EEPROM.
- Additional unit for RS485 communication.

Communication:

- Every meter is equipped with **IR optical communication** and **RS485 communication.** Both use the MODBUS protocol. It is used for setting and reading a meter with the WM-USB adapter or RS485 adapter. The *WM3M4 & WM3M4C energy meters* can also be connected to SG (smart gateway). It is intended to connect various equipment into the communication network.
- **The LED** shows the state of active energy. It flashes in proportion to the received active energy. When there is no load, the LED lights up.

1.3 Main features

- **3 DIN modules width** three-phase direct connected DIN-rail mounting meter**.**
- **Class 1** for active energy according to EN **62053-21**.
- MID approval WM3M4 & WM3M4C for **class B** according to EN 50470-3.
- Reference frequency **50 Hz or 60 Hz.**
- Maximum current ($\mathbf{I_{max}}$) **40 A**
- Basic current **5 A ($\mathbf{I_b}$)**
- Reference voltage **3x230 V/400 V ($\mathbf{U_n}$).**
- Voltage **operating range** (-20 % ... +15 %) U_n.
- Two row display **6+2** digit (**10 Wh** resolution) with backlight.
- **Multifunctional** front LED.
- **IR** Serial communication.
- **RS485** Serial communication.
- Measurement of
    - Power (active/reactive/apparent for each phase and total)
    - Energy (active - bidirectional).
    - Voltage (each phase).
    - Current (each phase).
    - Phase to phase voltage.
    - Phase to phase angle.
    - Frequency.
    - Power factor (each phase and total).
    - Power angle (each phase and total).
    - THD of voltage.
    - THD of current.
- **Crypto engine (Hash, signature)** for generation of secure datasets (valid only for WM3M4C).
- Possibility to connect as a single phase **(on L3)**.
- Remote control for **backlight LCD**.
- Secure data transfer (**digital signature**) (valid only for WM3M4C).
- **70°C** ambient operation temperature.
- **Sealable** terminal cover.

2 CONNECTION

This chapter deals with the instructions for connection of *the WM3M4 & WM3M4C energy meters*. Both the use and connection of the device include handling with dangerous currents and voltages. The connection shall thus be performed ONLY by a qualified person using appropriate equipment. ISKRA, d.o.o. does not take any responsibility regarding the use and connection. If any doubt occurs regarding connection and the use in the system which device is intended for, please contact a person who is responsible for such installations.

In this chapter you will find:

2.1 Mounting

The WM3M4 & WM3M4C energy meters are intended for DIN-rail mounting. In the case of using the stranded wire, the ferrule must be attached before the mounting.

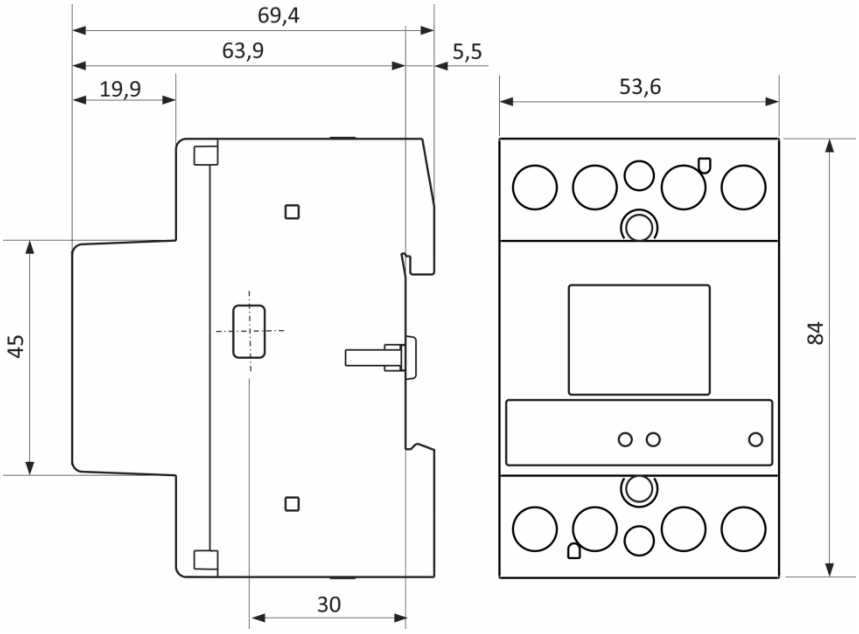
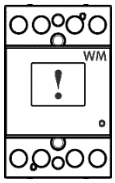


Figure 2: *Dimensional drawing and rear connection terminals position*

2.2 Electrical connection



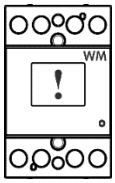
WARNING

Wrong or incomplete connection of voltage or other terminals can cause non-operation or damage to the device.

The meters are used for direct connection into the four-wire networks or single-phase (L3) operation. They are also equipped with communication terminals. Pictures below are showing equipped combination.

Recommended installation:

1 Mounting to DIN rail according to DIN EN60715
2 Main inputs:
   a. Contacts capacity: rigid (flexible) 2.5 mm^2 … 25 (16) mm^2
   b. Connection screws: M5
   c. Maximum torque: 3.5 Nm (PZ2)
   d. Length or removed isolation: 10 mm
3 Communication terminals:
   a. Contact capacity: 1 mm^2 … 2.5 mm^2
   b. Connection screws: M3
   c. Maximum torque: 1.2 Nm (PZ2)
   d. Length or removed isolation: 8 mm



PLEASE NOTE

Neutral wire must be connected to the meter.

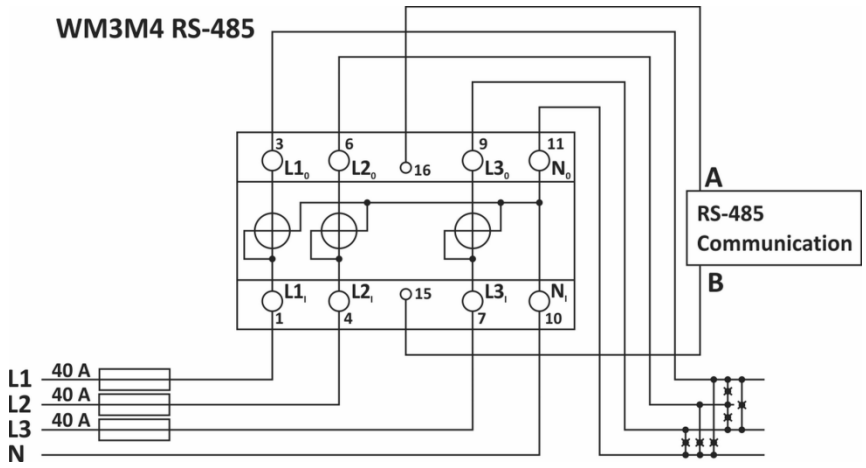


Figure 3: *Three - phase connection diagram*

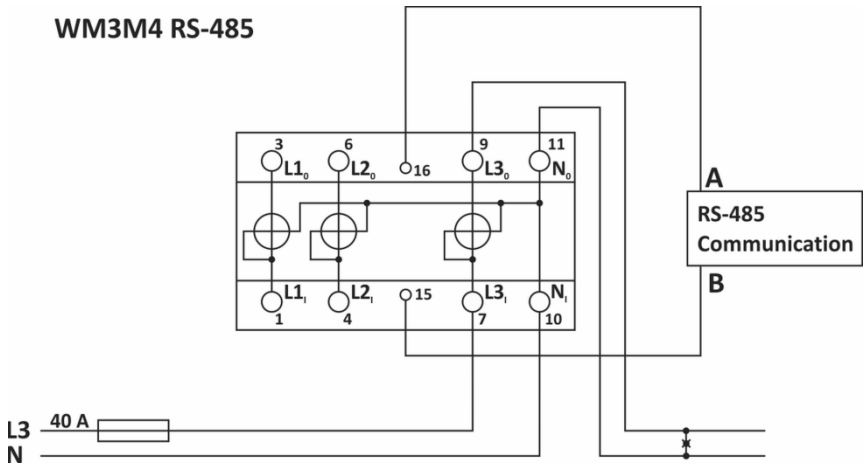


Figure 4: *Single-phase connection diagram*

3 FIRST STEPS

Programming *WM3M4 & WM3M4C energy meters* is very transparent and user-friendly. Numerous settings are organized in groups according to their functionality.

In this chapter you will find basic programming steps:

3.1 Display of device info

Energy meters have LCD display with following layout.

Layout of LCD:

1 Total kWh inport
2 User settable line
3 4 digit label
4 kWVA display
5 kWh display

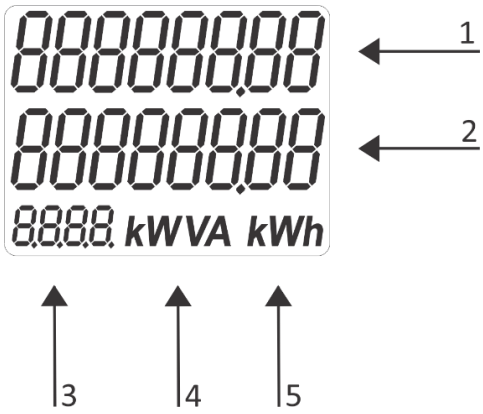


Figure 5: *Layout of LCD*

3.2 Welcome screens

LCD segment test

Figure 6: *LCD segment test*

FW identification window and MID relevant counters:

1 MID unlock counter
2 FW upgrade counter
3 CRC of main FW
4 CRC of measuring modules FW
5 FW version

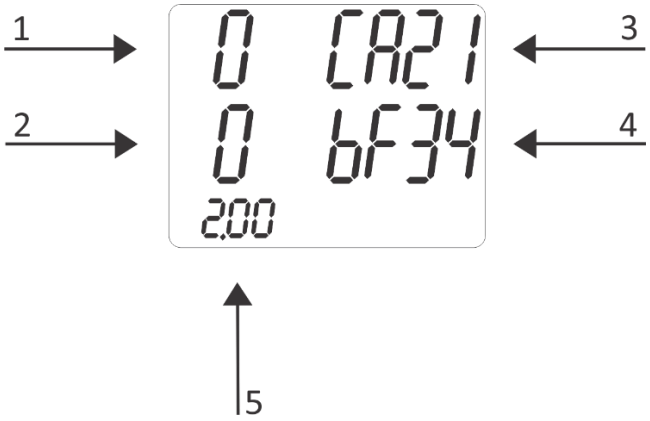


Figure 7: *FW identification window and MID relevant counters*

3.3 LCD Display information

LCD Display has 2 rows with 8 digits each and 4 digit label. Display scrolls automatically. Displayed quantities and scroll time can be set via communication by MiQen software. Top row always displays imported active energy consumption.

Row 2 is configurable to display following values:

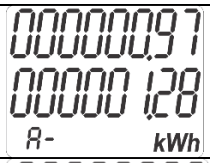
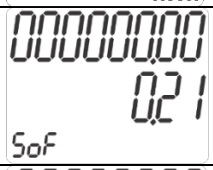
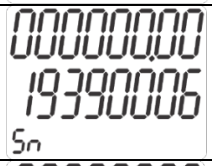
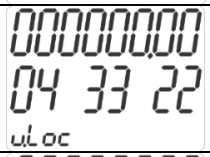
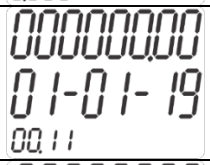
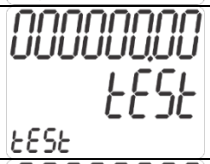
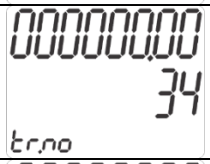
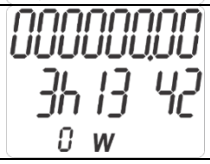
BIT 8	**Export active energy counter**		Status: A-
BIT 7	**SW version**		Status LCD: SoF
BIT 6	**Serial number**		Status LCD: Sn
BIT 5	**Time**		Status LCD: 1st digit: Clock status (see Table 5) Digits 2-4 options: • Loc (Local time), or • Utc (UTC time)
BIT 4	**Date**		Status LCD: hh.mm (time - e.g.: 00 (hour).11 (minutes))
BIT 3	**Custom String**		Status LCD: LCD Custom string label (see Table 3); Available characters (see chapter 3.3.2)
BIT 2	**Transaction number**		Status LCD: tr.no
BIT 1	**Duration**		Status LCD: Charging power (e.g.: 3h 13min 42s)
BIT 0	**Energy consumption**		Status LCD: 1st digit: Clock status (see *Table 5*) 2nd digit: Charging status (see *Table 6*) 3rd digit: Reserved 4th digit: Reserved

Table 1: LCD ROW2 Configuration

Default state is Energy consumption.

If multiple bits are selected, then values are cycling with period defined in MODBUS register 40174.

40174	LCD cycling period	Cycling time in Seconds

Table 2: LCD cycling period

Custom string is defined in register 47063:

47063	LCD Custom string	8 bytes to display on 7-segment LCD (non printable values are replaced with empty space)

Table 3: LCD Custom string

Custom string has configurable label in register 47064:

47064	LCD Custom string label	4 bytes to display on 7-segment LCD (non printable values are replaced with empty space)

Table 4: LCD custom string label

Value	Clock status	LCD status
0	Not sync (U)	u
1	Informative clock	i
2	Synchronized clock	S
3	Relative clock	r

Table 5: Clock sync status

Register 47000

Value	Charging Status	LCD status
0	Not charging (Idle)	I
1	Charging	C
2	Charging after power down	P
3	Charging after meter reset	d

Table 6: Charging status

3.3.1 LCD Error display

Errors are displayed on row 2 and have priority over other messages.

Error format is: Err 1234.

Number represents hexadecimal value of 16 bits error state.

Bit 0	Error Parameter CRC
Bit 2	Error MID-lock
Bit 3	Error phase module 1 CheckSum
Bit 4	Error phase module 2 CheckSum
Bit 5	Error phase module 3 CheckSum
Bit 6	Error Measurement module CheckSum
Bit 11	Error phase module 1 cal. data CheckSum
Bit 12	Error phase module 2 cal. data CheckSum
Bit 13	Error phase module 3 cal. data CheckSum
Bit 14	Error Crypto data CheckSum
Bit 15	Error Crypto chip failure

Table 7: Error bits

Example:

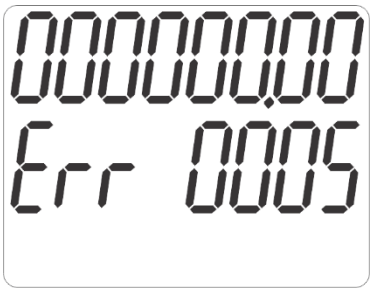


Figure 8: *Error display*

Err 0005 (binary representation: 0000 0000 0000 0101)

BIT0 and BIT2 are set, so we have Parameter CRC Error and MID-lock Error.

In case the meter is in Error state the start of charging process with digital signiture is blocked and the meter needs to be replaced.

3.3.2 List of available characters on LCD

0,O,1,I,l,2,3,4,5,S,6,G,7,8,9,A,B,b,C,D,d,E,F,H,L,J,N,P,R,U,V,c,h,i,r,n,o,v,u,t,-

4 SETTINGS

Settings of *the WM3M4 & WM3M4C energy meters* can be done via MiQen software. A setting structure, which is similar to a file structure in an explorer, is displayed in the left part of the MiQen setting window. Available settings of that segment are displayed in the right part by clicking any of the stated parameters.

In this chapter, you will find a detailed description of all *WM3M4 & WM3M4C energy meters* features and settings. The chapter is organized in a way to follow settings organization as in setting software MiQen.

4.1 Introduction

Parameterization can be modified by serial communication (RS485) or by a special WM-USB adapter (size 1 DIN module) and MiQen software version.

4.2 MiQen software

MiQen software is a tool for complete programming and monitoring of ISKRA measuring instruments, connected to a PC via serial communication or by a special WM-USB adapter. A user-friendly interface consists of six segments: devices management (Connection), instrument settings (Settings), real-time measurements (Measurements), data analysis (Analysis), saved preffered devices (My Devices – this action is not supported by this meter) and software upgrading (Upgrades – this action is not supported by this meter). These segments are easily accessed utilizing icons on the left side (see Figure 6).

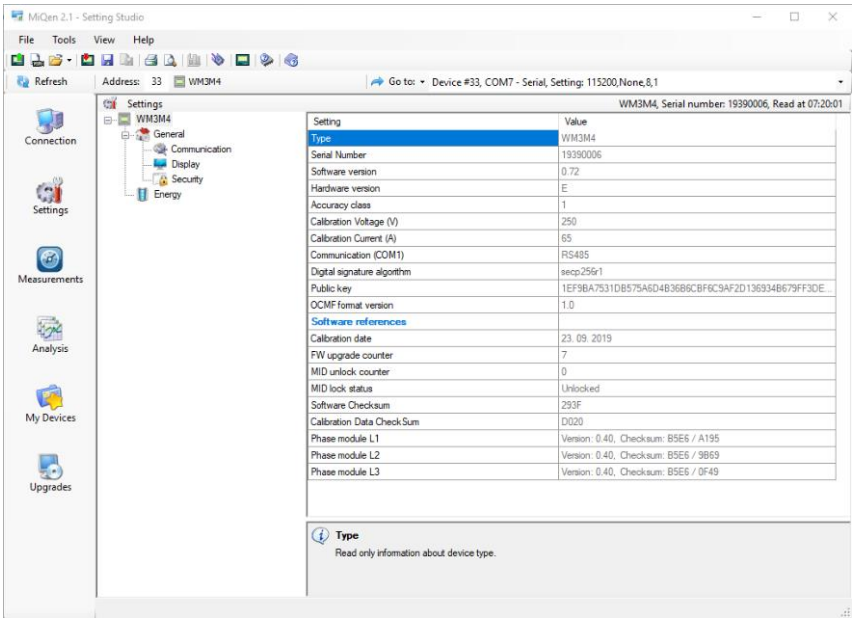


Figure 9: *MiQen programming and monitoring software*

For further managing those segments, icons on the top bar can be utilised.:

- READ SETTINGS : displays all device's settings
- READ MEMORY : data is read directly from a device's internal memory
- OPEN : data is read from a local database
- DOWNLOAD SETTINGS : changes should be confirmed by pressing this button when finished programming
- SAVE : the file settings will be saved
- EXPORT : data can be exported to an Access data base, Excel worksheets or as a text file
- PRINT : data listing can be exported into PDF file or printed on a paper

- PRINT PREVIEW : preview of a PDF file
- GRAPHICAL ANALYSIS : measurements can be shown in a graphical form
- COMMUNICATION PORT SETTING : under communication form
- INTERACTIVE INSTRUMENT : additional communication feature of a device allows interactive handling with a dislocated device as if it would be operational in front of a user)
- MEMORY INFO : shows available memory since last official data transfer
- HELP : for more detailed information how to handle a device

MiQen software is required for programming and monitoring *the WM3M4 & WM3M4C energy meters*. Software installation can be downloaded from https://www.iskra.eu/en/Iskra-Software/MiQen-Settings-Studio/

PLEASE NOTE

MiQen has very intuitive help system. All functions and settings are described in Info window on the bottom of MiQen window.

4.3 Connection

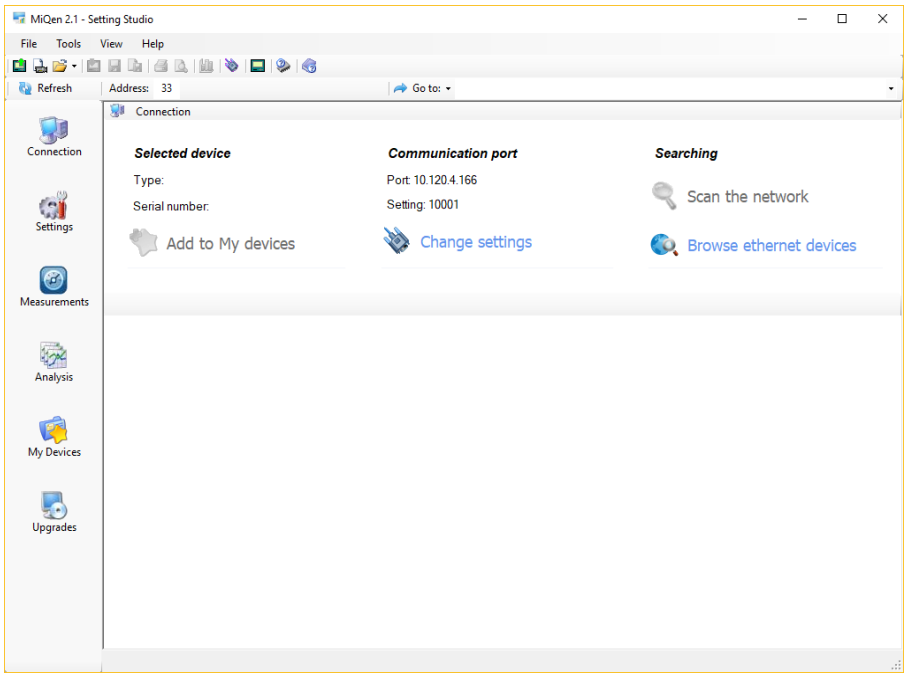


Figure 10: *MiQen Device Management window*

With MiQen it is very easy to manage devices. If dealing with the same device that has been accessed before it can be easily selected from a favourite's line.

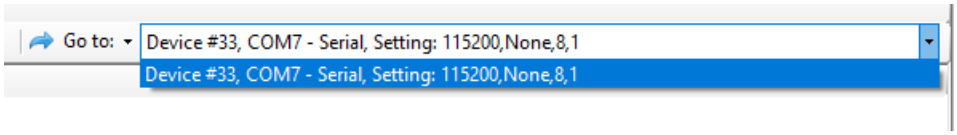
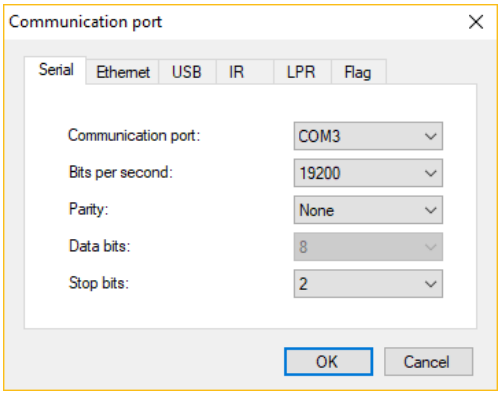


Figure 11: *Favourite's line*

This way is Communication port set automatically as it was during last access.
To communicate with new device, following steps should be followed:

Connect a device to a communication interface

Set Communication port parameters



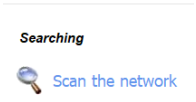
Under the *Communication port,* current communication parameters are displayed. To change those parameters click on the Change settings button. A Communication port window opens with different communication interfaces.

The WM3M4 & WM3M4C energy meters supports only serial communication, so only serial communication parameters can be set.

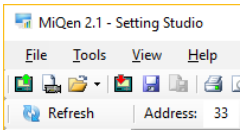
Figure 12: *Communication port window*

Start communicating with a device

Click on the REFRESH button and devices information will be displayed.



When a device is connected to a network and a certain device is required, it is possible to browse a network for devices. For this purpose choose ***Scan the network***.



Factory default **MODBUS address** for all devices is 33. Therefore it is required to change MODBUS address number of the devices if they are connected in the network so each device will have its unique address number.

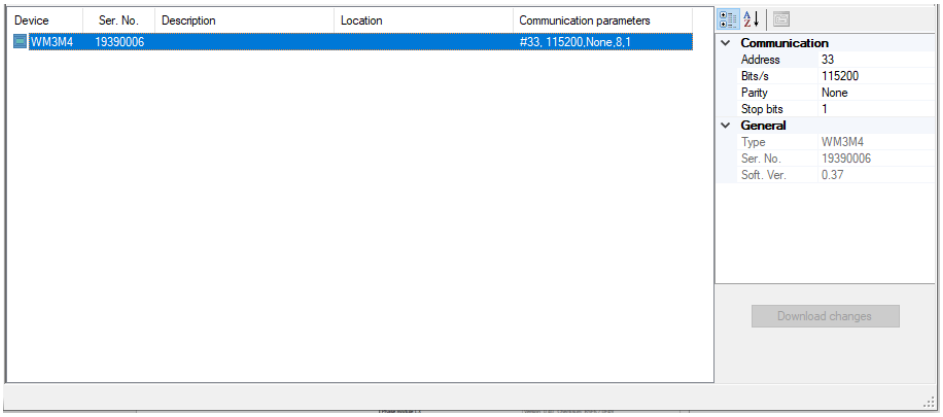


Figure 13: *Display of device's adress settings in the MiQen software*

4.4 Settings

After communication with a device is established, choose icon Settings from a list of MiQen functions on a left side.

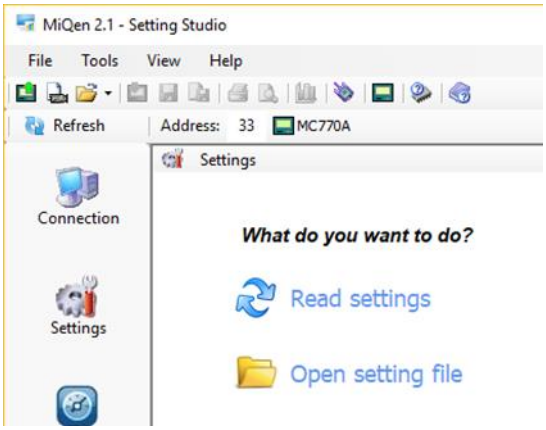


Figure 14: *MiQen Device Setting window*

Choose Read settings button to display all device's settings and begin adjusting them according to project requirement.

Settings are shown in the Settings set – the left part shows the hierarchical tree structure of settings, in the right part, the parameter values of the selected set of parameters are displayed. In addition to transferring the settings to the meter, there is a possibility of saving and reading from the set files. This can be done with a right click on a mouse on a certain parameter. Afterwards, a window is shown with a save and a read icon.

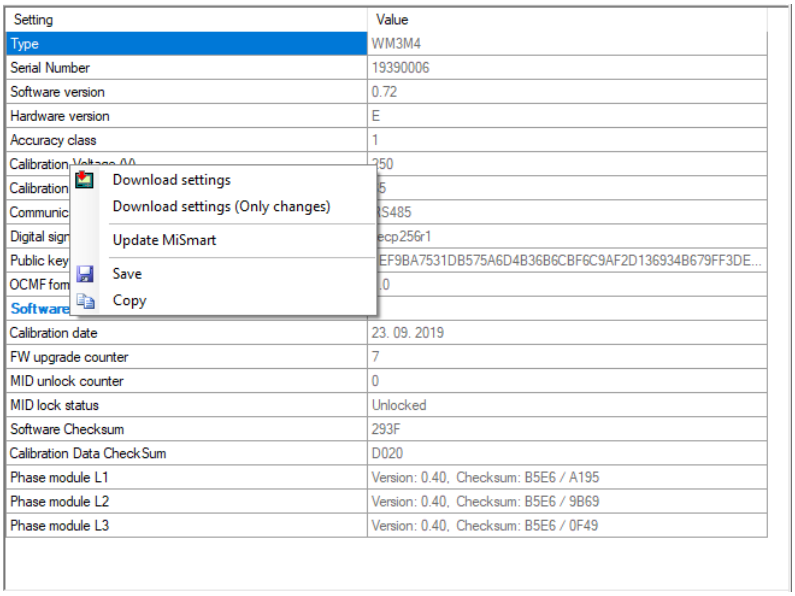


Figure 15: *Save and read parameters window*

Those icons can also be found on a top bar.

Settings values colored in gray are informative nature only.

Identification window:

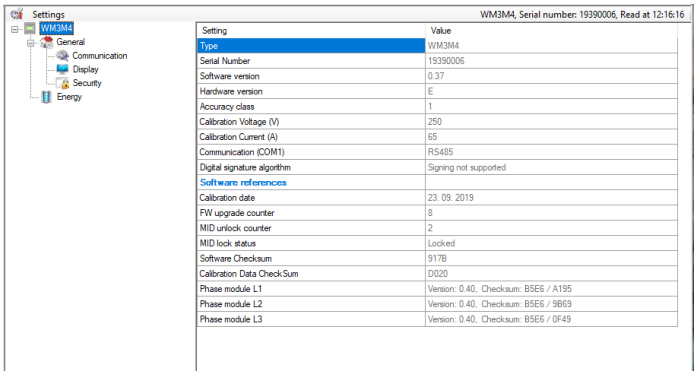


Figure 16: *WM3M4 Identification window*

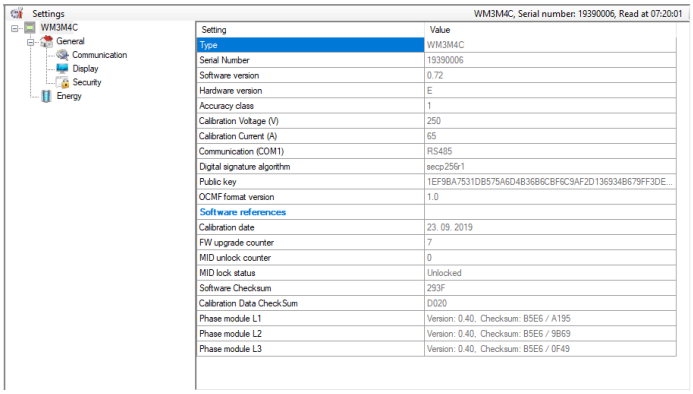


Figure 17: *WM3M4C Identification window*

- **Type**
- **Serial number**
- **Software version**
- **Hardware version**
- **Accuracy class**
- **Calibration voltage**
- **Calibration current**
- **Communication**
- **Digital signature algorithm** (supported only for WM3M4C)
- **Public key:** for further description see chapter *1.2.3.1. Generation of private/public key pair on page 32* (valid only for WM3M4C).
- **OCMF format version** (valid only for WM3M4C**)**

Software references:

- **Calibration date**
- **FW upgrade counter**
- **MID unlock counter**
- **MID lock status**
- **Software Checksum**
- **Calibration Data Checksum –** CRC of calibration parameters.
- **Phase module L1** – version of FW, CRC of FW and CRC of calibration parameters.
- **Phase module L2** – version of FW, CRC of FW and CRC of calibration parameters.
- **Phase module L3** – version of FW, CRC of FW and CRC of calibration parameters.

4.4.1 General settings

General settings set communication, display and security settings (passwords).

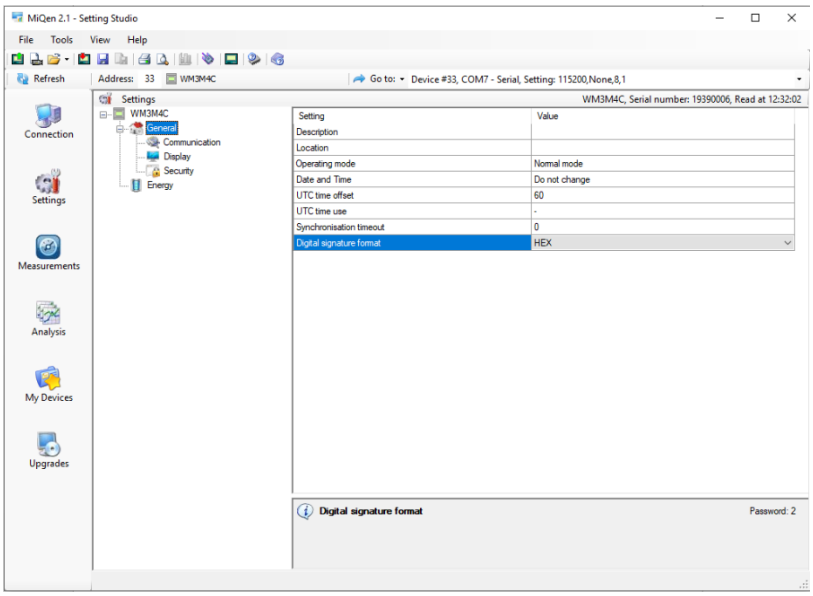


Figure 18: *General settings window*

- **The description and location** segment is intended for easier recognition of a certain unit. They are specially used for identification of the device or location on which measurements are performed.
- **Operating mode**: the test mode is used for meter testing and is designed to increase resolution of the energy counter and reduce the time required for testing.

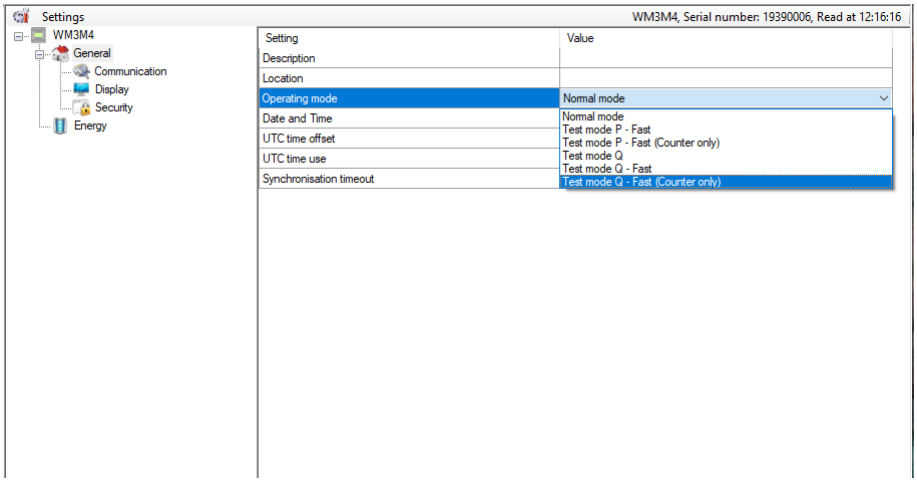


Figure 19: *Operating mode window*

- **Date and time**: date and time cannot be changed.
- **UTC time offset**: it is the difference in hours and minutes from Coordinated Universal Time (UTC) for a particular place and date.

- **UTC time use:** Energy meter has three time presentations: RS485 communication, LCD display, JSON transaction.

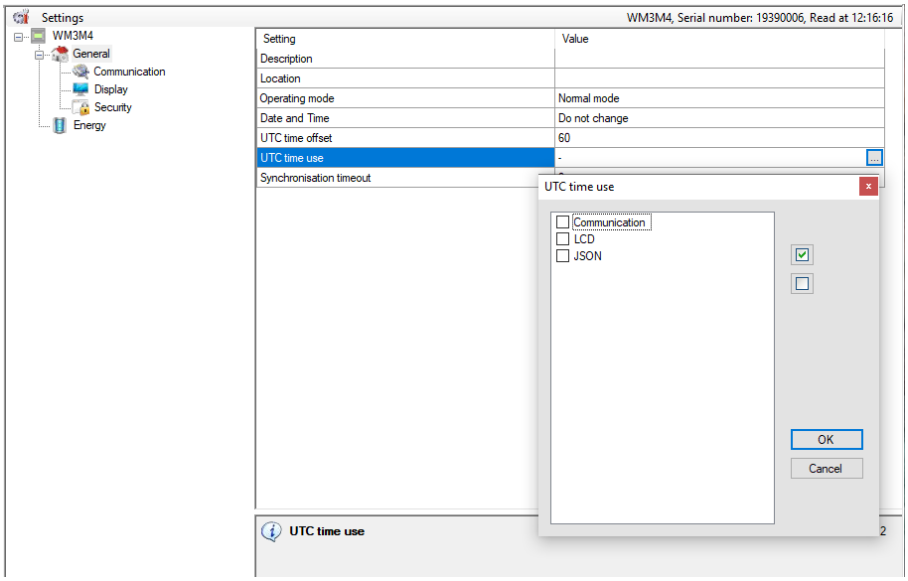


Figure 20: *UTC time use*

- **Synchronisation timeout**: maximum time to be waited (in milliseconds) until the object to be tested has adopted the expected state. The time to be waited between the attempts is included.
- **Digital signature format**: the energy meter supports ASN.1 and 64 signature format (valid only for WM3M4C).

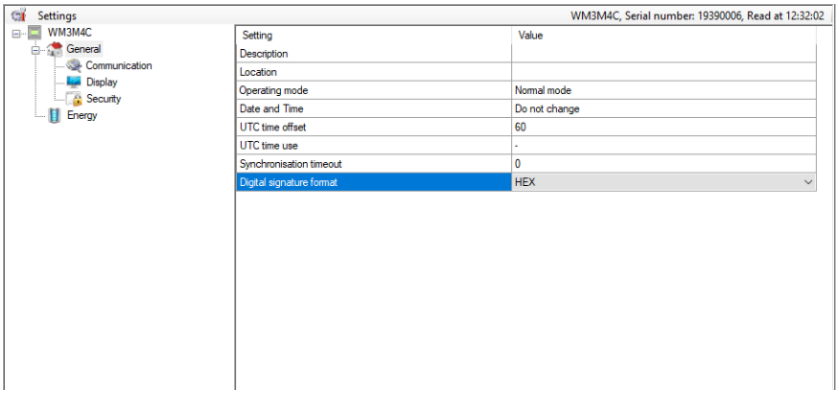


Figure 21: *Digital signature format window*

4.4.1.1 Communication

The communication segment is intended for setting the serial communication parameters (RS485).

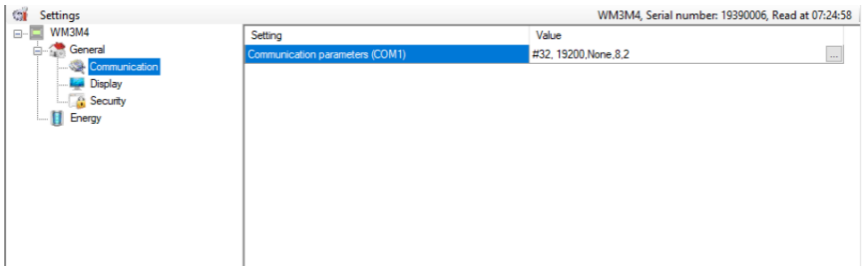


Figure 22: *Display of device's communication settings in the MiQen software*

4.4.1.2 Display

- **Backlight:** is possible to turn on/off via serial communication.

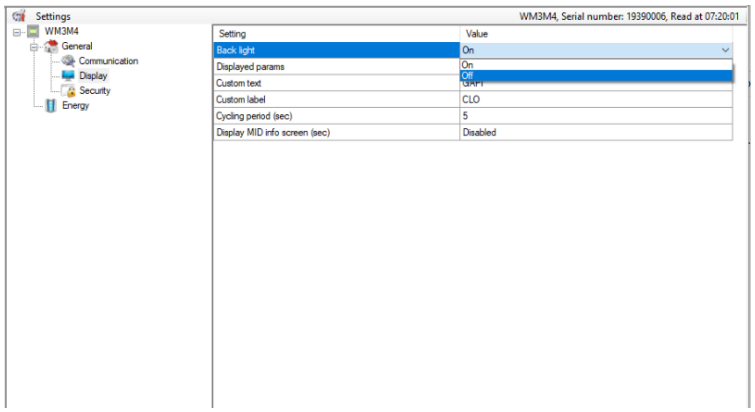


Figure 23: *Backlight window*

- **Display params** set the parameters displayed on the LCD.

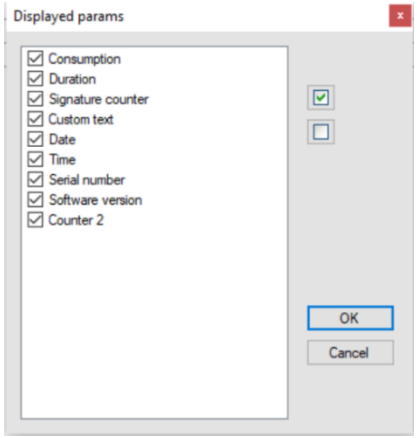


Figure 24: *Display params window*

- **Custom text** (list of available characters; see chapter 3.3.2)
- **Custom label (**Table 3: LCD Custom string**)**
- **Cycling period** defines the cycling period for measurements on LCD display, valid values from 5 s to 60 s.
- **Display MID info screen:** displays FW identification screen and MID relevant counters on LCD for a chosen period of time up to 60 seconds (see chapter *Welcome screens and item 6.5.16*).

4.4.1.3 *Security*

A password consists of four letters taken from the British alphabet from A to Z. When setting a password, only the letter being set is visible while the others are covered with●.

Settings parameters are divided into three groups regarding security level: PL1 >password level 1, PL2 >password level 2 and BP >a backup password.

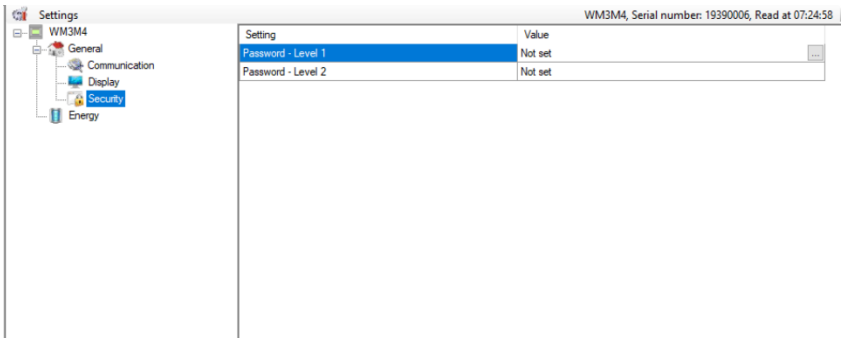


Figure 25: *Security window*

PLEASE NOTE

A serial number of the device is stated on the label and is also accessible with MiQen software.

Password-Level 1 >PL1

With level 1 password you can change the date and time and perform the re-start of the meter. The settings cannot be saved in the settings file.

Password-Level 2 >PL2

With level 2 password you can change all supported settings and perform reboot of the meter. The settings cannot be saved in the settings file.

A Backup Password->BP

A backup password >BP) is used if passwords at levels 1 >PL1) and 2 >PL2) have been forgotten, and it is different for each device >depending on a serial number of the device). The BP password is available in the user support department in ISKRA d.o.o., and is entered instead of the password PL1 or/and PL2. Do not forget to state the device serial number when contacting the personnel in ISKRA d.o.o.

Password modification

A password is optionally modified; however, only that password can be modified to which the access is unlocked at the moment.

Password disabling

A password is disabled by setting the "AAAA" password.

PLEASE NOTE

A factory set password is "AAAA" at both access levels >PL1 and PL2. This password does not limit access.

4.4.2 Energy

4.4.2.1 Counters

The WM3M4 & WM3M4C energy meters have two unresettable counters for which MID approval is valid. The setting of these counters is fixed in the production and the setting parameters cannot be modified during use and counters cannot be reset.

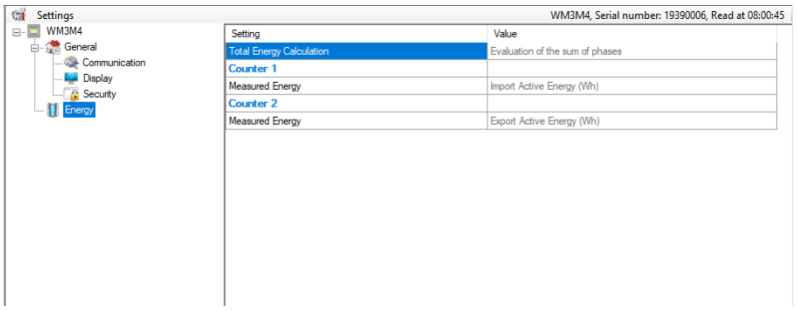


Figure 26: *MiQen energy counters*

Counter 1 displays imported active energy.

Counter 2 displays exported active energy.

4.5 Measurements

Measurements can be seen ONLINE when a device is connected to power supply and is communicating with MiQen. When a device is not connected it is possible to see OFFLINE measurements simulation. The latter is useful for presentations and visualization of measurements without the presence of an actual device.

In ONLINE mode all supported measurements and alarms can be seen in real-time in a tabular (Table view) or graphical form (Graphic view). All data can be exported to an Access database, Excel worksheets or as a text file.

Measurements window can be selected by clicking this tab: Charge control | Measurements

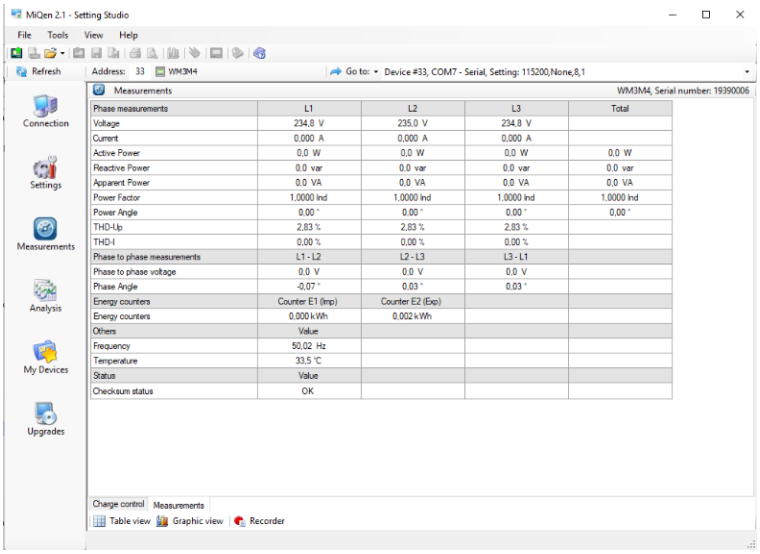


Figure 27: *Measurements window*

Charge control window can be selected by clicking this tab: Charge control | Measurements

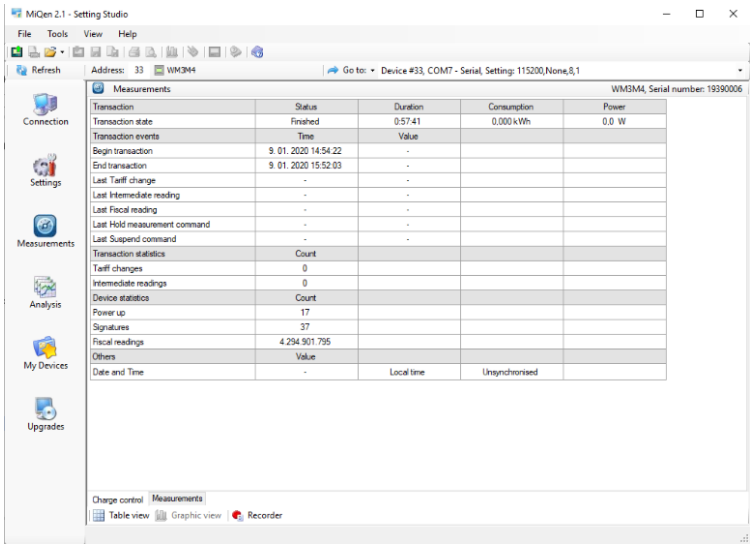


Figure 28: *Charge control window*

For further processing of the results of measurements, it is possible to set a recorder (Recorder button) on the active device that will record and save selected measurements to MS Excel .csv file format.

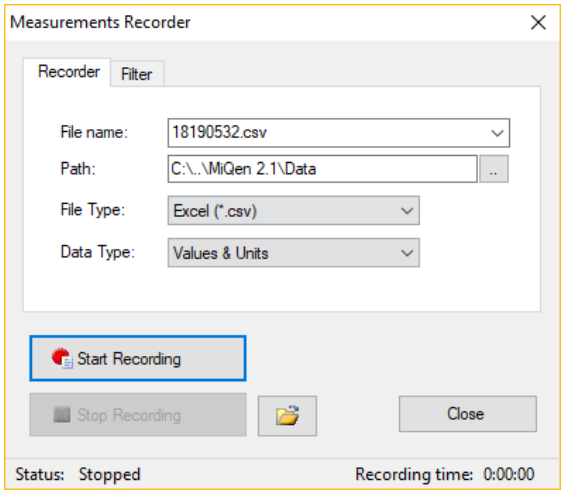


Figure 29: *Measurements Recorder*

5 MEASUREMENTS

The WM3M4 & WM3M4C energy meters ensure active energy measurement and actual measurements of other parameters of three phase network. *The meters* perform measurements with a constant sampling frequency of 3906.25 Hz.

5.1 Online measurements

Online measurements are available on display or can be monitored with setting and monitoring software MiQen.

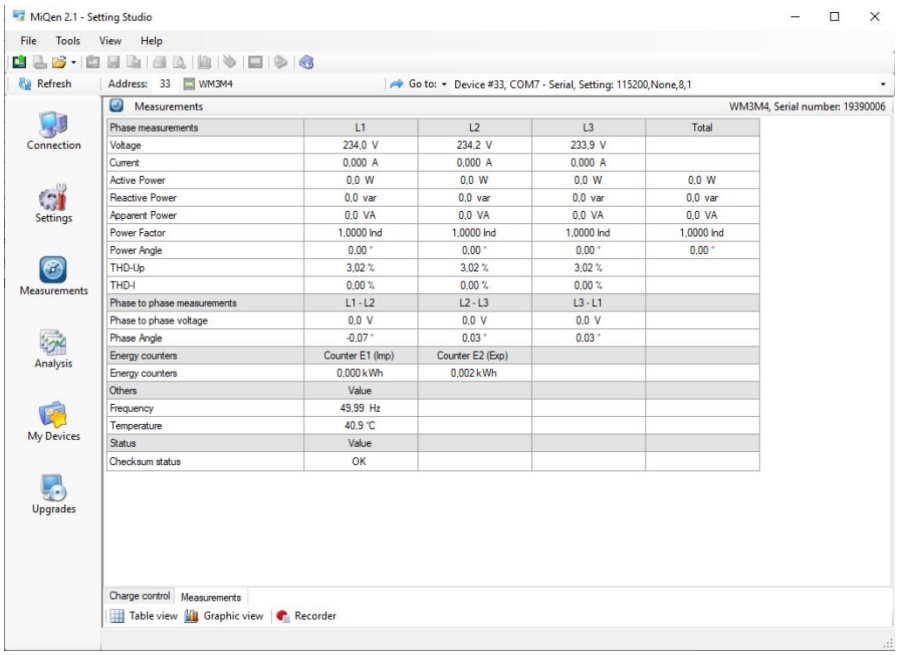


***Figure 30**: Online measurements window.*

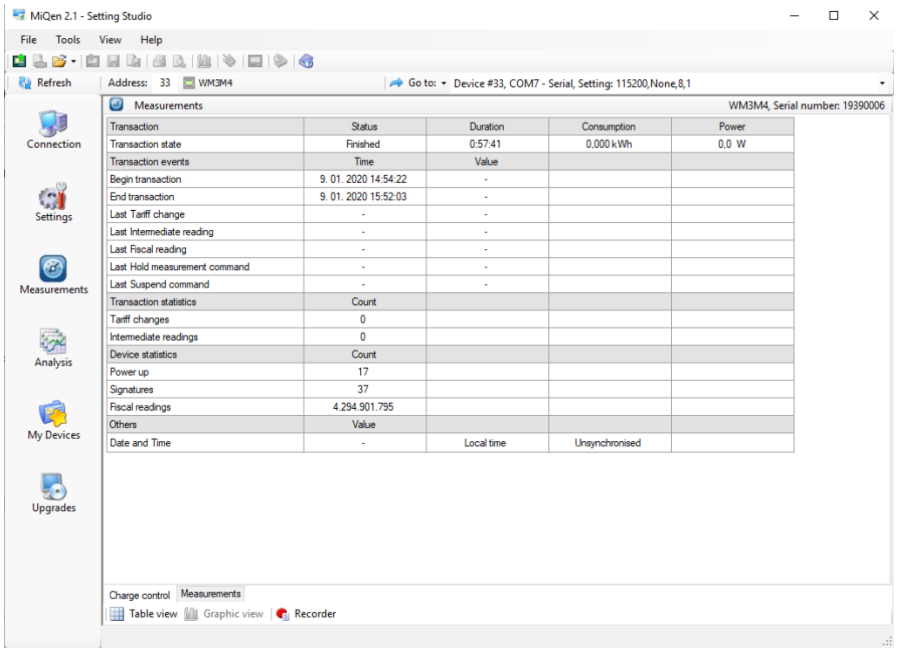


***Figure 31**: Charge control window.*

5.2 Selection of available quantities

Microprocesor calculates the RMS voltage, RMS current, active, reactive and apparent power, U-I phase angle, first harmonic of voltage, first harmonic of current, peak to peak voltage, THD of voltage and THD of current. Complete selection of available online measuring quantities is shown in a table below.

Meas. type	Measurement	Single-phase	3-phase	comments
Phase measurements	Voltage			
	U_{1-3_RMS}	☑	☑	
	Current			
	I_{1-3_RMS}	☑	☑	
	Power			
	P_{1-3_RMS}	☑	☑	
	P_{TOT_RMS}	☑	☑	
	Q_{1-3_RMS}	☑	☑📖	Reactive power can be calculated as a squared difference between S and P or as sample delayed
	Q_{TOT_RMS}	☑	☑	
	S_{1-3_RMS}	☑	☑	
	S_{TOT_RMS}	☑	☑	
	PF_{1-3_RMS}	☑	☑	
	PF_{TOT}	☑	☑	
	φ_{1-3_RMS}	☑	☑	
	φ_{TOT_RMS}	☑	☑	
	Harmonic analysis			
	$THD\text{-}U_{1-3}$	☑	☑	
	$THD\text{-}I_{1-3}$	☑	☑	
Phase to phase measurements	Voltage			
	Upp_{1-3_RMS}	☑	☑	
	φ_{x-y_RMS}	☑	☑	Phase-to-phase angle
Metering	Energy		☑	
	Counter E_1	☑	☑	
Other measurements	Miscellaneous			
	Frequency		☑	
	Temperature			
Status	Checksum status		☑	

📖 Further description is available in following subchapters

Table 8: Selection of available measurement quantitie

5.3 Calculation and display of measurements

This chapter deals with capture, calculation and display of all supported measurement quantities.

5.3.1 Voltage

Voltage related measurements are listed below:

- Real effective (RMS) value of all phase voltages (U_1, U_2, U_3) and phase-to-phase voltages (U_{12}, U_{23}, U_{31}).
- Phase and phase-to-phase voltage angles (φ_{12}, φ_{23}, φ_{31})

$$U_f = \sqrt{\frac{\sum_{n=1}^{N} u_n^2}{N}}$$

$$U_{xy} = \sqrt{\frac{\sum_{n=1}^{N} \left(u_{xn} - u_{yn}\right)^2}{N}}$$

***Figure 32**: Voltage equations*

All voltage measurements are available through communication.

5.3.2 Current

WM3M4 & WM3M4C energy meter measures:

- real effective (RMS) value of phase currents

$$I_{RMS} = \sqrt{\frac{\sum_{n=1}^{N} i_n^2}{N}}$$

***Figure 33**: Current equation*

All current measurements are available on communication.

5.3.3 Active, reactive and apparent power

Active power is calculated from instantaneous phase voltages and currents. All measurements are seen on communication.

5.3.4 Power factor (PF) and power angle

PF or distortion power factor is calculated as the quotient of active and apparent power for each phase separately and total power angle. It is called distortion power factor since true (distorted) signals are using in equation. A symbol for a coil (positive sign) represents inductive load and a symbol for a capacitor (negative sign) represents capacitive load.

5.3.5 Frequency

Network frequency is calculated from time periods of measured voltage. Instrument uses synchronization method, which is highly immune to harmonic disturbances.

5.3.6 Energy counters

Two different variants of displaying Energy counters are available:

- by individual counter,
- by tariffs for each counter separately.

5.3.7 Harmonic distortion

The WM3M4 & WM3M4C energy meters calculate THD for phase currents and phase voltages and are expressed as percent of high harmonic components regarding to fundamental harmonic.

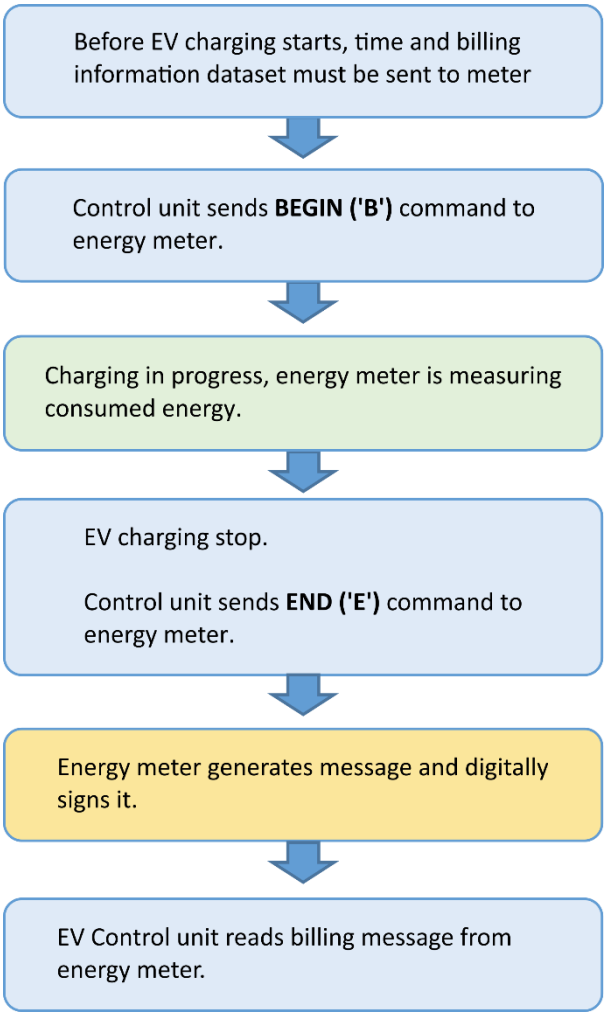
6 DIGITAL SIGNATURE (VALID ONLY FOR WM3M4C)

6.1 Introduction

Energy meter supports digital signing of billing information to ensure integrity of data for end customer. All digital signing procedures are HW based with dedicated crypto chip, which supports ECDSA FIPS186-3 Elliptic Curve Digital Signature. Energy meter supports MODBUS over RS485 for communication with EV control unit.

6.2 Digital signing procedure

EV charger control unit is responsible to send start and stop command to energy meter. Energy meter measures consumed energy during charging. When charging is finished, EV control unit provides billing dataset (customer info, time, etc.) to energy meter via MODBUS communication. Energy meter adds measured energy and generates final billing message with digital signature. EV charger control unit then reads complete billing information with measured energy consumption and digital signature.



6.3 Energy meter cryptographic functions explanation

Energy meter has HW based cryptographic unit for digital signing of billing dataset.

6.3.1 Generation of private/public key par

This is one-time procedure made at production of energy meter. Generation of key pair is HW based with dedicated crypto chip. Private key is stored internally within the crypto chip and there is no way of reading it.

6.3.2 Public Key as QR-code on front of enclosure and readable via MODBUS

Public key is available to end user for verification of digital signature. Therefore, public key is readable through MODBUS communication and printed with QR code on front of the meter.

6.3.3 Generation of billing dataset using internal energy meter value

Energy meter has MODBUS registers to store users billing dataset. Main EV charger SW must write billing dataset to energy meter. Energy meter will fill in measured energy and timestamp to complete billing information. Billing dataset is compatible with OCMF 1.0.

6.3.4 Generation of hash (SHA256) for billing dataset

After completing billing dataset, meter calculates hash of complete message with SHA-256 algorithm documented in the following site: http://nvlpubs.nist.gov/nistpubs/FIPS/NIST.FIPS.180-4.pdf. Hash is 32 bytes long identification of message and is used as an input for signature generation.

6.3.5 Generation of signature for billing dataset

Signing of previously prepared hash is cryptographic procedure with ECDSA NIST P256 prime curve. Crypto chip generates signature in less than a second. Algorithm is documented in:

FIPS 186-4 specification http://nvlpubs.nist.gov/nistpubs/FIPS/NIST.FIPS.186-4.pdf

6.3.6 Exporting billing dataset including signature

Complete billing dataset and digital signature are available for readout via MODBUS communication.

6.4 Consumption measuring and digital signing procedure

EV charger control unit must use following procedure to measure charging consumption and sign billing dataset:

1. Set time, time zone, signature format
2. Enter billing dataset
3. Enter dataset size
4. Send Begin command
5. Send intermediate reading commands (optional)
6. Send fiscal reading (optional)
7. Send tariff change command (optional)
8. Send End command (triggers signing process)
9. Check signature status register until signature is ready
10. Read Output message length
11. Read Output message
12. Read signature length
13. Read signature
14. Read public key

6.5 Crypto Register Definitions

6.5.1 Communication parameter

MODBUS register	Description	Format	Value	
40203	Baud Rate	T1	0	Baud rate 1200
			1	Baud rate 2400
			2	Baud rate 4800
			3	Baud rate 9600
			4	Baud rate 19200
			5	Baud rate 38400
			6	Baud rate 57600
			7	Baud rate 115200
40204	Stop Bit	T1	0	1 Stop bit
			1	2 Stop bits
40205	Parity	T1	0	No parity
			1	Odd parity
			2	Even parity
40206	Data Bits	T1	0	8 bits

Table 9: RS485 communication parameters table

Default settings:

Baud rate: 115200
Parity: None
Stop bits: 1

6.5.2 Cryptographic control registers

MODBUS Address	Size in bytes	Access Type	Description
47051	2	R/W	Command Register (see *Table 14*)
47052	2	R	Signature Status Register (see *Table 11*)
47053	2	R/W	Time zone Offset
47054 - 47055	4	R/W	Date and Time Synchronization
47056	2	R	Input Message Length
47057	2	R	Output Message Length
47058	2	R	Signature Length
47059	2	R/W	Signature Format (see Table 13)
47060	2	R/W	Signature Algorithm
47061	2	R/W	LCD Backlight
47062	2	R/W	LCD Display 2nd Row Mode (see *Table 1*)
47063 - 47066	8	R/W	LCD Display Custom String
47067 - 47068	4	R/W	LCD Display Custom String Label
47069	2	R	OCMF format version (upper 8 bits Major, lower 8 bits Minor, currently 1.0)
47070	2	W	Consumption and duration Reset register. Control unit can reset last charging values by setting BIT 0.
47071	2	R/W	Clock synchronization status (see *Table 5*)
47072	2	R/W	Clock synchronization timeout
47073	2	R/W	UTC / local time format
47074	2	W	Time adjustment (-3 seconds to +3 seconds)
47075	2	W	MID Status LCD screen

Table 10: Cryptographic control registers

6.5.3 Signature status register (47052)

Value	Description
0	Not initialised
1	Idle
2	Signature in progress
15	Signature OK
128	Invalid date time
129	CheckSum error
130	Invalid command
131	Invalid state
132	Invalid measurement
133	Test mode error
243	Verify state error
244	Signature state error
245	Keypair generation Error
246	SHA failed
247	Init failed
248	Data not locked
249	Config not locked
250	Verify error
251	Public key error
252	Invalid message format
253	Invalid message size
254	Signature error
255	Undefined error

Table 11: Signature status register

6.5.4 Setting time related registers

Control unit can set time, time sync status, time sync status timeout, UTC offset and UTC / local time presentation.

Time changing is not possible during charging!

One time adjustment (+-3 seconds) is permitted during charging.

6.5.4.1 Setting time

Write unix timestamp to MODBUS registers 47054 - 47055.

47054 : high 16 bits

47055 : low 16 bits

Example:

Unix time: 1570096309 hex:0x5D95C4B5

Write 0x5D95 to 47054

Write 0x C4B5 to 47055

The best practice is to set time at start of every charging procedure.

6.5.4.2 Time status

Control unit must also set the status of clock in register 47071. Statuses are defined in *Table 5*.

6.5.4.3 Time status timeout

Clock status changes to Unsynchronized after timeout (in minutes), which is set in register 47072.

6.5.4.4 Time zone

Write offset (in minutes) from UTC time to 47053.

Warning:

Energy meter does not support DST, so the current offset from UTC must be written.

Example:

Slovenia is UTC + 1:00, but in summer time writes 120 to 47053.

6.5.4.5 UTC / local time presentation

Time representation on LCD and in signature (JSON) can be displayed differently with UTC/local time setting.

For example, time is set in UTC format, but you want to have local time on LCD and in signature. Then UTC/local time setting should be set to 0x1 (BIT 0). It means that time on communication is in UTC format and time on LCD and JSON is in local time.

Energy meter has 3 time presentations:

1. RS485 communication
2. LCD display
3. Timestamp in JSON transaction

Every one of them can be set to UTC or local time. Default state for all is local time.

Register 47073 UTC / local time setting (0 = local time, 1 = UTC)

BIT 2	BIT 1	BIT 0
JSON	LCD	RS485

Table 12: UTC / local time register

6.5.4.6 Time adjusting

Fine time adjusting is a way to compensate clock drift during charging. Up to +- 3 seconds adjusting is permitted in register 47074.

6.5.5 Signature format

Energy meter supports hex (ASN.1) and Base 64 signature format in register 48188. Format can be set in register 47059:

Value	Signature format
0	HEX (ASN.1)
1	Base64

Table 13: Signature format

6.5.6 Signature algorithm

Energy meter currently supports only ECDSA-secp256r1-SHA256 algorithm.

Register 47060:

Value	Signature format
0	Without signature
4	ECDSA-secp256r1-SHA256

Table 14: Signature algorithm

6.5.7 Entering billing dataset

Dataset register is at MODBUS address 47100. Only 120 MODBUS registers (240 bytes) can be entered in one write command. Maximum size of billing dataset is 1024 bytes. Format is defined in ***Dataset format*** *paragraph*.

Example:

If 300 bytes need to be written:

- write 120 MODBUS registers to MODBUS address 47100
- write 30 registers to MODBUS address 47220 (47100 + 120).

After writing dataset, length (in bytes) must be written to MODBUS address 47056.

6.5.8 Transaction commands

Command register for transactions is at MODBUS address 47051. High 8 bits is command, lower 8 bits are reserved.

It is very important to check measurement status register (47000) before sending command, because energy meter accepts only commands which are valid for current state.

Time, input message and input message length must be set before sending command.

After sending command, check result of operation in control status register (47052).

Register 47051

Value	Command	Valid charging states (47000)
'B' (0x42)	Begin measurement	Idle state (0)
'E' (0x45) 'L' (0x4C) 'R' (0x52) 'A' (0x41) 'P' (0x50)	End measurement	Active state
'C' (0x43)	Intermediate Reading	Active state
'X' (0x58)	eXception	Active state
'T' (0x54)	Tariff Change	Active state
'S' (0x53)	Suspended command	Active state
'r' (0x72)	End measurement (with begin and end)	Active state
'f' (0x66)	Fiscal Reading	Any state
'h' (0x68)	Hold command	Active state

Table 15: Transaction commands

Signature process starts after every command. Control unit can read out signed dataset with current time and energy meter value reading.
Meter stores one value (timestamp and counter value) for each command. Registers are defined in measurements table (0).

If 'r' command is sent, array with begin and end reading is generated and signed.

Hold command is used for read and sign later procedure. Every energy value reading is stored by default. When 'h' command is sent, stored value is used for next signature instead of actual energy counter value.

6.5.9 Signature status

Control unit must check signature status before reading signed dataset and signature. Signing process takes up to 1 second, so control unit must check status few times with some delay.

MODBUS register address is 47052. Signature OK value is 15.

6.5.10 Output billing dataset

Signature process modifies original billing dataset, which was entered at start of measuring. Output billing dataset contains meter information (meter vendor, meter model, meter serial number and firmware version), measured value and unique pagination value (PG). Output billing dataset is available until next signature request or power down.

JSON and binary output are supported.

Only 120 MODBUS registers (240 bytes) can be read in one MODBUS read command.

6.5.11 JSON output

Size of JSON output billing dataset is at MODBUS address 47057.

JSON output billing dataset is at MODBUS address 47612.

6.5.12 Binary output

Size of binary output billing dataset is at MODBUS address 48316.

Binary output billing dataset is at MODBUS address 48317.

6.5.13 Signature

After successful signature process, control unit can read signature in specified signature format.

Signature length register is at MODBUS address 47058.

Signature register is at 48188.

6.5.14 Public key

Public key is stored in 64 bytes raw format at MODBUS address 48124.

For **Transparenz Software** check, public key header should be prepended:

3059301306072A8648CE3D020106082A8648CE3D03010703420004

For checking with ECDSA, public key header is: 04.

6.5.15 Dataset format

Format is compliant with OCMF v1.0.
Energy meter requires following fields in dataset:

```
{
"FV":"1.0",
"GI":"",
"GS":"",
"PG":"",
"MV":"",
"MM":"",
"MS":"",
"MF":"",
"IS":true,
"IF":[],
"IT":"NONE",
"ID":"",
"CT":"EVSEID",
"CI":"",
"RD":[]
}
```

Warning: JSON names must be in specified order and without whitespaces. Downloaded message should look like:
{"FV":"1.0","GI":"","GS":"","PG":"","MV":"","MM":"","MS":"","MF":"","IS":true,"IF":[],"IT":"NONE","ID":"","CT":"EVSEID","CI":"","RD":[]}

Example of valid JSON dataset (**newlines are added for better readability**):

```
{
"FV":"1.0",
"GI":"Gateway 1",
"GS":"123456789",
"PG":"",
"MV":"",
"MM":"",
"MS":"",
"MF": "",
"IS":true,
"IF":[
"RFID_PLAIN",
 "OCPP_RS_TLS"
],
"IT":"ISO14443",
"ID":"1F2D3A4F5506C7",
"CT":"EVSEID",
"CI":"",
"RD":[]
}
```

Fields highlighted in green are mandatory.

Energy meter fills following values:
PG:”T<signature counter>” or “F<fiscal counter>” for fiscal readings
MV:“Iskra”
MM:”WM3M4”

MS:"meter serial number"
MF:"meter firmware version"
RD: meter generates complete array of readings data
Example of modified dataset:


```
{
"FV":"1.0",
"GI":"Gateway 1",
"GS":"123456789",
"PG":"T82212",
"MV":"Iskra",
"MM":"WM3M4",
"MS":"18230001",
"MF":"0.21",
"IS":true,
"IF":[],
"IT":"NONE",
"ID":"",
"CT":"",
"CI":"",

"RD":[
{
"TM":"2019-11-11T13:22:28,000+0000 S",
"TX":"B",
"RV":123457.529,
"RI":"1-b:1.8.0",
"RU":"kWh",
"RT":"AC",
"EF":"",
"ST":"G"
},
{
"TM":"2019-11-11T13:24:12,000+0000 S",
"TX":"E",
"RV":123457.529,
"RI":"1-b:1.8.0",
"RU":"kWh",
"RT":"AC",
"EF":"",
"ST":"G"}
]
}
```


Highlighted data is generated by energy meter. Data is without whitespaces (**newline characters are added in this document for better readability).**

6.5.16 MID status register

MID status is displayed on LCD for number of seconds written to register 47075.

Displayed MID info is in two rows on LCD display:

Number of MID unlocks (2 digits)	Firmware CRC (4 digits)
Number of SW upgrades (2 digits)	Phase module CRC (4 digits)

***Figure 34**: Status LCD shows FW versions*

6.5.17 Measurements table

Control unit can check measurements and statuses during the charging process

47000		Measurement status	T1	0	Idle
				1	Active
				2	Active after power failure
				3	Active after reset
47001	47002	Duration	T3u		Seconds
47003	47004	Consumption	T_32U		Wh
47005	47006	Active Power Total (Pt)	T6		Reg (30140-30141)
47007	47008	Date and Time	T_Unix		
47009		Tarrif changes count	T1		Command T
47010		Intermediate readings count	T1		Command C
47011	47012	Fiscal Readings count	T3u		Command f
47013	47014	Signatures count (pagination)	T3		
47015	47016	Start Timestamp	T_Unix		
47017	47018	Start Counter value	T_32U		Wh
47019	47020	Stop Timestamp	T_Unix		
47021	47022	Stop Counter value	T_32U		Wh
47023	47024	Tariff change Timestamp	T_Unix		
47025	47026	Tariff change Counter value	T_32U		Wh
47027	47028	Intermediate Reading Timestamp	T_Unix		
47029	47030	Intermediate Reading Counter value	T_32U		Wh
47031	47032	Fiscal Reading Timestamp	T_Unix		
47033	47034	Fiscal Reading Counter value	T_32U		Wh
47035	47036	Hold measurement Timestamp	T_Unix		
47039	47040	Hold measurement Timestamp	T_Unix		
47041	47042	Hold measurement Counter value	T_32U		Wh
47039	47040	Suspend Timestamp	T_Unix		
47041	47042	Suspend Counter value	T_32U		Wh

Table 16: Measurements table

6.5.18 Input / Output Data Table

47100	47611	Input Message (JSON/Binary)
47612	48123	Output Message (JSON)
48124	48155	Public Key (raw)
48156	48187	Signature (raw)
48188	48315	Signature ASN.1
48316		Binary Output Message Lenght
48317		Binary Output Message

Table 17: Input/Output table

6.6 Power loss behaviour

If power loss happens during charging, meter continues to measure energy and duration after power is restored. All events are saved (begin and tariff changes) but meter does not save time, because it is not relevant anymore (meter is without battery). Meter detects this irregular state and reports it with measurement status 2 in register 47000.

Control unit must set time and billing dataset to continue. Then End transaction command can be send. Meter will generate and sign complete transaction with time error flag (“EF”: “t”).

6.7 Unexpected reset behaviour

Meter will set Energy error flag (“EF”: “E”) if unexpected reset happens during charging. Measured energy consumption is **not valid**.

7 TECHNICAL DATA

In following chapter all technical data regarding operation of *WM3M4 & WM3M4C energy meters* are presented.

7.1 Accuracy

Measured values	Accuracy class
Active energy:	class 1 EN 62053-21
	class B EN 50470-3
	±1.5% from I_{min} to I_{tr}
	±1% from I_{tr} to I_{max}
Voltage:	±1% of measured value
Current:	±1% of I_{ref} from I_{st} to I_{ref}
	±1% of measured value from I_{ref} to I_{max}
Active Power:	±1% of nominal power ($U_n * I_{ref}$) from I_{st} to I_{ref}
	±1% of measured value from I_{ref} to I_{max}
Reactive, Apparent power:	±2% of nominal power from I_{st} to I_{ref}
	±2% of measured value from I_{ref} to I_{max}
Frequency:	±0.5% of measured value

7.2 Mechanical characteristics of input

Rail mounting according to DIN EN 60715. In case of using the stranded wire, the ferrule must be attached before the mounting.

Terminals		Maximum conductor cross-sections
Main inputs	Contacts capacity:	Rigid (flexible) 2.5 mm^2... 25 (16) mm^2
	Connection screws:	M5
	Maximum torque:	3.5 Nm (PZ2)
	Length of removed isolation:	10 mm
Communication terminals	Contacts capacity:	1 mm^2... 2.5 mm^2
	Connection screws:	M3
	Maximum torque:	1.2 Nm (PZ2)
	Length or removed isolation:	8 mm

7.3 Electrical characteristics of input

Inputs and outputs		
Measuring input	*Type (connection):*	*three-phase (4u)*
	Reference current (I_{ref}):	*5 A*
	Maximum current (I_{max}):	*40 A*
	Minimum current (I_{min}):	*0.25 A*
	Transitional current (I_{tr}):	*0.5 A*
	Starting current:	*20 mA*
	Power consumption at I_{ref}	*0.1 VA*
	Nominal voltage (U_n):	*3x230 V/400 V (-20 %...+15 %)*
	Power consumption per phase at U_n:	*< 8 VA*
	Nominal frequency (f_n):	*50 Hz and 60 Hz*
	Minimum measuring time:	*10 s*
Security *(valid only for WM3M4C)*	*Hash generation:*	*SHA256*
RS485 Serial communication	*Type:*	*RS485*
	Speed:	*1200 bit/s to 115200 bit/s (default 115200 bit/s)*
	Frame:	*8, N, 1*
	Protocol:	*MODBUS RTU*
	Address:	*33 – (default)*
Optical communication	*Type:*	*IR*
	Connection:	*via WM-USB adapter*
	Speed:	*19200 bit/s*
	Frame:	*8, N, 1*
	Protocol:	*MODBUS RTU*
	Address:	*33 – (locked)*
	Remark:	*All settings are fixed*

7.4 Safety and ambient conditions

According to standards for indoor active energy meters.

Temperature and climatic condition according to EN 62052-11.

Dust/water protection	*IP50*
Operating temperature:	*-25 °C - +70 °C*
Storage temperature:	*-30 °C - + 80 °C*
Enclosure:	*self-extinguish, complying UL94-V*
Indoor meter:	*Yes*
Degree of pollution:	*2*
Protection class:	*II*
Installation category	*300 Vrms CAT.III*
Standard:	*IEC 62052-31*
Mechanical environment:	*M1*
Electromagnetic environment:	*E2*
Humidity:	*non condensing*
Weight (with packaging):	*228 g (248 g)*
Installation:	*DIN rail 35 mm*
Dimensions (W x H x D):	*53,6 mm x 84 mm x 69,4 mm*
Package dimensions (W x H x D):	*57 mm x 93 mm x 85 mm*
Colour:	*RAL 7035*

7.5 EU Directives conformity

EU Directive on Measuring instruments MID **2014/32/EU**

EU Directive on EMC **2014/30/EU**

EU Directive on Low Voltage **2014/35/EU**

EU Directive WEEE **2002/96/EC**

List of considered harmonized standards confirming appliance with the essential requirements of the Regulation:

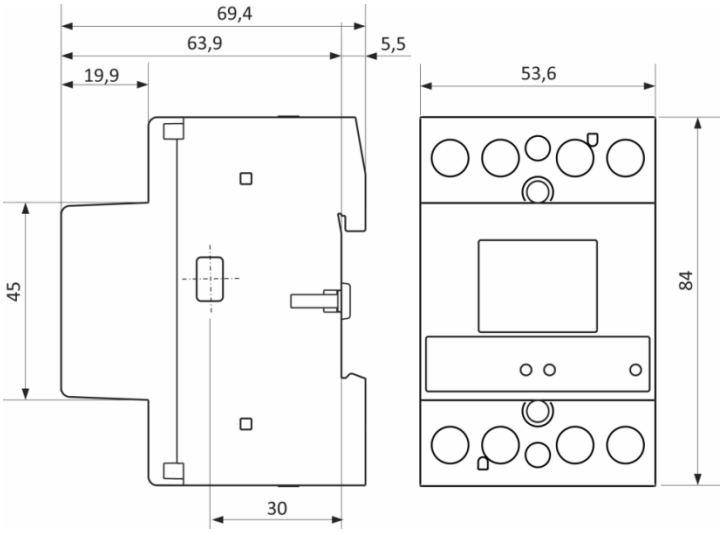
EN 50470-1:2006 Electricity metering equipment (ac) - Part 1: General requirements, tests and test conditions - Metering equipment (class indexes A, B and C)
EN 50470-3:2006 Electricity metering equipment (ac) - Part 3: Particular requirements - Static meters for active energy (class indexes A, B and C)

Other standards taken into account in the design and testing of the meter:

EN 62052-11:2003, EN 62052-11:2003/A1:2017 Electricity metering equipment (ac) - General requirements, tests and test conditions - Part 11: Metering equipment
EN 62053-21:2003, EN 62053-21:2003/A1:2017 Electricity metering equipment (ac) - Particular requirements - Part 21: Static meters for active energy (classes1 and 2)
EN 62053-23:2003, EN 62053-23:2003/A1:2017 Electricity metering equipment (ac) - Particular requirements - Part 23: Static meters for reactive energy (classes 2 and 3)
EN 62053-31:1998 Electricity metering equipment (a.c.) - Particular requirements - Part 31: Pulse output devices for electromechanical and electronic meters (two wires only)
EN 62052-31:2016 Electricity metering equipment (a.c.) - General requirements, tests and test conditions - Part 31: Safety requirements and tests
EN 62059-32-1:2012 Electricity metering equipment - Dependability - Part 32-1: Durability - Testing of the stability of metrological characteristics by applying elevated temperature
CLC/TR 50579:2012 Electricity metering equipment - Severity levels, immunity requirements and test methods for conducted disturbances in the frequency range 2 -150 kHz

7.6 Dimensions

7.6.1 Dimensional drawing

Construction	***Appearance***
Dimensions	All dimensions are in mm 

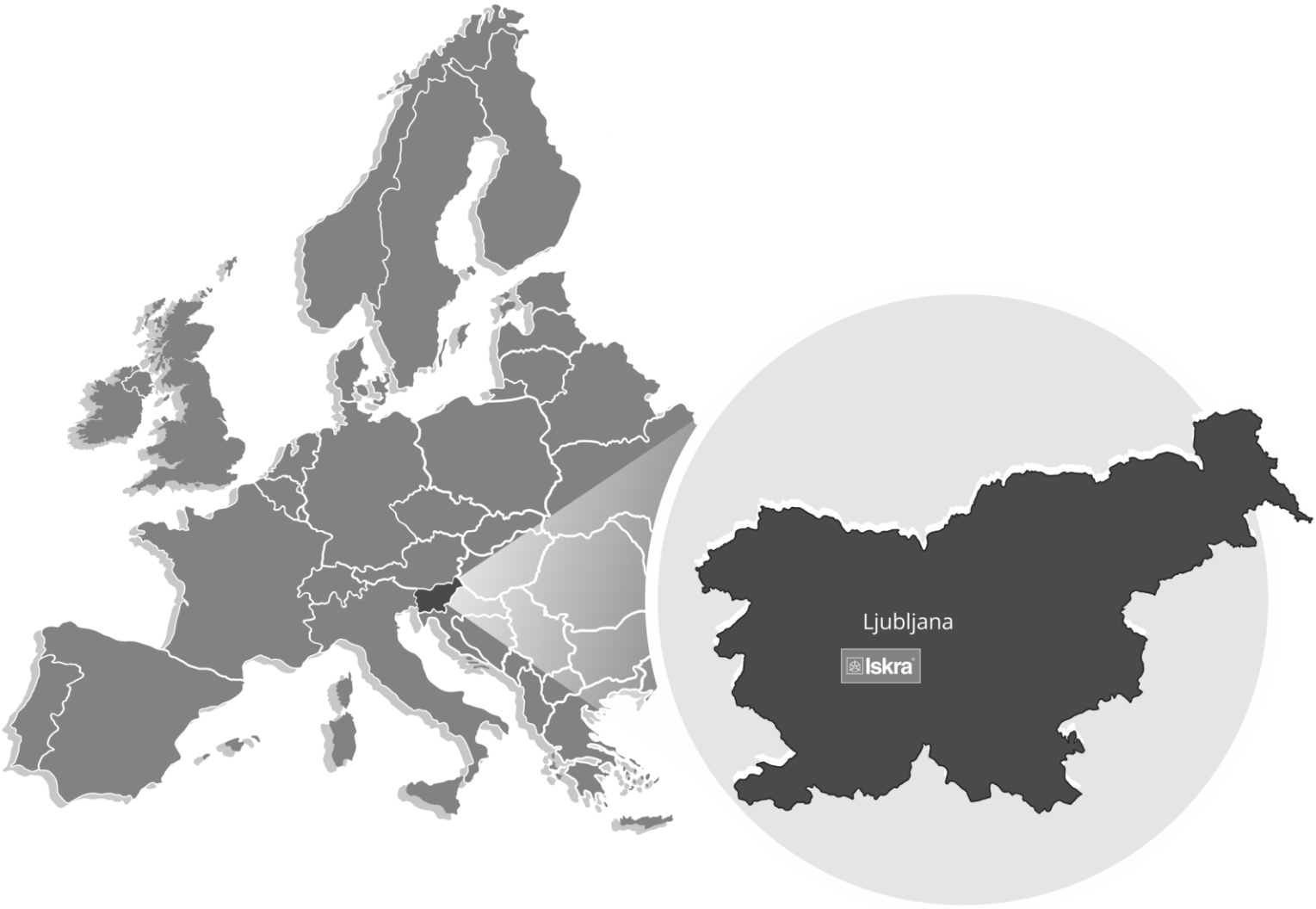
.

8 ABBREVIATION/GLOSSARY

Abbreviations are explained within the text where they appear the first time. Most common abbreviations and expressions are explained in the following table:

Term	*Explanation*
MODBUS / DNP3	*Industrial protocol for data transmission*
MiQen	*Setting Software for ISKRA instruments*
AC	*Alternating*
IR	*Infrared (optical) communication*
RMS	*Root Mean Square*
PA	*Power angle (between current and voltage)*
PF	*Power factor*
THD	*Total harmonic distortion*
EV	*Electrical vehicle*

List of common abbreviations and expressions



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