TECHNICAL DESCRIPTION

EN D 22.433.922

Three-phase electrical energy meter for charging stations
WM3M4 / WM3M4C

	Priimek	Datum	Naziv
Izdelal:.	**T. Tepina**	**3.3.2023**	**WM3M4 / WM3M4C**
Potrdil	**Edi Vovk**	**3.3.2023**	

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	WM3M4		L1-39	V1.07	EN	**D**	**22.433.922**

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THREE-PHASE ELECTRICAL ENERGY METER FOR CHARGING STATIONS WM3M4 / WM3M4C

1 BASIC DESCRIPTION AND OPERATION

The *WM3M4& WM3M4C energy meters* are 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.

Connecting terminals can be sealed up against non-authorised access with protection covers. They are built to be fastened according to EN 60715 standard.

1.1 Three-phase energy meters application

Energy meters have built-in optical (IR) communication port on the side as a standard. 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.

The meters features a **RS485** serial communication with the MODBUS protocol.

Communication modules enables data transmission and thus connection of the measuring places into the network for the control and management with energy.

1. RS485 terminals
2. Current terminals – to load
3. LCD display
4. IR COMM PORT – on side
5. Public key in 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 1.1: Appearance of a three-phase electric energy meter WM3M4 / WM3M4C

1.2 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 (I_{max}) **40 A.**
- Reference current **5 A (I_{ref}).**
- Reference voltage **3x230 V/400 V (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).
    - 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 only on one phase **(on L3)** – single phase connection.
- Remote control for **backlight LCD**.
- Secure data transfer (**digital signature**) (valid only for WM3M4C).
- **70°C** ambient operation temperature.
- **Sealable** terminal cover.

2 INSTALLATION AND CONNECTION

The WM3M4 & WM3M4C energy meters are used for direct connection into the four-wire networks. It can be used in three or single phase connection.

Recommended installation:

1 Mounting to DIN rail according to DIN EN60715
2 Main inputs:
   a. Contacts capacity: 1.5 mm^2 – 25 mm^2
   b. Connection screws: M5
   c. Max 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. Max torque: 1.2 Nm
   d. Length or removed isolation: 8 mm

PLEASE NOTE!

Neutral wire must be connected to the meter.

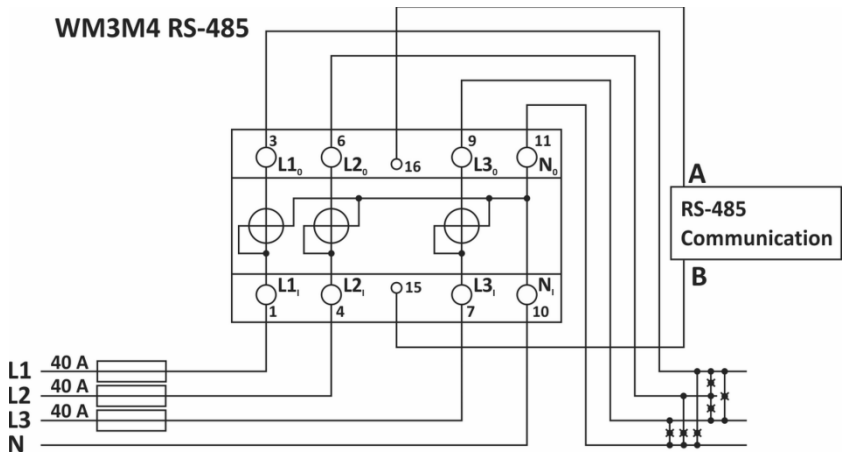


Figure 2.1: Connection diagram for RS-485 – three phase connection

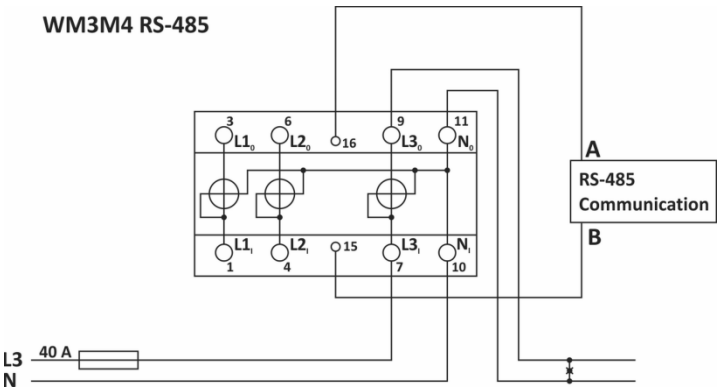


Figure 2.2: Connection diagram for RS-485 – single phase connection

Auxiliary terminal	15	16
RS-485	B	A

3 BLOCK DIAGRAM AND MODE OF OPERATION

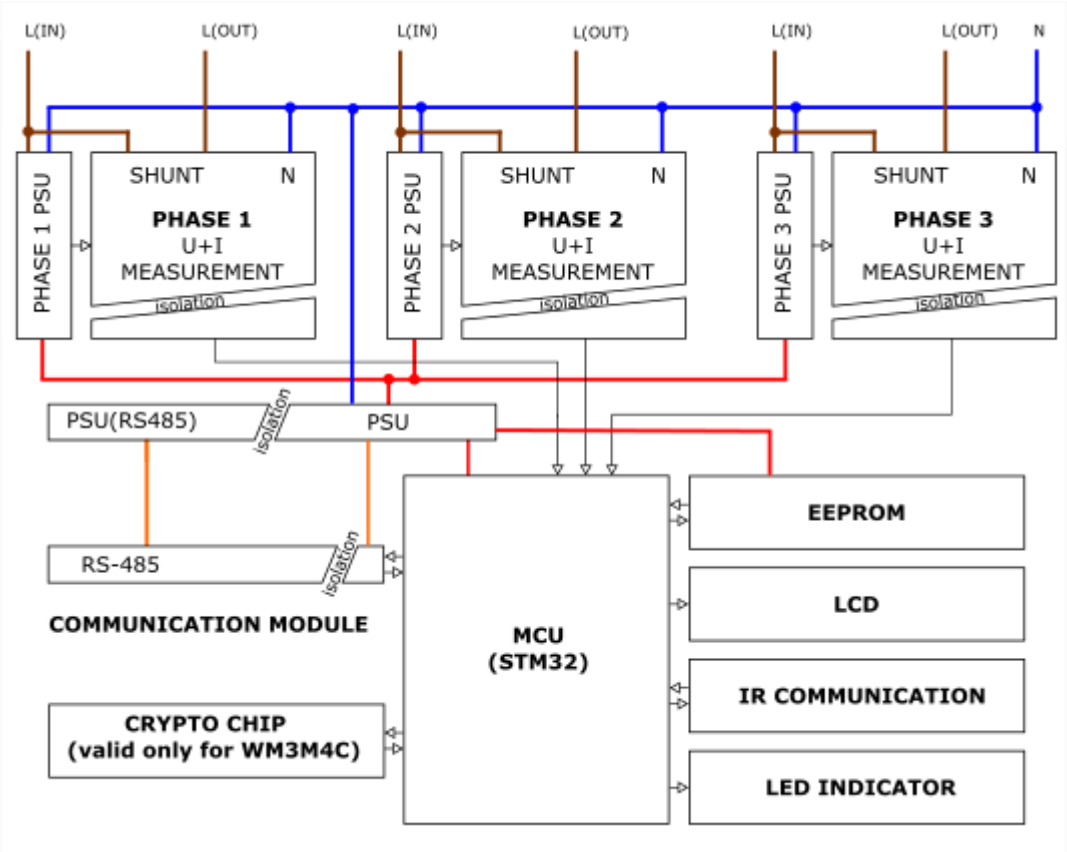


Figure 3.1: Block diagram of signal conversion and processing for WM3M4

Complete *WM3M4& WM3M4C* system is assembled with four main units:

- Individual phase measurement unit.
- Power supply unit (based on configuration).
- Processing unit (MCU) with IR communication, LED indicator, Crypto chip, LCD support and EEPROM.
- Communication module RS485.

*WM3M4& WM3M4C*energy meters are supplied from phase power supply units using capacitor based power supply. Current and voltage is measured in measurement system. Shunt resistor is used for current sensing. Measuring mains voltage is applied with resistor voltage divider.

Method for sampling voltage and current is based on A/D conversion. Microprocessor unit is used for signal and measurement processing.

Basic meter data, parameters and calibration constants are stored in EEPROM.

WM3M4& WM3M4C energy meters do not have any adjustable elements (potentiometers), which assures a better long-term stability.

LCD is driven directly from microprocessor and is used for displaying various parameters, energy registers, and digital signing process.

3.1 Communication

For communication with outside world multiple manners are used:

- **IR** communication module using MODBUS protocol is equipped on each meter. It can be usedfor setting and testing the meter using WM-USB adapter.
- **LED** diode is used for indication of no-load condition and test output proportional to measured active energy. It can be also switched to reactive energy for test purpose using IR communication.
- **RS-485** communication module is galvanic isolated from the meter. It enables setting the meter, data readout in the network and tariff setting.

4 SOFTWARE DESCRIPTION

4.1 Individual phase measurement unit

The microprocessor is used to process the voltage and current samples from the AD converter. It calculates the RMS voltage, RMS current, active and reactive power, U-I phase angle, first harmonic of voltage, first harmonic of current, the DC voltage, DC current, peak to peak voltage, peak to peak current, THD of voltage and THD of current. The internal temperature and supply voltage is measured also. All measurements are updated every two periods of 40 Hz to 70Hz signal and then transferred to the processing unit via one-way communication using hardware UART module.

4.2 Digital signing (only WM3M4C)

The 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 ATECC608A which supports ECDSA FIPS186-3 Elliptic Curve Digital Signature. All crypto functions are integrated in the main processor FW (MCU), which is legally relevant and approved. Energy meter supports Modbus over RS485 for communication with EV control unit.

4.3 Processing unit (MCU)

The microprocessor is used to process measuring function, controlling and monitoring of all the other hardware. It collects the measurements from all individual phase measurement units and measures time. It calculates frequency, apparent power, power factor and updates all energy registers and LED pulse output.

The microprocessor is used to process the voltage samples from the internal AD converter. It calculates the RMS phase to phase voltages and phase to phase angles. The internal temperature and supply voltage is measured also.

Firmware is installed on a 128 KB flash. 20 KB RAM is used to store variables and parameters for communication. Also RAM is used as a temporary storage for software update to the FLASH. Memory *map is as shown below.*

Address (hex)	Memory Technology	Memory Type	Typical Usage	Memory Size (bytes)
0x08000000 - 0x0801ffff	Flash Memory	Non-volatile	Common code area for the program and non-volatile data.	128KB
0x20000000 - 0x20004fff	Static RAM	Volatile	Miscellaneous I/O RAM (configuration RAM)	20kB
0x000 - 0x07ff	EEPROM	Non-volatile	Save user settings and energy counters	2kB

Table 1: Memory Map

Current, voltage and power are measured on phase measurement module and then transferred to microprocessor via one-way communication using hardware UART modules where measured data is to be processed and shown.

Power supply is constantly monitored for low-voltage event. In case of event energy registers are saved to EEPROM.

Supported communication protocol is MODBUS. All MODBUS registers are specified in MODBUS table (WM3M4C_F.xls).Communication between microprocessor and RS485communication module is done with hardware UART. Isolated RS485 module support following baud rates:

- 1200 bits/s
- 2400 bits/s
- 4800 bits/s
- 9600 bits/s
- 19200 bits/s
- 38400 bits/s
- 57600 bits/s
- 115200 bits/s

Isolated IR communication module uses hardware UART. Baud rate is fixed to 19200 bits/s.

EEPROM is used to store settings and registers. Watchdog is present. If program fails it is used to reset the meter. For energy measurements two 32 bit energy registers are provided with resolution 1 Wh. Energy registers are periodically saved in EEPROM every 5minutes during charging event or every 60 minutes on standby to maintain back-up values in case of watchdog activation. During the saving procedure in EEPROM CRC is calculated over the stored data and for storage 3 locations are provided using FIFO system. CRC is checked at reading from EEPROM. In case of one corrupted set the previous stored data are used.

Metering functions are done with the processing unit. There are 2different energy counters, which can be configured to measure import or export active energy. These are:

- Import Active Energy (kWh)
- Export Active Energy (kWh)

The energy register is a count of pulses. The number of CE units per pulse is a constant in the meter calibration data. Function add () adds the current interval's power data to a "remainder" variable. If this variable is larger than one pulse, then the number of pulses is added to the energy register, and remainder variable is decreased by the number of CE units that represent the same amount of energy.

Measuring values are averaged within 1 second and displayed on the LCD at the same interval. Parameters which can be shown are:

1) Energy registers:
    i) Energy counter 1 – Active energy Import
    ii) Energy counter 2 – Active energy Export
    iii) Other values related to charging process are explained in item 4.6

2) Actual measured values, which are available only via RS485 or IR communication using MODBUS protocol:
    i) Active Power, total, ph1,ph2,ph3
    ii) Reactive Power, total, ph1,ph2,ph3
    iii) Apparent Power total, ph1,ph2,ph3
    iv) Power Factor, total, ph1,ph2,ph3
    v) Voltages U1, U2, U3
    vi) Phase to phase voltages U12, U13, U23
    vii) Frequency
    viii) Current I1, I2, I3
    ix) Power Angle total

4.4 Display layout

Energy meter has LCD display with following layout.

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

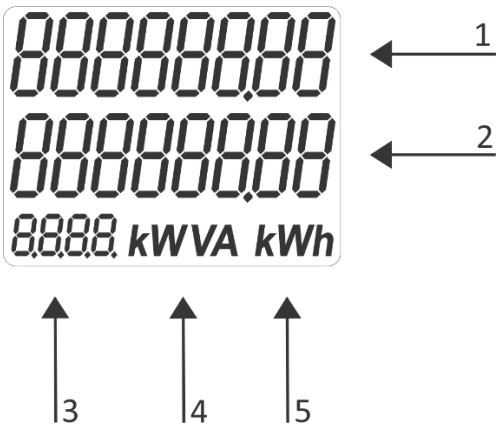


Figure 4.4.1: Layout of LCD

4.5 Welcome screens

LCD segment test

FW identification screen

1 CRC of main FW (MCU)-32 bit
2 CRC of measuring modules FW – 16 bit
3 Main FW version (MCU)

First line of display is reserved for import active energy counter, second line is configurable to display various settings, errors and measurements.

Energy registers are displayed with resolution 6 + 2 (kWh). The meter can be set to *Test measuring mode* which displays energy registers with better resolution. The test mode is used for test purposes during type testing and test of meter constant during initial verification. After power off meter automatically goes back to normal operation.

Test output is provided as LED with number of impulses proportional to active energy. Pulse constant is 1000 imp/kWh.

Energy measurement is blocked for the currents less than 20 mA. The meter measures actual voltage and frequency. Current and power values are set to zero and there is no energy registration. No load condition is indicated with the LED on.

4.6 Display description

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. Parameter cycling period is settable from 5 seconds to 60 seconds. Top row always displays imported active energy consumption.

Row 2 is configurable to display following values:

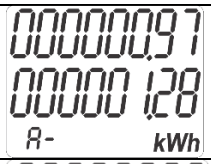
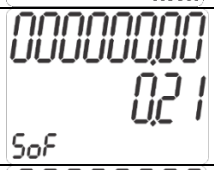
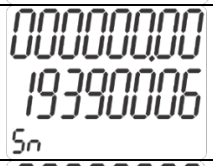
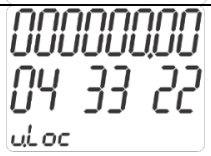
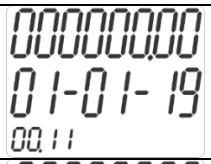
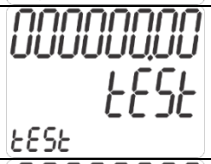
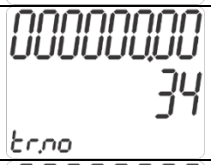
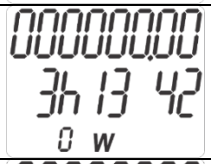
BITS	**ROW 2 DESCRIPTION**	ROW 3 DESCRIPTION/ABBREVIATION	LCD EXAMPLES
BIT 8	**Export active energy counter**	A- Unit: kWh	
BIT 7	**SW version**	SoF	
BIT 6	**Serial number**	Sn	
BIT 5	**Time**	1st digit: Clock status (see **Napaka! Vira klicevanja ni bilo mogoče najti.**) Digits after dot: • Loc (Local time), or • Utc (UTC time)	
BIT 4	**Date** **(e.g.: day, month, year)**	hh.mm (hour.minutes) (time - e.g.: 00 (hour).11 (minutes))	
BIT 3	**Custom String**	LCD Custom string label (see Table 3); Available characters (see chapter **Napaka! Vira sklicevanja ni bilo ogoče najti.**)	
BIT 2	**Transaction number**	tr.no	
BIT 1	**Duration** **(e.g.: 3h 13min 42 s)**	Charging power (e.g.: 0 W)	
BIT 0	**Energy consumption in charging process (Default)**	End: consumption of last finished charging (in idle state) Run: consumption during actual charging Status LCD: 1st digit: Clock status (see Table 3) 2nd digit: Charging status (see Table 4) 3rd digit: Reserved 4th digit: Reserved	

Table 2: LCD ROW2 Configuration

Default state is Energy consumption.

If multiple bits are selected, then values in row 2 are cycling with period defined in Modbus register 40174.

40174	LCD cycling period	Cycling time in Seconds

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)

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)

Status LCD (4 digits):

1st digit: Clock status (Table 3: Clock sync status)

2nd digit: Charging status (Table 4: Charging status)

3rd digit: Reserved

4th digit: Reserved

Value	Clock status	LCD status
0	Not sync (U)	u
1	Informative clock	i
2	Synchronized	5
3	Relative clock	r

Table 3: Clock sync status

Register 47000

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

Table 4: Charging status

4.6.1 LCD Error display

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

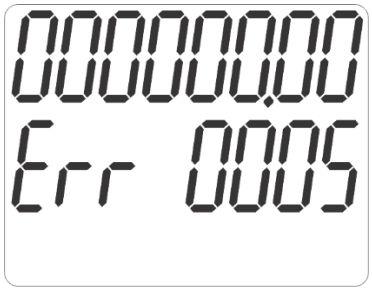
Error format is: Err 1234.

Number represents hexadecimal value of 16 bits error state.

Error bits:

Bit 0	Error Parameter CRC
Bit 2	Error MID-lock
Bit 3	Error phase module 1 FW
Bit 4	Error phase module 2 FW
Bit 5	Error phase module 3 FW
Bit 6	Error main FW CRC (MCU)
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 CRC
Bit 15	Error Crypto chip failure

Example:



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.

4.6.2 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,-

5 SOFTWARE FUNCTIONS

5.1 General info

Identification – SW version can be read from LCD or using RS 485 or IR communication. The complete FW is identified with version and check sum (CRC) of a main processor (3 on LCD Firmware identification screen - picture in item 4.5) and check sum of the program of phase measuring modules (2 on LCD Firmware identification screen - picture in item 4.5). They are calculated and displayed during initialization and later they can be read from MODBUS registers or LCD using MODBUS command FW Identification display (see item 5.5.14). For the main FW CRC calculation CRC-32 algorithm is generated from the entire flash contents. If CRC for code is changed and does not correspond to the initial CRC an ERROR is detected during startup and ERROR Code is shown on the LCD. This is checked after every running minute of the meter.

The firmware of phase measuring modules can be changed only with direct access to programming pins on the PCB with the meter opened. There is no support for upgrade through the communication interface. Main processor firmware can be upgraded using IR or RS485 but it is not available on the field. Additional SW lock is used. The meter can be unlocked only in case of the unlocking command is applied with the jumper on programming pins inside the meter. For evidence of mechanical opening of the meter the sealing labels over the housing edges are used.

In case the meter is not locked the Error MID lock is shown on LCD.

Calibration parameters can only be changed in production. They cannot be changed by upgrade or different processes. Special factory software is used to calibrate the parameters for current, voltage, phase angle and linearity. If these parameters were tenaciously or accidentally changed, an error is detected and ERROR Code is shown on the LCD. Calibration parameters are checked every minute for consistency and if error is found, ERROR Code is immediately shown on LCD. Calibration parameters are protected from modifications with the same SW lock as the main processor firmware, so opening of the meter is needed for readjustments.

For the cryptographic functionality Error crypto data CRC is generated in case of modified CRC over some crypto parameters and Error crypto chip failure in case of wrong or missing response from ATECC608A.

In case any Error is detected in the meter charging process cannot be started and the meter needs to be replaced.

There is an option for a password to protect the instrument. Password has four levels of protection. Meter has possibility of two level user defined password (4 characters from A to Z).

WM3M4 supports MODBUS protocol. RTU mode is used. RTU messages start and end with a silent interval of at least 3,5 character times (t1-t2-t3-t4 as shown below). Each message is transmitted in a continuous stream. If a silent interval of more than1,5 character times occurs before completion of the frame, the

device flushes the incomplete message and assumes that the next byte will be the address field of a new message. Cyclic Redundancy Check (CRC) is used.

All parameterization is done via communication with MiQen software (version 2.1 or later). WM3M4 (MID) has limited parameterization. Counter and tariff settings are not enabled. If these settings or any measuring relevant parameters on **WM3M4** were tenaciously or accidentally changed, an error is detected and ERROR Code is shown on the LCD. Settings are checked every minute for consistency.

Firmware allows also user defined parameterization software using MODBUS protocol with specified MODBUS registers.

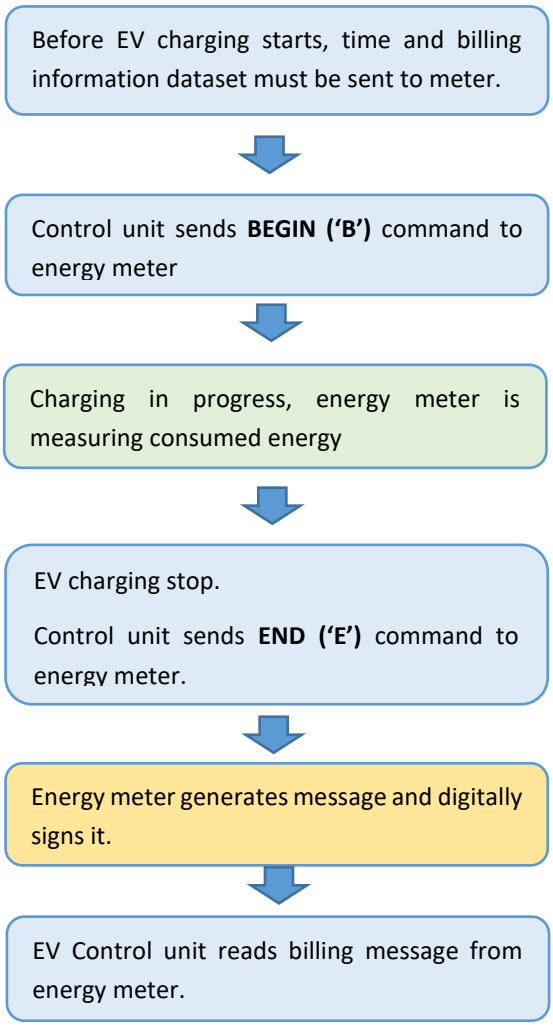
5.2 Digital signing procedure (VALID ONLY FOR WM3M4C)

5.2.1 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.

5.2.2 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.



5.3 Energy meter cryptographic functions explanation

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

5.3.1 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.

5.3.2 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.

5.3.3 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.

5.3.4 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.

5.3.5 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

5.3.6 Exporting billing dataset including signature

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

5.4 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

5.5 Crypto Register Definitions

5.5.1 Communication parameter

RS485 communication parameters table:

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 5: Selection of available measurement quantities

Default settings:

Baud rate: 115200, Parity: None, Stopbits: 1

5.5.2 Cryptographic control registers

Modbus Address	Size in bytes	Access Type	Description
47051	2	R/W	Command Register (see Table 11)
47052	2	R	Signature Status Register (see Table 7)
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)
47060	2	R	Signature Algorithm
47061	2	R/W	LCD Backlight
47062	2	R/W	LCD Display 2nd Row Mode
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
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
47076	2	R/W	End transaction specification in data set (format of complete transaction)

Table 6: Cryptographic control registers

5.5.3 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
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 7: Signature status register

5.5.4 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.

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.

5.5.4.1 Time status

Control unit must also set the status of clock in register 47071. Statuses are defined in **Napaka! Vira klicevanja ni bilo mogoče najti.**

5.5.4.2 Time status timeout

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

5.5.4.3 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 write 120 to 47053.
```

5.5.4.4 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 8: UTC / local time register

5.5.4.5 Time adjusting

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

5.5.5 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 9: Signature format

5.5.6 Signature algorithm

Energy meter currently supports only ECDSA-secp256r1-SHA256 algorithm. This parameter is not settable using MODBUS communication. It is a constant depending on the type of instrument (with or without crypto function). It is used only as information if the crypto function is implemented.

Register 47060:

Value	Signature format
0	Without signature (WM3M4)
4	ECDSA-secp256r1-SHA256 (WM3M4C)

Table 10: Signature algorithm

5.5.7 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.

5.5.8 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 transaction	Idle state (0)
'E' (0x45) 'L' (0x4C) 'R' (0x52) 'A' (0x41) 'P' (0x50)	End transaction	Active state
'C' (0x43)	Intermediate	Active state
'X' (0x58)	eXception	Active state (sets EF field to "Et")
'T' (0x54)	Tariff Change	Active state
'S' (0x53)	Suspended	Active state
'r' (0x72)	End transaction (with begin and end)	Active state
'f' (0x66)	Fiscal Reading	Any state
'h' (0x68)	Hold command	Active state
'i' (0x69)	Last charge reading	Idle state

Table 11: 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.

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.

If ‘i’ command is sent, array with begin and end reading of the last charge is generated and signed (added in the SW version 2.08).

5.5.9 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.

5.5.10 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.

Size of output billing dataset is at Modbus address 47057.

Output billing dataset is at Modbus address 47612.

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

5.5.11 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.

5.5.12 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.

5.5.13 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":[]
}
```


Energy meter fills following values:

PG:”T<signature counter>” or “F<fiscal counter>” for fiscal readings

MV:“Iskra”

MM:”WM3M4C”

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":"WM3M4C",
"MS":"18230001",
```

```
"MF":"2.08",
"IS":true,
"IF":[],
"IT":"NONE",
"ID":"",
"CT":"",
"CI":"",

"RD":[
{
"TM":"2022-11-11T13:22:28,000+0000 S",
"TX":"B",
"RV":123457.52,
"RI":"1-b:1.8.0",
"RU":"kWh",
"RT":"AC",
"EF":"",
"ST":"G"
},
{
"TM":"2022-11-11T13:24:12,000+0000 S",
"TX":"E",
"RV":123457.52,
"RI":"1-b:1.8.0",
"RU":"kWh",
"RT":"AC",
"EF":"",
"ST":"G"}
]
```


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

5.5.14 FW Identification display (47075)

FW identification is displayed on LCD for number of seconds written to register 47075.

Displayed info are presented in three rows on LCD display:

Main Firmware CRC (8 digits) in row 1
Phase module CRC (4 digits) in row 2
Main FW version in row 3

FW Identification screen:

5.5.15 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		
47037	47038	Hold measurement Counter value	T_32U		Wh
47039	47040	Suspend Timestamp	T_Unix		
47041	47042	Suspend Counter value	T_32U		Wh

5.5.16 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

5.5.17 Power loss behavior

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 detect 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”).

5.5.18 Unexpected reset behavior

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

5.5.19 End transaction specification in data set

In the SW version 2.05 MODBUS parameter 47076 is implemented. It defines the value TX in the end transaction block of data set in case ‘r’ command is used. Value “E” specifies basic end transaction and provides better presentation of output data in Transparenz software. Value “r” was used in initial version and with this setting it can be still used in actual applications.

Register 47076:

Value	TX value in end transaction block	Description
0	“TX”: “r”	The same operation as in version 2.03
1	“TX”: “E”	Improves presentation of data in the Transparenz software
2	“TX”: “E” Command ‘E‘ generates begin and end transaction	Allows compatibility with other devices in case of different approach to OCMF specification

Table 12: End transaction specification in data set

5.6 Password settings

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

PLEASE NOTE

A serial number of device is stated on the label and is also accessible with MiQen software. It can be found on the LCD under info sub-menu as well.

5.6.1 Password-Level 1 >PL1)

There are no settings in these meters protected by Password-level 1.

5.6.2 Password-Level 2 >PL2)

Password for second level is required.

Available settings: All settings are available.

5.6.3 A Backup Password->BP)

A backup password >BP) is used if passwords at level 2 >PL2 has 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..

5.6.4 Password locks time >min)

Password lock time is fixed – 1 minute.

5.6.5 Password setting

A password consists of four letters taken from the British alphabet from A to Z.

5.6.6 Password modification

A password is optionally modified; however, PL1 and PL2 password can be modified with access level of password PL2.

5.6.7 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.

6 TECHNICAL DATA

Rail mounting according DIN EN 60715

6.1 Terminals

Main inputs

Contacts capacity:	2.5mm^2 ... 25 (16) mm^2
Connection screws:	M5
Max torque:	3.5 Nm (PZ2)
Length of removed isolation>	10 mm

Communication module

Contact capacity:	1 ... 2.5 mm^2
Screws:	M3
Max torque:	1.2 Nm

6.2 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}	< 0.05 VA
Nominal voltage (U_n):	230 V (+15-20 %)
Power consumption	
per phase at U_n:	< 8 VA , 0.6 W
Nominal frequency (f_n):	50 Hz and 60 Hz
Minimum measuring time:	10 s

6.3 Accuracy

Active energy:	class 1 EN 62053-21,
	class B EN 50470-3
	±1.5% from Imin to Itr
	±1% from Itr to Imax
Voltage:	±1% of measured value
Current:	±1% of Iref from Ist to Iref
	±1% of measured value from Iref to Imax
Active Power:	±1% of nominal power (Un*Iref) from Ist to Iref
	±1% of measured value from Iref to Imax
Reactive, Apparent power:	±2% of nominal power from Ist to Iref
	±2% of measured value from Iref to Imax
Frequency:	±0.5% of measured value

6.4 LCD

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

6.5 LED

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

6.6 RS-485 Serial communication

Type:	RS-485
Speed:	1200 to 115200 bit/s (default 115200 bit/s)
Frame:	8, N, 1
Protocol:	MODBUS RTU
Address:	33 – (default)

6.7 Optical communication

Type:	IR
Connection:	via WM-USB adapter
Speed:	19200 bit/s
Frame:	8, N, 1
Protocol:	MODBUS RTU
Address:	33
Remark:	All settings are fixed

6.8 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
Humidity	Non condensing
Storage temperature	-30°C - + 80°C
Enclosure	self extinguish, complying UL94-V
Indoor meter:	yes
Degree of pollution:	2
Protection class:	II
Standard:	IEC 62052-31
Mechanical environment	M1
Electromagnetic environment	E2

7 EU DIRECTIVES CONFORMITY

EU Directive on Measuring Instruments **2014/32/EU**

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

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

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

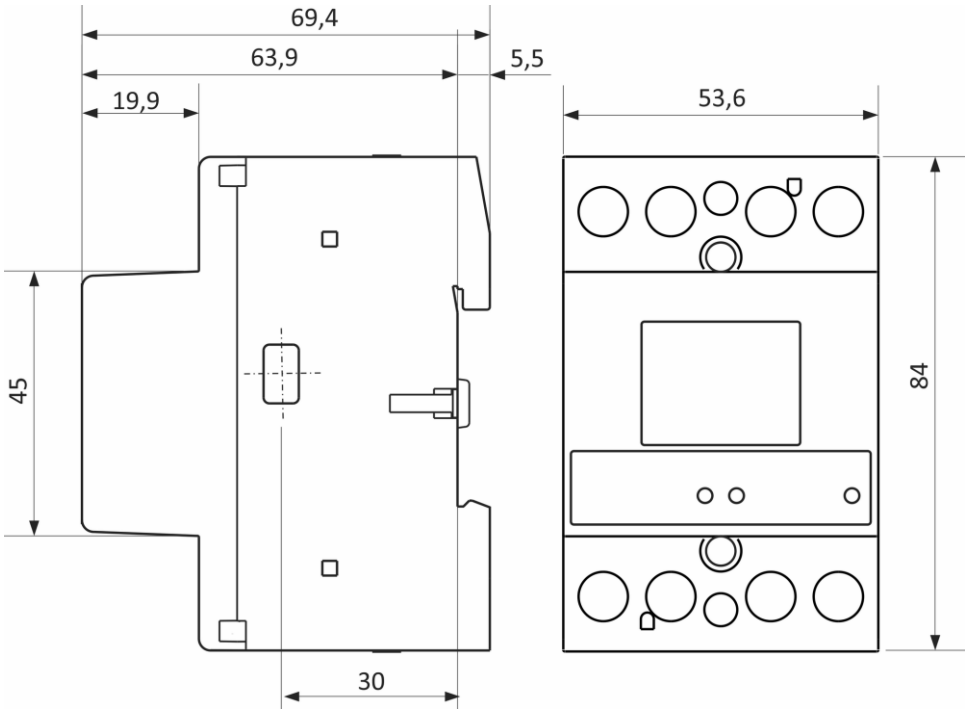
EU RED Directive **2014/53/EU**

8 DISPOSAL

It is forbidden to deposit electrical and electronic equipment as municipal waste.

The manufacturer or provider shall take waste equipment free of charge.

9 DIMENSIONAL DRAWINGS



10 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 quantity*
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*

Table 12: List of common abbreviations and expressions

Version	Owner	Comment	Date
1.02	Monika Ravnikar	1st issue.	12.5.2020
1.03	Monika Ravnikar	Add description saving of counters at PD. Correction of the definition of error Status.	29.5.2020
1.04	Manja Ščetinec	Definition of CRC of main CPU – 32 bit. Changing of upgrading of FW – PTB requirement. Additional explanation and new pictures.	22.4.2021
1.05	Manja Ščetinec	Update value for self consumption.	11.6.2021
1.06	Manja Ščetinec	Table 2 updated. Added item 5.5.19 – implemented parameter for setting the End transaction presentation in data set Item 5.6.1 corrected description for Pasword level 1 – there are no parameters under this level of protection	30.6.2021
1.07	Tea Tepina	Table 1, 2 and 11 updated. Added command 'i' in the reg. 47051	3.3.2023