User 's Manual

EN

Series of three-phase meters IE38Mx:

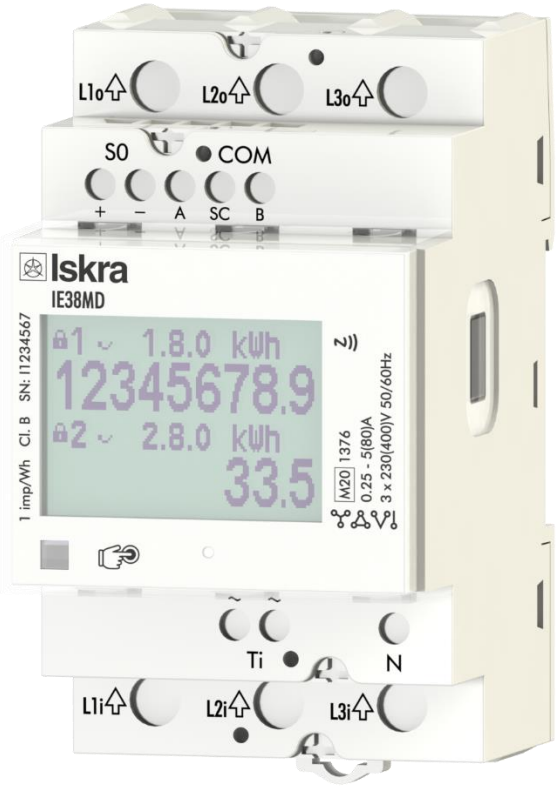
- IE38MS
- IE38MM
- IE38MD

January 2021 • Version 1.02

Three-phase electrical energy meter

IE38Mx

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 a three-phase energy meter IE38Mx.
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

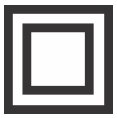
This booklet contains instructions for installation and use of three-phase energy meter IE38Mx. Installation and use of a device also includes handling with dangerous currents and voltages therefore should be installed, operated, serviced and maintained by qualified personnel only. ISKRA Company assumes 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 switching the device ON

Check the following before switching on the device:

- Nominal voltage.
- Terminals integrity.
- Protection fuse for voltage inputs (recommended maximal external fuse size is 80 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 and voltage level of I/O module.

Used symbols on devices' housing and labels

SYMBOL	*EXPLANATION*
	Three-phase 4-wire connection (3W4).
	Three-phase 3-wire 3 system connection (3W3).
	Three-phase 3-wire 2 system connection (2W3 Aron connection).
	Single-phase connection (1W).
	**WARNING** Indicates situations where careful reading of this manual is required and following requested steps to avoid potential injury is advised.
	Double insulation in compliance with the EN 61010−1: 2010 standard.
	NFC communication.
	IR - infrared (optical) communication.

SYMBOL	*EXPLANATION*
Modbus	Modbus communication.
M-Bus	MBus communication
	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.
CE	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 a three-phase energy meter IE38Mx required to understand its purpose, applicability and basic features connected to its operation.
In this chapter you will find:

1.1 Introduction

Regarding the options of a three phase energy meter, different chapters should be considered since it might vary in functionality.

1.1.1 Tables

Supported functions and measurements are listed in tables. Symbols in tables indicate support of enabled functions for different connection schemes. Additionally a legend is placed below table of used symbols. Meaning of symbols is:

- ● Function is supported
- × Function is not supported
- ○ Symbol meaning varies and is described in the legend below the table

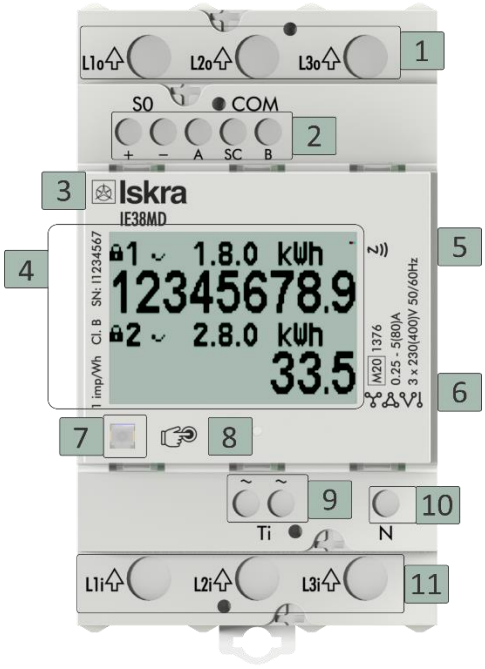
1.2 Description of the device

The three-phase energy meters **IE38Mx** are intended for energy measurements in three-phase electrical power network and can be used in residential, industrial and utility applications. Meters measure energy directly in 3-wire and 4-wire networks according to the principle of fast sampling of voltage and current signals. A built-in microprocessor calculates active/reactive/apparent power and energy, current, voltage, frequency, power factor, power angle and frequency (for each phase and total sum) from the measured signals. This smart meter can also perform basic harmonic analysis (THDU, THDI). This enables quick overview of harmonic distortion either coming from a network or generated by the load. Microprocessor also controls LCD, LED, IR communication and optional extensions.

A capacitive touch button on the front of the energy meter enables access to switch between measurements and settings in the menu.

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

1.2.1 Appearance



1. **Current terminals – to load**
2. **AUX terminals (options):**
   - RS485 (MODBus)
   - M-BUS
   - PULSE OUTPUT ($S0_{1,2}$)
3. **NFC**
4. **Information display**
5. **DIN-Rail fitting**
6. **IR communication port –ON SIDE**
7. **LED indicator**
8. **Cap touch**
9. **Tariff clock input**
10. **Neutral input**
11. **Current terminal – source (max 80 A)**

LCD

Display type:	Matrix (128 x 64)
Illumination:	white (normal operation)
	red (alarm indication)

LED

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

Figure 1: *Appearance of three-phase electric energy meter IE38Mx*

1.3 Three-phase energy meters application

Energy meters have built-in optical (IR) communication port on the side. It can be used for controlling Bistable switch – BICOM or in combination with SG smart gateway (more info about BICOM and SG can be found on https://www.iskra.eu/. It can be used for direct communication with a PC to change settings of devices without any communication installed.

Optional the meter can be equipped with the following communications:

- **RS485** serial communication with the MODBUS protocol,
- **M-BUS** serial communication.

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

Besides of communication modules, there are also **tariff input** and built-in **pulse output**.

Tariff input provides measurement of two tariffs for selected energy registers.

Pulse output $S0_{1,2}$ is sending data to the devices for checking and monitoring consumed energy.

Energy meters are equipped with **NFC communication** for easy setting and downloading data via mobile app.

NFC communication is implemented for parametrization as well as for reading data (e.g. counters, measurements, etc.) from the smart meter. Special application available from our internet site has to be used to perform such operations.

1.4 Main features

- Three-phase direct connected DIN-rail mounting meters up to maximum current **80 A (I_{max}).**
- **MID** approval.
- **Class 1** for active energy according to EN 62053-21 and **B** according to EN 50470-3 .
- **Class 2** for reactive energy according to IEC 62053-23.
- **Bidirectional** energy measurement (import/export).
- **Temperature range** climatic condition as indoor meter according EN 50470.
- Display segment **Matrix LCD**.
- Multifunctional front red **LED**.
- **IR serial communication**.
- Measurement of:
    - **power** (active, reactive, apparent) and **energy** (each phase and total),
    - **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),
    - **active tariff** (option),
    - **THD of voltage**,
    - **THD of current**.
- **2nd multifunction pulse output** *(valid only for IE38MS)***.**
- **RS485 Serial communication** *(valid only for IE38MD)***.**
- **NFC (option)** enables an easy setting and downloading meter data via mobile app.
- **M-bus Serial communication** *(valid only for IE38MM)***.**
- **Tariff input** (230 V AC).
- **Tariff** management (up to 6 tariffs manageable via communication).
- **-25°C - 70°C** ambient operation temperature.
- **Limit control (Alarm)** function can give info about exceeded conditions and trigger BICOM switch through IR communication**.**
- **3-DIN rail** width mounting according to EN 60715.
- **Sealable** terminal cover.

1.5 Type differences

Different type differ on functionality and equipment as shown in the following table.

General hardware features	IE38MS	IE38MM	IE38MD
MID approval	●	●	●
Pulse output $S0_1$	●	●	●
Pulse output $S0_2$	●	×	×
Tariff input	●	●	●
85°C display	●	●	●
Infrared (optical) communication - IR	●	●	●
MODBUS comm. Protocol RS485	×	×	●
General software features	IE38MS	IE38MM	IE38MD
MODBUS comm. Protocol (IR)	●	●	●
M-bus serial comm.	×	●	×
NFC communication	●	●	●

***Table 1**: General hardware and software features of different types of meters*

2 CONNECTION

This chapter deals with the instructions for three-phase electrical energy meter IE38Mx connection. Both the use and connection of the device includes handling with dangerous currents and voltages. Connection shall therefore be performed ONLY by a qualified person using an appropriate equipment. ISKRA, d.o.o. does not take any responsibility regarding the use and connection. If any doubt occurs regarding connection and 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

Threee-phase electrical energy meter IE38Mx is intended for DIN-rail mounting. In case of using the stranded wire, the ferrule must be attached before the mounting.

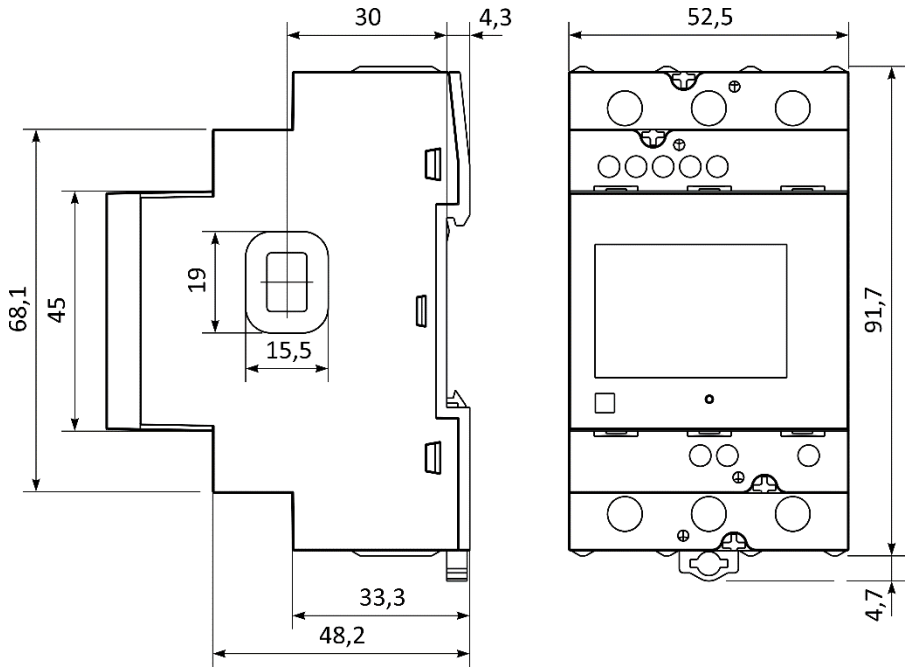


Figure 2: *Dimensional drawing and rear connection terminals position*

2.2 Electrical connection

WARNING!

Wrong or incomplete connection of voltage or other terminals can cause non-operation or damage to the device.
Installation must be carried out and inspected by a specialist or under his supervision. When working on the meter, switch off the mains voltage! It is recommended to use 3x80 A fuse for the line protection.

Meter is used for direct connection into the three-phase four-wire or three-wire networks. It can be used also in single-phase network, connected in the phase L3. Three-wire 2 system connection network measures only phase to phase values (phase values are not available). After electrical installation for MID approved meters the installation should be also set and confirmed in software. Until installation confirmation warning Installation not set is displayed on LCD. For installation setting see item 3.2.3.5.3. Meter can be equipped with different modules. Pictures below are showing equipped combinations.

PLEASE NOTE

Setting of installation can be done just once, so take care to confirm the connection which fits the required connection and required use.

Recommended installation:

1 Mounting to DIN rail according to DIN EN60715
2 Power contacts:
   a. Power contacts capacity 2.5 mm^2 – 25 mm^2
   b. Connection screws M5
   c. Max torque 3.5 Nm
3 Auxiliary terminals:
   a. Auxiliary terminals contact capacity 0.05 mm^2 – 1.5 mm^2
   b. Auxiliary terminals screws M3
   c. Max torque 1.2 Nm

Mark	*Meaning*
$L_{1,2,3}$	*Line input*
N	*Neutral input*

Table 2: *Marks used on wire connection diagrams*

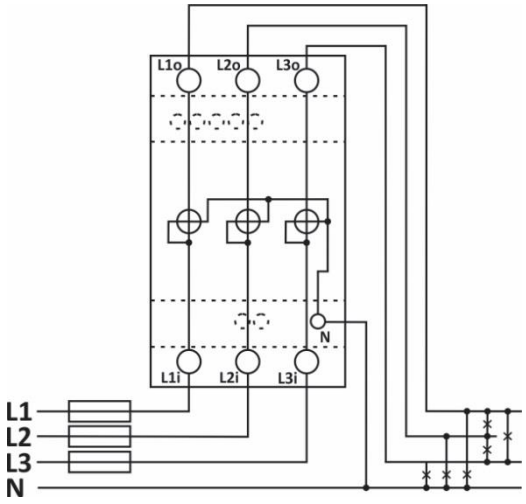


Figure 3: *Three-phase 4-wire connection diagram (3W4)*

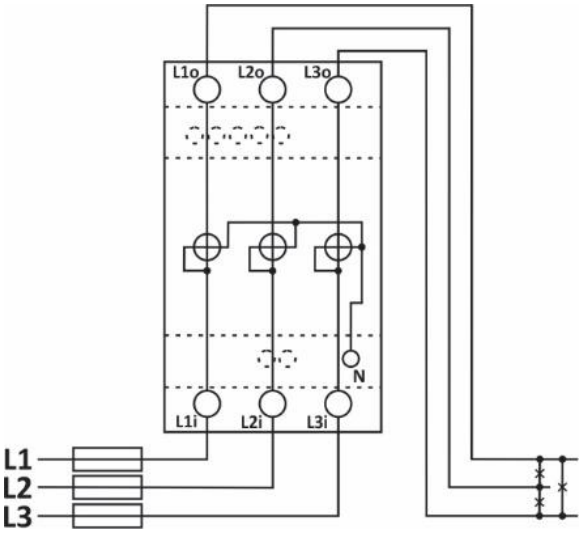


Figure 4: *Three-phase 3-wire 3 system connection diagram (3W3)*

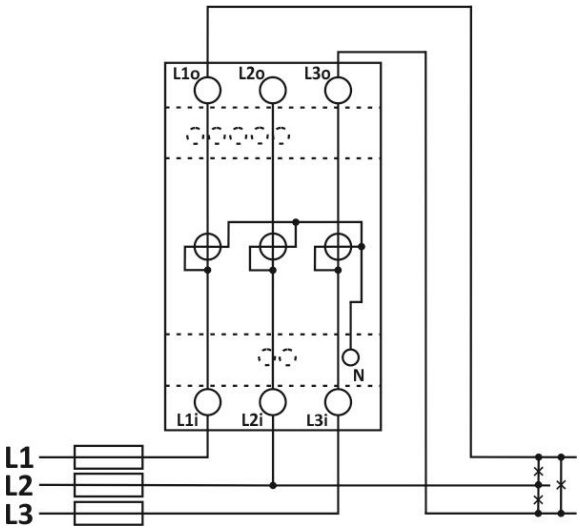


Figure 5*: Three-phase 3-wire 2 system connection diagram (2W3)*

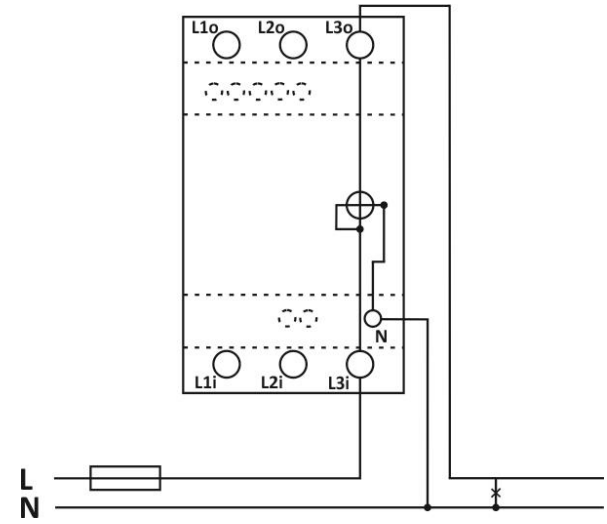


Figure 6: *Single.-phase connection diagram 1W*

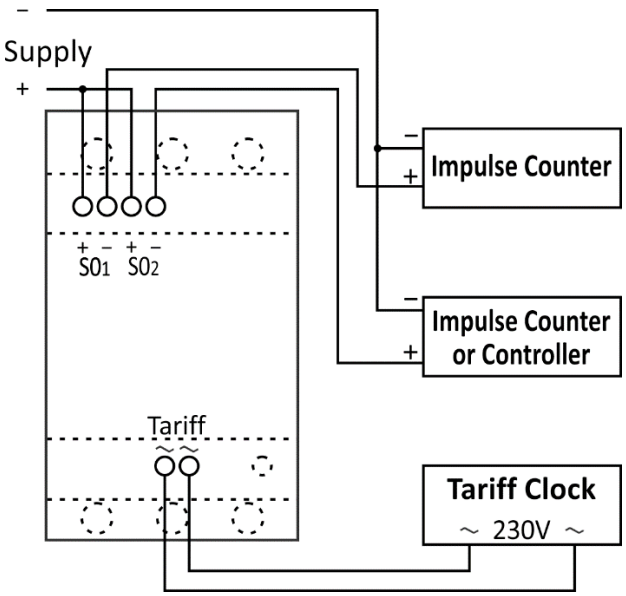


Figure 7: *Connection diagram of S0 output, impulse counter, impulse counter or controller and tariff clock*

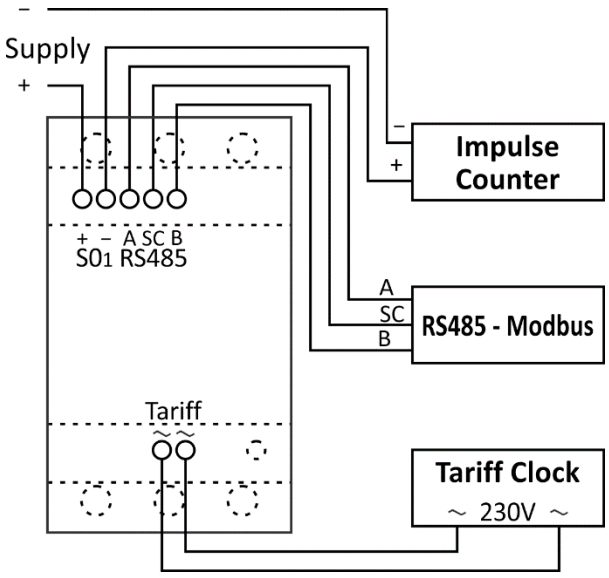


Figure 8: *Connection diagram of S0 output, impulse counter, RS485 - Modbus and tariff clock*

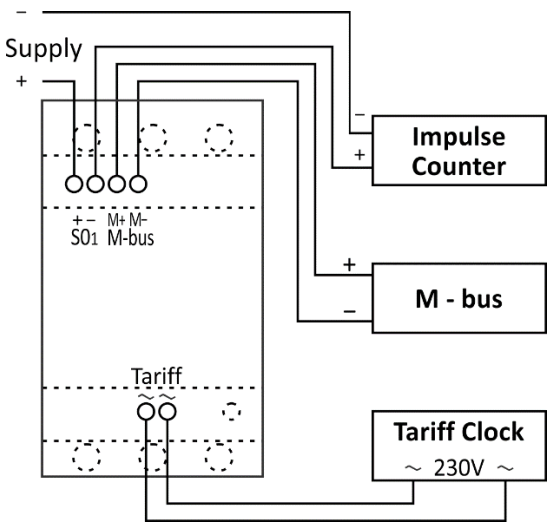


Figure 9: *Connection diagram of S0 output, impulse counter, M - bus and tariff clock*

2.2.1 Auxiliary circuit connection

For communication with outside world multiple manners are used:

- **IR communication module (option)** using MODBUS protocol. It can be used for setting and testing the meter using USB adapter.
- **$S0_{1,2}$ output** module is used for counting number of pulses depending on consumed energy. The $S0_2$ output can be programmed as alarm output.
- **RS485 (option)** communication module is galvanic isolated from meter main circuit. It enables setting the meter, data readout in the network and tariff setting.
- **M-BUS (option)** communication module is galvanic isolated from meter main circuit. It enables setting the meter, data readout in the network and tariff setting.
- **NFC (option)** enables an easy setting and downloading meter data via mobile app.
- **Tariff input (option)** module is used to set active tariff.
- **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 or cap touch.
- **A capacitive touch button** enables access to switch between measurements and settings in the menu.

Auxiliary terminal			
Pulse output (S01, S02)	+	-	
Tariff input	~	~	
M-bus (COM)	M+	M-	
RS485 (COM)	A	*SC	B

**It is intended to be used for shielding for RS485.*

Table 3: *Survey of auxiliary circuit connection*

PLEASE NOTE

Check markings on the side of the meter to check what modules are built in.

3 FIRST STEPS

Programming a three-phase electrical energy meter IE38Mx 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 Keyboard navigation

The capacitive touch (symbol below) is used for shifting between screens, for selecting the specific segment of the menu and for confirming the settings. Press the capacitive touch (**short-touch**) to move forward between the screens. **Long-touch** (approximately 3 seconds) is used to confirm the selection, to sett the next digit, or to enter the sub-menu. **Very-long-touch** (approximately 5 seconds) considers the function *ESC* (during the parameter setting the screen goes back to the explicit parameter in the other cases the LCD returns in the initial cycling mode).

If the screen backlight is off, the first touch turns on the backlight, then the long-touch to view the main menu.

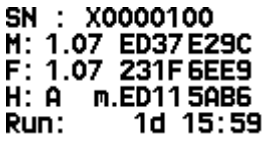
If the lock of the capacitive touch is available, to activate it, a very long-touch is needed.

Figure 10: *The symbol of capacitive touch*

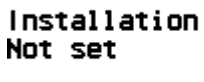
3.2 LCD User Interface

3.2.1 LCD display at start up

SN: serial number
MID: Version and CRC of Part 2
FUN: Version and CRC of Part 2
HW: Hardware version; m. : CRC of phase measuring modules (high, low)
Run: Operational time (days hours minutes)



After the electrical connection, the display shows an info screen (picture on top) for two seconds. The following is automatic cycling of measurements on the screen regarding the period that is defined in settings (for more details see chapter Settings, Device settings, General settings, Display). Measurements consist of energy counters and other actual measured values. The MID approved meter shows a warning screen (picture on the right) *Installation Not set* every 5 seconds if the installation of connection mode is not set yet.



Besides the cycling of measurements, one can enter the display menu structure by using a long touch. If the capacitive touch is not pressed for more than 90 seconds, the cycling of measurements automatically begines again. Hold page function is a function that locks a measurement screen. Therefore, even if the menu structure is entered and left for more than 90 seconds, that specific measurement screen will be shown. This is also in case of a powerdown.

The explicit settings can be changed through the Setting menu (for more details see chapter Display of device setting), MiQen software or mobile app using NFC.

PLEASE NOTE

All settings that are performed can be subsequently changed via MiQen by means of communication.

PLEASE NOTE

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.

3.2.2 Capacitive touch self calibration process

In a reported fixed 64s interval the average, minimum and maximum value of the capacitive touch sensor is calculated. If the conditions are stable (without interruptions) then the average value of the capacitive touch sensor is used as a reference value. If the new reference value deviates sufficiently from the permanently stored value, it is permanently saved. Permanently stored value is used when the power is turned on.

3.2.3 Energy counters

There are two sets of energy registers – four non-resettable registers which can be assigned for active energy (MID approved), reactive energy (national approval) or apparent energy (no approval). The meter with MID approval should have at least one register with active energy measurement. There are additional 16 energy registers which can be parameterised by the user regarding type of energy, active quadrants, direction of counting and tariff and they can also be resetted using MODBUS command or cap touch.

On the LCD up to two energy counters are displayed. There is the lock sign for the fixed legally relevant non-resettable counters, the counter designation, the sign of currently active register, an additional code and the unit. For the code the user can choose between the OBIS code or letter description code. The 9-digit numerical number shows the value of the energy. The decimal dot is fixed and resolution is fixed to 100 Wh. The screen is displayed for the pre-set cyclic period.

Legally relevant non-resettable registers are designated with letters 1 to 4 after the lock sign , while legally non-relevant resettable registers are designated with 01 to 16. The code is specified in table 4 and table 5.

Register description E1 to E4	***OBIS code***	***Letter description code***
Active energy Q1+Q4 – all tariffs	1.8.0	A.I.0
Active energy Q1+Q4 – tariff 1 or 2	1.8.1 or 1.8.2	A.I.1 or A.I.2
Active energy Q2+Q3 – all tariffs	2.8.0	A.E.0
Active energy Q2+Q3 – tariff 1 or 2	2.8.1 or 2.8.2	A.E.1 or A.E.2
Active absolute energy– all tariffs (Abs(Q1+Q4) + abs(Q2+Q3))	15.8.0	A.A.0
Active absolute energy– tariff 1 or 2 (Abs(Q1+Q4) + abs(Q2+Q3))	15.8.1 or 15.8.2	A.A.1 or A.A.2
Reactive energy – Q1+Q2 - all tariffs	3.8.0	r.I.0
Reactive energy – Q1+Q2 - tariff 1 or 2	3.8.1 or 3.8.2	r.I.1 or r.I.2
Reactive energy – Q3+Q4 - all tariffs	4.8.0	r.E.0
Reactive energy – Q3+Q4 - tariff 1 or 2	4.8.1 or 4.8.2	r.E.1 or r.E.2
Reactive absolute energy– all tariffs	95.8.0 (manufacturer specification)	r.A.0
Reactive absolute energy– tariff 1 or 2	95.8.1 or 95.8.2 (manufacturer specification)	r.A.1 or r.A.2
Apparent absolute energy-all tariffs	9.8.0	S.A.0
Apparent absolute energy- tariff 1 or 2	9.8.1 or 9.8.2	S.A.1 or S.A.2

Table 4*: OBIS code and letter description code for E1 to E4*

Register description C1 to C16	***OBIS code***	***Letter description code***
Active energy Q1+Q4 – all tariffs	1.8.0	A.I.0
Active energy Q1+Q4 – tariff 1 to 6	1.8.1 to 1.8.6	A.I.1 to A.I.6
All energy types – tariff 1 to 6	x.x.1 to x.x.6	x.x.1.to x.x.6
All energy types – mixed tariffs (example tariff 1 and tariff 2)	x.x.9	x.x
Active energy Q2+Q3 – all tariffs	2.8.0	A.E.0
Active absolute energy– all tariffs (Abs(Q1+Q4) + abs(Q2+Q3))	15.8.0	A.A.0
Active energy (signed)– all tariffs (Abs(Q1+Q4) – abs(Q2+Q3))	16.8.0	A.b.0
Active energy Q1– all tariffs	17.8.0	A. .0
Active energy Q2– all tariffs	18.8.0	A. .0
Active energy Q3– all tariffs	19.8.0	A. .0
Active energy Q4– all tariffs	20.8.0	A. .0
Reactive energy – Q1+Q2 - all tariffs	3.8.0	r.I.0
Reactive energy – Q3+Q4 - all tariffs	4.8.0	r.E.0
Reactive energy – Q1 - all tariffs	5.8.0	r. .0
Reactive energy – Q2 - all tariffs	6.8.0	r. .0
Reactive energy – Q3 - all tariffs	7.8.0	r. .0
Reactive energy – Q4 - all tariffs	8.8.0	r. .0
Reactive absolute energy– all tariffs	95.8.0 (manufacturer specification)	r.A.0
Apparent absolute energy-all tariffs	9.8.0	S.A.0
Apparent energy –Q1+Q4 – all tariffs	9.8.0	S.I.0
Apparent energy – Q2+Q3 – all tariffs	10.8.0	S.E.0
Other unspecified custom setting regarding power, quadrants	0.0.y y (0,1,2,3,4,9)	x. .y x x (A,r,S), y (0,1,2,3,4,» «)

Table 5*: OBIS code and letter description code for C1 to C16*

3.2.4 Initial display menu structure

The following is a main menu divided into several sub-menus (ESC, Measurements, Info, Settings, Resets, Installation).

Main menu
ESC
Measurements
Info
Settings
Resets
Installation
www.iskra.eu / Temperature 27 °C

3.2.4.1 *ESC*

Long-touch ESC, the screen cyclings between chosen measurements on default mode. The mode could be changed in MiQen software, to counter n1 or to hold page (hold the page of the selected measurement). Short-touch to shift between sub-menus.

3.2.4.2 *Display of device measurements*

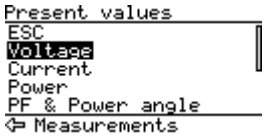
Short-touch Measurements, the sub-menu is entered (ESC, Present values, Limits). Long-touch ESC to return to the main menu. Long-touch Present values to observe the specifics measurements or Limits to observe the limits.

Measurements
ESC
Present values
Limits
⇐Main menu

3.2.4.2.1 Present values

Present values
ESC
Voltage
Current
Power
PF & Power angle
Frequency
Energy
THD
Custom
Overwiew
⇐Measurements

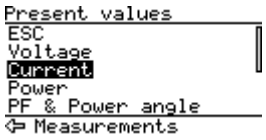
Long- touch Present values, the sub-menu is entered (ESC, Voltage, Current, Power, PF & Power angle, Frequency, Energy, THD, Custom, Overview). Long-touch ESC to return to the measurements menu.



➢ **VOLTAGE**

Long-touch Voltage to observe the phase voltage, phase to phase voltage, voltage angle, average values of phase voltage, and average values of phase to phase voltage.

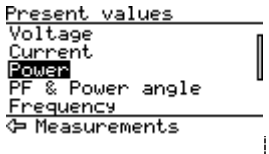
Phase voltage 1,2,3	*Phase to phase voltage*	*Voltage angle*	*Averages*
18.59 V U1	0.00 V U12	+0.00° φ12	82.77 V UA
18.60 V U2	226.44 V U23	+0.00° φ23	153.10 V UΔ
234.51 V U3	226.41 V U31	+0.00° φ31	



➢ **CURRENT**

Long- touch Current to observe the phase current, and average current.

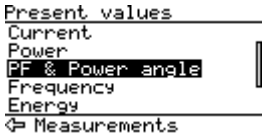
Phase current	*Average current*
--- A I1	0.0000 A Iavg
--- A I2	0.0000 A I
0.0000 A I3	



➢ **POWER**

Long- touch *Power* to observe the power (active, reactive, apparent), phase power (active, reactive, apparent).

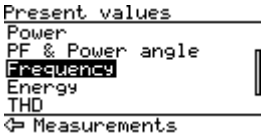
Power	*Phase active power*	*Phase reactive power*	*Phase apparent power*
0.00 W P+	--- W P1	--- var Q1	--- var Q1
0.00 var Q∋	--- W P2	--- var Q2	--- var Q2
0.00 VA S	0.00 W P3+	0.00 var Q3∋	0.00 var Q3∋



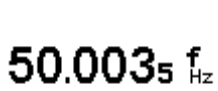
➢ **PF & POWER ANGLE**

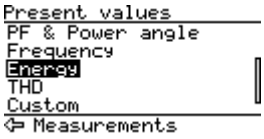
Long- touch *PF & Power angle* to observe the power factor and power angle, phase power factor and phase power angle.

Power factor, power angle	*Phase power factor*	*Phase power angle*
+1.000 ∋ PF	--- PF1	--- ° φ1
+0.00° φ	--- PF2	--- ° φ2
	+1.000 ∋ PF3	+0.00° φ3



➢ **FREQUENCY**

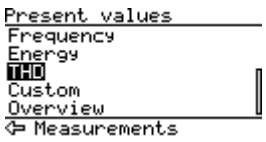




➢ **ENERGY**

Long- touch *Energy* to observe the measured energy. Two different types of energy registers are shown (resettable and non-resettable). Disabled energy counters are not shown on the screen. The resettable energy counter (Non-MID meters) can be reset, while the non-resettable (the symbol of lock representing it) has been measuring the quantity continuously. The resettable energy counters enable to set the value of measured energy (see chapter Settings, energy, counters). The energy counter you reset starts to re-measure the value from the zero.

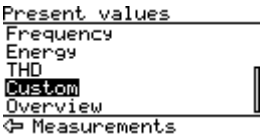
Measured energy	*Measured energy*	*Measured energy (resettable)*
🔒1 1.8.0 kWh 0.0 🔒2 2.8.0 kWh 0.0	🔒3 3.8.0 kvarh 0.0 🔒4 4.8.0 kvarh 0.0	01 1.8.0 kWh 0.0 02 2.8.0 kWh 0.0
Measured energy (resettable)	*Measured energy (resettable)*	*Measured energy (resettable)*
03 3.8.0 kvarh 0.0 04 4.8.0 kvarh 0.0	05 1.8.0 kWh 0.0 06 2.8.0 kWh 0.0	07 3.8.0 kvarh 0.0 08 4.8.0 kvarh 0.0



➢ **THD**

Long- touch *THD* to observe the total harmonic distortion of current and voltage.

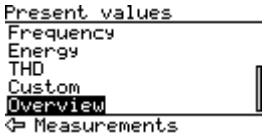
THD of current	*THD of voltage*
0.00 %THD I1% 0.00 %THD I2% 0.00 %THD I3%	1.99 %THD U1% 1.99 %THD U2% 1.96 %THD U3%



➢ **CUSTOM**

Long- touch *Custom* to observe the measurements of phase one, measurements of phase two, measurements of phase three and custom measurements.

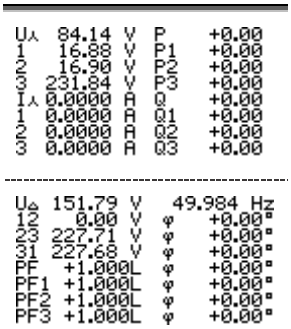
Phase 1	*Phase 2*	*Phase 3*	*Custom*
17.82 V U1 --- A I1 --- W P1	17.85 V U2 --- A I2 --- W P2	233.84 V U3 0.0000 A I3 0.00 W P3 +	U1 17.87 V I1 0.0000 A P1 0.00 W + U2 17.88 V I2 0.0000 A



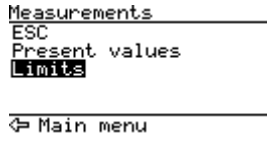
➢ **Overview**

Long- touch *Overview* to observe the custom screens.

Values of measurements



3.2.4.2.2 Limits



Long- touch *Limits* to observe the limits set in settings (see chapter 4 Settings, Limits). Long- touch *ESC* to return to the measurements menu.

Limits
ESC
Group 1: 1….
Group 2: ….
Group 3: …..
Group 4: …..
⇐Measurements

Group 1	*Group 2*	*Group 3*	*Group 4*
G1L1 U1 < 200.00 G1L2 -- G1L3 -- G1L4 --	G2L1 I1 > 96.00 G2L2 -- G2L3 -- G2L4 --	G3L1 -- G3L2 -- G3L3 -- G3L4 --	G4L1 -- G4L2 -- G4L3 -- G4L4 --

3.2.4.3 *Display of device info*

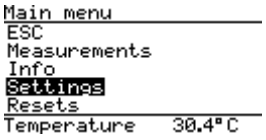
Long- touch *Info* to view informations about the energy meter (name, date, hour, firmwhare/technical informations, informations of locking, error informations).

Name	*Instrument info*	*Date and hour*
Iskra **IE38MD** Energy Meter www.iskra.eu	Info SN : X0000100 MID: 1.07 ED37 E29C U 2 FUN: 1.07 231F 6EE9 L 0 HW : A m.ED11 5AB6 Mx8 Run: 1d 16h 22' ⇦ Main menu	Info **24.08.2020** **12:49:57** Temperature 30.2°C
Icon info	*Error info*	
Info Locked Clock not set ⇦ Main menu	Info **Error 0** **Data CRC 00** **Code CRC 00** ⇦ Main menu	

Instrument info abbreviations:

SN: serial number
MID: Version and CRC of Part 2, U: upgrade counter
FUN: Version and CRC of Part 2, L: unlock counter
HW: Hardware version, m. : CRC of phase measuring modules (high, low)
Run: Operational time (days hours minutes)

3.2.4.4 *Display of device settings*



Long- touch *Settings* to enter the sub menu (table below).

Settings
ESC
General
Date & Time
Communication
LCD
Security
Energy
⇐Main menu

3.2.4.4.1 General

General
ESC
Language
⇐Settings

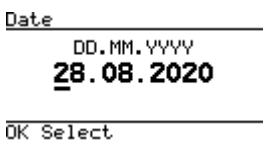
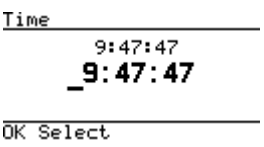
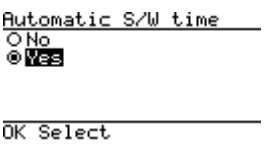
Long- touch *General*, the sub-menu is entered (ESC, Language). Long- touch *ESC* to return to the settings menu. Long- touch *Language* to set language (the options are shown in pictures below). Short-touch to chose the requested language, then long-touch *ESC* to confirm it.

3.2.4.4.2 Date and time

Long- touch *Date and time*, the sub-menu is entered (ESC, Date, Time. Automatic S/W time). Long-touch *ESC* to return to the settings menu. Long-touch *Date* to set the date and on *Time* to set the time. Long-touch *Automatic S/W time* to set automatically change between summer or winter time.

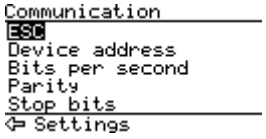
PLEASE NOTE

The clock is for informational purposes only.

Date	*Time*	*Automatic S/W time*
		

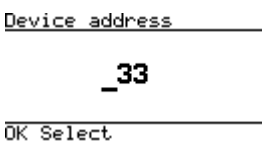
3.2.4.4.3 Communication

Communication menu is available at M-bus and MODBus RS485 option (IE38MxMM and IE38MxMD) and can be used for setting communication parameters (communication addresses, bits per second, parity and stop bits).



Long-touch *Communication*, the sub-menu is entered (ESC, Device address, Bits per second, Parity, Stop bits). Long-touch *ESC* to return to the settings menu.

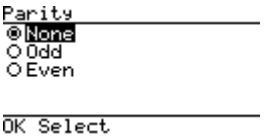
➢ **DEVICE ADRREESS**



Long-touch *Device address* to set the address number. Non configured devices have the same factory Modbus address set to 33. Short-touch to move between the numbers. Long-touch the selected number to save the value. Very long-touch to save the device address.

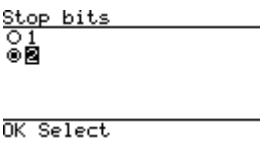
➢ **BITS PER SECOND**

Long-touch *Bits per second* to set the value of specific communication.



➢ **PARITY**

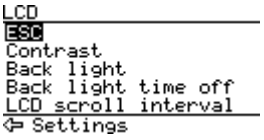
Set the party of communication (none, odd or even). Long-touch to set the selection.



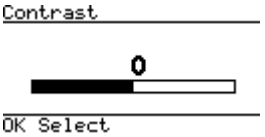
➢ **STOP BITS**

Set the stop bits of communication (1 or 2). Long press to set the selected value.

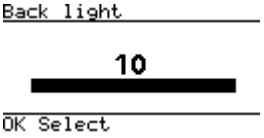
3.2.4.4.4 LCD



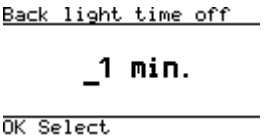
Long-touch *LCD*, the sub-menu is entered (ESC, Contrast, Backlight, Backlight time off, LCD scroll interval). Long-touch *ESC* to return to the settings menu.



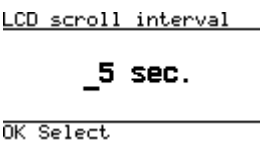
Long-touch *Contrast* to set the value of the contrast of the screen (from -10 to 10). Long-touch the selected value to save the settings.



Long-touch *Backlight* to change the screen brightness (from 0 to 10). Long-touch the selected value to save the settings.

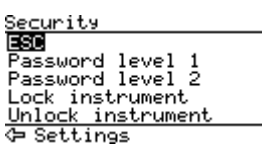


Long-touch *Backlight time off* to set the period of turn off the backlight of the screen (from 0 to 9 minutes or no). Long-touch the selected value to save the settings.



Long-touch the *LCD scroll interval* to set the value of the interval of scrolling measurements (from 5 seconds to 65 seconds). Long-touch the selected value to save the settings.

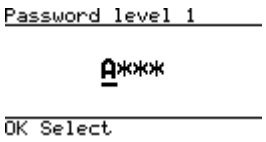
3.2.4.4.5 Security



Long-touch *Security*, the sub-menu is entered (ESC, Password level 1, Password level 2, Lock instrument, unlock instrument). Long-touch *ESC* LCD returns to the settings menu.

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 single groups regarding security level: PL1 >password level 1, PL2 >password level 2 and BP >a backup password.



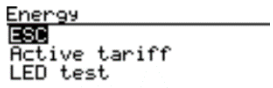
Long-touch *Password level 1* to set the passworld (4 letters). Long-touch the selected letter to save the settings.

Long-touch *Password level 2* to set the passworld (4 letters). Long-touch the selected letter to save the settings.

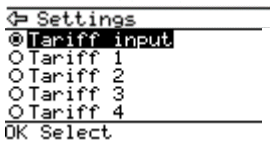
Long-touch *Lock instrument* to lock the meter.

Long-touch *Unlock instrument* to write the password for unlock (4 letters). Long-touch the selected letter to save the settings.

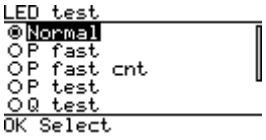
3.2.4.4.6 Energy

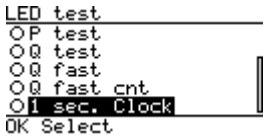


Long-touch *Energy*, the sub-menu is entered (ESC, Active tariff, LED test). Long-touch *ESC* to return to the settings menu.



Long-touch *Active tariff* to set the tariff (Tariff input, tariff 1, 2, 3, 4, 5, 6). Long-touch the selection. Tariff management is possible for 16 NON-MID counters. As default management of 2 tariffs is possible using tariff input. In case all active MID registers from E1 to E4 are parameterized for cumulative energy (all tariffs) it is possible to set any single tariff as a set value. In this case, it is possible to switch 6 tariffs through a communication interface using the MODBUS register.





Long-touch *LED test* to set specifics test. Long-touch the selection.

This function shall be used only for testing purposes during type testing and metrological verification of the meters.

Test modes:

Normal – 1000 imp/kWh, counter resolution 100 Wh/100 varh.

P fast (Test mode P Fast) – 100000 imp/kWh, counter resolution 1 Wh/1 varh.

P fast cnt (Test mode P Fast – counter only) – 1000 imp/kWh, counter resolution 1 Wh/1 varh.

P test (Test mode P) – 1000 imp/kWh, counter resolution 100 Wh/100 varh.

Q test (Test mode Q)– 1000 imp/kvarh, counter resolution 100 Wh/100 varh.

Q fast (Test mode Q fast) – 100000 imp/kvarh, counter resolution 1 Wh/1 varh.

Q fast cnt (Test mode Q fast - counter only) – 1000 imp/kvarh, counter resolution 1 Wh/1 varh.

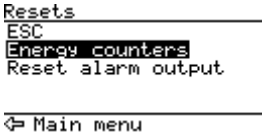
Long-touch *LED No. of pulses* to set the number of puleses (). Long-touch the selection.

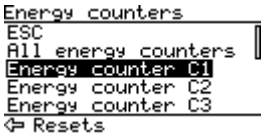
3.2.4.5 *Display of device resets*

Long-touch *Reset*, the sub-menu is entered (ESC, Energy counters, Reset alarm output).

Resets
ESC
Energy counters
Reset alarm output
⇦Main menu

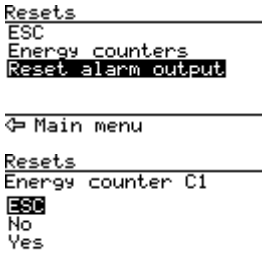
3.2.4.5.1 Energy counters





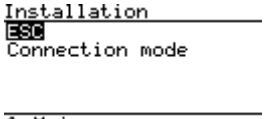
Long-touch *Energy counters* to chose the counter to reset (ESC, All energy counters, from energy counter C1 to C16). Long-touch *ESC* to return to the *Resets*.

3.2.4.5.2 Reset alarm output

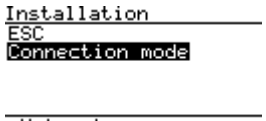


Long-touch the *Reset alarm output* to chose the alarm reset (ESC, no, yes). Long-touch *ESC* to return to Resets, long-touch *No* that the selected counter is not reset or *Yes* to reset the selected counter.

3.2.4.5.3 Installation



Long-touch *Installation* to set the connection mode of the MID approved meter. Long-touch *ESC* LCD returns to the *Main menu*.



The connection mode can be set only once. Until the connection mode is not set, the warning screen appears every 5 seconds (Installation Not set). Long-touch *Connection mode* setting menu is entered to select one of three options (see picture below):

- 3W4, 1W, 3W3 – Vector (Evaluation of the sum of phases),
- 3W4, 1W – Arithmetic (Evaluation of individual phases),
- 2W3 – Vector (Evaluation of the sum of phases).

Evaluation of individulal phases means that in case of opposite energy flow in different phases the energy is registered to both import and export registers taking into accout each individual phase. It is applicable only in 4-wire connection.

Import – export evaluation (example):

P1 = P, P2 = P, P3 = -P

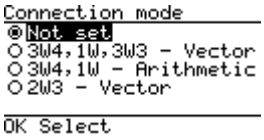
Evaluation as the sum of phases – summated power Preg registered

Preg = P1 + P2 + P3 = P + P – P = P(+) *Active power P(+) registered in counter A+.*

Evaluation regarding individual phases:

Preg = P(+) + P(+) + P(-) = 2P(+) + P(-) *Active power 2P(+) registered in counter A+*

Active power P(-) registered in counter A-



Default value is the common three-phase 4-wire connection (3W4) which enables also single-phase measurement in L3 (1W) and 3-system 3–wire connection (3W3) with import – export evaluation as the sum of phases. Also this connection has to be confirmed to block further changes and after confirmation the message Installation not set is switched off.

In case 4-wire arithmetic mode with import-export evaluation for individual phases or 3-wire 2-system connection are chosen the password DCBA has to be entered to allow the modification. In 2W3 connection the phase measurements are blocked on LCD while in 3W3 connection they are not automaticly blocked. It is recommended to remove phase voltage and power measurements at Displayed measurement setting as these are not relevant at 3-wire connection.

3.2.5 Error display on LCD

If error is detected Error display appears on LCD after each cycle for 5 seconds. The first two bits are the summary description of CRC errors. The decimal value of first 3 Bits (0 ...7) is displayed as Error.
The other bits are shown with 2 values:

- Data CRC – shows Parameter CRC details – decimal value (0...3f) of bits 8 to 13.
- Code CRC – shows Firmware CRC details – decimal value (0 ...1f) of bits 3 to 7.

3.3 Calibration and setting parameters

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, and phase angle. If these parameters were tenaciously or accidentally changed, an error type 1 is detected and Error 1 is shown on the LCD. Calibration parameters are checked every 64 seconds.
The parameters related to energy measurement can only be changed if the MID key is unlocked.

3.4 Freeze counters

3.4.1 Meaning

Since IE38Mx energy meter does not support internaly synchronised real-time clock (RTC) for the purpose of simultaneous capture of measurements, the freeze function is implemented. Use is enabled only when the meter is on.

Freeze function enables using IE38Mx smart meters for billing or sub-billing purposes and to compare sub-metering data with main energy meter. Reading several hundred serially connected counters can last more than 10 minutes. That is why IE38Mx supports command Freeze counters. Its purpose is to freeze data simultaneously on all devices in the network.

The freeze function operation is also performed in case of device power supply failure or device reset.

3.4.2 Set up

To perform the freeze function, the energy meters should be connected to the serial communication RS485 and belonging software which use Modbus registers.

The energy meter IE38Mx enables several ways to activate freeze function:

- Freeze status register,
- time to freeze register,
- auto freeze interval register.

3.4.3 Time to freeze register (41902)

The purpose of the time to freeze register is to freeze all energy meters simultaneously. Set the number of time to freeze register (41902), the value of appropriate time (in seconds) before the time of the freeze and time of the freeze. After an expired time, the freeze command is executed automatically. Due to unreliability in communication, it is recommended that the desired time is sent more than ones, to ensure that freeze is simultaneous on all instruments. The desired time need to be sent in the interval of one minute.

For example, if you want that freeze function is executed at 10 am, run the command seven times, starting 7 s before 10 am and repeat it with a one second interval (see the picture below).

All instruments that received one of the commands will freeze at the same time. This is the advantage of the described register, so it is recommended to use it.

It is also possible to individually enter the appropriate time in register 41902 of each instrument.

3.4.4 Auto freeze interval register (41901)

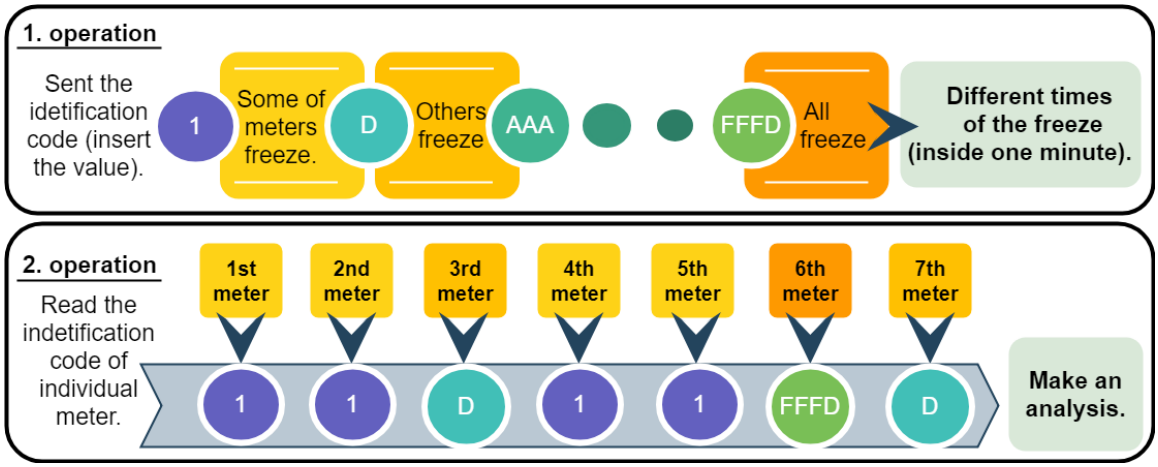
The purpose of the auto freeze interval register is to freeze energy meters in the same time interval, for example, every day. Set the certain auto freeze interval (in minutes). Maximum allowed value is 65535 minutes. Periodic synchronization is activated automatically after the entered interval. If the interval is set to 0, the auto freeze interval function is turned off.

The disadvantage of this register is that the time is not appropriate if the meters reset or in case of another failure.

3.4.5 Status register of freeze (41905)

The purpose of the status register is to test the reliability of RS485 communication. Enter the broadcast command of different identification codes between 1 to FFFD in the freeze status register (41905). Repeatedly send a different identification code to the freeze status register (41905) in order to increase the reliability of receiving commands. The reliability of reading different numbers of identification code enables analysis of communication reliability. In the case of 100% reliability of communication, all instruments have the value of the first sent identification code, when reading the status register.

After the instrument receives the identification code, it ignores all entries in the status register in the interval of one minute. Send as many different identification codes in a short time interval. For example, send the different identification codes ten times within one second. Use numbers from 1 to FFFD (1 - 65533). For example, first use value 1, then D, AAA and at the end FFFD (see picture below). Please note that you never know if all the meters will freeze, so send as many commands as possible within one minute.



PLEASE NOTE

Please do not use the values 0000, FFFF or FFFE. The 0000 is reserved to start the meter when connected to the power supply. Freeze function is performed. The FFFF is reserved to trigger freezing function automatically (same as time to freeze register 41902). The FFFE is reserved for the auto interval freeze.

Send the command for reading the register, so you can see which identification code has been accepted by the individual instrument. The server calculates time from a freeze of the device.

3.4.6 Access and interpretation of data

After the execution of the freeze command, the counters are stored into registers 41906 to 41938, which can be read by the master. Register 41906 displays frozen tariff counter and registers 41907 to 41938 display frozen energy counters (1 - 16). The data we read on all devices can this way be compared. Encoded information should be read with Modbus table (see Appendix A).

In addition, the time since the last freeze can be checked with time from freeze register (41903, 41904). The purpose of these register is to control if displayed measurements are relevant. The register contains time (in seconds) from the last freeze counters execution.

4 SETTINGS

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 detailed description of all ***IE38Mx*** features and settings. Chapter is organized in a way to follow settings organisation as in setting software MiQen.

4.1 Introduction

Parameterization can be modified by serial communication (RS485 or Mbus) or by a special WM-USB adapter (size 1 DIN module) and MiQen software version 2.0 or higher.

4.2 MiQen software

MiQen software is a tool for a 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 five segments: devices management (Connection), instrument settings (Settings), real-time measurements (Measurements), data analysis (Analysis), and software upgrading (Upgrades). These segments are easily accessed by means of five icons on the left side.

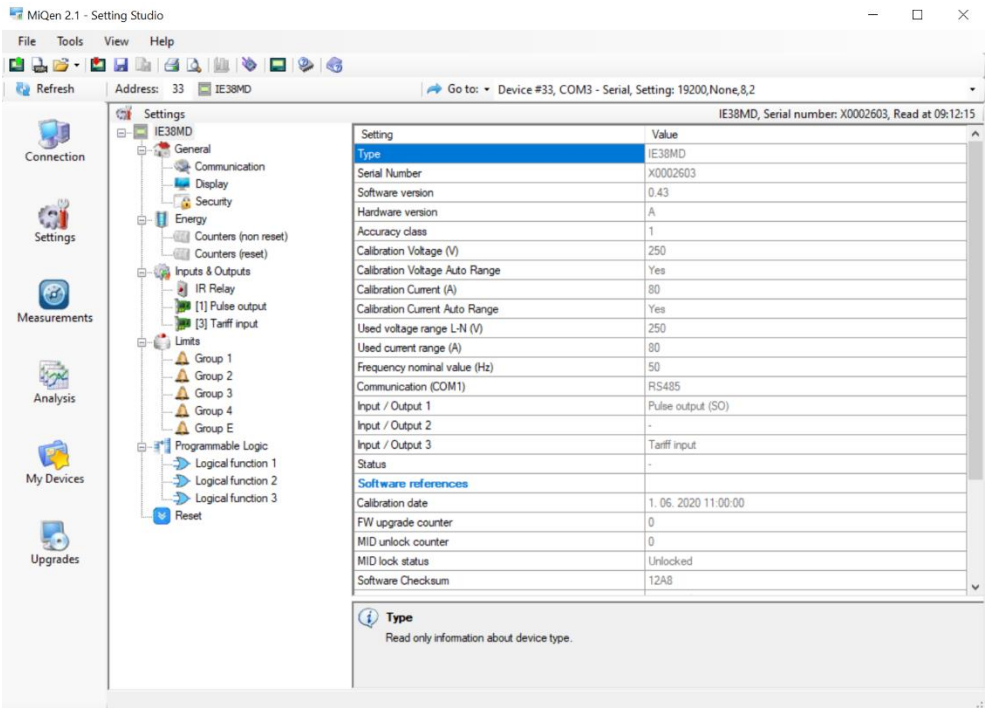


Figure 11: *MiQen programming and monitoring software*

MiQen version 2.1 or higher is required for programming and monitoring ***IE38Mx***. Software installation is stored on a CD as a part of consignment or it 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 Devices management

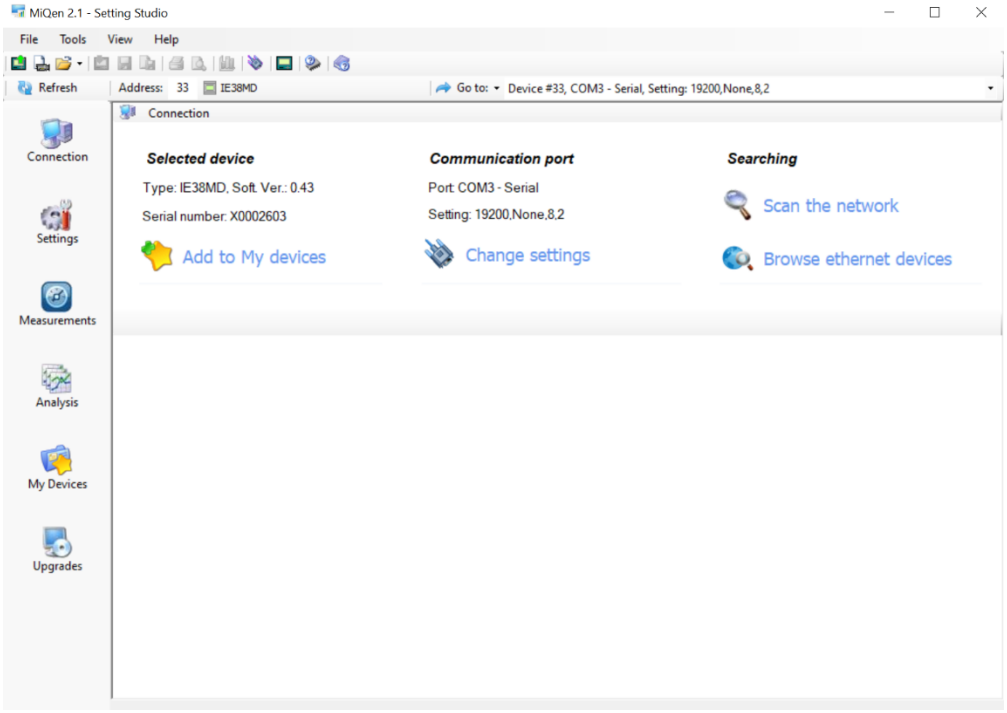


Figure 12: *MiQen Device Management window*

Use Scan the network explorer to set and explore the network of the device. Communication parameters of all devices and their addresses in a network can be easily set. Selected devices can be added to the list of My devices.

Set Communication port parameters

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

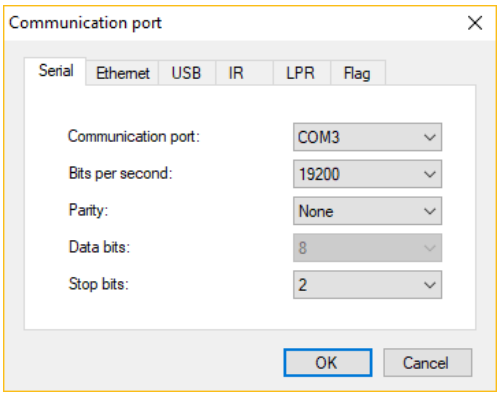
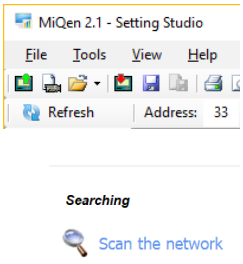


Figure 13: *Communication port window*

IE38Mx supports only serial communication, so only serial communication parameters can be set.

Set device Modbus address number

Each device connected to a network has its unique Modbus address number. An appropriate address number should be set to communicate with the device.



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

Start communicating with a device

Click on REFRESH button and devices information will be displayed.

When devices are 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***.

4.4 Device settings

Multi Register Edit technology assures a simple modification of settings that are organized in a tree structure. Besides transferring settings into the instrument, storing and reading from the setting files is also available.

4.4.1 General settings

General settings set the LCD properties and Security settings (passwords).

Description and location segment is intended for easier recognition of a certain unit. They are especially used for identification of the device or location on which measurements are performed.

Date and Time segment is intended for set the date and time.

Auto Summer/Winter time segment is intended for choose the automatic change of summer pr wintertime.

Average interval for measurements (sec): the averaging interval defines a refresh rate of measurements on display or communication. It is also used for actual alarm value calculation for alarm triggering**.**

Touch key control to enable lock of touch key control.

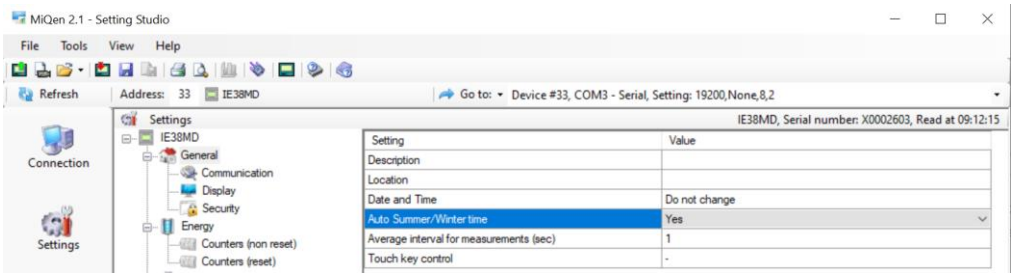


Figure 14: *Set of optional measurements*

4.4.1.1 *Communication*

Communication segment is intended for setting the serial communication parameters (M-Bus or RS485).

4.4.1.2 *Display*

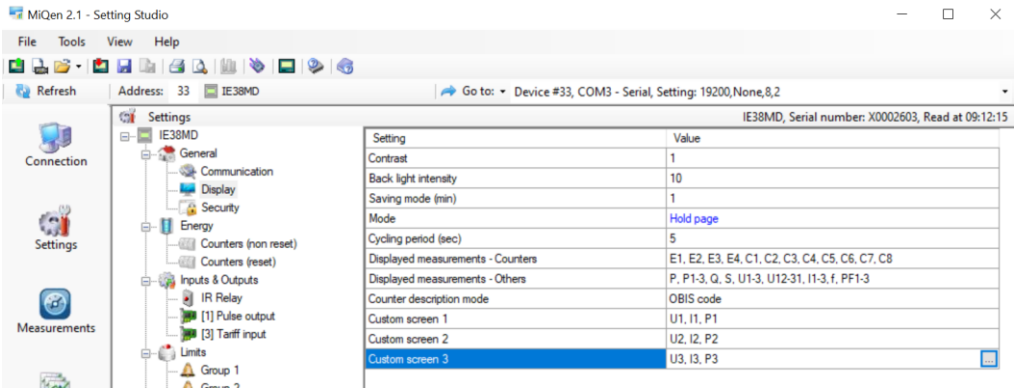


***Figure 15**: Settings of display*

Contrast defines the t ratio between the luminance of the brightest white and the darkest black that a monitor can produce (from -10 to 10).

Backlight intensity: defines the visibility and legibility of a display. Display settings shall be defined in compliance with the conditions in which they will be monitored. Economizing mode switches off the backlight according to the set time of inactivity.

Saving mode (min): defines the time in minutes for the instrument to get into an energy-saving mode (backlight off). Enter value 0 if you don't want to use energy-saving mode.

The mode defines whether displayed values automatically cycle between different measurands or display only one measurement (Hold page function).

Cycling period (sec) sets the period of cycling, valid values from 5 s to 60 s.

Displayed measurements – Counters: sets the counters displayed at the display. A user can select them on the drop-down menu (low-cost version (IE38MS)):

Displayed measurements – Others: sets the measurements at the startup display.

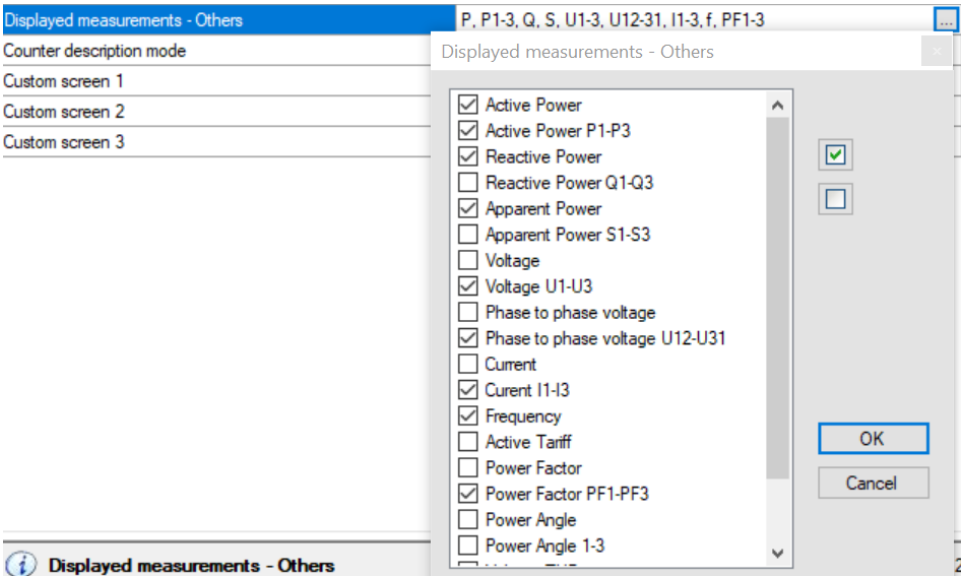


***Figure 15**: Set other measurement values shown on the display*

Counter description mode offers options for the description with OBIS code or by letters.

Custom screens 1, 2, 3 offer to set the measurements to observe on the screen.

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.

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.

4.4.1.3.1 Password levels

Password-Level 1 >PL1

The password for the first level is required. It can be used only if Password – Level 2 is also applied.
Available settings that require password level 1:

General	Reset
Date and Time	Reset energy counters
Auto Summer/Winter time	Reset limit control IR relay

***Table 6**: Data that required first level password*

Password-Level 2 >PL2

Password for second level is required. Available settings that require password level 2:

General	Communication	Display	Security
Description	Primary address	Contrast	Password Level 1
Location	Secondary address	Backlight intensity	Password Level 2
Average interval for measurements	Baud rate	Saving mode	
Touch key control	Communication parameters	Mode	
		Cycling period	
		Displayed measurement-Counters	
		Displayed measurements - Others	
		Counter description mode	
		Custom screen 1, 2, 3	

Energy	IR Relay	Pulse output
Counters (Reset)	Operating mode	Enabled groups
	Enabled groups	Output signal
	Output signal	

Limits	Logical function 1	Logical function 2
Group 1	Gate 1	Gate 1
Group 2	Gate 2	Gate 2
Group 3	Gate 3	Gate 3
Group 4		
Group E		

***Table 7**: Data that required second level password*

Password-Level 0>PL0

Password for level 0 is only used for reading settings (Energy: Operating mode).

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. (https://www.iskra.eu/en/Where-Are-We/).

4.4.1.3.2 Generating passwords

Enter L1 password. Example: BBBB

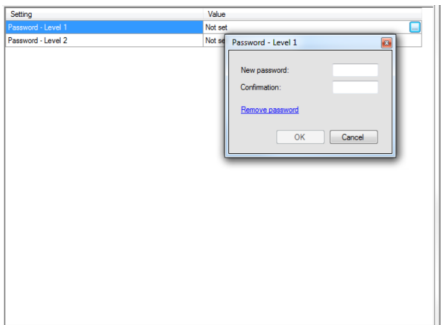


***Figure 16**: Password Level 1 window*

Enter L2 password. Example: CCCC

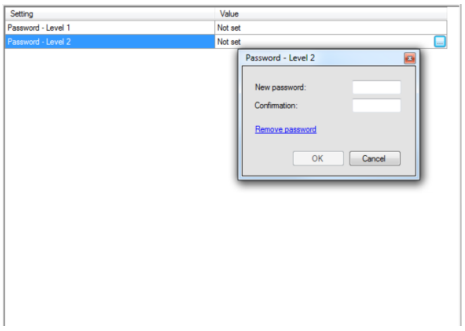


***Figure 17**: Password Level 2 window*

Right click on the mouse and execute “Download settings”.

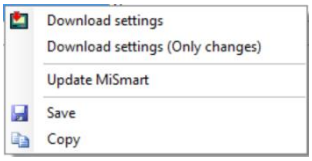


***Figure 17**: Download settings window*

After the execution, the passwords are entered.

PLEASE NOTE

L1 password can only be used if L2 is also entered, because of its higher priority.

4.4.1.3.3 Operation test for passwords (example for L1)

Go to the “Reset window”. Choose the option “Reset energy counters”.

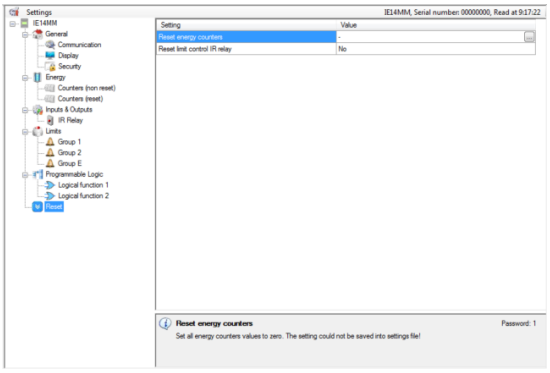


***Figure 18**: Reset window*

Mark the counter you want to reset.

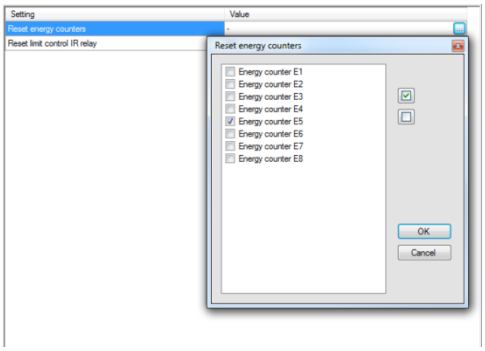


***Figure 19**: Reset energy counters window*

Click “OK”. Right click on the mouse and execute “Download settings”.

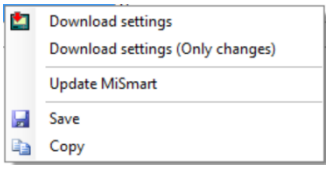


***Figure 20:** Download settings window*

Then L1 password is required.

***Figure 21:** Password entry window*

After the password entry, the meter resets. The state is maintained even if the meter is disconnected from the power supply.

4.4.1.3.4 Wrong password entry

In the case of a wrong L1 or L2 password entry, a note appears stating that the password is incorrect.

***Figure 22**: Wrong password entry window*

Another entry can be carried out after 5 s. if you enter the L2 password in this field where the L1 password is required, the action will run without disruption. That is because the L2 password is stronger and is the condition for L1 password execution at the same time (User/Admin relation).

4.4.1.3.5 Removing or changing password

In the case of a changing or removing L1 password, MiQen demands the L2 password. With the L2 password entry, L1 changes or is removed. L2 password still remains and is active for the settings change, when it is demanded. The changes that demand L1 or L0 password are executed without a password request. The user with an assigned L1 password is prevented from changing the password without knowing (L2)-Admin.

The procedure of removing both passwords is:

Choose “Settings window” and Security section.

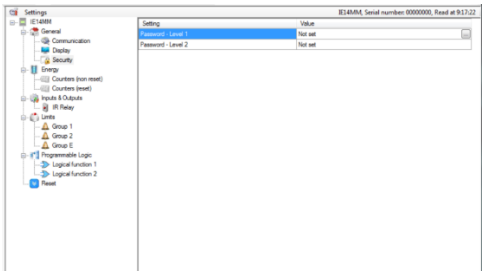


***Figure 23:** Security window*

Under L2 password chose the “Remove password option”.

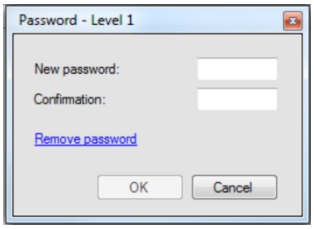


***Figure 24:** New password window*

And go to “Download settings”.

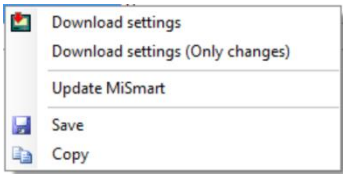


***Figure 25:** Download window*

Then type the CCCC password (for example).

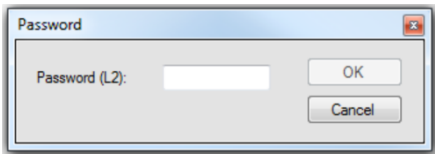


Figure 26: *Password 2 entry window*

L2 password is removed, and L1 also after that.

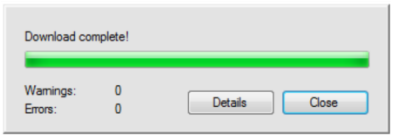


Figure 27: *Download complete window*

Both password positions are now set to not set.

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

Active tariff

Default setting is tariff input as IE38Mx meters have tariff input as standard. For meters with RS485 communication it is possible to manage 6 tariffs using communication in case all active MID registers from E1 to E4 are parametrized for cumulative energy (all tariffs). Switching from tariff input to communication management is done by selecting any form 6 tariffs in a drop-down menu (picture below).

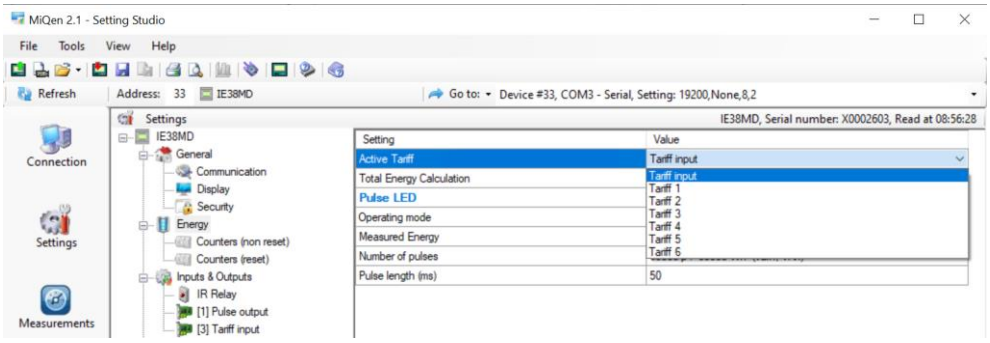


Figure 28: *Active tariff window*

Pulse LED

Test output LED can be set in test modes for type testing and verification purposes. The test mode setting cannot be saved. After powering down the meter, it always starts in normal operation mode. Test mode description sees chapter First steps, Energy. Measured energy, number of pulses, and pulse length cannot be permanently changed at MID approved meters.

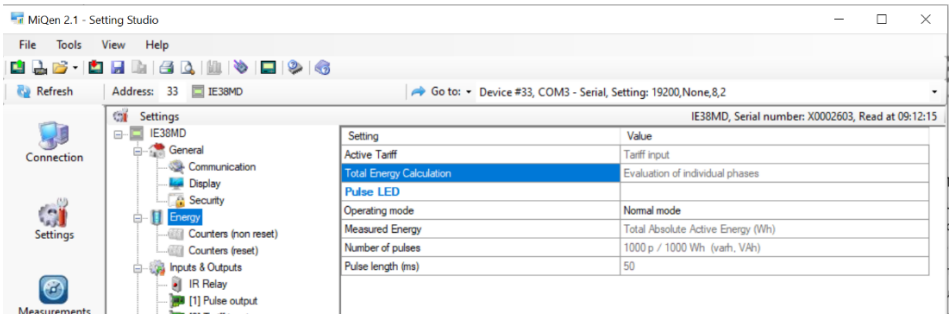


Figure 29: *Energy window*

4.4.2.1 *Counters*

The meter has four unresettable counters for which MID approval is valid. The setting of these counters is fixed in the production. The setting parameters can not be modified and the counters can not be reset during use.

Additionally, the meter has 16 counters which are user-configurable (Counters (reset)). Users can set Disabled, Total absolute active energy, Total absolute reactive energy, Total absolute apparent energy, Import active energy, Export active energy, Import reactive energy, Export reactive energy, Custom setting. In the Custom setting, there are additional options for measurement in individual quadrants and setting for absolute and inverse counting.

For meters with RS485 communication, the counters C1 to C16 can be parametrized for tariffs from Tariff 1 to Tariff 6. The tariff can be changed by writing the tariff value to the MODBUS register 40030 using system software (not supported in Fi-MIS software). The value can not be stored, so after power down the meter restarts in the tariff defined in Active tariff setting (register 40401).

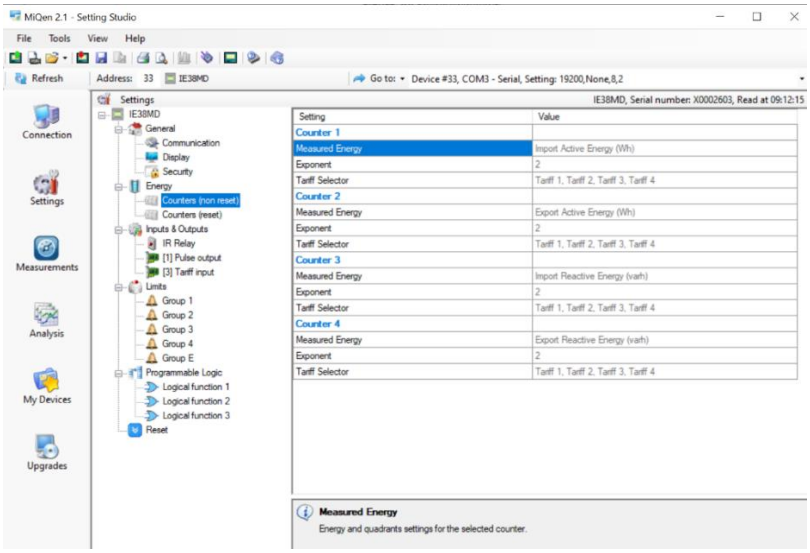


***Figure 30**: MiQen energy counters*

WARNING!

In case of modification of energy parameters during operation, the values of energy counters must be recorded to avoid wrong interpretation of readings.

Resetting counters function is applicable only for sixteen resettable counters.

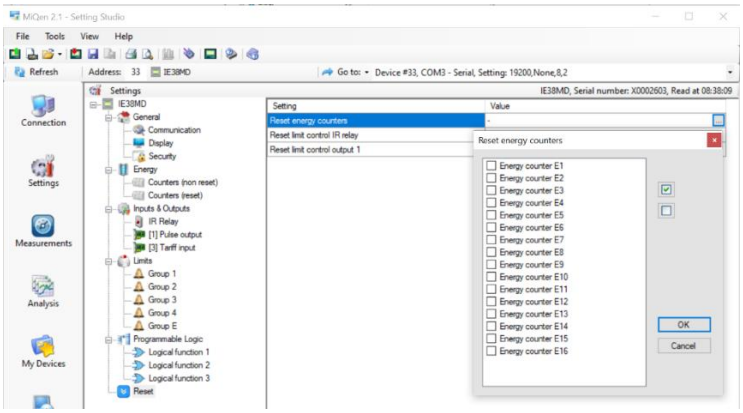


***Figure 31:** MiQen reset counters*

4.4.3 Inputs & outputs

I/O functionality is a powerful tool of **IE38MX** using various I/O modules. The device can be used not only for monitoring main electrical quantities but also for monitoring process quantities (temp., pressure, wind speed, etc.) and for various control purposes. **IE38MX** can be equipped with different I/O modules with different functionality.

4.4.3.1 *IR relay*

IR Relay module supports control of ISKRA bistable switch BICOMxxx-WM3 via IR port. IR Relay operating mode defines how IE38MX controls external bistable switch BICOM via propriety IR communication. Available modes are: Not connected, Manual, and Limit control. The preset is not connected. Manual mode enables control of BICOM via RS485 communication. Limit Control enables IE38MX internal set limits for switching BICOM. For a more precise description of Limits please see chapter First steps, Limits.

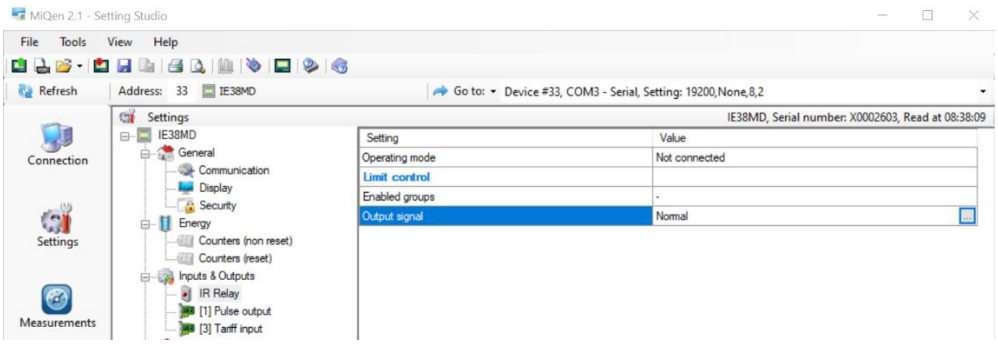


Figure 32: *MiQen IR relay*

4.4.3.2 *Pulse output*

The pulse output is a solid-state, optocoupler open collector switch. Its main purpose is pulse output for selected energy counter, but can also be used as an alarm or general-purpose digital output.

In the case of MID approved meter pulse output is fixed to absolute active energy with the fixed constant of 1000 imp/kWh.

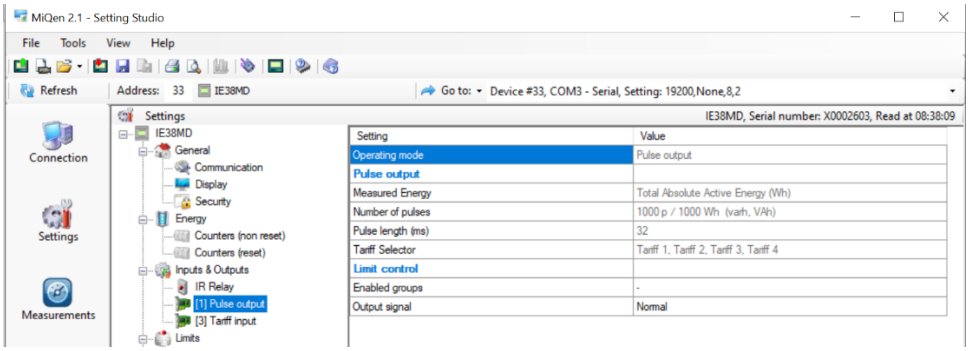


Figure 33*: Pulse output window*

4.4.3.3 *Tariff input*

Tariff input has no setting. It operates by setting active tariff at a tariff input. The meter has only one tariff input so only two tariffs are possible using tariff input.

Active tariff	Input T1
Tariff 1	0
Tariff 2	1

***Table 8**: Active tariff selection table*

4.4.4 Limits

IE38MX has a built-in limit function which can control the bistable relay using IR communication or optional S0 output. They are divided into 5 groups (1, 2, 3, 4, E), each having 4 limits. Each group of limits has some common settings applicable to all limits within this group.

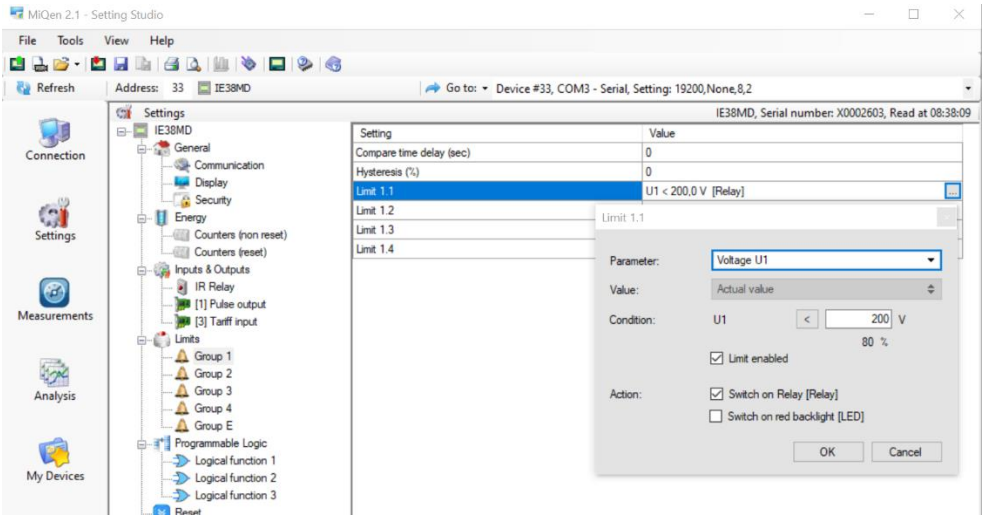


Figure 34: *Limits window*

Compare time delay (sec): This setting defines delay time (if required) between satisfying the alarm condition and alarm activation. If the alarm condition is shorter then this setting alarm will not be triggered. This setting is used to rule out sporadic and very short duration triggers.

Hysteresis (%): This setting defines alarm deactivation hysteresis. When monitored quantity is close to a set limit line its slight variation can trigger numerous alarms. Hysteresis should be set according to the estimated variation of monitored quantity.

Individual limit settings: For each individual alarm different settings are possible.

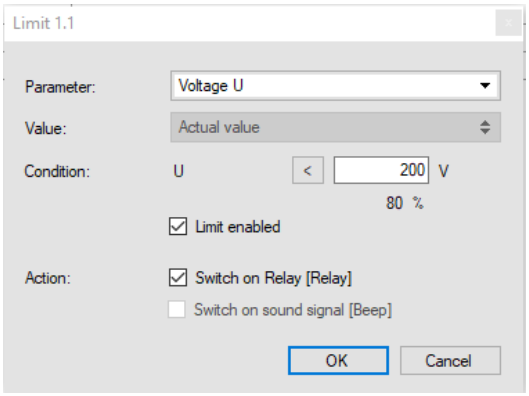


Figure 35: *Limit settings window*

4.4.5 Programmable logic

4.4.5.1 *Logical function 1, 2, 3*

Basic logical functions are: AND, OR, XOR, NOT, NAND, NOR and XNOR. **IE38MX** supports AND/OR logical functions.

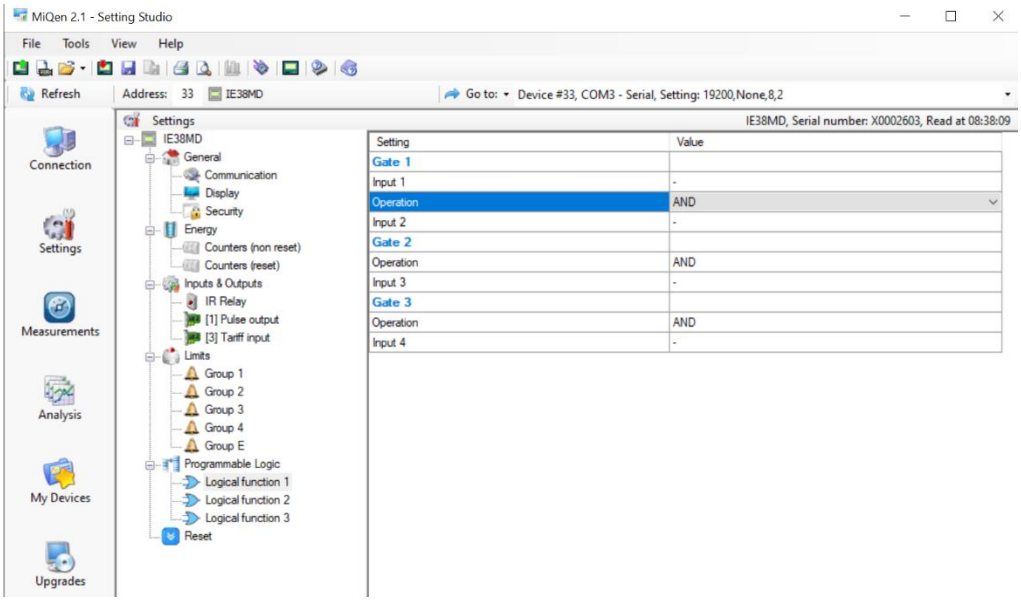


Figure 36: *Logical function window*

Logical function - Select logical function over existing logical inputs:

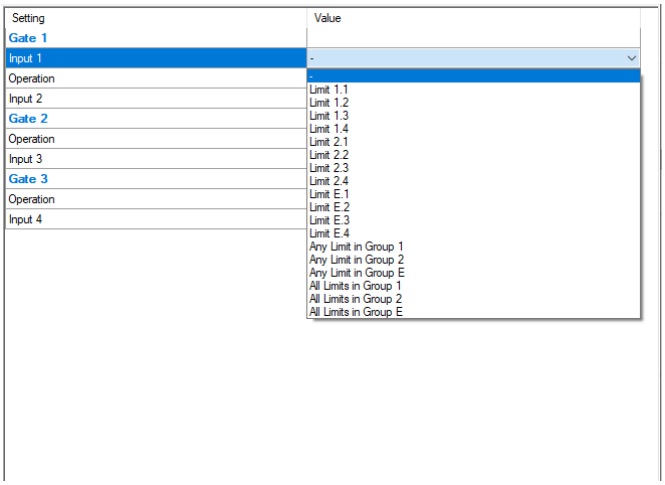


Figure 37: *Logical function selection window*

4.4.6 Resets

Resetting counters function is applicable only for 16 resettable counters. MID approval applies only to four non-resettable counters, which can not be reset.

Resetting limit control of IR relay and output 1.

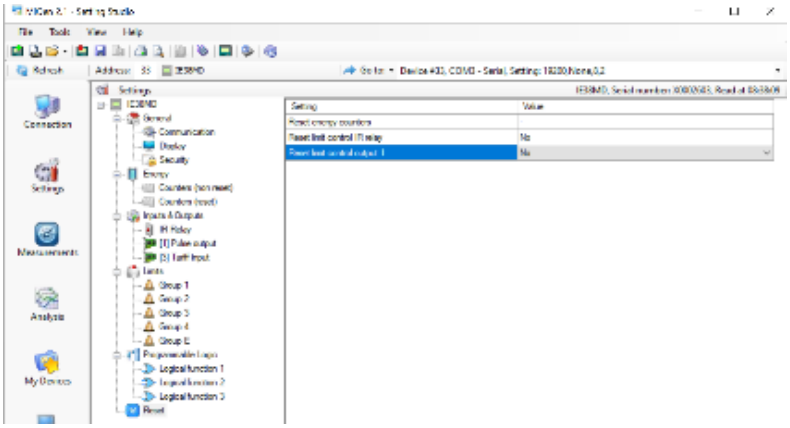
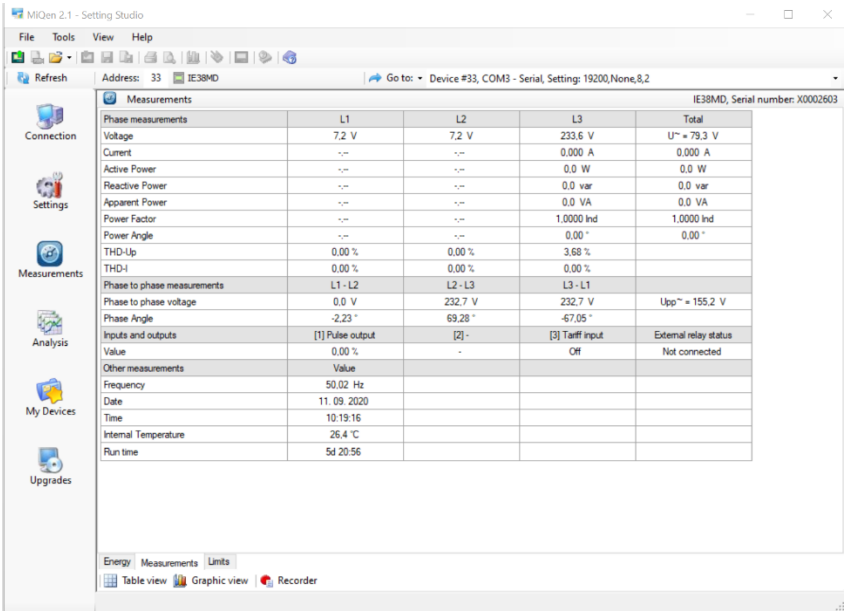


***Figure 38**: Reset selection window*

4.5 Real-time measurements

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

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



Phase measurements	L1	L2	L3	Total
Voltage	7,2 V	7,2 V	233,6 V	U~ = 79,3 V
Current	-,--	-,--	0,000 A	0,000 A
Active Power	-,--	-,--	0,0 W	0,0 W
Reactive Power	-,--	-,--	0,0 var	0,0 var
Apparent Power	-,--	-,--	0,0 VA	0,0 VA
Power Factor	-,--	-,--	1,0000 Ind	1,0000 Ind
Power Angle	-,--	-,--	0,00 °	0,00 °
THD-Up	0,00 %	0,00 %	3,68 %	
THD-I	0,00 %	0,00 %	0,00 %	
Phase to phase measurements	L1 - L2	L2 - L3	L3 - L1	
Phase to phase voltage	0,0 V	232,7 V	232,7 V	Upp~ = 155,2 V
Phase Angle	-2,23 °	69,28 °	-67,05 °	
Inputs and outputs	[1] Pulse output	[2] -	[3] Tariff input	External relay status
Value	0,00 %	-	Off	Not connected
Other measurements	Value			
Frequency	50,02 Hz			
Date	11. 09. 2020			
Time	10:19:16			
Internal Temperature	26,4 °C			
Run time	5d 20:56			

***Figure 39:** Measurements in tabular form*

Actual measurements in the Graphic view show a vector diagram and a graph of 96 average 15 minutes values of active power, which represents the values for one day. The values are taken from the set of 128 average active power values of the RAM logger. It is not stored in the non-volatile memory, so it is lost at power down.

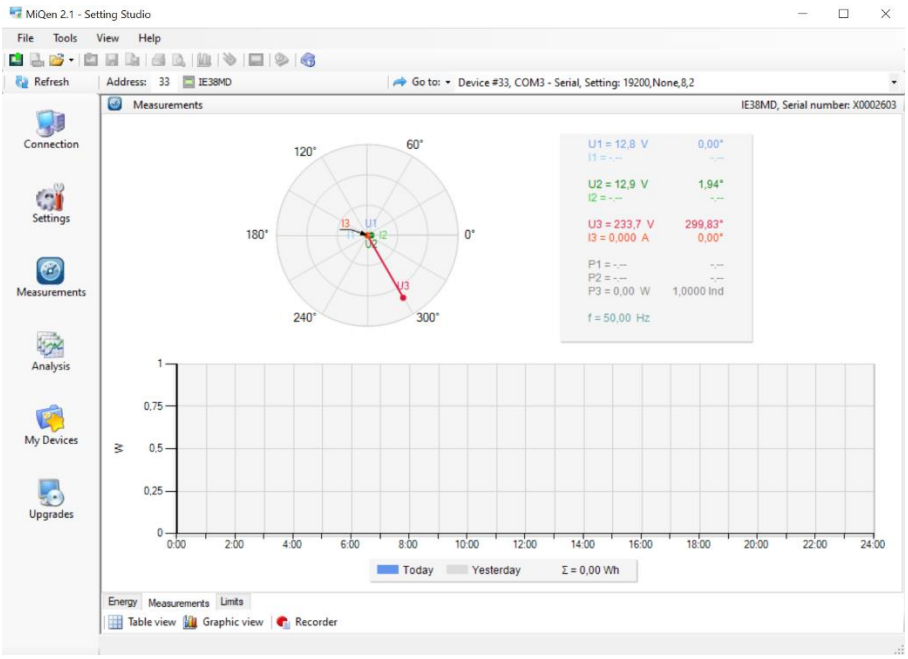


Figure 40: *Measurements in graphical form*

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

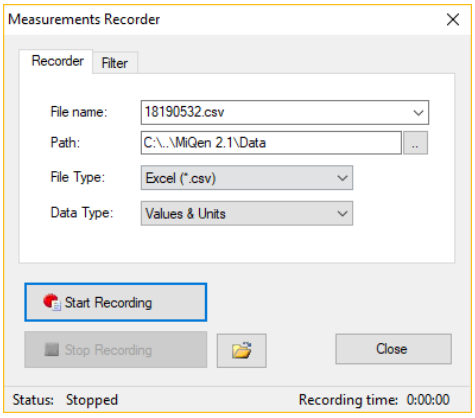


Figure 41: *Measurements Recorder*

4.6 Data analysis

PLEASE NOTE

The other energy meters IE38Mx do not support data analysis.

4.7 My devices

My devices section enables the personal selection of devices.

4.8 Software upgrading

Software in the meter is divided into two parts. Basic measuring part of software is MID approved and it cannot be upgraded on the field during use. The other part of the software supports all other additional functions (communication, NFC, limits and alarms, bistable switch support) and this part can be upgraded during use, using IR communication with USB adapter or RS485 communication.
Always use the latest version of software, both MiQen and software in the device. The program automatically informs you about available upgrades (device firmware upgrades and MiQen software upgrades) that can be transferred from the web site and used for upgrading.

PLEASE NOTE

MiQen cannot be used for execution of firmware upgrades of devices. It only informs that new version is available and offers link to download it from the server. Software for execution of firmware upgrades is included in downloaded zip file together with upgrade file, upgrade procedure description and revision history.

PLEASE NOTE

More information about MiQen software can be found in MiQen Help system!

In order to modify instrument settings with MiQen, current parameters must be loaded first. Instrument settings can be acquired via a communication link (serial or USB to IR adapter) or can be loaded off-line from a file on a local disk. Settings are displayed in the MiQen Setting Window - the left part displays a hierarchical tree structure of settings, the right part displays parameter values of the chosen setting group.

PLEASE NOTE

Supported settings and functions depend on the type of device.

4.10 **NFC settings**

NFC allows the reading of the energy registers and different meter parameters. The advantage of NFC implemented functionality on Iskra d.o.o./electricity meters is that in the event of a power down, it remembers all the last measured values, which can be read via NFC.

NFC reading is possible with every type that has the following label:

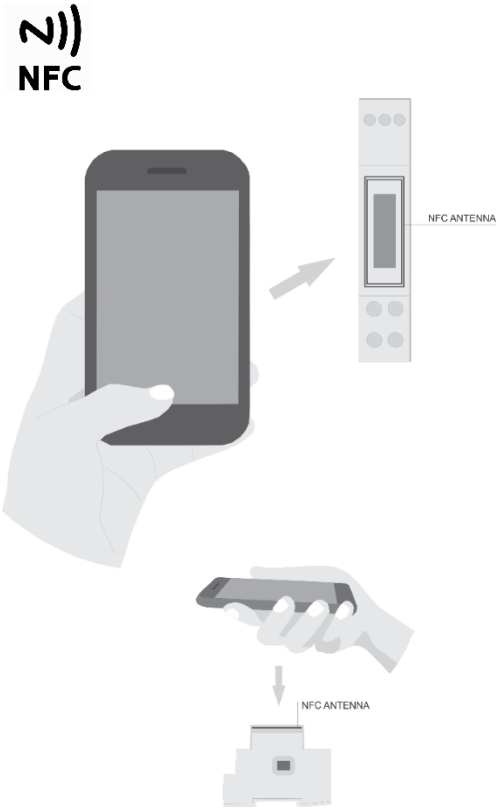


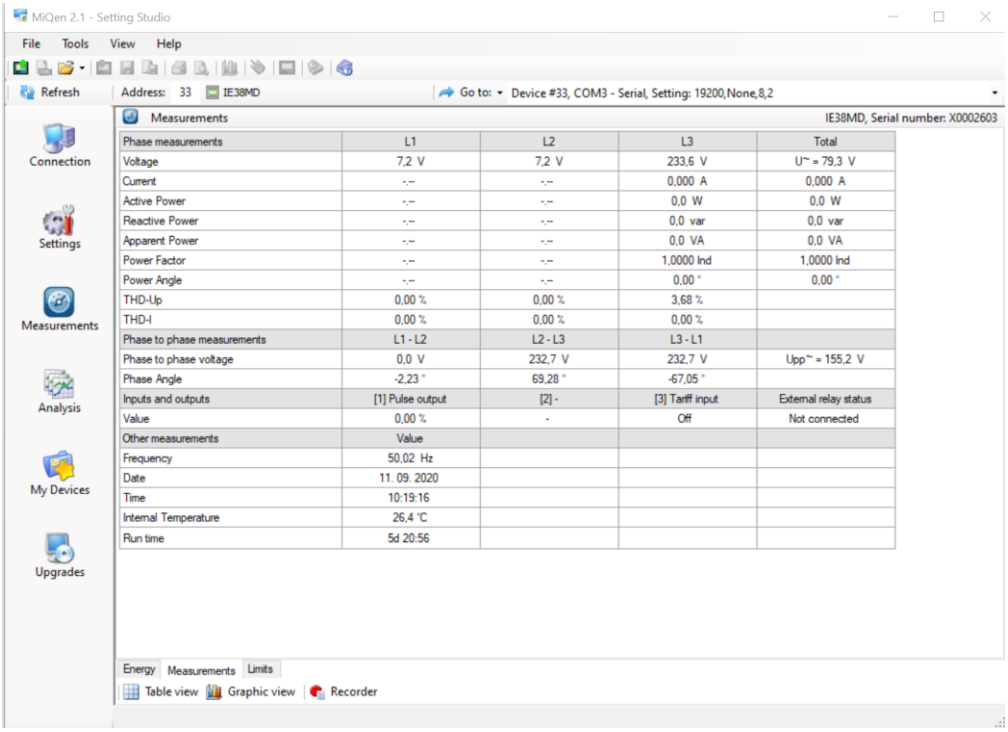
***Figure 42**: NFC use*

5 MEASUREMENT

The IE38MX is bidirectional energy meter measures voltage and current. From which it is able to calculate different quantities, energy (imported and exported), voltage, current, power, frequency, etc.. The IE38MX energy meter performs measurements with a sampling frequency equal to 3906,25 Hz.

5.1 Online measurements

Online measurements are available on display or can be monitored with setting and monitoring software MiQen. Most of parameters are averaged value with average period of 1 second.



Phase measurements	L1	L2	L3	Total
Voltage	7,2 V	7,2 V	233,6 V	U~ = 79,3 V
Current	-.--	-.--	0,000 A	0,000 A
Active Power	-.--	-.--	0,0 W	0,0 W
Reactive Power	-.--	-.--	0,0 var	0,0 var
Apparent Power	-.--	-.--	0,0 VA	0,0 VA
Power Factor	-.--	-.--	1,0000 Ind	1,0000 Ind
Power Angle	-.--	-.--	0,00 °	0,00 °
THD-Up	0,00 %	0,00 %	3,68 %	
THD-I	0,00 %	0,00 %	0,00 %	
Phase to phase measurements	L1 - L2	L2 - L3	L3 - L1	
Phase to phase voltage	0,0 V	232,7 V	232,7 V	Upp~ = 155,2 V
Phase Angle	-2,23 °	69,28 °	-67,05 °	
Inputs and outputs	[1] Pulse output	[2] -	[3] Tariff input	External relay status
Value	0,00 %	-	Off	Not connected
Other measurements	Value			
Frequency	50,02 Hz			
Date	11. 09. 2020			
Time	10:19:16			
Internal Temperature	26,4 °C			
Run time	5d 20:56			

Figure 43: *Online measurements in tabelaric form*

5.2 Selection of available quantities

Microprocesor calculates the TRMS voltage, TRMS 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	3-phase	comments
Phase measurements	Voltage		
	$U_{1\text{-}3\_TRMS}$	☑	
	U_{TOT_TRMS}	☑	
	Current		
	$I_{1\text{-}3\_TRMS}$	☑	
	I_{TOT_TRMS}	☑	
	Power		
	$P_{1\text{-}3\_TRMS}$	☑	
	P_{TOT_TRMS}	☑	
	$Q_{1\text{-}3\_TRMS}$	☑🕮	
	Q_{TOT_TRMS}	☑	
	$S_{1\text{-}3\_TRMS}$	☑	
	S_{TOT_TRMS}	☑	
	$PF_{1\text{-}3\_TRMS}$	☑	
	PF_{TOT}	☑	
	$\varphi_{1\text{-}3\_TRMS}$	☑	
	φ_{TOT_TRMS}	☑	
	Harmonic analysis		
	$THD\text{-}U_{1\text{-}3}$	☑	
	$THD\text{-}I_{1\text{-}3}$	☑	
Phase to phase measurements	Voltage		
	$Upp_{1\text{-}3\_TRMS}$	☑	
	Upp_{TOT_TRMS}	☑	
	$\varphi_{x\text{-}y\_TRMS}$	☑	Phase-to-phase angle
Metering	Energy	☑	
	Counter $E_{1\text{-}4}$	☑	Each counter can be dedicated to any of four quadrants (P-Q, import-export, L-C). Total energy is a sum of one counter for all tariffs. Tariffs can be fixed, tariff input dependent
	Counter $C_{1\text{-}16}$	☑	
	Active tariff	☑	
Inputs and Outputs	Value	☑	
Other measurements	Miscellaneous		
	Frequency		
	Date		
	Time		
	Internal temperature		
	Run time		

🕮 Further description is available in following subchapters

Table 9: *Selection of available measurement quantities*

5.3 Calculation and display of measurements

This chapter deals with capacitiveture, calculation and display of all supported measurement quantities. For more information about display presentation see chapter 3.2 LCD User Interface. Only the most important equations are described; however, all of them are shown in a chapter APPENDIX C: EQUATIONS with additional descriptions and explanations.

5.3.1 Voltage

Voltage related measurements are listed below:

- Real effective (TRMS) 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})

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

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

All voltage measurements are available through communication as well as on standard or customized displays.

5.3.2 Current

IE38MX energy meter measures:

- real effective (TRMS) value of phase currents

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

All current measurements are available on communication as well as standard and customized displays on LCD.

5.3.3 Active, reactive and apparent power

Active power is calculated from instantaneous phase voltages and currents. All measurements are seen on communication or are displayed on LCD. For more detailed information about calculation see chapter APPENDIX C: EQUATIONS.

5.3.4 Power factor 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 (all equations are presented in chapter APPENDIX C: EQUATIONS). A symbol for a coil (positive sign) represents inductive load and a symbol for a capacitiveacitor (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

The 16 programmable energy counters could be set.

5.3.7 Harmonic distortion

IE38MX energy meter calculates THD for phase currents and phase voltages and is expressed as percent of high harmonic components regarding to fundamental harmonic.

6 TECHNICAL DATA

In following chapter all technical data regarding operation of a three-phase electrical energy meter is presented.

6.1 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}
Reactive energy:	*class 2 EN 62053-23*
	±2.5% from I_{min} to I_{tr}
	±2% 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*

6.2 Mechanical characteristics of input

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

Terminals		***Max. conductor cross-sections***
Main inputs	*Contacts capacitiveacity:*	*1.5 mm^2 ... 25 (16) mm^2*
	Connection screws:	*M5*
	Max torque:	*3.5 Nm (PH2)*
	Length of removed isolation:	*10 mm*
Optional modules	*Contacts capacitiveacity:*	*0.5 mm^2... 1.5 mm^2*
	Connection screws:	*M3*
	Max torque:	*0.6 Nm*
	Length or removed isolation:	*8 mm*

6.4 Electrical characteristics of input

Inputs and outputs		
Measuring input	Type (connection):	three-phase (4u and 3u) single-phase (1b)
	Reference current (I_{ref})	5 A
	Maximum current (I_{max}):	80 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

Pulse output $S0_1$	Pulse rate:	500 imp/kWh
	Pulse duration:	32 ms ± 2 ms
	Rated voltage DC (max):	27 V
	Switched current (max):	27 mA
	Standard:	EN 62053-31 (A&B)
Pulse output $S0_2$ (option)	Type:	Programmable
	Rated voltage DC (max):	27 V
	Switched current (max):	27 mA
M-BUS Serial communication (option)	Type:	M-BUS
	Speed:	300 bit/s to 9600 bit/s (default 2400 bit/s)
	Protocol:	M-BUS
	Primary address:	0 – (default)
RS485 Serial communication (option)	Type:	RS485
	Speed:	1200 bit/s to 115200 bit/s (default 115200 bit/s)
	Frame:	8, N, 2
	Protocol:	MODBUS RTU
	Address:	33 – (default)
Optical IR communication	Type:	IR
	Connection:	via USB adapter
	Speed:	19200 bit/s
	Frame:	8, N, 2
	Protocol:	MODBUS RTU
	Address:	33
	Remark:	All settings are fixed
NFC	Protocol:	ISO/IEC 14443 Part 2 and 3 compliant
	Frequency range:	13.56 Mhz
	Baudrate:	106 kbps
	Operating distance:	up to 15 mm from LCD (distance depends on used reader)
Tariff input	Rated voltage:	230 V (+15 %- 20 %)
	Input resistance:	360 kOhm
	Rated voltage:	230 V (+15 %- 20 %)
	Maximum load current:	50 mA

6.5 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 (For IP51 it should be installed in appropriate cabinet.)*
Operating temperature:	*-25 °C - +70 °C (non-condensig humudity)*
Storage temperature:	*-40 °C - + 85°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*
Max weight (with packaging):	*225 g (258.5 g)*
Installation:	*DIN Rail 35 mm*
Dimensions (W x H x D):	*52.5 mm x 91.7 mm x 68.2 mm*
Package dimensions (W x H x D):	*74 mm x 106 mm x 80 mm*
Colour:	*RAL 7035*

6.6 EU directives conformity

6.6.1 MID certified meters

MID approval applies to non-resettable active energy counters.

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

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

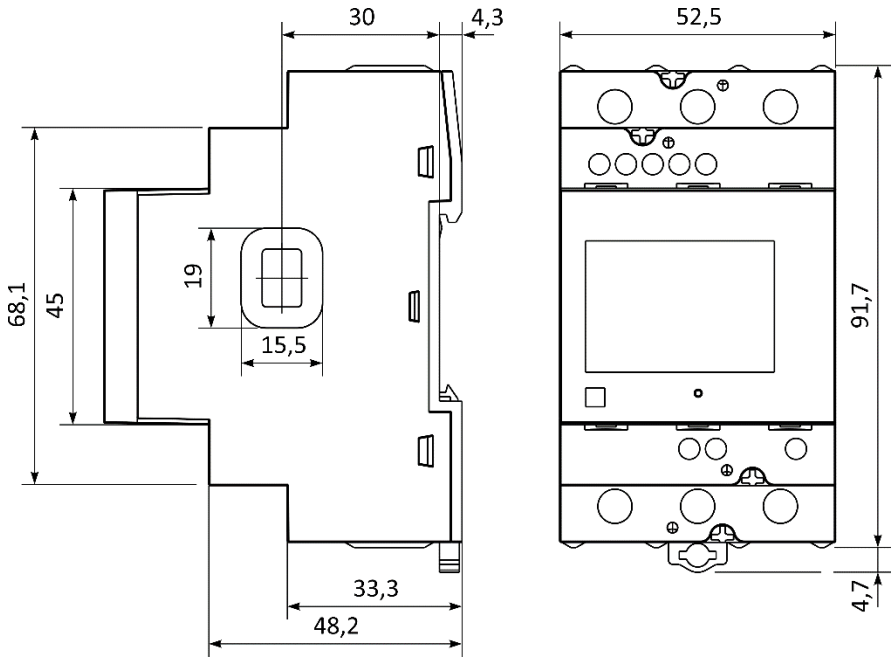
EU Directive on Low Voltage **2014/35/EU**

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

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

6.7 Dimensions

6.7.1 Dimensional drawing

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

7 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	*Industrial protocol for data transmission*
MiQen	*Setting Software for ISKRA instruments*
Ethernet	*IEEE 802.3 data layer protocol*
AC	*Alternating quantity*
PI	*Pulse input module*
IR	*Infrared (optical) communication*
RMS	*Root Mean Square*
TRMS	*True Root Mean Square*
PO	*Pulse output*
PA	*Power angle (between current and voltage)*
PF	*Power factor*
THD	*Total harmonic distortion*
RTC	*Real-time clock*
NFC	*Near Field Communication*
NC	*Not connected*
SC	*Shield*
SW	*Software*
MID	*Measuring Instruments Directive*

Table 10: *List of common abbreviations and expressions*

8 APPENDICES

8.1 Appendix A: MODBUS communication protocol

Modbus protocol enables operation of device on Modbus networks. For IE38MX\ with serial communication the Modbus protocol enables multi drop communication via RS485 communication. Modbus protocol is a widely supported open interconnect originally designed by Modicon.
The memory reference for input and holding registers is 30000 and 40000 respectively.

PLEASE NOTE

The Modbus table is subject to change without notice. For the latest and complete Modbus table please visit ISKRA web page.

Communication operates on a master-slave basis where only one device (the master) can initiate transactions called 'Requests'. The other devices (slaves) respond by supplying the requested data to the master. This is called the 'Request - Response Cycle'.
The master could send the MODBUS request to the slaves in two modes:

- **Unicast mode**, where the master sends the request to an individual slave. It returns a replay to the master after the request is received and processed. A MODBUS transaction consists of two messages. Each slave should have an unique address.
- **Broadcast mode**, where the master sends a request to all slaves and an answer is never followed. All devices should accept the broadcast request function. The Modbus address 0 is reserved to identify the broadcast request.

Master to Slave Request

Device address	Function Code	nx8 bit data bytes	Error check

Slave to Master Response

Device address	Function Code	nx8 bit data bytes	Error check

Request

This Master to Slave transaction takes the form:

- **Device address**: master addressing a slave (Address 0 is used for the broadcast address, which all slave devices recognize.)
- **Function code** e.g. 03 asks the slave to read its registers and respond with their contents.
- **Data bytes**: tells the slave which register to start at and how many registers to read.

Response

This Slave to Master transaction takes the form:

- **Device address**: to let the master know which slave is responding.
- **Function code**: this is an echo of the request function code.
- **Data bytes**: contains the data collected from the slave.

Request Frame

		Starting Register	Register Count	CRC
Slave Address	Function Code	HI LO	HI LO	LO HI
21	04	00 6B	00 02	

Response Frame

			Register Data	CRC
Slave Address	Function Code	Byte Count	HI LO HI LO	LO HI
21	04	04	FE 00 59 96	

Request- response cycle example

Address number of slave: 21
Function code: 04 → 30000
Starting register HI…LO: 00…$6B_{(16)}$ → $107_{(10)}$ +$30000_{(10)}$ = **$30107_{(10)}$** (Meaning that actual measurement is U1. For further informations *see REGISTER TABLE FOR THE ACTUAL MEASUREMENTS*.)
Register count HI…LO: 00…$02_{(16)}$ → $2_{(10)}$ (Two registers: 30107 and 30108)
Data type: T5 (Unsigned Measurement (32 bit) – *see table of DATA types decoding*)
Register data: FE 00 59 $74_{(16)}$ → $22934 * 10^{-2}$ V = **229,34 V**

REGISTER TABLE FOR THE ACTUAL MEASUREMENTS

The tables below represent the complete set of MODBUS register map. Register refresh frequency for actual measurement from register 30105 to register 30190 is one second. Register refresh frequency for energy counters (from 30406 to 30441) is 40 ms. The registers from 30426 to 30441 (1000 x Energy Counter from 30406 to 30413 and from 30418 to 30425) represent the same energy counters at 1000-times higher resolution. This registers cam be read to calculate the energy difference in the time interval more accurate.

ACTUAL MEASUREMENTS

Address		Contents	Data	Ind	Values / Dependencies
		Input Registers			
		READ ONLY INFO			
30000		**Memory Reference**			
		READ ONLY INFO			
30001	30008	Model Number	T_Str16		
30009	30012	Serial Number	T_Str8		
30013		Software Reference	T1		Software version
30014		Hardware Reference	T_Str2		Hardware version
30015		Calibration voltage	T16		V/100
30017		Calibration current	T16		A/100
30019		Accuracy class	T17		100=1,00
30020		MiNet Flag	T1	0	
30024		COM1: Communication Type	T1	0	No Communication
				2	RS485
				13	M-bus
				15	WiFi
30028		Memory type	T1	0	No memory
				3	8 MB Flash
				4	16 MB Flash
30029		I/O 1	T1	0	No I/O
				5	Tariff Input
				10	Digital input
				12	Pulse Output (SO)
30030		I/O 2	T1		See I/O 1
30031		I/O 3	T1		See I/O 1
30032		I/O 4	T1		See I/O 1
30044		Status register	T1	Bit-0	Locked
				Bit-1	Wrong connection
				Bit-2	Low battery
				Bit-3	Low supply
				Bit-4	Clock not set
30055	30057	Ethernet MAC Address	T_Hex6		
30058		Ethernet Software Reference	T1		Ethernet Software version
30059	30060	Ethernet: IP Address	T_Hex4		Actual Ethernet IP Address
30061		phase module 1 Software reference	T17		100=1,0
30062		phase module 2 Software reference	T17		100=1,0
30063		phase module 3 Software reference	T17		100=1,0
30064		phase module 1 CheckSum	T1		
30065		phase module 2 CheckSum	T1		
30066		phase module 3 CheckSum	T1		
30067		phase m. 1 Calibration Data CheckSum	T1		
30068		phase m. 2 Calibration Data CheckSum	T1		
30069		phase m. 3 Calibration Data CheckSum	T1		
30070		Measurement module Software ref.	T17		100=1,0
30071		Measurement module CheckSum	T1		
30072		Meas. m. Calibration Data CheckSum	T1		

Address		Contents	Data	Ind	Values / Dependencies
		Input Registers			
30073		MID Setting Data CheckSum	T1		
30074		Setting Data CheckSum	T1		
30075		Software Checksum	T1		
30076		MID lock status	T1	0	unlocked
				1	locked
30077	30078	Calibration Time Stamp	T_unix		
30079		MID unlock counter	T1		
30080		FW upgrade counter	T1		
30081		Software Checksum HI	T1		
30082		Measurement module CheckSum HI	T1		
30083		phase module 1 CheckSum HI	T1		
30084		phase module 2 CheckSum HI	T1		
30085		phase module 3 CheckSum HI	T1		
30097		Software options	T1		
30098		Active Communication Port	T1	1	COM1
30099		Modbus Max. Register Read at Once	T1		
39000		Device group	T1	5	IMPACT

Address		Contents	Data	Ind	Values / Dependencies
		Input Registers			
		ACTUAL MEASUREMENTS			
30101		Phase valid measurement	T1	Bit 0	Invalid measurement phase 1
				Bit 1	Invalid measurement phase 2
				Bit 2	Invalid measurement phase 3
30102		reserved			
30103	30104	Run time	T3		seconds
30105	30106	Frequency	T5		
30107	30108	U1	T5		
30109	30110	U2	T5		
30111	30112	U3	T5		
30113	30114	Uavg (phase to neutral)	T5		
30115		j12 (angle between U1 and U2)	T17		
30116		j23 (angle between U2 and U3)	T17		
30117		j31 (angle between U3 and U1)	T17		
30118	30119	U12	T5		
30120	30121	U23	T5		
30122	30123	U31	T5		
30124	30125	Uavg (phase to phase)	T5		
30126	30127	I1	T5		
30128	30129	I2	T5		
30130	30131	I3	T5		
30132	30133	INc	T5		
30134	30135	Inm - reserved	T5		
30136	30137	Iavg	T5		
30138	30139	S I	T5		
30140	30141	Active Power Total (Pt)	T6		
30142	30143	Active Power Phase L1 (P1)	T6		
30144	30145	Active Power Phase L2 (P2)	T6		
30146	30147	Active Power Phase L3 (P3)	T6		
30148	30149	Reactive Power Total (Qt)	T6		
30150	30151	Reactive Power Phase L1 (Q1)	T6		
30152	30153	Reactive Power Phase L2 (Q2)	T6		
30154	30155	Reactive Power Phase L3 (Q3)	T6		
30156	30157	Apparent Power Total (St)	T5		
30158	30159	Apparent Power Phase L1 (S1)	T5	30158	30159
30160	30161	Apparent Power Phase L2 (S2)	T5	30160	30161
30162	30163	Apparent Power Phase L3 (S3)	T5	30162	30163
30164	30165	Power Factor Total (PFt)	T7	30164	30165
30166	30167	Power Factor Phase 1 (PF1)	T7	30166	30167
30168	30169	Power Factor Phase 2 (PF2)	T7	30168	30169
30170	30171	Power Factor Phase 3 (PF3)	T7	30170	30171

30174		angle between U2 and I2	T17		
30175		angle between U3 and I3	T17		
30181		Internal Temperature	T17		
		THD HARMONIC DATA			
30182		U1 THD%	T16		
30183		U2 THD%	T16		
30184		U3 THD%	T16		
30188		I1 THD%	T16		
30189		I2 THD%	T16		
30190		I3 THD%	T16		
		I/O STATUS			
30191		Alarm Status Flags(G1, G2	T1	Bit 0..4	Group 1 Limit 1 .. 4
				Bit 8..12	Group 2 Limit 1 .. 4
30192		Alarm Status Flags(G3, G4	T1	Bit 0..4	Group 3 Limit 1 .. 4
30193		I/O 1 Value	T17		
30194		I/O 2 Value	T17		
30195		I/O 3 Value	T17		
30196		I/O 4 Value	T17		
30197		External relay status	T1	0	Off
				1	On
				250	Comm. Error
				255	Not connected
30198		Reserved for Load control output status	T1	0	Off
				1	On
30199		Reserved for Digital input status	T1	0	Off
				1	On
30200		Alarm Status Flags(GE	T1	Bit 0..4	Group E Limit 1 .. 4
30201		Logic functions values	T1	Bit 0	Logic function 1
				Bit 1	Logic function 2
				Bit 2	Logic function 3
30202	30395	Reserved			
30396	30399	Actual time	T_Time		

Address		Contents	Data	Ind	Values / Dependencies
		Input Registers			
		ENERGY			
30400		CheckSum Status	T1	0	No Error (OK)
				Bit 0	Error Parameter CRC
				Bit 1	Error Firmware 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 7	Error Software Checksum
				Bit 8	Error Calibration Data CheckSum
				Bit 9	Error MID Setting Data CheckSum
				Bit 10	Error Setting Data CheckSum
				Bit 11	Error phase m. 1 Cal. Data CheckSum
				Bit 12	Error phase m. 2 Cal. Data CheckSum
				Bit 13	Error phase m. 3 Cal. Data CheckSum
				Bit 15	Instalation not set
30401		Energy Counter n1 Exponent	T2		
30402		Energy Counter n2 Exponent	T2		
30403		Energy Counter n3 Exponent	T2		
30404		Energy Counter n4 Exponent	T2		
30405		Current Active Tariff	T1		
30406	30407	Energy Counter n1	T3		
30408	30409	Energy Counter n2	T3		
30410	30411	Energy Counter n3	T3		
30412	30413	Energy Counter n4	T3		
30414	30415	Energy Counter 1	T3		
30416	30417	Energy Counter 2	T3		
30418	30419	Energy Counter 3	T3		
30420	30421	Energy Counter 4	T3		
30422	30423	Energy Counter 5	T3		
30424	30425	Energy Counter 6	T3		
30426	30427	Energy Counter 7	T3		
30428	30429	Energy Counter 8	T3		
30430	30431	Energy Counter 9	T3		
30432	30433	Energy Counter 10	T3		
30434	30435	Energy Counter 11	T3		
30436	30437	Energy Counter 12	T3		
30438	30439	Energy Counter 13	T3		
30440	30441	Energy Counter 14	T3		
30442	30443	Energy Counter 15	T3		
30444	30445	Energy Counter 16	T3		

Address		Contents	Data	Ind	Values
		ENERGY			
30446		Energy Counter 1 Exponent	T2		
30447		Energy Counter 2 Exponent	T2		
30448		Energy Counter 3 Exponent	T2		
30449		Energy Counter 4 Exponent	T2		
30450		Energy Counter 5 Exponent	T2		
30451		Energy Counter 6 Exponent	T2		
30452		Energy Counter 7 Exponent	T2		
30453		Energy Counter 8 Exponent	T2		
30454		Energy Counter 9 Exponent	T2		
30455		Energy Counter 10 Exponent	T2		
30456		Energy Counter 11 Exponent	T2		
30457		Energy Counter 12 Exponent	T2		
30458		Energy Counter 13 Exponent	T2		
30459		Energy Counter 14 Exponent	T2		
30460		Energy Counter 15 Exponent	T2		
30461		Energy Counter 16 Exponent	T2		
30462	30463	1000 x Energy Counter n1	T3		
30464	30465	1000 x Energy Counter n2	T3		
30466	30467	1000 x Energy Counter n3	T3		
30468	30469	1000 x Energy Counter n4	T3		
30470	30471	1000 x Energy Counter 1	T3		
30472	30473	1000 x Energy Counter 2	T3		
30474	30475	1000 x Energy Counter 3	T3		
30476	30477	1000 x Energy Counter 4	T3		
30478	30479	1000 x Energy Counter 5	T3		
30480	30481	1000 x Energy Counter 6	T3		
30482	30483	1000 x Energy Counter 7	T3		
30484	30485	1000 x Energy Counter 8	T3		
30486	30487	1000 x Energy Counter 9	T3		
30488	30489	1000 x Energy Counter 10	T3		
30490	30491	1000 x Energy Counter 11	T3		
30492	30493	1000 x Energy Counter 12	T3		
30494	30495	1000 x Energy Counter 13	T3		
30496	30497	1000 x Energy Counter 14	T3		
30498	30499	1000 x Energy Counter 15	T3		
30500	30501	1000 x Energy Counter 16	T3		

Address		Contents	Data	Ind	Values
		ENERGY			
32480	32481	Run time	T_float		seconds
32482	32483	Reserved for Frequency (fast response)	T_float		
32484	32485	Uavg (phase to neutral)	T_float		
32486	32487	Uavg (phase to phase)	T_float		
32488	32489	S I	T_float		
32490	32491	Active Power Total (Pt)	T_float		
32492	32493	Reactive Power Total (Qt)	T_float		
32494	32495	Apparent Power Total (St)	T_float		
32496	32497	Power Factor Total (PFt)	T_float		
32498	32499	Frequency	T_float		
32500	32501	U1	T_float		
32502	32503	U2	T_float		
32504	32505	U3	T_float		
32506	32507	Uavg (phase to neutral)	T_float		
32508	32509	U12	T_float		
32510	32511	U23	T_float		
32512	32513	U31	T_float		
32514	32515	Uavg (phase to phase)	T_float		
32516	32517	I1	T_float		
32518	32519	I2	T_float		
32520	32521	I3	T_float		
32522	32523	S I	T_float		
32524	32525	I neutral (calculated)	T_float		
32526	32527	I neutral (measured)	T_float		
32528	32529	Iavg	T_float		
32530	32531	Active Power Phase L1 (P1)	T_float		
32532	32533	Active Power Phase L2 (P2)	T_float		
32534	32535	Active Power Phase L3 (P3)	T_float		
32536	32537	Active Power Total (Pt)	T_float		
32538	32539	Reactive Power Phase L1 (Q1)	T_float		
32540	32541	Reactive Power Phase L2 (Q2)	T_float		
32542	32543	Reactive Power Phase L3 (Q3)	T_float		
32544	32545	Reactive Power Total (Qt)	T_float		
32546	32547	Apparent Power Phase L1 (S1)	T_float		
32548	32549	Apparent Power Phase L2 (S2)	T_float		
32550	32551	Apparent Power Phase L3 (S3)	T_float		
32552	32553	Apparent Power Total (St)	T_float		
32554	32555	Power Factor Phase 1 (PF1)	T_float		
32556	32557	Power Factor Phase 2 (PF2)	T_float		
32558	32559	Power Factor Phase 3 (PF3)	T_float		
32560	32561	Power Factor Total (PFt)	T_float		
32562	32563	CAP/IND P. F. Phase 1 (PF1)	T_float		
32564	32565	CAP/IND P. F. Phase 2 (PF2)	T_float		
32566	32567	CAP/IND P. F. Phase 3 (PF3)	T_float		

32568	32569	CAP/IND P. F. Total (PFt)	T_float		
32570	32571	j1 (angle between U1 and I1)	T_float		
32572	32573	j2 (angle between U2 and I2)	T_float		
32574	32575	j3 (angle between U3 and I3)	T_float		
32576	32577	Power Angle Total (atan2(Pt,Qt))	T_float		
32578	32579	j12 (angle between U1 and U2)	T_float		
32580	32581	j23 (angle between U2 and U3)	T_float		
32582	32583	j31 (angle between U3 and U1)	T_float		
32584	32585	Frequency	T_float		
32586	32587	Reserved			
32588	32589	I1 THD%	T_float		
32590	32591	I2 THD%	T_float		
32592	32593	I3 THD%	T_float		
32638	32639	Energy Counter n1	T_float		
32640	32641	Energy Counter n2	T_float		
32642	32643	Energy Counter n3	T_float		
32644	32645	Energy Counter n4	T_float		
32658	32659	Internal Temperature	T_float		
		ENERGY			
32750	32751	Aktiv Tariff	T_float		
32752	32753	Energy Counter n1	T_float		
32754	32755	Energy Counter n2	T_float		
32756	32757	Energy Counter n3	T_float		
32758	32759	Energy Counter n4	T_float		
32760	32761	Energy Counter 1	T_float		
32762	32763	Energy Counter 2	T_float		
32764	32765	Energy Counter 3	T_float		
32766	32767	Energy Counter 4	T_float		
32768	32769	Energy Counter 5	T_float		
32770	32771	Energy Counter 6	T_float		
32772	32773	Energy Counter 7	T_float		
32774	32775	Energy Counter 8	T_float		
32776	32777	Energy Counter 9	T_float		
32778	32779	Energy Counter 10	T_float		
32780	32781	Energy Counter 11	T_float		
32782	32783	Energy Counter 12	T_float		
32784	32785	Energy Counter 13	T_float		
32786	32787	Energy Counter 14	T_float		
32788	32789	Energy Counter 15	T_float		
32790	32791	Energy Counter 16	T_float		
		NOMINAL VALUES			
32985	32986	nominal phase voltage	T_float		Unom
32987	32988	nominal phase current	T_float		Inom
32989	32990	nominal phase power	T_float		Pnom
32991	32992	nominal total power	T_float		Ptot
32993	32994	nominal total current	T_float		Itot
32995	32996	nominal frequency	T_float		Fnom
34999	35000	Run time	T3		seconds

INTERVAL MEASUREMENTS

Interval measurements are intended for data collection and synchronization of the time for data reading, trough the communication. The time interval of data reading is programmable, by default is one minute. The minimum and maximum measurements could be read within a given time interval.

Address		Contents	Data	Ind	Values / Dependencies
		Input Registers			
		AVERAGE MEASUREMENTS			
35500		The last Average interval duration	T1		Seconds/10
35501		Time since the last average meaurements	T1		Seconds/10
35502		Average measurements counter	T1		
35503	35504	Timestamp (Run time)	T_unix		'= 0 after reset
35505	35506	Frequency	T5		
35507	35508	U1	T5		
35509	35510	U2	T5		
35511	35512	U3	T5		
35513	35514	Uavg (phase to neutral)	T5		
35515		j12 (angle between U1 and U2)	T17		
35516		j23 (angle between U2 and U3)	T17		
35517		j31 (angle between U3 and U1)	T17		
35518	35519	U12	T5		
35520	35521	U23	T5		
35522	35523	U31	T5		
35524	35525	Uavg (phase to phase)	T5		
35526	35527	I1	T5		
35528	35529	I2	T5		
35530	35531	I3	T5	35530	35531
35536	35537	Iavg	T5		
35538	35539	S I	T5		
35540	35541	Active Power Total (Pt)	T6		
35542	35543	Active Power Phase L1 (P1)	T6		
35544	35545	Active Power Phase L2 (P2)	T6		
35546	35547	Active Power Phase L3 (P3)	T6		
35548	35549	Reactive Power Total (Qt)	T6		
35550	35551	Reactive Power Phase L1 (Q1)	T6		
35552	35553	Reactive Power Phase L2 (Q2)	T6		
35554	35555	Reactive Power Phase L3 (Q3)	T6		
35556	35557	Apparent Power Total (St)	T5		
35558	35559	Apparent Power Phase L1 (S1)	T5		
35560	35561	Apparent Power Phase L2 (S2)	T5		
35562	35563	Apparent Power Phase L3 (S3)	T5		
35564	35565	Power Factor Total (PFt)	T7		
35566	35567	Power Factor Phase 1 (PF1)	T7		
35568	35569	Power Factor Phase 2 (PF2)	T7		
35570	35571	Power Factor Phase 3 (PF3)	T7		
35572		Power Angle Total (atan2(Pt,Qt))	T17		
35573		j1 (angle between U1 and I1)	T17		
35574		j2 (angle between U2 and I2)	T17		
35575		j3 (angle between U3 and I3)	T17		

Address		Contents	Data	Ind	Values / Dependencies
		Input Registers			
		AVERAGE MEASUREMENTS			
		THD HARMONIC DATA			
35582		U1 THD%	T16		
35583		U2 THD%	T16		
35584		U3 THD%	T16		
35588		I1 THD%	T16		
35589		I2 THD%	T16		
35590		I3 THD%	T16		
		MAXIMUM MEASUREMENTS			
35605	35606	Frequency	T5		
35607	35608	U1	T5		
35609	35610	U2	T5		
35611	35612	U3	T5		
35613	35614	Uavg (phase to neutral)	T5		
35615		j12 (angle between U1 and U2)	T17		
35616		j23 (angle between U2 and U3)	T17		
35617		j31 (angle between U3 and U1)	T17		
35618	35619	U12	T5		
35620	35621	U23	T5		
35622	35623	U31	T5		
35624	35625	Uavg (phase to phase)	T5		
35626	35627	I1	T5		
35628	35629	I2	T5		
35630	35631	I3	T5		
35632	35633	Reserved: Inc	T5		
35634	35635	Reserved: Inm	T5		
35636	35637	Iavg	T5		
35638	35639	S I	T5		
35640	35641	Active Power Total (Pt)	T6		
35642	35643	Active Power Phase L1 (P1)	T6		
35644	35645	Active Power Phase L2 (P2)	T6		
35646	35647	Active Power Phase L3 (P3)	T6		
35648	35649	Reactive Power Total (Qt)	T6		
35650	35651	Reactive Power Phase L1 (Q1)	T6		
35652	35653	Reactive Power Phase L2 (Q2)	T6		
35654	35655	Reactive Power Phase L3 (Q3)	T6		
35656	35657	Apparent Power Total (St)	T5		
35658	35659	Apparent Power Phase L1 (S1)	T5		
35660	35661	Apparent Power Phase L2 (S2)	T5		
35662	35663	Apparent Power Phase L3 (S3)	T5		
35664	35665	Power Factor Total (PFt)	T7		
35666	35667	Power Factor Phase 1 (PF1)	T7		
35668	35669	Power Factor Phase 2 (PF2)	T7		
35670	35671	Power Factor Phase 3 (PF3)	T7		
35672		Power Angle Total (atan2(Pt,Qt))	T17		
35673		j1 (angle between U1 and I1)	T17		
35674		j2 (angle between U2 and I2)	T17		

Address		Contents	Data	Ind	Values / Dependencies
		Input Registers			
		AVERAGE MEASUREMENTS			
35675		j3 (angle between U3 and I3)	T17		
35681		Internal Temperature	T17		
		THD HARMONIC DATA			
35682		U1 THD%	T16		
35683		U2 THD%	T16		
35684		U3 THD%	T16		
35685		U12 THD%	T16		
35686		U23 THD%	T16		
35687		U31 THD%	T16		
35688		I1 THD%	T16		
35689		I2 THD%	T16		
35690		I3 THD%	T16		
		MINIMUM MEASUREMENTS			
35700	35704	Reserved			
35705	35706	Frequency	T5		
35707	35708	U1	T5		
35709	35710	U2	T5		
35711	35712	U3	T5		
35713	35714	Uavg (phase to neutral)	T5		
35715		j12 (angle between U1 and U2)	T17		
35716		j23 (angle between U2 and U3)	T17		
35717		j31 (angle between U3 and U1)	T17		
35718	35719	U12	T5		
35720	35721	U23	T5		
35722	35723	U31	T5		
35724	35725	Uavg (phase to phase)	T5		
35726	35727	I1	T5		
35728	35729	I2	T5		
35730	35731	I3	T5		
35736	35737	Iavg	T5		
35738	35739	S I	T5		
35740	35741	Active Power Total (Pt)	T6		
35742	35743	Active Power Phase L1 (P1)	T6		
35744	35745	Active Power Phase L2 (P2)	T6		
35746	35747	Active Power Phase L3 (P3)	T6		
35748	35749	Reactive Power Total (Qt)	T6		
35750	35751	Reactive Power Phase L1 (Q1)	T6		
35752	35753	Reactive Power Phase L2 (Q2)	T6		
35754	35755	Reactive Power Phase L3 (Q3)	T6		
35756	35757	Apparent Power Total (St)	T5		
35758	35759	Apparent Power Phase L1 (S1)	T5		
35760	35761	Apparent Power Phase L2 (S2)	T5		
35762	35763	Apparent Power Phase L3 (S3)	T5		
35764	35765	Power Factor Total (PFt)	T7		
35766	35767	Power Factor Phase 1 (PF1)	T7		
35768	35769	Power Factor Phase 2 (PF2)	T7		
35770	35771	Power Factor Phase 3 (PF3)	T7		

Address		Contents	Data	Ind	Values / Dependencies
		Input Registers			
		AVERAGE MEASUREMENTS			
35772		Power Angle Total (atan2(Pt,Qt))	T17		
35773		j1 (angle between U1 and I1)	T17		
35774		j2 (angle between U2 and I2)	T17		
35775		j3 (angle between U3 and I3)	T17		
35781		Internal Temperature	T17		
		THD HARMONIC DATA			
35782		U1 THD%	T16		
35783		U2 THD%	T16		
35784		U3 THD%	T16		
35785		U12 THD%	T16		
35786		U23 THD%	T16		
35787		U31 THD%	T16		
35788		I1 THD%	T16		
35789		I2 THD%	T16		
35790		I3 THD%	T16		
RAM logger					
36000		Measurement parameter	T1		See OutTypes
36001		Time interval	T1		minuteas
36002		Number of valid results	T1		
36003		Time stamp of last result	T2		minutes since midnight (<0 if no time)
36004	36131	Logger table (newest to oldest)	T17		Normalised values

SETTINGS

		SYSTEM COMMANDS						
40001	40002	User Password (L1, L2)	T_Str4	A…Z	Password to attempt user access level upgrade			0
40003	40005	Factory Password (FAC)	T_Str6	A…Z	Password to attempt factory access level upgrade			0
40006	40007	Lavel 1 - User password	T_Str4	A…Z				1
40008	40009	Lavel 2 - User password	T_Str4	A…Z				2
40010		Active Acces Level	T1	0	Full protection	0	0	0
				1	Access up to level 1 user password			
				2	Access up to level 2 user password			
				3	Access up to level 2 (backup pass.)			
				4	Factory access level			
40011		Manual password activation	T1	1	Lock instrument			0
40012		Operator Command Register	T1	1	Save Settings	1	5	1
				2	Abort Settings			
				3	Restart Instrument			
40014		Reset command register 2	T1	Bit-0	Reset alarm ouptut relay 1			1
				Bit-1	Reset alarm ouptut relay 2			
				Bit-8	Reset alarm ouptut IR			

40015		IR external relay command action		0	Off	0	1	0
				1	On			
40030		Select Active Tariff	T1			1	6	1
40031		Reset energy command register 1	T1	Bit-0..7	Reset counter 1 .. 8	0	65535	1
				Bit-8..15	Reset counter 9 .. 16			
40032		Reset energy command register 2	T1	Bit-i	Reset counter i+17	0	65535	1
		INSTALATION SETTINGS						
40051	40052	Instalation Password	T_Str4	A…Z	Password to attempt instalation access level			0
40053		Connection and Total Energy Calculation	T1	0	Not set	0	3	0
				1	4u, 1b, 3u(3W3) – Vector			
				2	4u, 1b - Aritmetic			
				3	3u(2W3) - Vector			
		GENERAL SETTINGS						
40101	40120	Description	T_Str40					2
40121	40140	Location	T_Str40					2
40143		Conection Mode	T1	0	No mode	1	5	2
				1	1b - Single Phase			
				2	3b - 3 phase 3 wire balanced			
				3	4b - 3 phase 4 wire balanced			
				4	3u - 3 phase 3 wire unbalanced			
				5	4u - 3 phase 4 wire unbalanced			
40144		CT Secundary	T4		mA			2
40145		CT Primary	T4		A/10			2
40146		VT Secundary	T4		mV			2
40147		VT Primary	T4		V/10			2
40148		Current input range (%)	T16		10000 for 100%	5,00	260,00	2
40149		Voltage input range (%)	T16		10000 for 100%	2,50	100,00	2
40150		Frequency nominal value	T1		Hz	50	50	2
40151		CT connection	T1	Bit-0	Disable display "Wrong connection"			2
				Bit-1	Reverse Energy flow direction			
				Bit-2	Reverse CT connection			
40161	40162	Time	T9					1
40163	40164	Date	T10					1
40166		Automatic change S/W time	T1	0	No	0	1	1
40170		LCD configurations	T1	Bit 0	Counter description mode (*0=OBIS code; 1=letters)	0	1	2
40171		LCD Contrast	T2			-10	10	2
40172		LCD Back Light Intesnity	T1		0=No Backlight	0	10	2
40173		LCD Back Light Time Off	T1		Minutes (0=Always on)	0	60	2
40174		LCD scroll interval	T1		Seconds	5	60	2
40175		LCD Custom screen 1 - Line 1	T1		See OutTypes	0	100	2

40176		LCD Custom screen 1 - Line 2	T1		See OutTypes	0	100	2
40177		LCD Custom screen 1 - Line 3	T1		See OutTypes	0	100	2
40178		LCD Custom screen 2 - Line 1	T1		See OutTypes	0	100	2
40179		LCD Custom screen 2 - Line 2	T1		See OutTypes	0	100	2
40180		LCD Custom screen 2 - Line 3	T1		See OutTypes	0	100	2
40181		LCD Custom screen 3 - Line 1	T1		See OutTypes	0	100	2
40182		LCD Custom screen 3 - Line 2	T1		See OutTypes	0	100	2
40183		LCD Custom screen 3 - Line 3	T1		See OutTypes	0	100	2
40184		LCD scroll parameters 1	T1	Bit 0	Counter n1 (Allways)	1	65535	2
				Bit 1	Counter n2			
				Bit 2	Counter n3			
				Bit 3	Counter n4			
40185		LCD scroll parameters 2		Bit 0..7	Counter 1 .. 8	0	65535	2
				Bit 8..15	Counter 9 .. 16			
40186		LCD scroll parameters 3		Bit 0	Active Power Total (Pt)	0	65535	2
				Bit 1	Active Power P1 .. P3 (P12)			
				Bit 2	Reactive Power Total (Qt)			
				Bit 3	Reactive Power Q1 .. Q3 (Q12)			
				Bit 4	Apparent Power Total (St)			
				Bit 5	Apparent Power S1 .. S3 (S12)			
				Bit 6	Uavg (phase to neutral)			
				Bit 7	Voltage U1 .. U3			
				Bit 8	Uavg (phase to phase)			
				Bit 9	Voltage U12 .. U31			
				Bit 10	Curent Total			
				Bit 11	Curent I1 .. I3 (I12)			
				Bit 12	Frequency			
				Bit 13	Active Tariff			
				Bit 14	Power Factor Total (PFt)			
				Bit 15	Power Factor PF1 .. PF3 (PF12)			
40187		LCD scroll parameters 4		Bit 0	Power Angle Total (atan2(Pt,Qt))	0	31	2
				Bit 1	Power Angle 1 .. 3 (12)			
				Bit 2	THD of voltage			
				Bit 3	THD of current			
				Bit 4	Clock			
40188		LCD return mode	T1	0	Auto scroll	0	2	2
40192		Comm. & LCD average interval	T1		10=1,0 sec	0,1	5,0	2
40193		Touch Key Control	T1	Bit 0	Touch Key Lock enable	0	1	2

Address		Contents	Data	Ind	Values	min	max	P. Level
		COMMUNICATION						
40202		Port 1: Device Adress (Modbus)	T1			1	247	2
40203		Port 1: Boud Rate	T1	0	Baud rate 1200	1	7	2
				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		Port 1: Stop Bit	T1	0	1 Stop bit	0	1	2
				1	2 Stop bits			
40205		Port 1: Parity	T1	0	No parity	0	2	2
				1	Odd parity			
				2	Even parity			
40206		Port 1: Data Bits	T1	0	8 bits	0	0	2
				1	7 bits			
40207		Port 1: TCP Port	T1			1	65535	2
40208	40227	Port 1: IP Host name	T_Str40					2
40228	40229	Port 1: IP Address	T_Hex4					0
40230	40231	Port 1: Subnet Mask	T_Hex4					0
40232	40233	Port 1: Default Router	T_Hex4					2
40234	40241	WIFI password	T_Str16					2
40242	40249	WIFI SSID	T_Str16					2
40250		Bluetooth ON/OFF	T1	0	Off			2
				1	On			
		IR						
40251		res. for Port 2: Device Adress (DNP3)	T1			0	65519	2
40252		Port 2: Device Adress (Modbus)	T1			1	247	2
40253		Port 2: Boud Rate	T1		see Port 1: Boud Rate	3	7	2
40254		Port 2: Stop Bit	T1		see Port 1: Stop Bit	0	1	2
40255		Port 2: Parity	T1		see Port 1: Parity	0	2	2
40256		Port 2: Data Bits	T1		see Port 1: Data Bits	0	0	2
40257	40270	Reserved						
		M-bus						
40271		M-bus Primary address	T1			0	250	2
40272		M-bus: Boud Rate	T1	0	Baud rate 300	1	5	2
				1	Baud rate 600			
				2	Baud rate 1200			
				3	Baud rate 2400			
				4	Baud rate 4800			
				5	Baud rate 9600			
40273	40274	M-bus Secondary address	T3		Digits only (Default = Serial number)	0	99999999	2
40202		Port 1: Device Adress (Modbus)	T1			1	247	2
40203		Port 1: Boud Rate	T1	0	Baud rate 1200	1	7	2

				1	Baud rate 2400			
				4	Baud rate 4800			
				5	Baud rate 9600			
40273	40274	M-bus Secondary address	T3		Digits only (Default = Serial number)	0	99999999	2

Address		Contents	Data	Ind	Values	min	max	P. Level
		ENERGY						
40401		Active Tariff	T1	0	Tariff input	0	6	1
				1..4	Tariff 1..4			
				5..6	Tariff 5..6			
40402		Common Energy Counter Exponent	T2			-3	4	2
40403	40418	Reserved						
40419		Total Energy Calculation	T1	0	Evaluation of the sum of phases	0	1	2
				1	Evaluation of individual phases			
40420		Reactive power calculation	T1	0	Standard calculation (Q^2=S^2-P^2)	0	1	2
				1	Delayed Current method			
		NON-RESETABLE COUNTERS						
40421		Energy Counter n1 Parameter	T1	0	No Parameter	0	95	2
				1	Active Power			
				2	Reactive pover			
				3	Apparent Power			
				5	Active Power Phase 1			
				6	Reactive pover Phase 1			
				7	Apparent Power Phase 1			
				9	Active Power Phase 2			
				10	Reactive pover Phase 2			
				11	Apparent Power Phase 2			
				13	Active Power Phase 3			
				14	Reactive pover Phase 3			
				15	Apparent Power Phase 3			
				33	Active Power individual phases			
				34	Reactive Power individual phases			
				35	Apparent Power individual phases			
40422		Energy Counter n1 Configuration	T1	Bit-0	Quadrant I Enabled	0	63	2
				Bit-1	Quadrant II Enabled			
				Bit-2	Quadrant III Enabled			
				Bit-3	Quadrant IIII Enabled			
				Bit-4	Absolute Value			
				Bit-5	Invert Value			
40423		Energy Counter n1 Exponent	T2			-3	6	2
40424		Energy Counter n1 Tarif Selector	T1	Bit-0	Tarif 1 Enabled	0	63	2
				Bit-1 Bit-2	Tarif 2 Enabled Tarif 3 Enabled			
				Bit-3	Tarif 4 Enabled			
				Bit-4	Tarif 5 Enabled			
				Bit-5	Tarif 6 Enabled			
40425		Energy Counter n2 Parameter	T1		see Energy Counter n1 Parameter	0	95	2

40426		Energy Counter n2 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40427		Energy Counter n2 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40428		Energy Counter n2 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40429		Energy Counter n3 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40430		Energy Counter n3 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40431		Energy Counter n3 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40432		Energy Counter n3 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40433		Energy Counter n4 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40434		Energy Counter n4 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40435		Energy Counter n4 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40436		Energy Counter n4 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
		RESETABLE COUNTERS						
40437		Energy Counter 1 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40438		Energy Counter 1 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40439		Energy Counter 1 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40440		Energy Counter 1 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40441		Energy Counter 2 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40442		Energy Counter 2 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40443		Energy Counter 2 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40444		Energy Counter 2 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40445		Energy Counter 3 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40446		Energy Counter 3 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40447		Energy Counter 3 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40448		Energy Counter 3 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40449		Energy Counter 4 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40450		Energy Counter 4 Configuration	T1		see Energy Counter n1 Configuration	0	63	2

40451		Energy Counter 4 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40452		Energy Counter 4 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40453		Energy Counter 5 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40454		Energy Counter 5 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40455		Energy Counter 5 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40456		Energy Counter 5 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40457		Energy Counter 6 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40458		Energy Counter 6 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40459		Energy Counter 6 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40460		Energy Counter 6 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40461		Energy Counter 7 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40462		Energy Counter 7 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40463		Energy Counter 7 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40464		Energy Counter 7 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40465		Energy Counter 8 Parameter	T1		see Energy Counter n1 Parameter	0	95	2
40466		Energy Counter 8 Configuration	T1		see Energy Counter n1 Configuration	0	63	2
40467		Energy Counter 8 Exponent	T2		see Energy Counter n1 Exponent	-3	6	2
40468		Energy Counter 8 Tarif Selector	T1		see Energy Counter n1 Tarif Selector	0	63	2
40469	40472	Energy Counter 9			see Energy Counter n1			2
40473	40476	Energy Counter 10			see Energy Counter n1			2
40477	40480	Energy Counter 11			see Energy Counter n1			2
40481	40484	Energy Counter 12			see Energy Counter n1			2
40485	40488	Energy Counter 13			see Energy Counter n1			2
40489	40492	Energy Counter 14			see Energy Counter n1			2
40493	40496	Energy Counter 15			see Energy Counter n1			2
40497	40500	Energy Counter 16			see Energy Counter n1			2

SUPPORTED FUNCTIONS AND USAGE

Code DEC	Code HEX	Function	References
3	03	to read from holding registers	(4XXXX memory references)
4	04	to read from input registers	(3XXXX memory references)
6	06	to write to a single holding register	(4XXXX memory references)
16	10	to write to one or more holding register	(4XXXX memory references)

DATA TYPES DECODING

Registers defined in the Modbus database will define data as one of the data types described in the following table:

Type	Value / Bit Mask	Description
T1		Unsigned Value (16 bit) Example: 12345 stored as 12345 = $3039_{(16)}$
T2		Signed Value (16 bit) Example: -12345 stored as -12345 = $CFC7_{(16)}$
T3		Signed Long Value (32 bit) Example: 123456789 stored as 123456789 = 075B CD $15_{(16)}$
T4	bits # 15..14 bits # 13..00	Short Unsigned float (16 bit) Decade Exponent(Unsigned 2 bit) Binary Unsigned Value (14 bit) Example: $10000*10^2$ stored as $A710_{(16)}$

Type	Value / Bit Mask	Description
T5	 bits # 31..24 bits # 23..00	Unsigned Measurement (32 bit) Decade Exponent(Signed 8 bit) Binary Unsigned Value (24 bit) Example: $123456*10^{-3}$ stored as FD01 $E240_{(16)}$
T6	 bits # 31..24 bits # 23..00	Signed Measurement (32 bit) Decade Exponent (Signed 8 bit) Binary Signed value (24 bit) Example: - $123456*10^{-3}$ stored as FDFE $1DC0_{(16)}$
T7	 bits # 31..24 bits # 23..16 bits # 15..00	Power Factor (32 bit) Sign: Import/Export (00/FF) Sign: Inductive/Capacitive (00/FF) Unsigned Value (16 bit), 4 decimal places Example: 0.9876 CAP stored as 00FF $2694_{(16)}$
T8	 bits # 31..24 bits # 23..16 bits # 15..08 bits # 07..00	Time stamp (32 bit) Minutes 00 - 59 (BCD) Hours 00 - 23 (BCD) Day of month 01 - 31 (BCD) Month of year 01 - 12 (BCD) Example: 15:42, 1. SEP stored as 4215 $0109_{(16)}$
T9	 bits # 31..24 bits # 23..16 bits # 15..08 bits # 07..00	Time (32 bit) 1/100s 00 - 99 (BCD) Seconds 00 - 59 (BCD) Minutes 00 - 59 (BCD) Hours 00 - 24 (BCD) Example: 15:42:03.75 stored as 7503 $4215_{(16)}$
T10	 bits # 31..24 bits # 23..16 bits # 15..00	Date (32 bit) Day of month 01 - 31 (BCD) Month of year 01 - 12 (BCD) Year (unsigned integer) 1998..4095 Example: 10, SEP 2000 stored as 1009 $07D0_{(16)}$
T_Str4 (T11)		Text String 4 characters Two characters per 16 bit register
T_Str6 (T12)		Text String 6 characters Two charcters per 16 bit register
T_Str8		Text String 8 characters Two characters per 16 bit register.
T_Str16		Text String 16 characters Two characters per 16 bit register.
T_Str20		Text String 20 characters Two characters per 16 bit register.
T16		Unsigned Value (16 bit), 2 decimal places Example: 123.45 stored as 123.45 = $3039_{(16)}$
T17		Signed Value (16 bit), 2 decimal places Example: -123.45 stored as -123.45 = $CFC7_{(16)}$

Type	Value / Bit Mask	Description
T_Time		Time and Date (64 bit)
	bits # 63..56	1/100s 00 - 99 (BCD)
	bits # 55..48	Seconds 00 - 59 (BCD)
	bits # 47..40	Minutes 00 - 59 (BCD)
	bits # 39..32	Hours 00 - 24 (BCD)
	bits # 31..24	Day of month 01 - 31 (BCD)
	bits # 23..16	Month of year 01 - 12 (BCD)
	bits # 15..00	Year (unsigned integer) 1998..4095
		Example: 15:42:03.75, 10. SEP 2000 stored as 7503 4215 1009 $07D0_{(16)}$
T_TimeIEC		Time and Date (64 bit) = IEC870-5-4 "Binary Time 2a"
	bits # 63..55	Reserved
	bits # 54..48	Years (0 .. 99)
	bits # 47..44	Reserved
	bits # 43..40	Months (1 .. 12)
	bits # 39..37	Day of Week (1 .. 7)
	bits # 36..32	Day of Month (1 .. 31)
	bit # 31	Summer Time (0 .. 1): Summer time (1), Standard time (0)
	bits # 30..29	Reserved
	bits # 28..24	Hours (0 .. 23)
	bit # 23	Invalid (0 .. 1): Invalid (1), Valid (0)
	bit # 22	Reserved
	bits # 21..16	Minutes (0 .. 59)
	bits # 15..00	Miliseconds (0 .. 59999)
		Example: 15:42, 1. SEP stored as 4215 $0109_{(16)}$
T_Data		Record Data
		Size and SubTypes depends on the Actual Memory Part
T_Str40		Text String 40 characters
		Two characters per 16 bit register.
T_float		IEEE 754 Floating-Point Single Precision Value (32 bit)
	bits # 31	Sign Bit (1 bit)
	bits # 30..23	Exponent Field (8 bit)
	bits # 22..0	Significand (23 bit)
		Example: 123.45 stored as 123.45000 = 42F6 $E666_{(16)}$
T9A		Time (16 bit)
	bits # 15..08	Minutes 00 - 59 (BCD)
	bits # 07..00	Hours 00 - 24 (BCD)
		Example: 15:42 stored as $4215_{(16)}$
T10A		Date (16 bit)
	bits # 15..08	Day of month 00 - 31 (BCD)
	bits # 07..00	Month of year 00 - 12 (BCD)
		Example: 30, SEP stored as $3009_{(16)}$
T18		Signed Value (16 bit), 4 decimal places
		Example: -0.2345 stored as -2345 = $F6D7_{(16)}$
T_unix		Unix time (32 bit)
	Bits # 31..00	Seconds since January 1, 1970
		Example: 16 May 2012 10:36:46 GMT stored as 4FB3 $833E_{(16)}$

8.2 Appendix B: M-BUS

The M-BUS interface fully complies with M-BUS European standard EN13757-2. The entire communication is ensured with 8 Data Bits, Even Parity, 1 Stop Bit and a Baud Rate from 300 to 9600 Bauds.

Communication settings

Default communication settings are: 2400, 8, E, 1 primary address 0 and secondary address is set to serial number of device.

Initialize M-Bus (SNK_NKE)

This Short Telegram initializes the M-BUS IE38MX. The M-BUS IE38MX confirms correct receipt by Single Character Acknowledgement (ACK = E5). If the telegram was not correctly received the IE38MX will not send an acknowledgement.

Select M-BUS IE38MX Using Secondary Address (SND_UD)

This Telegram enables to select M-BUS IE38MX. The M-BUS IE38MX confirms the correct receipt by ACK. If the telegram has not been correctly received the M-BUS IE38MX will not send an Acknowledgement. After issue of the Single Character Acknowledgement the M-BUS IE38MX is ready to transmit the entire Read-out Data within 3 seconds from receiving the Telegram „Transmit Read-out Data“. At the end of 3 seconds the M-BUS IE38MX will switch back to normal mode.

Transmit Read-out Data via Primary/Secondary Address (REQ_UD2)

This Short Telegram enables to select the M-BUS IE38MX and to command it to transmit the Read-out Data parameterized. The M-BUS IE38MX confirms correct receipt by transmitting of the Read-out Data. If the Short Telegram has not been received correctly; no Data will be transmitted by the M-BUS IE38MX. The Read-out Data are sent within 35 ms – 75 ms from receipt of the Short Telegram by the M-BUS Meter (fom more infomations see section M-Bus telegrams).

Set Baud Rate via Primary/Secondary Address (SND_UD)

This telegram enables to set the desired Baud Rate. The M-BUS IE38MX confirms the correct receipt by ACK. If the telegram was not received correctly the M-BUS IE38MX does not send an Acknowledgement. The (ACK) is sent by the M-BUS IE38MX in the Old Baud Rate. As soon as ACK is transmitted the M-BUS Meter switches to the baud rate newly parameterized. If the IE38MX now does not receive a new Telegram under the new baud rate within a period of 30 seconds – 40 seconds, it automatically switches back to the old baud rate. This is apt to prevent that a faulty setting of the baud rate may interrupt communication.

Set Primary Address via Primary/Secondary Address (SND_UD)

This Telegram enables to set a new Primary Address. The M-BUS IE38MX confirms the correct receipt by ACK. If the telegram has not been correctly received the M-BUS IE38MX will not send an Acknowledgement.

Set Secondary Address via Primary/Secondary Address (SND_UD)

This Telegram enables to set a new Secondary Address. The M-BUS IE38MX confirms the correct receipt by ACK. If the telegram has not been correctly received the M-BUS IE38MX will not send an Acknowledgement.

Secondary Address (UD) consists of:

Identification Number:	00000000 – 99999999	8-digit Secondary Address number
Manufacturer’s Code:	73 26	2 Byte Company Constant (Iskra = “73 26”)
Version Number:	01 – FF	1 Byte
Medium: 02	1 Byte Constant Electricit	

Reset, Restart M-BUS MC350 via Primary/Secondary Address (SND_UD)

This Telegram reset/restarts M-BUS MC350. The M-BUS IE38MX confirms correct receipt by ACK. If the telegram was not correctly received the M-BUS IE38MX will not send an acknowledgement.

M-Bus Telegram

Total Energy counters 0, 1, 2, 3

Energy counters could represent: +/- active energy, +/-reactive energy or apparent energy and one of 4-th tariff.

	DIF	DIFE	DIFE	VIF	VIFE	VIFE	VIFE	DATA	
								xx.xx.xx.xx	
T0:	04	none	none						
T1:	84	10	none						
T2:	84	20	none						
A+:				05	None	none	none	$*10^{5-3}$	Wh
A-:				85	3C	none	none	$*10^{5-3}$	Wh
R+:				FB	82	75	none	$*10^{5-3}$	varh
R-:				FB	82	F5	3C	$*10^{5-3}$	varh
App:				FB	84	75	none	$*10^{5-3}$	VAh

Active Tariff number

Tariff number in progress (1 to 4)

	DIF	DIFE	DIFE	VIF	VIFE	VIFE	VIFE	DATA
	01			FF	01			xx

DATA: value represent as 8-bit integer

Active Power Total Pt (W)

Active power total in 32 bit x $10^{(2-3)}$ W

	DIF	DIFE	DIFE	VIF	VIFE	DATA
	04			2A		xx.xx.xx.xx

Active Power Total (kvar)

Reactive power total in 32bit x$10^{(2-3)}$ var

	DIF	DIFE	VIF	VIFE	VIFE	VIFE	DATA
	04		FB	97	72		xx.xx.xx.xx

Instant Apparent Power Total (VA)

Apparent power total in 32 bit x $10^{(5-6)}$ VA

	DIF	DIFE	VIF	VIFE	VIFE	VIFE	DATA
	04		FB	B4	75		xx.xx.xx.xx

n - 0…7

Power Factor: -: leading et +: lagging: PF

Power factor as 32-bit integer * 10^{-3}

	DIF	DIFE	DIFE	VIF	VIFE	VIFE	VIFE	DATA
	04			A8	B4	35		xx.xx.xx.xx

Unit : W/V/A

Current Total (A)

Total current as 32 bit x $10^{(9-12)}$ A

	DIF	DIFE	VIF	VIFE	VIFE	DATA
	04		FD	59		xx.xx.xx.xx

System frequency (Hz/1000)

Contains the line frequency 32-bit integer in mHz.

	DIF	DIFE	DIFE	VIF	VIFE	VIFE	VIFE	DATA
	04			FB	2C			xx.xx.xx.xx

Active Power in Phase 1, 2, 3 (W)

Active power in 32bit x $10^{(2-3)}$ W

	DIF	DIFE	DIFE	VIF	VIFE	VIFE	DATA
	04						xx.xx.xx.xx
P1:				AA	FC	01	
P2:				AA	FC	02	
P3:				AA	FC	03	

Current in Phase 1, 2, 3, Neutral (A)

Phase current as 32 bit x $10^{(9-12)}$ A

	DIF	DIFE	VIF	VIFE	VIFE	VIFE	DATA
	04						xx.xx.xx.xx
I1:			FD	D9	FC	01	
I2:			FD	D9	FC	02	
I3:			FD	D9	FC	03	

Voltages (V)

Voltage as 32 bit x $10^{(7-9)}$ V

	DIF	DIFE	VIF	VIFE	VIFE	VIFE	DATA
	04						xx.xx.xx.xx
U1:			FD	C7	FC	01	
U2:			FD	C7	FC	02	
U3:			FD	C7	FC	03	
U12:			FD	C7	FC	05	
U23:			FD	C7	FC	06	
U31:			FD	C7	FC	07	

8.4 Appendix C: Equations

Number	Symbol	Definition
1	MP	Average interval
2	U_f	Phase voltage (U_1, U_2 or U_3)
3	U_{ff}	Phase-to-phase voltage (U_{12}, U_{23} or U_{31})
4	N	Total number of samples in a period
5	n	Sample number ($0 \leq n \leq N$)
6	x, y	Phase number (1, 2 or 3)
7	i_n	Current sample n
8	u_{fn}	Phase voltage sample n
9	u_{ffn}	Phase-to-phase voltage sample n
10	ϕ_f	Power angle between current and phase voltage f (ϕ_1, ϕ_2 or ϕ_3)

Voltage

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

Phase voltage

N – samples in averaging interval (up to 65 Hz)

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

Phase-to-phase voltage

u_x, u_y – phase voltages (U_f)

N – a number of samples in averaging interval

Current

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

Phase current

N – samples in averaging interval (up to 65 Hz)

Power

$\mathrm{P}_f = \frac{1}{\mathrm{N}}\sum_{\mathrm{n}=1}^{\mathrm{N}}(u_{fn} \times \mathrm{i}_{fn})$	**Active power by phases** N – a number of periods n – index of sample in a period f – phase designation
$P_t = P_1 + P_2 + P_3$	**Total active power** t – total power 1, 2, 3 – phase designation
$\mathrm{SignQ_f}(\varphi)$ $\varphi \in [0° - 180°] \rightarrow \mathrm{SignQ}_f(\varphi) = +1$ $\varphi \in [180° - 360°] \rightarrow \mathrm{SignQ}_f(\varphi) = -1$	**Reactive power sign** Q_f – reactive power (by phases) □ – power angle
$S = U_f \cdot I_f$	**Apparent power by phases** U_f – phase voltage I_f – phase current
$S_t = S_1 + S_2 + S_3$	**Total apparent power** S_t – apparent power by phases
$Q_f = SignQ(\varphi) \times \sqrt{{S_f}^2 - {P_f}^2}$	**Reactive power by phases** S_f – apparent power by phases P_f – active power by phases
$Q_f = \frac{1}{N} \cdot \sum_{n=1}^{N}(u_{fn} \times i_{f[n+N/4]})$	**Reactive power by phases (displacement method)** N – a number of samples in a period n – sample number (0 ≤ n ≤ N) f – phase designation
$Q_t = Q_1 + Q_2 + Q_3$	**Total reactive power** Q_t – reactive power by phases
$\varphi_s = a\ tan2\ (P_f, Q_f)$ $\varphi_s = [-180°, 179{,}99°]$	**Total power angle** P_t – total active power Q_t – total reactive power
$PF = \frac{\lvert P \rvert}{S}$	**Distortion power factor** P – active power S –apparent power

THD

$I_f\ THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} I_{fn}^2}}{I_{f1}} 100$	**Current THD** I_1 – value of first harmonic n – number of harmonic
$U_f\ THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} U_{fn}^2}}{U_{f1}} 100$	**Phase voltage THD** U_1 – value of first harmonic n – number of harmonic

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Published by Iskra, d.o.o. • Subject to change without notice • Version 1.02 January 2021 • EN K22.433.926