Iskra®

User 's Manual

EN

Measuring transducers:

- *Power Transducer iMT510*
- *Power Transducer & Recorder iMT511*
- *Voltage Transducer iMT516*
- *Current Transducer iMT518*

July 2021 • Version 1.00

Power Transducer iMT510

Power Transducer & Recorder iMT511

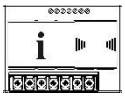
Voltage Transducer iMT516

Current Transducer iMT518

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 measuring transducers iMT510, iMT511, iMT516, and iMT518.
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 measuring transducer. 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 d.o.o. 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.
- Proper connection of auxiliary supply.
- Nominal frequency.
- Voltage ratio and phase sequence.
- Current transformer ratio and terminals integrity.
- Protection fuse - recommended maximal external fuse size is 6 A.
- Integrity and proper connection of earth protective terminals (where necessary).

Important: A current transformer secondary should be short circuited before connecting the meter.

Used symbols on devices' housing and labels

SYMBOL	EXPLANATION
	**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 **SIST EN 61010–1** standard.
	Protective conductor terminal. Terminal which is bonded to conductive parts of an instrument for safety purposes and is intended to be connected to an external protective earthing system.
	Functional ground potential. **Note**: This symbol is also used for marking a terminal for protective ground potential if it is used as a part of connection terminal or auxiliary supply terminals.
	Compliance of the product with directive 2002/96/EC, as first priority, the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment.
	Compliance of the product with European CE directives.

Important: A current transformer secondary should be short circuited before connecting the transducer.

Battery replacement ●○○○

Some instruments are equipped with a built-in battery. When empty, replace with a corresponding type (Varta, type 6032 CR2032 SLF or equivalent). A battery shall be replaced by an authorized service. The battery lifetime is approx. 6 years. Instruction on battery replacement is given in chapter 5: Battery replacement.

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 multifunction transducers required to understand its purpose, applicability and basic features connected to its operation.
In this chapter you will find:

1.1 Introduction

Regarding the type of measuring transducer different chapters should be considered since the types differ in functionality and design. More detailed description of device functions is given in chapter Type differences. Al types of measuring transducers are available in DIN or ANSI housing. Instruments in DIN housing are marked as types iMT5xx; instruments in ANSI housing are marked as types iUMT5xx. Specifications of housing for both types are specified in chapter Dimensions.

1.1.1 Description of symbols

In different chapters or tables different symbols may appear in User's Manual. According to the position of symbols, they have different meaning.

1.1.1.1 *Chapter*

Due to differences among devices, some chapters do not relate to your instrument. Five symbols next to chapter heading are for faster surveying. Type of symbol indicates to which extent the chapter applies for each type of measuring transducer. Meaning of each symbol is:

○ – Function not supported

◖ – Function partially supported (see a note)

● – Function completely supported

Each of the three positions, where the symbols are indicates a Measuring transducer type. Positions follow from left to right:

iMT511/iMT510/iMT516/iMT518

1.1.1.2 *Subchapter*

Symbols next to the subchapters indicate accessibility of functions described. Accessibility of functions is indicated with the following symbols:

PC – Function accessible via communication (MiQen software)

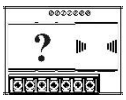
1.1.1.3 *Tables*

Supported functions and measurements are listed in tables for all types. Symbols in tables indicate support of enabled functions for each type. 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



USER INFORMATION

For unknown technical terms please refer to Glossary at the end of the document.

1.2 Description of the device

Measuring transducer is intended for measuring, analyzing and monitoring single-phase electrical power network. It measures true RMS values by means of fast sampling of voltage and current signals, which makes instrument suitable for acquisition of transient events. A built-in microcontroller calculates measurements (voltage, current, frequency, energy, power, power factor, THD, phase angles, MD) from the measured signals.

1.2.1 Appearance

Measuring transducer can differ from yours depending on the type and functionality.

1 – Communication ports (RS485 only)
2 –I/O modules
3 – Auxiliary supply
4 – Voltage inputs
5 – Current inputs
6 – LED indicators, RJ45 Ethernet connector (option) and USB-B type connector (option)

1.2.1.1 *Communication ports and LED indicators*

Under the sliding, semitransparent cover are connectors for various communication types, which should be chosen at placing the order. Serial communication can be connected through DB9 connector (RS232 or RS485) or screw-in connector (RS485 only). Ethernet communication can be connected through standard RJ-45 type connector. USB can be connected through USB-B type connector. There is also additional communication port (RS485), which is intended for Remote display connection (RJ-11 type connector).

Two LED indicators are intended for POWER ON signaling (red LED) and COMMUNICATION IN PROGRESS signaling (green LED blinking).

1.2.1.2 *I/O modules*

Two I/O module slots are intended for various I/O modules, which should be chosen at placing the order. Digital inputs, analogue outputs, alarm / digital outputs and pulse outputs.

1.2.1.3 *Auxiliary supply*

Auxiliary supply is connected through three screw-in connectors. For safety purposes it is important that all three wires (Line, Neutral and Earth) are firmly connected. Auxiliary supply can be either LOW (19 VDC – 70 VDC; 48 VAC – 77 VAC) or HIGH (70 VDC – 300 VDC; 80 VAC – 276 VAC), which should be chosen at placing the order.

1.2.1.4 *Voltage inputs*

Each voltage input is connected to measuring circuit through input resistor chain (4.2 MΩ per phase). Maximum value of input voltage is 600 V_{L-N}.

1.2.1.5 *Current inputs*

Each current input is connected to measuring circuit through current transformer (0.01 Ω per phase). Maximum allowed thermal value of input current is 15 A (cont.).

1.3 Purpose and use of different types of measuring transducers

1.3.1 Voltage transducer iMT516

iMT516 is intended for measuring and monitoring single-phase electrical power network. Voltage input is electrically isolated from the system by means of high resistive input chain. It measures true RMS voltage value by means of fast sampling of voltage signals, which makes instruments suitable for acquisition of transient events. A built-in microcontroller calculates measurands (voltage, frequency) from the measured signals. Measurands can be then converted into load independent DC current or voltage which is proportional to the true RMS measured value for the purpose of regulation of analogue and/or digital devices.

1.3.2 Current transducer iMT518

iMT518 is intended for measuring and monitoring single-phase electrical power network. Input current is electrically isolated from the system by means of current transformer. iMT518 measures true RMS current value by means of fast sampling of current signals, which makes instruments suitable for acquisition of transient events. A built-in microcontroller calculates measurands (current, frequency) from the measured signals. Measurands can be then converted into load independent DC current or voltage which is proportional to the true RMS measured value for the purpose of regulation of analogue and/or digital devices.

1.3.3 Power transducer iMT510

iMT510 is intended for measuring and monitoring single-phase electrical power network. Input voltage and input current are electrically isolated from the system by means of high resistive input chain and current transformer respectively. It measures true RMS values by means of fast sampling of voltage and current signals, which makes instruments suitable for acquisition of transient events. A built-in microcontroller calculates measurands (voltage, current, frequency, energy, power, power factor, THD phase angles, etc.) from the measured signals.

1.3.4 Power transducer & recorder iMT511

iMT511 measures all parameters like iMT510 and additionally it records the readings and alarms in the internal memory for the period of three years or more. Internal battery powered real time clock enables also energy measurement as well as recording of time – stamped events (alarms) in the internal memory.

Wide range of various I/O modules makes iMT51x family of trnasducers a perfect choice for numerous applications. iMT51x can be delivered pre-configured to the required measuring set-up and output characteristic or they can be delivered un-configured for customer configuration with user friendly setting software MiQen. They support a wide range of communication interfaces. Standard serial RS232/485 with speed up to 115200 baud is perfect for simple applications and serial bus interfacing. Ethernet 10/100 is ideal for a long distance monitoring and configuration of numerous transducers. USB 2.0 can be used for a fast set-up or memory acquisition.

1.4 Type differences

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

Differences in hardware

Feature		iMT511	iMT510	iMT516	iMT518
Internal flash memory		8Mb	×	×	×
Real time clock (RTC) with battery		●	×	×	×
Communication interface RS232 and Ethernet/USB		●/○	●/○	●/○	●/○
I/O 1	AN/AL /PO/DI	○/○/○/○	○/○/○/○	○/○/×/○	○/○/×/○
I/O 2	AN/AL /PO/DI	○/○/○/○	○/○/○/○	○/○/×/○	○/○/×/○
Automatic voltage / current range		●/●	●/●	●/×	×/●
Universal power supply LO / HI		○/●	○/●	○/●	○/●
LED indicator: Power/Comm		●/●	●/●	●/●	●/●

AN-analogue out, AL-alarm/digital out, PO-pulse out, DI-digital in

Software functions

	Functions	iMT511	iMT510	iMT516	iMT518
	MODBUS protocol	●	●	●	●
	Programmable alarms	16	16	16	16
	Alarms recording	●	×	×	×
	Measurements recording	●	×	×	×

Supported measurements

	Basic measurements	iMT511	iMT510	iMT516	iMT518
Phase	Voltage U_1	●	●	●	×
	Current I_1	●	●	×	●
	Active power P_1	●	●	×	×
	Reactive power Q_1	●	●	×	×
	Apparent power S_1	●	●	×	×
	Power factor PF_1	●	●	×	×
	Power angle ϕ_1	●	●	×	×
	THD of phase voltage U_{f1}	●	●	●	×
	THD of phase current I_1	●	●	×	●
	Frequency	●	●	●	●
	Internal temperature	●	●	●	●
	Date & Time	●	×	×	×
	MD	●	●	●	●
Energy	Counter 1	●	●	×	×
	Counter 2	●	●	×	×
	Counter 3	●	●	×	×
	Counter 4	●	●	×	×

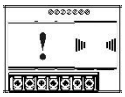
● – *serial* × – *not supported*

2 CONNECTION

This chapter deals with the instructions for measuring transducer connection. Both the use and connection of the device includes handling with dangerous currents and voltages. Only a qualified person shall therefore perform connection. 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:

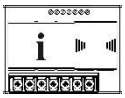
2.1 Introduction

Before use: Check voltages, supply voltage and nominal frequency.
Check protective fuse rating (the recommended maximum rating of the external protective fuse for this equipment is 6 A - Red Spot type or equivalent).



WARNING!

Wrong or incomplete connection of voltage, protective ground or other terminals can cause malfunction or damage the device.



PLEASE NOTE

After connection, settings have to be performed via communication or remote display (connection mode, current and voltage transformers ratio …).

2.2 Mounting

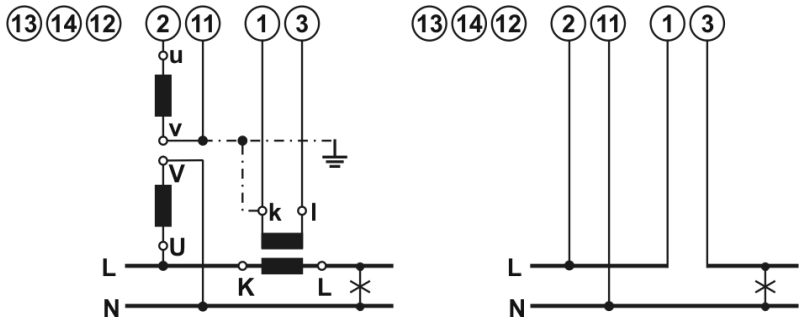
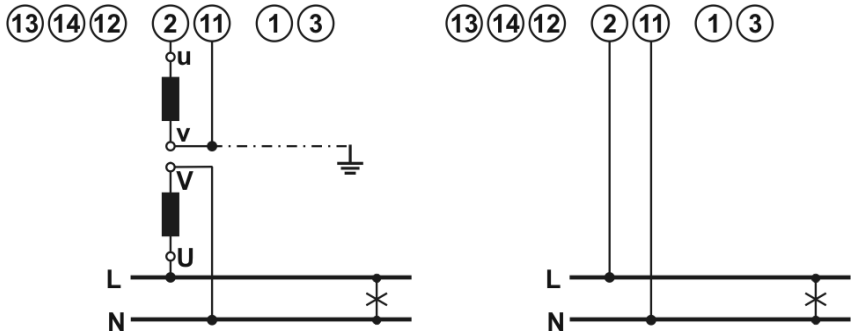
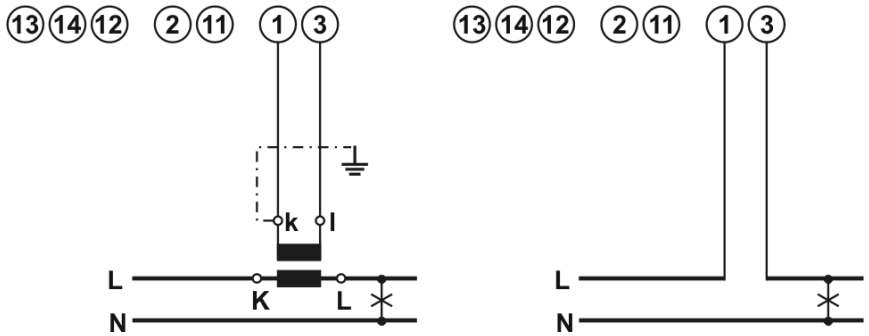
iMT51x measuring transducer is designed for panel mounting. It should be mounted on a 35 mm DIN rail by means of three plastic fasteners. Before installation fasteners should be in open position (pulled). After device is on place, fasteners are locked (pushed) to close position.

2.3 Electrical connection ●●●●

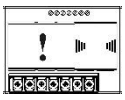
Voltage inputs of measuring transducer can be connected directly to low-voltage network or via appropriate voltage measuring transformer to medium or high voltage network.

Current inputs of measuring transducer can be connected directly to low-voltage network or via a corresponding current transformer.

Choose corresponding connection from the figures below and connect corresponding voltages and currents. Information on electrical characteristics is given in chapter Inputs.

System/connection	Terminal assignment
Connection 1b (1W) *Single-phase connection* iMT510/511	
Connection 1b (1W) *Single-phase connection* iMT516	
Connection 1b (1W) *Single-phase connection* iMT518	

2.4 Connection of input/output modules ●●●●



WARNING!

Check the module features that are specified on the label, before connecting module contacts. Wrong connection can cause damage or destruction of module and/or device.

Connect module contacts as specified on the label. Examples of labels are given below and describe modules built in the device. Information on electrical properties of modules is given in chapter Modules.

I/O 1 Relay output 48 V DC/AC 15 1000 mA 16	Alarm (relay) module. (Example of alarm module as I/O module 1)
I/O 1 Pulse output 40 V DC/AC 15 30 mA 16	Pulse output (solid state) module for energy counters. (Example of pulse module as I/O module 1)
I/O 1 Analogue output 0...–/+20 mA 15 0...–/+10 V 16	Analogue output module with analogue output, proportional to measured quantities. The outputs may be either short or open-circuited. They are electrically insulated from each other and from all other circuits. (Example of analogue output module as I/O module 1)
I/O 1 Digital input 48 V DC/AC 15 + 40% max 16	Digital input module enables reception of impulse signal. (Example of digital module as I/O module 1)
I/O 1 Watchdog output 48 V DC/AC 15 1000 mA 16	Watchdog output (relay) module enables proper instrument operation supervision. (Example of Watchdog output module as I/O module 1)

2.5 Communication connection ●●●●

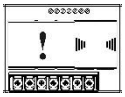
iMT51x has a wide variety of communication possibilities to suit specific demands. In the case of simultaneous use of Ethernet and USB communication, the standard port (COM1) is shared by two communication channels: COM1A (Ethernet) and COM1B (USB). This allows different users to access data from iMT51x simultaneously and by using Ethernet communication, data can be accessed worldwide.

Different configurations are possible (to be specified with an order):

Configuration	*COM1A*	*COM1B*
1	*RS232/485*[1]	*/*
2	*Ethernet*	*USB*

[1] *RS485 communication is available through DB9 or screw-in terminals, while RS232 is available only through DB9*

WARNING!

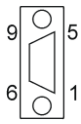
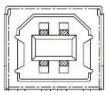


When connecting a DB9 communication connector it is necessary to assure that only RS232 or RS485 communication is used. Terminals of a DB9 connector that are not necessary for the used communication should remain unconnected, otherwise the communication module and/or device can be damaged or destroyed. See connection diagrams below.

Connect a communication line by means of a corresponding terminal. Corresponding data are stated on the instrument label, regarding the selected communication. Connector terminals are marked on the label on the upper side of the instrument. More detailed information on communication is given in chapter Communication.

COMMUNICATION				
Terminal:		23	A	
RS485		25	B	
DB9 - FEMALE				
RS232			RS485	
Tx	Rx	⏚	B	A
2	3	5	7	8

COMMUNICATION
Ethernet
MAC No.:
USB 2.0 Type B

	DB9 connector for RS232 and RS485 communication
	RJ45 Ethernet connector
	USB-B type connector

2.5.2 RS232

RS232 communication is intended for direct connection of the measuring transducer to the personal computer. It is necessary to assure the corresponding connection of individual terminals of the DB9 connector (see a table on the next page).

2.5.3 RS485

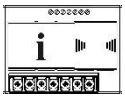
RS485 communication is intended for connection of devices to network where several instruments with RS485 communication are connected to a common communication interface. We recommend the use of Iskra d.o.o. communication interfaces for best compatibility!
Correct connection of individual terminals of the DB9 connector shall be provided (see a table on the next page).

2.5.4 Ethernet

Ethernet communication allows for integration of the device into global Ethernet-based networks. The device supports fast Ethernet (10/100 Mbps). For proper operation, standard IEEE 802.3 compliant 100BASE-T CAT5 Ethernet cable is recommended. The device is supplied with a unique MAC address for identification. The MAC address is printed on the label, positioned on the upper side of the instrument.

2.5.5 USB

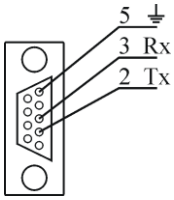
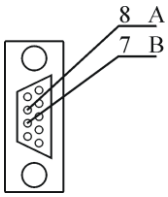
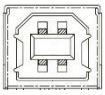
USB communication serves as a fast peer-to-terminal data link. The instrument is detected by host as a USB 2.0 compatible device. The USB connection is provided through a USB standard Type B connector.



PLEASE NOTE

When iMT51x is connected to a PC through USB communication for the first time, a user is prompted to install a driver. The driver is provided on the CD, enclosed in the original shipment package, or can be downloaded from the Iskra d.o.o. web page https://www.iskra.eu/en/. With this driver installed, USB is redirected to a serial port, which should be selected when using MiQen software.

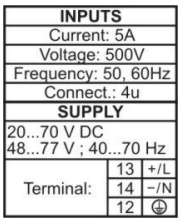
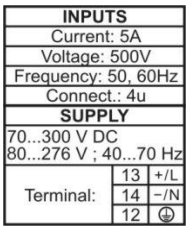
Survey of communication connection

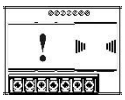
	Connector	Terminals	Position	Data direction	Description
RS232	DB9		1	Not connected	–
			2	From	Data transmission (Tx)
			3	To	Data reception (Rx)
			4	Not connected	–
			5	–	Grounding (⏚)
			6	Not connected	–
			7	–	Do not connect!
			8	–	Do not connect!
			9	Not connected	–
RS485	DB9		1	Not connected	–
			2	–	Do not connect!
			3	–	Do not connect!
			4	Not connected	–
			5	–	Do not connect!
			6	Not connected	–
			7	To/From	B
			8	To/From	A
			9	Not connected	–
	SCREW-IN		23	To/From	A
			24	Not connected	C
			25	To/From	B
Ethernet	RJ−45		100BASE-T CAT5 cable recommended		
USB	USB-B		Standard USB 2.0 compatible cable recommended (Type B plug)		

2.6 Connection of auxiliary power supply ●●●●

Measuring transducer has universal (AC/DC) auxiliary power supply. Information on electric consumption is given in chapter Technical data. Auxiliary supply is connected through three screw-in connectors. It can be either LOW (19 VDC – 70 VDC; 48 VAC – 77 VAC) or HIGH (70 VDC – 300 VDC; 80 VAC – 276 VAC), which should be chosen at placing the order.

According to power supply voltage specification on the label, choose and connect the power supply voltage:

	Connection of universal power supply (LOW) to terminals 13, 14 and 12
	Connection of universal power supply (HIGH) to terminals 13, 14 and 12



WARNING!

For safety purposes it is important that all three wires (Line, Neutral and Protective Earth) are firmly connected. They should be connected only to the designated terminals as shown on the label above as well as on the front foil.

3 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 ***Multifunction tranduscers*** features and settings. Chapter is organized in a way to follow settings organisation as in setting software MiQen.

3.1 INTRODUCTION

Instrument settings can be remotely modified with communication (COM1) and MiQen software, when connected to a PC.

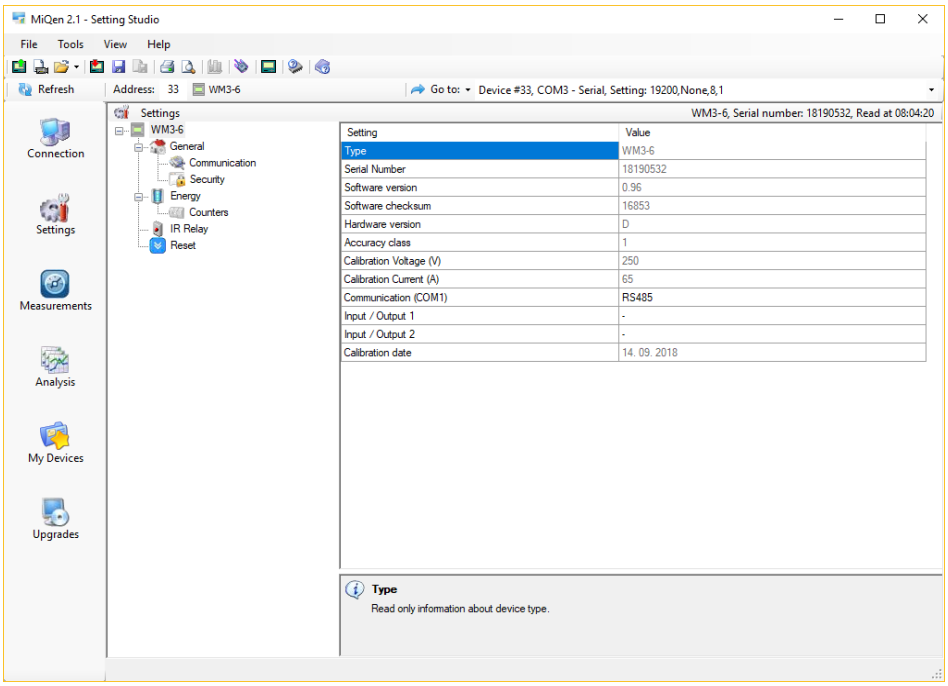
3.2 MiQen software

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.

Two editions of MiQen software are available:

- Professional edition with full functionality and supports all software functionality. CDKey is required for the installation.
- Standard edition, freeware edition which supports all software functionality except data analysis.

Sample off MiQen programming and monitoring software:

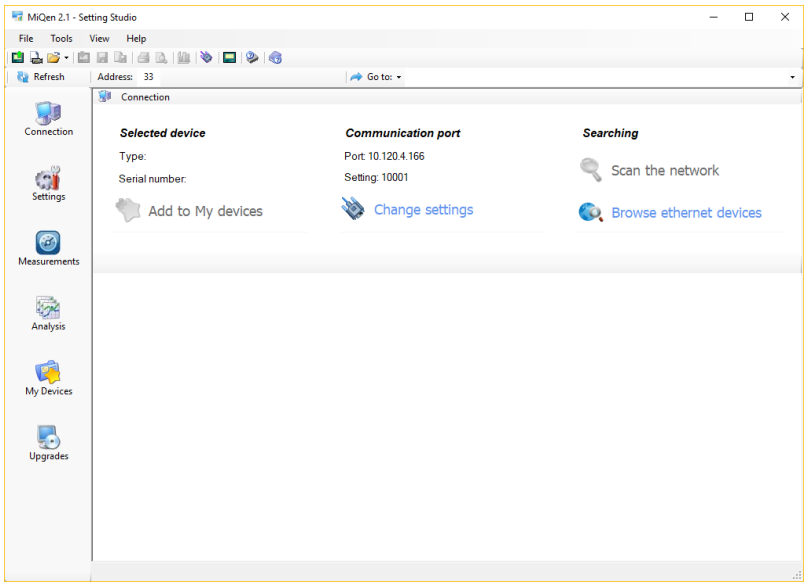


MiQen version 2.1 or higher is required for programming and monitoring ***Multifunction tranduscers***. Software installation is stored on a CD as a part of consignment or it can be downloaded from https://www.iskra.eu/en/Iskra-Software/MiQen-Settings-Studio/

PLEASE NOTE

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

DEVICES MANAGEMENT



Select the instrument in a favorite's line. Use the network explorer to set and explore the devices network. Communication parameters of all devices and their addresses in network can be easily set.

INSTRUMENT 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.

REAL-TIME MEASUREMENTS

All supported measurements can be captured in real time in a table form. Harmonics and their time-reconstructed signals are displayed also graphically. For further processing of the results of measurements, copying via a clipboard into standard Windows formats is supported.

DATA ANALYSIS

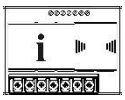
Analysis can be performed for the instruments with a built-in memory. Recorded quantities can be monitored in a tabular or a graphical form. The events that triggered alarms can be analyzed. All data can be exported to an Access data base, Excel worksheets or as a text file.

SOFTWARE UPGRADING

Always use the latest version of software, both MiQen and software in the instrument. The program automatically informs you on available upgrades that can be transferred from the web site and used for upgrading.

3.4 Setting procedure

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 TCP/IP) 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. For a survey of supported measurements and functions see chapter Type differences.

3.5 General settings ●●●●

General settings are essential for measuring transducer. They are divided into four additional sublevels (Connection, Communication and Security).

3.5.1 Description and Location PC

Two parameters that are intended for easier recognition of a certain unit. They are especially used for identification of the device or location on which measurements are performed.

3.5.2 Average interval PC

The averaging interval defines the refresh rate of measurements on communication.

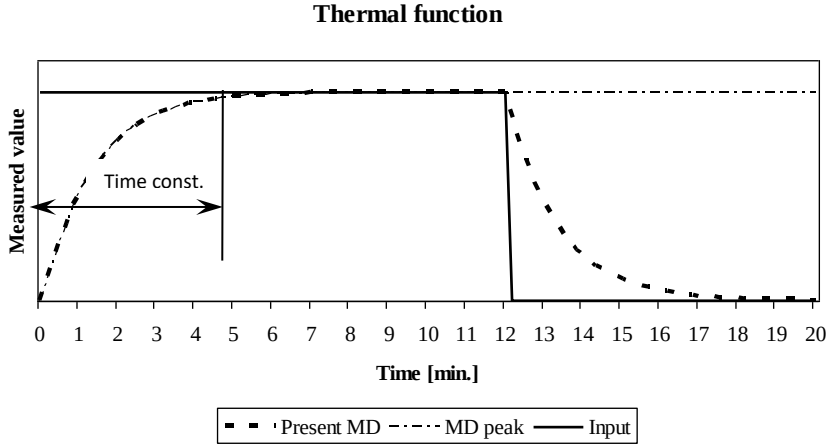
3.5.3 Date and time PC

Set date and time of the meter. Setting is important for correct memory operation, maximal values (MD).

3.5.4 Maximum demand calculation (MD mode) PC

The instrument provides maximum demand values from a thermal function demand values.
A thermal function assures exponent thermal characteristic based on simulation of bimetal meters.
Maximal values and time of their occurrence are stored in device. A time constant (t. c.) can be set from 1 to 255 minutes and is 6 − time thermal time constant (t. c. = 6 * thermal time constant).
Example:

- Mode: Thermal function
- Time constant: 8 min.
- Present MD and MD peak: Reset at 0 min.



3.5.5 Starting current for PF and PA (mA) PC

At all measuring inputs noise is usually present. It is constant and its influence on the accuracy is increased by decreasing measuring signals. It is present also when measuring signals are not connected and it occurs at all further calculations as very sporadic measurements. By setting a common starting current, a limit of input signal is defined where measurements and all other calculations are still performed.

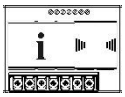
3.5.6 Starting current for all powers (mA) PC

Noise is limited with a starting current also at measurements and calculations of powers.

3.5.7 Starting voltage for SYNC (V) PC

This parameter sets a voltage threshold for measurement synchronization. If voltage signal is below this threshold or there is no voltage signal, current synchronization is used. If also current is below starting current value, fixed (default) frequency value is used for synchronization. This value is set under General/connection/Frequency nominal value(Hz). This value should be set to 50/60Hz according to power frequency used.

3.6 Connection ●●●●



PLEASE NOTE

Settings of connections shall reflect actual state otherwise measurements are not valid.

3.6.1 Connection PC

When connection is selected, load connection and the supported measurements are defined (see chapter Survey of supported measurements regarding connection mode).

3.6.2 Setting of current and voltage ratios PC

Before setting current and voltage ratios it is necessary to be familiar with the conditions in which device will be used. All other measurements and calculations depend on these settings. Up to five decimal places can be set. To set decimal point and prefix on remote display position the cursor (left /right) to last (empty) place or the decimal point.

Settings range	VT primary	VT secondary	CT primary	CT secondary
Maximal value	1638.3 kV	13383 V	1638.3 kA	13383 A
Minimal value	0.1 V	1 mV	0.1 A	1 mA

3.6.3 Used voltage and current range PC

Setting of the range is connected with all settings of alarms, analogue outputs and a display (calculation) of energy and measurements recording, where 100% represents 500 V 5A. In case of subsequent change of the range, alarms settings shall be correspondingly changed, as well.

3.6.4 Nominal frequency PC

A valid frequency measurement is within the range of nominal frequency ±32 Hz. This setting is used for alarms and recorders only.

3.7 Serial Communication (COM1) ●●●●

3.7.1 Communication parameters PC

They define parameters that are important for the operation in RS485 network or connections with PC via RS232 communication. Factory settings of communication are #33\115200,n,8,2 (address 1 to 247\rate 2400 to 115200 b/s, parity, data bits, stop bit).

3.7.2 USB Communication PC

For description of all settings see *Serial Communication (COM1)*.

3.7.3 Ethernet communication PC

3.7.3.1 *IP address* PC

Communication interface should have a unique IP address in the Ethernet network. Two modes for assigning IP are described:

- ***Fixed IP address:*** In most installations a fixed IP address is required. A system provider usually defines IP addresses. An IP address should be within a valid IP range, unique for your network and in the same subnetwork as your PC.
- ***DHCP:*** Automatic method of assigning IP addressed (DHCP) is used in most networks. If you are not sure if DHPC is used in your network, check it at your system provider.

3.7.3.2 *Local Port* PC

The physical connector on a device enabling the connection to be made. Use a non reserved port number from 1025 to 65535. If using Redirector software, the port number should be between 14000 and 14009.

Port numbers	Function
1 – 1024, 9999, 30718, 33333	Reserved numbers
14000 – 14009	Reserved for Redirector

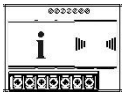
Factory settings of Ethernet communication are:

IP Address	DHCP (automatically)
TCP Port	10001
Subnet Mask	255.255.255.0

3.8 Security ●●●●

Settings parameters are divided into four groups regarding security level:

1. At the first level (PL1), settings of a real time clock can be changed, and energy meters and MD can be reset.
2. At the second level (PL2), the access to all data that are protected with the first level (PL1) and setting of all other parameters in the »SETTINGS« menu are available.
3. A backup password (BP) is used if passwords at levels 1 (PL1) and 2 (PL2) have been forgotten, and it is different for each device (depending on a serial number of the meter). 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 meter serial meter when contacting the personnel in Iskra d.o.o..



PLEASE NOTE

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

3.8.1 Password setting PC

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 *.

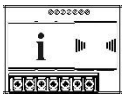
Two passwords (PL1, PL2) and the time of automatic activation could be set.

Password modification PC

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

Password disabling PC

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



PLEASE NOTE

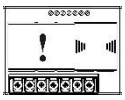
A factory set password is "AAAA" at both access levels (L1 and L2). This password does not limit access.

Password and language

Language change is possible without password input. When language is changed from or to Russian, character transformation has to be taken in to account. Character transformation table (English or Russian alphabet) is stated below.

English	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Russian	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О	П	Р	С	Т	У	Ф	Х	Ц	Ч	Ш	Щ

3.9 Energy ●●○○



WARNING!

After modification of energy parameters, the energy meters must be reset otherwise all further energy measurements could be incorrect.

3.9.1 Common energy exponent PC

Common energy exponent defines minimal energy that can be displayed on the energy counter. On the basis of this and a counter divider, a basic calculation prefix for energy is defined (−3 is 10^{-3}Wh = mWh, 4 is 10^{4}Wh = 10 kWh). A common energy exponent also influences in setting a number of impulses for energy of pulse output or alarm output functioning as an energy meter.

Define common energy exponent as recommended in table below, where counter divider is at default value 10. Values of primary voltage and current determine proper Common energy exponent.
exponent.

Current / Voltage	1 A	5 A	50 A	100 A	1000 A
110 V	−1	0	1	1	2
230 V	0	0	1	2	3
1000 V	0	1	2	3	4
30 kV	2	2	3	4	4*

* − Counter divider should be at least 100

3.9.2 Counter divider PC

The counter divider additionally defines precision of a certain counter, according to settings of common energy exponent.

An example for 12.345kWh of consumed active energy:

Common energy exponent	0	2	2
Counter divider	1	1	100
Example of result, display	12.345 kWh	12.3 kWh	0.01 MWh

3.10 Inputs and outputs ●●●●

Module settings depend on built-in modules.

3.10.1 Analogue output module PC

Each of up to four analogue outputs is fully programmable and can be set to any of 6 ranges.

Output parameter

Set the measured parameter to be transformed onto the analogue output.

Output range

Defines analogue output full-scale ranges:

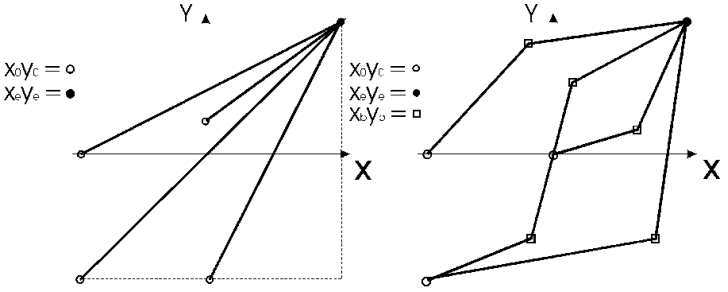
DC current output	DC voltage output
-1…0…1 mA	-1…0…1 V
-5…0…5 mA	
-10...0...10 mA	-10…0…10 V
-20...0...20 mA	

Output signal

Defines the shape and up to 5 break points of an analogue output. For intrinsic-error for analogue outputs with bent or linear zoom characteristic multiply accuracy class with correction factor (c). Correction factor c (the highest value applies):

Linear characteristic	Bent characteristic
$c = \frac{1-\frac{y_0}{y_e}}{1-\frac{x_0}{x_e}}$ or $c = 1$	$x_{b-1} \le x \le x_b$ b – number of break points (1 to 5) $c = \frac{y_b - y_{b-1}}{x_b - x_{b-1}} \cdot \frac{x_e}{y_e}$ or $c = 1$

Example of settings with linear and bent characteristic:



Limit of the output range

Average interval for analogue output

Defines the average interval for measurements on the analogue output. Available settings are from 1 period (0.02 sec by 50 Hz) up to 256 periods (5.12 sec by 50 Hz).

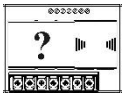
3.10.2 Alarm/Digital output module PC

Alarm groups that are connected with an alarm module and a signal shape are defined.

An alarm module can also function as a pulse output with limited pulse length (min. 10 ms) or general purpose digital output. Other parameters are defined in the same way as at a pulse module. A parallel RC filter with time constant of at least 250 µs (R·C ≥ 250 µs) should be used in case of a sensitive pulse counter. RC filter attenuates relay transient signals.

Signal shape:

- Normal − A relay is closed until condition for the alarm is fulfilled.
- Normal inverse − A relay is open until condition for the alarm is fulfilled.
- Holds − A relay is closed when condition for the alarm is fulfilled, and remains closed until it is reset via communication.
- Pulse − an impulse of the set length is sent always when condition for the alarm is fulfilled.
- Always switched on / off (permanent) – A relay is permanently switched on or off irrespective of the condition for the alarm.

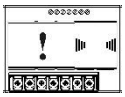


USER INFORMATION

Digital output functionality. Permanent alarm setting enables remote control via communication.

3.10.3 Pulse output module PC

A corresponding energy counter can be assigned to a pulse output. A number of pulses per energy unit, pulse length, and a tariff in which output is active are set.



WARNING!

Pulse parameters are defined by SIST EN 62053−31 standard. In chapter Calculation of recommended pulse parameters, below a simplified rule is described to assist you in setting the pulse output parameters.

The pulse module can also function as an alarm output with limited current load (max. 20 mA).

Calculation of recommended pulse parameters

Number of pulses per energy unit should be in certain limits according to expected power. If not so the measurement from pulse output can be incorrect. Settings of current and voltage transformers can help in estimation of expected power.

Principle described below for pulse setting, where e is prefix, satisfies SIST EN 62053−31: 2001 standards pulse specifications:

$$1{,}5\ldots 15\ \mathrm{eW} \rightarrow 100\ \mathrm{p}/1\ \mathrm{eWh}$$

Examples:

Expected power	→	Pulse output settings
150 − 1500 kW	→	1 p/1 kWh
1.5 − 15 MW	→	100 p/1 MWh
15 − 150 MW	→	10 p/1 MWh
150 − 1500 MW	→	1 p/1 MWh

3.10.4 Digital input module PC

No setting. General purpose digital input can be used for various alarms function.

3.10.5 Watchdog output module PC

The purpose is to detect potential malfunction of transducer or auxiliary power supply failure. This module can be set for normal operation (relay in close position) or for test purposes to open position (manual activation). After test module should be set back to normal operation.

3.11 **Alarms**

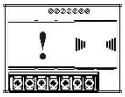
Alarms are used for alarming exceeded set values of the measured quantities.

◖ – iMT510/516/518 do not support alarms recording into memory.

3.11.1 Alarms setting PC

Measuring transducer supports recording and storing of 16 alarms in 2 groups. For each group of alarms a delay time and alarm deactivation hysteresis can be defined.

Quantity, value and a condition for alarm switch-on are defined for every individual alarm.



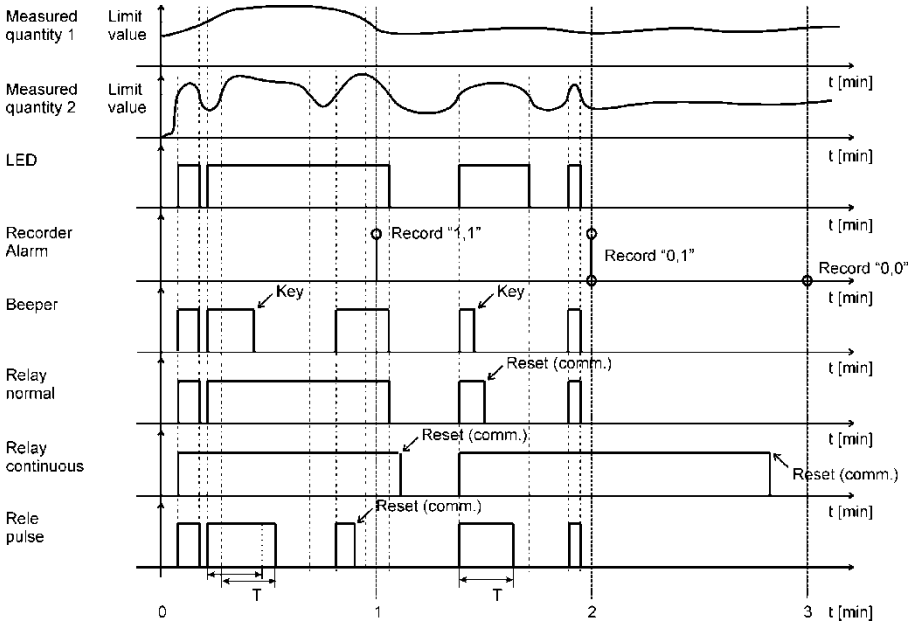
WARNING!

New values of alarms are calculated in percentage at modification of connection settings.

3.11.2 Types of alarms

Alarm output (pulse)

According to the alarm signal shape the output relay will behave as shown on figure below.



3.12 Memory ●○○○

Measurements, alarms, reports and details of supply voltage quality are stored in a built in memory in the iMT511 - 8MB flash. All records stored in memory are accessible via communication with MiQen software.

○ – iMT510/516/518 have no memory

3.12.1 Memory division PC

Memory is divided into 3 partitions which size is defined by the user. The A and B recorders are intended for recording measurements, while all alarms that occurred are recorded in an alarm partition.

3.12.1.1 *Memory operation*

Memory functions in a cyclic mode in compliance with the FIFO method. This means that only the latest records are stored in the memory that will replace the oldest ones. A number of stored data or a storing period depends on selected partition size, a number of recorded quantities and time of division sampling.

3.12.1.2 *Memory clearing* PC

There is usually no need to clear the memory, because it works in cyclic mode. If you want to clear memory data anyway, the data storing must be stopped first. Read the instrument settings with MiQen and set “Recorder state” in Memory setting group to “stopped”. Download changes to the device and open Memory info form and then click on Clear memory button. Select memory partitions to be cleared on Memory clearing form and click on OK button. Set “Recorder state” setting back to “active”.

3.13 Reset operations ●◖◖◖

◖ – iMT510/516/518 do not support some measurements for reset.

3.13.1 Reset energy counters (E1, E2, E3, E4) PC

All or individual energy meters are reset.

3.13.2 Reset maximal MD values PC

Current and stored MDs are reset.

3.13.3 Reset the last MD period PC

Current MD value is reset.

3.13.4 Reset alarm output PC

All alarms are reset.

4 MEASUREMENTS

In the following chapters the device operation is explained more in detail.

4.1 Supported measurements

Measurements support regarding the device type is described in chapter Type differences, page 5. Selection of supported measurements of individual instrument type is changed with the connection settings. All supported measurements could be read via communication (MiQen).

4.2 Explanation of basic concepts

4.2.1 Sample factor – M_V

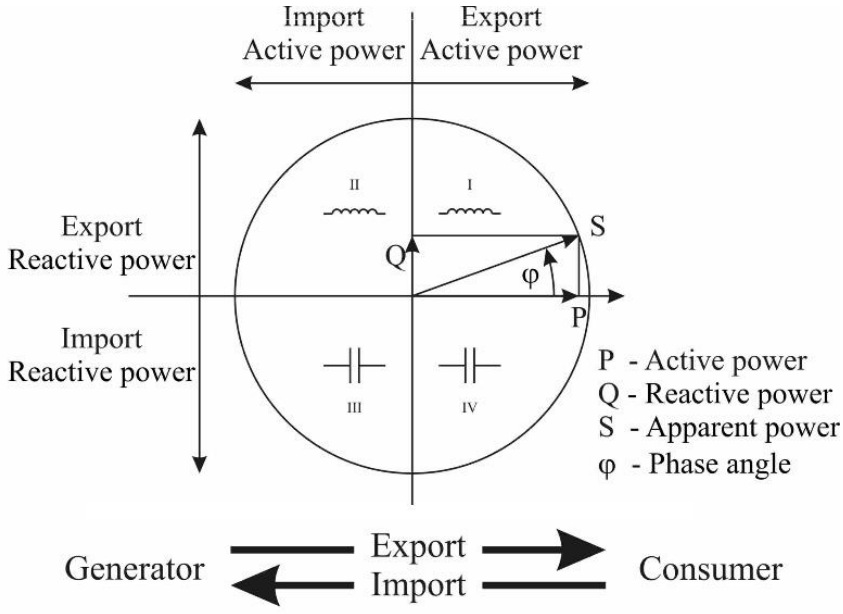
A meter measures all primary quantities with the sample frequency of 6.991 kHz. The minimum of 107 samples must be in the calculation period. Based on these limitations (65Hz·107 samples) a sample factor is calculated. A sample factor (M_V), depending on frequency of a measured signal, defines a number of periods for a measurement calculation and thus a number of harmonics considered in calculations.

4.2.2 Average interval – M_P

Due to readability of measurements from communication, an Average interval (M_P) is calculated with regard to the measured signal frequency. The Average interval (see chapter Average interval) defines refresh rate of displayed measurements based on a sampling factor.

4.2.3 Power and energy flow

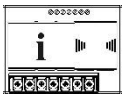
Figures below show a flow of active power, reactive power and energy.



4.4 Calculation and display of measurements ●●◖

This chapter deals with capture, calculation and display of all supported quantities of measurement. Only the most important equations are described; however, all of them are shown in chapter Equations with additional descriptions and explanations.

◖ – iMT516/518 do not have all described measurements supported (see chapter Type differences).



PLEASE NOTE

Calculation and display of measurements depend on the device type. For more detailed information see chapter Type differences.

4.5 Present values ●●◖

4.5.1 Voltage PC

Instrument measures real effective (rms) value of phase voltage (U1), connected to the meter.
Voltage measurement is available via communication.

4.5.2 Current PC

Instrument measures real effective (rms) value of phase currents, connected to current input.
Current measurement is available via communication.

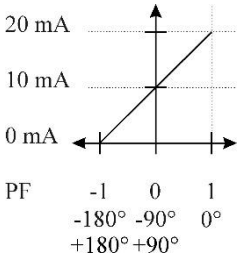
4.5.3 Active, reactive and apparent power PC

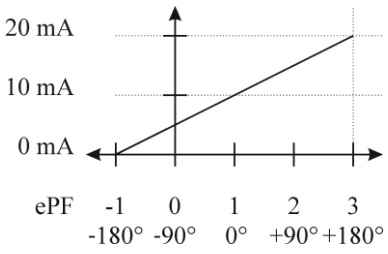
Active power is calculated from instantaneous phase voltages and currents. All measurements are seen via communication or are displayed on remote display. For more detailed information about calculation see chapter Equations.

4.5.4 Power factor and power angle PC

Power factor is calculated as quotient of active and apparent power (cosφ). For correct display of PF via analogue output and application of the alarm, ePF (extended power factor) is applied. It illustrates power factor with one value as described in the table below.

Example of analogue output for PF and ePF:





Power angle represents angle between first voltage harmonic and first current harmonic. A positive sign shows inductive load, and a negative sign shows capacitive load.

4.5.5 Frequency PC

Network frequency is calculated from time periods of measured voltage.

4.5.6 Energy PC

Four individual counters of energy measurements are available.

4.5.7 MD values PC

Measurements of MD values.

4.5.8 THD – Total harmonic distortion PC

THD is calculated for phase currents, phase voltages and is expressed as percent of high harmonic components relative to first harmonic.
Instrument uses measuring technique of real effective (rms) value that assures exact measurements with the presence of high harmonics up to 53rd harmonic.

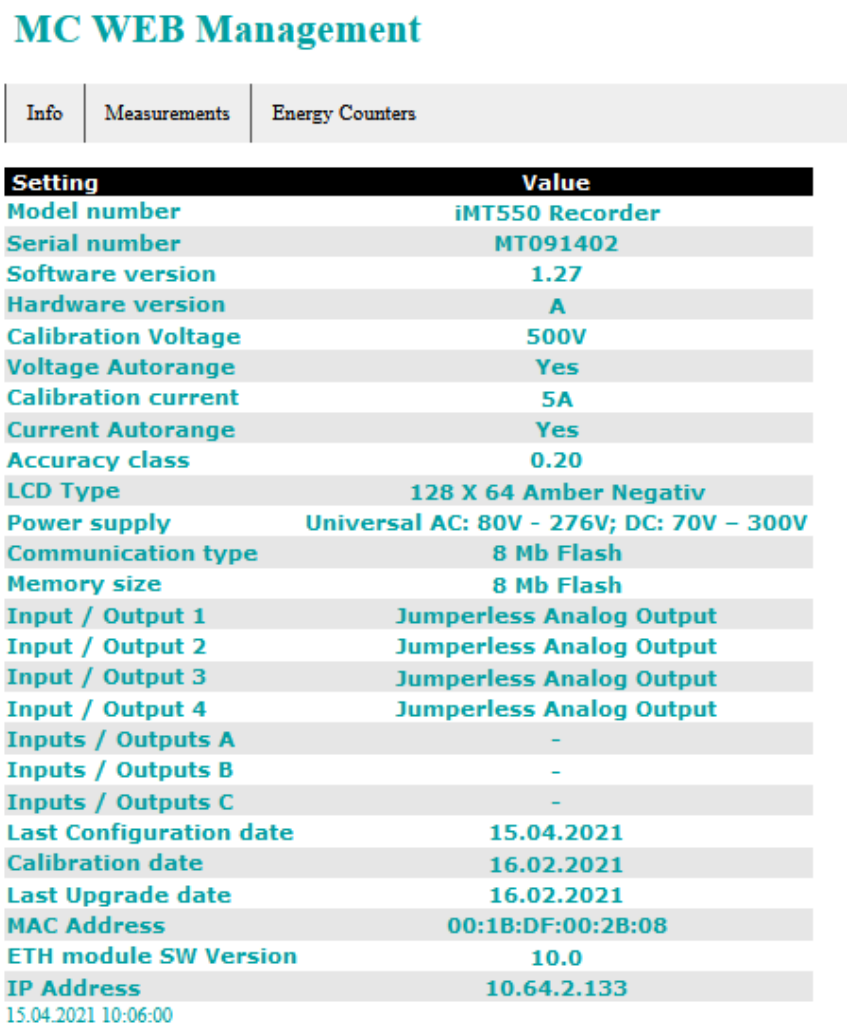
4.6 Alarms ●●●●

Two groups of 8 alarms with alarm conditions are measured.
required, yearly reports have to reset manually.
In order to reset reports choose setting Power supply quality / Monitoring mode and change the value to “No monitoring”. Download settings to instrument. Then choose the same setting in change the value back to “EN50160”. Again download settings to instrument. Now all yearly reports (anomaly counters) are reset.

4.7 WEB Interface

A built-in WEB interface is intended to view settings and teal-time measurements without additional SW such as MiQen.

4.7.1 Settings Page



MC WEB Management

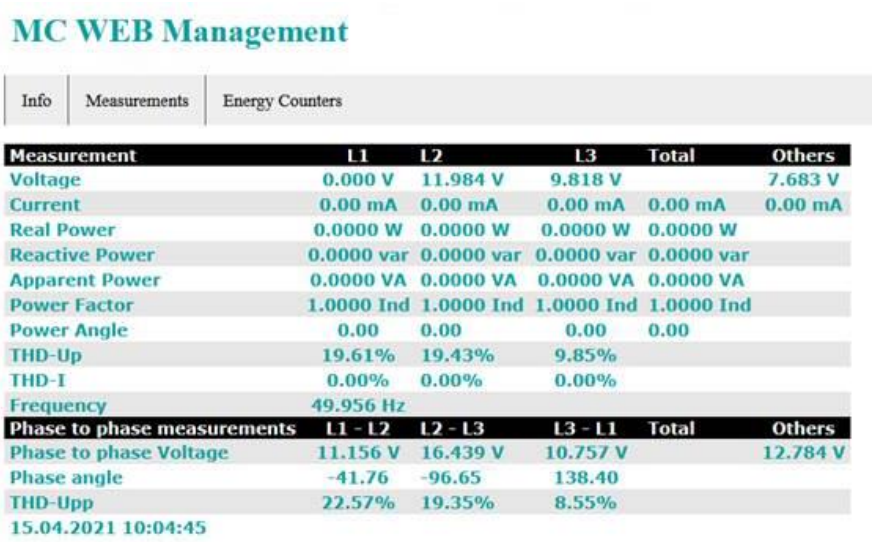
Info | Measurements | Energy Counters

Setting	Value
Model number	iMT550 Recorder
Serial number	MT091402
Software version	1.27
Hardware version	A
Calibration Voltage	500V
Voltage Autorange	Yes
Calibration current	5A
Current Autorange	Yes
Accuracy class	0.20
LCD Type	128 X 64 Amber Negativ
Power supply	Universal AC: 80V - 276V; DC: 70V – 300V
Communication type	8 Mb Flash
Memory size	8 Mb Flash
Input / Output 1	Jumperless Analog Output
Input / Output 2	Jumperless Analog Output
Input / Output 3	Jumperless Analog Output
Input / Output 4	Jumperless Analog Output
Inputs / Outputs A	-
Inputs / Outputs B	-
Inputs / Outputs C	-
Last Configuration date	15.04.2021
Calibration date	16.02.2021
Last Upgrade date	16.02.2021
MAC Address	00:1B:DF:00:2B:08
ETH module SW Version	10.0
IP Address	10.64.2.133

15.04.2021 10:06:00

Web management settings page

4.7.2 Measurements Page



Web management measurements page

4.7.3 Energy Counters Page

Web management energy counters page

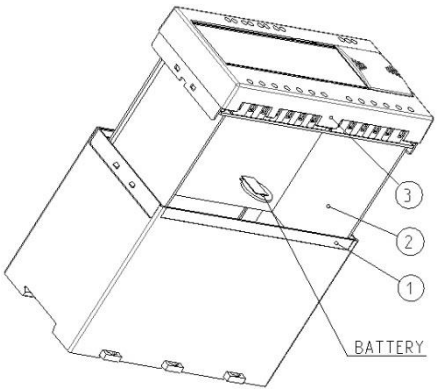
5 BATTERY REPLACEMENT

The Measuring transducer contains a lithium battery. It is used to preserve data (date and time) in the device memory when if the power supply is off. Life time of battery is app.6 years (typical). High temperature and humidity shortens the battery's functionality. Battery has no effect on other functionality of the device, except date and time.

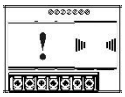
It is recommended that the instrument is sent back in the factory for battery replacement. Although it is possible that replacement is made by the qualified person, but in this case Iskra d.o.o. does not take on responsibility for any injuries, dysfunction of the instrument or mechanical damage.

5.1 Instructions for replacement

1. Disconnect the instrument from measuring grid and power supply (read the safety section) and take it out of the mounting rail.
2. With flat screwdriver remove the cover [3] from instrument [1] (see picture below).
3. Pull out printed circuit board (PCB) assembly [2].
4. Remove the battery from its holder on the PCB and replace it with the same model (Varta, type 6032 CR2032 SLF).



5. To put the instrument together replay steps from 2 to 3 in inverse order.



WARNING

You should set device date and time again after replacing the battery.

6 TECHNICAL DATA

In following chapter all technical data regarding operation of multifunction transducers is presented.

6.1 Accuracy

Total accuracy (measurements and analogue output) according to IEC/EN 60 688 is presented as percentage of range except when it is stated as an absolute value.

Measured values	***Range***		***Accuracy class****
Rms current I_1	*250 mA – 6 A (common I_n 1 A or 5 A)*		*0.2 (0.1)***
Maximum current	*12.5 A*		*0.2 (0.1)***
Rms voltage U_1	*50 - 500 V $_{L-N}$*		*0.2 (0.1)***
Maximum voltage	*600 V $_{L-N}$*		*0.2 (0.1)***
Frequency (f) – actual	*50 / 60Hz*		*10 mHz*
Nominal frequency range	*16…400 Hz*		*10 mHz*
Power angle (φ)	*–180…0…180°*		*0.1°*
Power factor (PF)	*–1…0…+1* *U = 50 … 120 % U_n* *I = 2 % … 20 % I_n* *I = 20 % … 200 % I_n*		 *0.5* *0.1*
Maximal values (MD)	*75* *120* *250* *500* *[W/var/VA]* *I_n = 1 A*	*375* *600* *1250* *2500* *[W/var/VA]* *I_n = 5 A*	*1.0*
THD	*5…500 V* *0.1…10A* *0…400 %*		*0.5*
Active power	*75* *120* *250* *500* *[W/var/VA]* *I_n = 1 A*	*375* *600* *1250* *2500* *[W/var/VA]* *I_n = 5 A*	*0.2 (0.2)***
Reactive power			*0.2 (0.2)***
Apparent power			*0.2 (0.2)***
Active energy			*Class 1 (Option 0.5S)*
Reactive energy			*Class 2*
Real time clock (RTC)	*–*		*1 min/month*
Analogue output (internal supply)	*-20…+20 mA* *-10…+10 V*		*± 20 µA* *± 10mV*

PLEASE NOTE

** – All measurements are calculated with high harmonic signals.*

*** – Measurements on communication.*

6.2 Mechanical characteristics of input

6.2.1 Permitted conductor cross-sections

Terminals	*Max. conductor cross-sections DIN / ANSI housing*
Voltage inputs (2)	*0.325 mm²… 2.5 mm² (22 – 14 AWG) one conductor*
Current inputs (2)	*0.325 mm²… 2.5 mm² (22 – 14 AWG) one conductor*
Supply (3)	*0.325 mm²… 2.5 mm² (22 – 14 AWG) one conductor*
Modules (2 x 2)	*0.325 mm²… 2.5 mm² (22 – 14 AWG) one conductor*
Communication (2)	*0.325 mm²… 2.5 mm² (22 – 14 AWG) one conductor*

6.3 Electrical characteristics of input

Voltage input		
	Rated voltage (U_N)	*57.7…500 V_{L-N}*
	Max. allowed value	*1.2 × U_N permanently, 2 × U_N 10 s*
	Minimal measurement	*2 V sinusoidal*
	Maximal measurement	*600 V_{L-N}*
	Input impedance	*4.2MΩ*
	Consumption	*U^2 / 4.2MΩ*
Current input		
	Rated current (I_N)	*0.31…5 A*
	Max. allowed value (thermal)	*15 A continuous*
		20 × I_N (5 × 1s)
	Min. measurement	*Settings from starting current for all powers**
	Max. measurement	*12.5 A sinusoidal*
	Consumption	*I^2 × 0.01Ω*
Frequency		
	Rated frequency (f_N)	*50, 60 Hz*
	Measuring range	*16…400 Hz*
	Maximum range	*10 Hz…1 kHz*
Power supply		
Universal HIGH	*AC Rated voltage*	*80…276 V*
	AC Rated frequency	*40…70 Hz*
	DC Rated voltage	*70…300 V*
	Consumption	*< 5VA*
	Power-on transient current	*< 20 A; 1 ms*
Universal LOW	*AC Rated voltage*	*48 V…77 V*
	AC Rated frequency	*40 Hz…70 Hz*
	DC Rated voltage	*19 V…70 V*
	Consumption	*< 5VA*
	Power-on transient current	*< 20 A; 1 ms*

**** Starting current is set by setting software MiQen/settings/general***

6.4 I/O modules ●●●●

Alarm/Digital/ Watchdog output module	*Type*	*Relay switch*	
	Rated voltage	*48 V AC/DC (+40% max)*	
	Max. switching current	*200 mA*	
	Contact resistance	*≤ 100 mΩ (100 mA, 24V)*	
	Impulse	*Max. 4000 imp/hour*	
		Min. length 100 ms	
	Signal shape		
	Normal	*Until the condition is fulfilled*	
	Impulse	*Start at any new condition*	
	Permanent	*Since condition*	
Pulse output module			
	Type	*Solid state*	
	Max. voltage	*40 V AC/DC*	
	Max. current	*30 mA (R_{ONmax} = 8Ω)*	
	Pulse length	*programmable*	
		2…1000 ms	
Digital input module			
	Rated voltage	*48 V AC/DC (+ 40% max)*	
	Max. current	*< 1.5 mA*	
	Min. signal width	*20 ms*	
	Min. pause width	*40 ms*	
	SET voltage	*40...120 % of rated voltage*	
	RESET voltage	*0...10 % of rated voltage*	

6.5 Analogue output ●●●●

General			
	Linearization	*Linear, Quadratic*	
	No. of break points	*5*	
	Output value limits	*± 120% of nominal output*	
	Response time	*Input → output*	*< 100 ms*
	Residual ripple	*< 0.5 % p.p.*	
DC Current output			
	Output range values	*–100…0…100%*	
	-1…0…1 mA	*Range 1*	
	-5…0…5 mA	*Range 2*	
	-10...0...10 mA	*Range 3*	
	-20...0...20 mA	*Range 4*	
	Other ranges	*possible by MiQen software*	
	Burden voltage	*10 V*	
	External resistance	*RB_{max} =10 V / I_{outN}*	
DC Voltage output			
	Output range values	*–100…0…100%*	
	-1…0…1 V	*Range 5*	
	-10…0…10 V	*Range 6*	
	Other ranges	*possible by MiQen software*	
	Burden current	*5 mA*	
	External resistance	*RBmin= UoutN / 5 mA*	

6.6 Communication ●●●●

Type	Ethernet	RS232(1)	RS485(1)	USB
Type of connection	Network	Direct	Network	Direct
Max. connection length	–	3 m	1000 m	–
Number of bus stations	–	–	≤32	–
Terminals	RJ–45	DB9(1) / Screw terminals(1)		USB-B
Insulation	Protection class I, 3.3 kV_{ACRMS} 1 min			
Transfer mode	Asynchronous			
Protocol	MODBUS TCP	MODBUS RTU		
Transfer rate	10/100Mb/s auto detect	2.400 to 115.200 bit/s		USB 2.0

(1) Both types of comm. are available but only one at a time

6.7 Electronic features ●◖◖◖

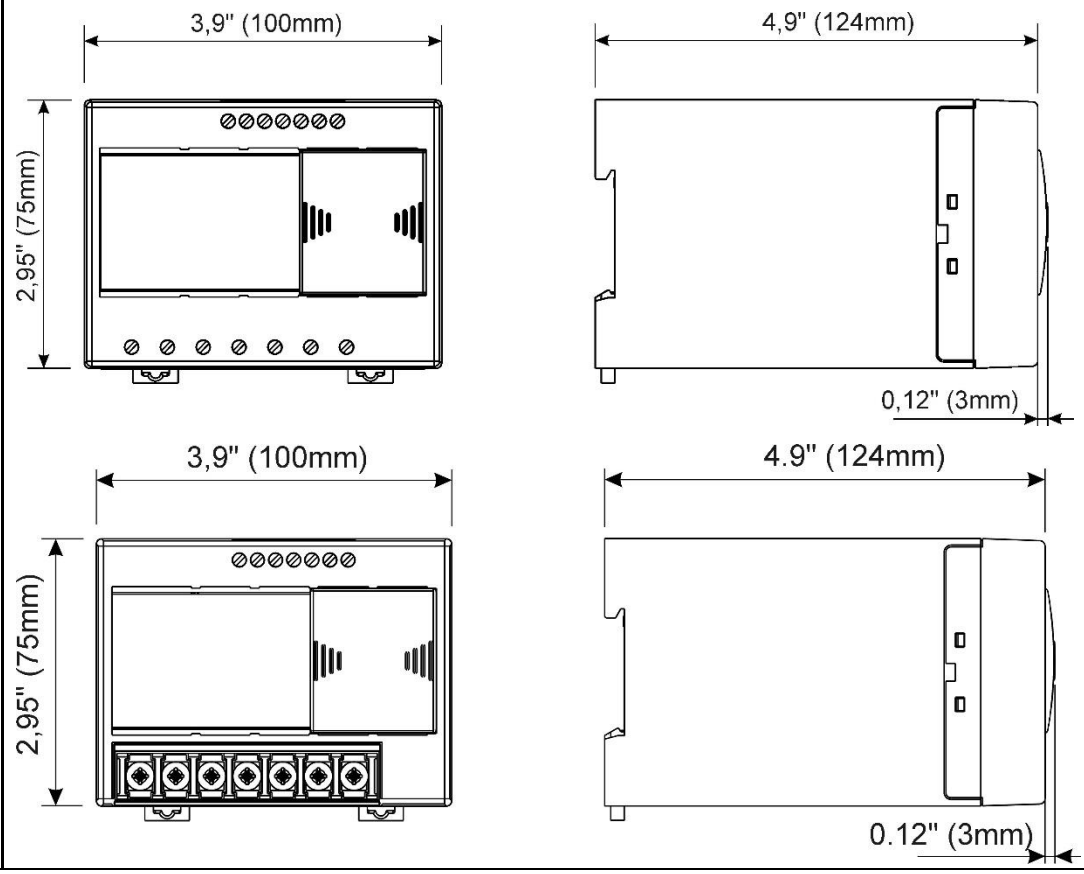
Response time	
Input → communication	All calculations are averaged over an interval of between 8 to 256 periods. Preset interval is 64 periods, which is 1.28 second at 50 Hz. Average interval below 64 periods may result to unstable measurements, depended on measuring signal.
Battery	
Manufacturer	Varta
Type	CR2032 Li-battery
Battery lifetime	Approx. 6 years (at 23°C – typical)
Memory	iMT511
Capacity	8 MB
Divisions	Recorder A Recorder B Alarms recorder
Sampling period	1 min to 60 min

Status LED's		
COM	Green	Communication in progress
PWR	Red	Instrument power ON

6.8 Safety features ●●●●

Protection	***Protection class I***
⚠ ⏚	*(protective earth terminal due to touchable metal parts (USB-B, RJ-45, DB9), current limiting fuse 1 A on aux. Supply (L terminal)* *Voltage inputs via high impedance* *Double insulation on I/O ports and COM1-2 ports*
Pollution degree	*2*
Installation category	*CAT III; 600 $V_{⏚}$ meas. Inputs Acc. to EN 61010-1* *CAT III; 300 $V_{⏚}$ aux. supply Acc. to EN 61010-1*
Test voltages	*U_{AUX}↔I/O, COM1, 2: 2210 VAC_{rms}* *U_{AUX}↔U, I inputs: 3320 VAC_{rms}* *U, I inputs↔I/O, COM1, 2: 3320 VAC_{rms}* *HV Tariff input↔I/O, COM1, 2: 2210 VAC_{rms}* *U inputs↔I inputs: 3320 VAC_{rms}*
EMC	*Directive on electromagnetic compatibility 2004/108/EC* *Acc. to EN 61000-6-2 and EN 61000-6-4*
Ambient conditions	
Ambient temperature	*usage group II* *0…15…30…55 °C* *Acc. to IEC/EN 60 688*
Operating temperature	*-30 to +70 °C*
Storage temperature	*-40 to +70 °C*
Average annual humidity	*≤93% r.h.*
Enclosure	
DIN	*ABS & PC (transparent sliding cover; PC) − self-extinguishability, in compliance with UL 94 V0*
ANSI	
RD500	
Enclosure protection	*IP 40 (IP 20 for terminals)*
Flammability	*Acc. to UL 94 V-0*
Mounting	*Rail mounting 35 × 15 mm acc. to DIN EN 50 022*
Dimensions	*100 × 127 ×75 mm*
Weight	*375 g*

6.9 Dimensions ●●●●

Construction	Appearance
Measuring transducers iMT51x (standard EU clamp style terminals): iMT51x (ring type terminal block):	

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 / DNP3	*Industrial protocol for data transmission*
MiQen	*Setting Software for ISKRA instruments*
PI	*Pulse input module*
AC	*Alternating quantity*
IR	*Infrared (optical) communication*
Pt1000	*Temperature sensor*
RMS	*Root Mean Square*
PO	*Pulse output*
PA1	*Power angle (between current and voltage)*
PF	*Power factor*
Flash	*Type of a memory module that keeps its content in case of power supply failure*
Ethernet	*IEEE 802.3 data layer protocol*
PA total	*Angle calculated from total active and apparent power*
PA1, PA2, PA3	*Angle between fundamental phase voltage and phase current*
THD	*Total harmonic distortion*
MD	*Measurement of average values in time interval*
FFT graphs	*Graphical display of presence of harmonics*
Harmonic voltage – harmonic	*Sine voltage with frequency equal to integer multiple of basic frequency*
Hand-over place	*Connection spot of consumer installation in public network*
Flicker	*Voltage fluctuation causes changes of luminous intensity of lamps, which causes the so-called flicker*
RTC	*Real Time Clock*
M_v *– Sample factor*	*Defines a number of periods for measuring calculation on the basis of measured frequency*
M_p *– Average interval*	*Defines frequency of refreshing displayed measurements on the basis of a Sample factor*
Hysteresis expressed as percentage [%]	*Percentage specifies increase or decrease of a measurement from a certain limit after exceeding it*
TI	*Tariff input module*
AL	*Alarm output module*
AN	*Analogue output module*
AI	*Analogue input module*
DO	*Digital output module*
DI	*Digital input module*
COM2	*2nd communication port module*

List of common abbreviations and expressions

8 APPENDICES

In this chapter you will find

8.1 APPENDIX A: MODBUS communication protocol

Modbus and DNP3 protocol are enabled via RS232 and RS485 or Ethernet communication.

8.1.1 Modbus

There are two Modbus protocol types: Modbus RTU for serial communication and Modbus TCP for Ethernet communication. Modbus protocol enables operation of device on Modbus networks. For device with serial communication the Modbus protocol enables point to point (for example Device to PC) communication via RS232 communication and 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.

REGISTER TABLE FOR THE ACTUAL MEASUREMENTS

The tables below represent the complete set of MODBUS register map.

Parameter	***MODBUS***		
	Register		***Type***
	Start	***End***	
Actual measurements			
Frequency	*34101*	*34102*	*T5*
U1	*34103*	*34104*	*T5*
I1	*34105*	*34106*	*T5*
Active Power (P1)	*34107*	*34108*	*T6*
Reactive Power (Q1)	*34109*	*34110*	*T6*
Apparent Power (S1)	*34111*	*34112*	*T5*
Power Factor (PF1)	*34113*	*34114*	*T7*
φ1 (angle between U1 and I1)	*34115*		*T17*
Internal Temperature	*34116*		*T17*
U1 THD%	*34117*		*T16*
I1 THD%	*34118*		*T16*
Alarm Status Flags (No. 1…16)	*34119*		*T1*
I/O 1 Value	*34121*		*T17*
I/O 2 Value	*34122*		*T17*
Energy			
Energy Counter 1 Exponent	*34201*		*T2*
Energy Counter 2 Exponent	*34202*		*T2*
Energy Counter 3 Exponent	*34203*		*T2*
Energy Counter 4 Exponent	*34204*		*T2*
Energy Counter 1	*34206*	*34207*	*T3*
Energy Counter 2	*34208*	*34209*	*T3*
Energy Counter 3	*34210*	*34211*	*T3*
Energy Counter 4	*34212*	*34213*	*T3*

Parameter	MODBUS		
	Register		Type
	Start	End	
Demand values			
Dynamic demand values			
U1	34302	34303	T5
I1	34304	34305	T5
Apparent Power (Sn)	34306	34307	T5
Active Power (Pn) - (positive)	34308	34309	T6
Active Power (Pn) - (negative)	34310	34311	T6
Reactive Power (Qn) - L	34312	34313	T6
Reactive Power (Qn) - C	34314	34315	T6
Max demand since last reset			
U1	34316	34317	T5
I1	34318	34319	T5
Apparent Power (Sn)	34320	34321	T5
Active Power (Pn) - (positive)	34322	34323	T6
Active Power (Pn) - (negative)	34324	34325	T6
Reactive Power (Qn) - L	34326	34327	T6
Reactive Power (Qn) - C	34328	34329	T6
Normalized measurements			
Actual measurements			
U1	34401		T16
I1	34402		T16
Active Power (P1)	34403		T17
Reactive Power (Q1)	34404		T17
Apparent Power (S1)	34405		T16
Power Factor (PF1)	34406		T17
CAP/IND P. F. (PF1)	34407		T17
φ1 (angle between U1 and I1)	34408		T17
Frequency	34409		T17
I1 THD%	34410		T16
U1 THD%	34411		T16
Max demand since last reset			
Active Power (Pn) - (positive)	34412		T16
Active Power (Pn) - (negative)	34413		T16
Reactive Power (Qn) - L	34414		T16
Reactive Power (Qn) - C	34415		T16
Apparent Power (Sn)	34416		T16
I1	34417		T16
U1	34418		T16
Dynamic demand values			
Active Power (Pn) - (positive)	34419		T16
Active Power (Pn) - (negative)	34420		T16
Reactive Power (Qn) - L	34421		T16
Reactive Power (Qn) - C	34422		T16
Apparent Power (Sn)	34423		T16

Parameter	MODBUS		
	Register		
	Start	End	Type
I1	34424		T16
U1	34425		T16
Energy			
Energy Counter 1	34426		T17
Energy Counter 2	34427		T17
Energy Counter 3	34428		T17
Energy Counter 4	34429		T17
Internal Temperature	34430		T17
FAST RESPONSE normalized actual measurements			
U1	34501		T16
I1	34502		T16
Active Power (P1)	34503		T17
Reactive Power (Q1)	34504		T17
Apparent Power (S1)	34505		T16
Power Factor (PF1)	34506		T17
CAP/IND P. F. (PF1)	34507		T17
φ1 (angle between U1 and I1)	34508		T17
Frequency	34509		T17
I1 THD%	34510		T16
U1 THD%	34511		T16
MEASUREMENTS (IEEE 754)			
U1	34601	34602	T_float
I1	34603	34604	T_float
Active Power (P1)	34605	34606	T_float
Reactive Power (Q1)	34607	34608	T_float
Apparent Power (S1)	34609	34610	T_float
Power Factor (PF1)	34611	34612	T_float
CAP/IND P. F. (PF1)	34613	34614	T_float
φ1 (angle between U1 and I1)	34615	34616	T_float
Frequency	34617	34618	T_float
I1 THD%	34619	34620	T_float
U1 THD%	34621	34622	T_float
Max demand since last reset			
Active Power (Pn) - (positive)	34623	34624	T_float
Active Power (Pn) - (negative)	34625	34626	T_float
Reactive Power (Qn) - L	34627	34628	T_float
Reactive Power (Qn) - C	34629	34630	T_float
Apparent Power (Sn)	34631	34632	T_float
I1	34633	34634	T_float
U1	34635	34636	T_float
Dynamic demand values			
Active Power (Pn) - (positive)	34637	34638	T_float
Active Power (Pn) - (negative)	34639	34640	T_float
Reactive Power (Qn) - L	34641	34642	T_float

Parameter	*MODBUS*		
	Register		
	Start	*End*	*Type*
Reactive Power (Qn) - C	*34643*	*34644*	*T_float*
Apparent Power (Sn)	*34645*	*34646*	*T_float*
I1	*34647*	*34648*	*T_float*
U1	*34649*	*34650*	*T_float*
Energy			
Energy Counter 1	*34651*	*34652*	*T_float*
Energy Counter 2	*34653*	*34654*	*T_float*
Energy Counter 3	*34655*	*34656*	*T_float*
Energy Counter 4	*34657*	*34658*	*T_float*
Internal Temperature	*34659*	*34660*	*T_float*

REGISTER TABLE FOR THE NORMALIZED ACTUAL MEASUREMENTS

Parameter	*MODBUS*		*100% value*
	Register	*Type*	
Actual measurements			
U1	*34401*	*T16*	*Un*
I1	*34402*	*T16*	*In*
Active Power (P1)	*34403*	*T17*	*Pn*
Reactive Power (Q1)	*34404*	*T17*	*Pn*
Apparent Power (S1)	*34405*	*T16*	*Pn*
Power Factor (PF1)	*34406*	*T17*	*1*
CAP/IND P. F. (PF1)	*34407*	*T17*	*1*
φ1 (angle between U1 and I1)	*34408*	*T17*	*100°*
Frequency	*34409*	*T17*	*Fn+10Hz*
I1 THD%	*34410*	*T16*	*100%*
U1 THD%	*34411*	*T16*	*100%*
Max demand since last reset			
Active Power (Pn) - (positive)	*34412*	*T16*	*Pn*
Active Power (Pn) - (negative)	*34413*	*T16*	*Pn*
Reactive Power (Qn) - L	*34414*	*T16*	*Pn*
Reactive Power (Qn) - C	*34415*	*T16*	*Pn*
Apparent Power (Sn)	*34416*	*T16*	*Pn*
I1	*34417*	*T16*	*In*
U1	*34418*	*T16*	*Un*
Dynamic demand values			
Active Power (Pn) - (positive)	*34419*	*T16*	*Pn*
Active Power (Pn) - (negative)	*34420*	*T16*	*Pn*
Reactive Power (Qn) - L	*34421*	*T16*	*Pn*
Reactive Power (Qn) - C	*34422*	*T16*	*Pn*
Apparent Power (Sn)	*34423*	*T16*	*Pn*
I1	*34424*	*T16*	*In*
U1	*34425*	*T16*	*Un*

Parameter	MODBUS		100% value
	Register	Type	
Energy			
Energy Counter 1	34426	T17	Actual counter value MOD 20000 is returned
Energy Counter 2	34427	T17	
Energy Counter 3	34428	T17	
Energy Counter 4	34429	T17	
Internal Temperature	34430	T17	100°
FAST RESPONSE normalized actual measurements			
U1	34501	T16	Un
I1	34502	T16	In
Active Power (P1)	34503	T17	Pn
Reactive Power (Q1)	34504	T17	Pn
Apparent Power (S1)	34505	T16	Pn
Power Factor (PF1)	34506	T17	1
CAP/IND P. F. (PF1)	34507	T17	1
φ1 (angle between U1 and I1)	34508	T17	100°
Frequency	34509	T17	Fn+10Hz
I1 THD%	34510	T16	100%
U1 THD%	34511	T16	100%

100% values calculations for normalized measurements

Un =	(R40147 / R40146) * R30015 * R40149
In =	(R40145 / R40144) * R30017 * R40148
Pn =	Un*In
Fn =	R40150

Register	Content
30015	Calibration voltage
30017	Calibration current

Register table for the basic settings

Register	*Content*	*Type*	*Ind*	*Values / Dependencies*	*Min*	*Max*	*P. Level*
40144	*CT Secondary*	*T4*		*mA*			*2*
40145	*CT Primary*	*T4*		*A/10*			*2*
40146	*VT Secondary*	*T4*		*mV*			*2*
40147	*VT Primary*	*T4*		*V/10*			*2*
40148	*Current input range (%)*	*T16*		*10000 for 100%*	*5.00*	*200.00*	*2*
40149	*Voltage input range (%)*	*T16*		*10000 for 100%*	*2.50*	*100.00*	*2*
40150	*Frequency nominal value*	*T1*		*Hz*	*10*	*1000*	*2*

DATA TYPES DECODING

Type	*Bit mask*	*Description*
T1		*Unsigned Value (16 bit)* *Example: 12345 = 3039(16)*
T2		*Signed Value (16 bit)* *Example: -12345 = CFC7(16)*
T3		*Signed Long Value (32 bit)* *Example: 123456789 = 075B CD15(16)*
T4	*bits # 15…14* *bits # 13…00*	*Short Unsigned float (16 bit)* *Decade Exponent(Unsigned 2 bit)* *Binary Unsigned Value (14 bit)* *Example: $10000*10^{2}$ = A710(16)*
T5	*bits # 31…24* *bits # 23…00*	*Unsigned Measurement (32 bit)* *Decade Exponent(Signed 8 bit)* *Binary Unsigned Value (24 bit)* *Example: $123456*10^{-3}$ = 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: - $123456*10^{-3}$ = 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 = 00FF 2694(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 = 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 = 1009 07D0(16)*
T16		*Unsigned Value (16 bit), 2 decimal places* *Example: 123.45 = 3039(16)*

T17		*Signed Value (16 bit), 2 decimal places* *Example: -123.45 = CFC7(16)*
T_Str4		*Text: 4 characters (2 characters for 16 bit register)*
T_Str6		*Text: 6 characters (2 characters for 16 bit register)*
T_Str8		*Text: 8 characters (2 characters for 16 bit register)*
T_Str16		*Text: 16 characters (2 characters for 16 bit register)*
T_Str40		*Text: 40 characters (2 characters for 16 bit register)*

8.2 APPENDIX C: CALCULATIONS & EQUATIONS

Calculations

Definitions of symbols

No	Symbol	Definition
1	M_v	Sample factor
2	M_P	Average interval
3	U_f	Phase voltage (U_1, U_2 or U_3)
4	N	Total number of samples in a period
5	n	Sample number ($0 \leq n \leq N$)
6	i_n	Current sample n
7	u_{fn}	Phase voltage sample n
8	φ_f	Power angle between current and phase voltage f (φ_1, φ_2 or φ_3)
9	U_c	Agreed supply voltage

EQUATIONS

Voltage

	Phase voltage
$U_f = \sqrt{\frac{\sum_{n=1}^{N} u_n^2}{N}}$	N – samples in one period (up to 65 Hz) N – samples in M_v periods (above 65Hz) Example: 400 Hz → M_V = 7

Current

	Phase current
$I_{RMS} = \sqrt{\frac{\sum_{n=1}^{N} i_n^2}{N}}$	N – 128 samples in a period (up to 65 Hz) N – 128 samples in more periods (above 65 Hz)

Power

	Active power by phases
$P = \frac{1}{N}\sum_{n=1}^{N}(un \times in)$	N – Total number of samples in a period n – a number of samples in a period
$SignQ_f(\varphi)$ $\varphi \in [0° - 180°] \rightarrow SignQ(\varphi) = +1$ $\varphi \in [180° - 360°] \rightarrow SignQ(\varphi) = -1$	**Reactive power sign** Q_f – reactive power ϕ – power angle
	Apparent power
$S = U \times I$	U – phase voltage I – phase current
	Reactive power
$Q = SignQ(\varphi) \times \sqrt{S^2 - P^2}$	S – apparent power P – active power
	Power angle
$\varphi = a\ tan2\ (P, Q)$ $\varphi = [-180°, 179{,}99°]$	P – active power S – apparent power
	Power factor
$PF = \frac{P}{S}$	P – active power S – apparent power

THD

$I_{THD}(\%) = \frac{\sqrt{\sum_{n=2}^{N} In^2}}{I_1} 100$	Current THD I_1 – value of first harmonic n – number of harmonic
$U_{THD}(\%) = \frac{\sqrt{\sum_{n=2}^{N} Un^2}}{U_1} 100$	Voltage THD U_1 – value of first harmonic n – number of harmonic

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