GB

User's Manual

Measuring transducers:
Transducer & Analyzer MT560/UMT560
Transducer & Recorder MT550/UMT550
Multifunction Transducer MT540/UMT540
Remote Display RD500

Iskra

Iskra MIS

Table of Contents

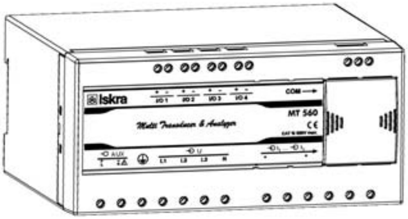
Meaning of symbols ○ ◖ ● see page 6!

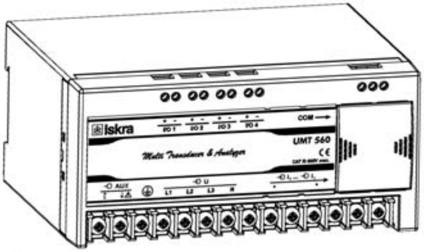
1. SECURITY ADVICE AND WARNINGS

1.1 Welcome

Please read this chapter carefully before starting work with a Measuring transducer.

This chapter deals with important information and warnings that should be considered for safe work with a Measuring transducer.





1.2 Introduction

This booklet contains instructions for installation and use of Measuring transducers MT560, MT550, MT540, UMT560, UMT550, UMT540 and Remote display RD500. Installation and use of devices also includes handling with dangerous currents and voltages and shall therefore be carried out by qualified persons. The Iskra MIS 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 instrument is used for measuring or supervision, please contact a person who is responsible for installation of such system.

1.3 Health and safety

The purpose of this chapter is to provide a user with information concerning safe installation and handling with the product in order to assure its correct use and continuous operation.

It is essential that everyone using the product is 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.

1.4 Safety warnings and instructions for use

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 transducer.

Battery replacement

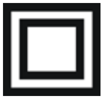
Some instruments are equipped with a built-in battery. When empty, replace with a corresponding type (Varta, type 6032 CR2032 SLF or equivalent). A battery shall be replaced by an authorized service. The battery lifetime is approx. 6 years. Instruction on battery replacement is given in chapter 8: Battery replacement, page 63.

Waste

It is forbidden to deposit electrical and electronic equipment 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 EZ 2002/96/EG about restriction on the use of certain hazardous substances in electrical and electronic equipment or a corresponding Url 118/04.

1.5 Warnings, information and notes regarding designation of the product

Used symbols:

	See product documentation.
	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.

Contents of consignment

The consignment includes:

− Measuring transducer MT560, MT550, MT540, UMT560, UMT550, UMT540

− Quick guide

Or

− Remote display RD500

− Connection cable

− Quick guide

2. BASIC DESCRIPTION AND OPERATION OF MEASURING TRANSDUCER

2.1 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, pages 10 to 12. Al types of measuring transducers are available in DIN or ANSI housing. Instruments in DIN housing are marked as types MT5xx; instruments in ANSI housing are marked as types UMT5xx. Specifications of housing for both types are specified in chapter Dimensions on page 72.

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.

<u>Chapter</u>

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:

(U)MT540 / (U)MT550 / (U)MT560

<u>Subchapter</u>

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)
OK − Function accessible via navigation keys on remote display RD500

<u>Tables</u>

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 on the next page.

2.2 Glossary

Term	Explanation
RMS	Root Mean Square value
Flash	Type of a memory module that keeps its content in case of power supply failure
Ethernet	IEEE 802.3 data layer protocol
MODBUS / DNP3	Industrial protocol for data transmission
MiQen	Software for Iskra MIS instruments
AC	Alternating voltage
PA total	Angle calculated from total active and apparent power
PA1, PA2, PA3	Angle between fundamental phase voltage and phase current
PF	Power factor
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.
PO	Pulse output module
PI	Pulse input module
TI	Tariff input module
AL	Alarm output module
AO	Analogue output module
AI	Analogue input module
DO	Digital output module
DI	Digital input module
COM2	2^{nd} communication port module

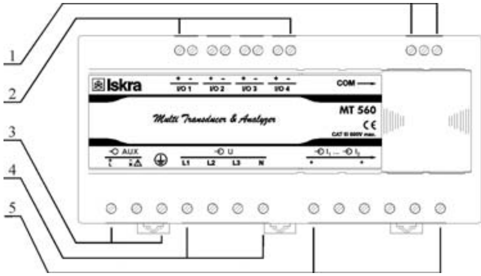
2.3 Description of the product

Measuring transducer is intended for measuring, analyzing and monitoring single-phase or three-phase electrical power network. It measures RMS value 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, etc.) from the measured signals.

Appearance

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

1 – Communication ports and LED indicators
2 – I/O modules
3 – Auxiliary supply
4 – Voltage inputs
5 – Current inputs



<u>Communication ports and LED indicators</u>

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).

<u>I/O modules</u>

Four I/O module slots are intended for various I/O modules, which should be chosen at placing the order. Tariff inputs, digital inputs, digital outputs, analogue inputs, analogue outputs, pulse inputs, pulse outputs alarm outputs, and additional (COM2) communication port.

<u>Auxiliary supply</u>

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.

<u>Voltage inputs</u>

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} (1000 V_{L-L}).

<u>Current inputs</u>

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

2.4 Purpose and use of different types of measuring transducers

Multifunction transducer MT540 / UMT540

The instrument is used for monitoring and measuring electric quantities of three-phase electrical power distribution system. The meter is provided with 32 program adjustable alarms, up to four input or output modules and communication. With the RS232/RS485, Ethernet or USB communication, the meter can be set and measurements can be checked. The meter also functions as an energy counter, with the additional function of cost management by tariffs. A tariff input or a tariff clock can be set. At tariff clock setting, four seasons and four day groups as well as energy cost for each period and a day group (16 different cost periods) are available. Additionally, the instrument can store up to 20 holidays. As an energy counter it can record energy in four tariffs in all four quadrants of the load power diagram.

Network recorder MT550 / UMT550

The instrument is used for monitoring, measuring and recording measurements of electric quantities of electrical power distribution system. The (U)MT550 measure all parameters like (U)MT540 and up to 32 measurements and up to 32 alarms could be recorded in the internal memory. The memory is separated into two sections for measurements (A and B) and one section for recording alarms. The memory division is defined by the user via communication.

Network analyzer MT560 / UMT560

The instrument measure all parameters like (U)MT550 and is used also for permanent analysis of electricity supply quality in compliance with the SIST EN 50160 standard. A partition in the internal memory is reserved for storing reports for a period of the last seven years. The internal memory capacity enables storing of more than 170,000 variations of the measurements from the standard values, which enables finding eventual reasons for the problems in network. Limits and required quality in a monitored period can be defined for each monitored characteristic. The following characteristics are measured and recorded:

- Frequency variations
- Voltage variations
- Voltage unbalances
- Voltage dips
- Voltage interruptions
- Rapid voltage changes
- Flickers Pst & Plt
- Temporary overvoltages
- THD's
- Harmonics

Remote display RD500

Remote display is very useful for a quick look-up to all measured parameters or to set up the (U)MT5xx measuring transducers without the PC. A graphical display with the resolution of 128x64 enables graphical representation of signals and parameters. With five select buttons it is possible to browse through the user-friendly menu.

2.5 Type differences

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

Differences in hardware

Feature		MT540 UMT540	MT550 UMT550	MT560 UMT560	RD500
Internal flash memory		×	8Mb	8Mb	×
Real time clock (RTC) with battery		●	●	●	×
Communication interface RS232 and RS485 / Ethernet / USB		●/○/○	●/○/○	●/○/○	RS485
I/O 1	AO/AI/AL/COM2/PO/PI/TI/DO/DI	○/○/○/×/○/○/○/○/○	○/○/○/×/○/○/○/○/○	○/○/○/×/○/○/○/○/○	×
I/O 2	AO/AI/AL/COM2/PO/PI/TI/DO/DI	○/○/○/×/○/○/○/○/○	○/○/○/×/○/○/○/○/○	○/○/○/×/○/○/○/○/○	×
I/O 3	AO/AI/AL/COM2/PO/PI/TI/DO/DI	○/○/○/×/○/○/×/○/○	○/○/○/×/○/○/×/○/○	○/○/○/×/○/○/×/○/○	×
I/O 4	AO/AI/AL/COM2/PO/PI/TI/DO/DI	○/○/○/○/○/○/×/○/○	○/○/○/○/○/○/×/○/○	○/○/○/○/○/○/×/○/○	×
Automatic voltage / current range		●/●	●/●	●/●	×/×
Universal power supply LO / HI		○/○	○/○	○/○	×
Universal power supply		×	×	×	●
Graphical LCD display		×	×	×	●
LED indicator: Power/Comm./Alarm		●/●/×	●/●/×	●/●/×	×/●/●
Control keys on front panel (5)		×	×	×	●

● – serial ○ – option × – not supported

AO-analogue out, AI-analogue in, AL-alarm/digital out, PO-pulse out, PI-pulse in, TI-tariff in, DO-digital out, DI-digital in, COM2-additional communication port

Software functions

	Functions	MT540 UMT540	MT550 UMT550	MT560 UMT560	RD500
Basic	MODBUS and DNP3 protocols	●	●	●	×
	Tariff clock	●	●	●	×
	MD calculation (TF, FW, SW)	●/●/●	●/●/●	●/●/●	×/×/×
	Programmable alarms (32)	●	●	●	×
	Alarms recording	×	●	●	×
	Measurements recording	×	●	●	×
	Measurements graphs (time/FFT)	●/●*	●/●*	●/●	×/×
	Evaluation of voltage quality in compliance with EN 50160	×	×	●	×
Remote	Setup wizard	×	×	×	●
	Wrong connection warning	×	×	×	●
	Custom screens (3)	×	×	×	●
	Demonstration screen cycling	×	×	×	●
	Programmable refresh time	×	×	×	●

● – serial × – not supported

* (U)MT540 & (U)MT550 support harmonic analysis up to 31st harmonic, (U)MT560 up to 63rd

Supported measurements

	Basic measurements	**MT540 UMT540**	**MT550 UMT550**	**MT560 UMT560**
Phase	Voltage U_1, U_2, U_3 and $U^{\sim}$	●	●	●
	Current I_1, I_2, I_3, I_n, I_t and I_a	●	●	●
	Active power P_1, P_2, P_3, and P_t	●	●	●
	Reactive power Q_1, Q_2, Q_3, and Q_t	●	●	●
	Apparent power S_1, S_2, S_3, and S_t	●	●	●
	Power factor PF_1, PF_2, PF_3 and $PF^{\sim}$	●	●	●
	Power angle φ_1, φ_2, φ_3 and $\varphi^{\sim}$	●	●	●
	THD of phase voltage U_{f1}, U_{f2} and U_{f3}	●	●	●
	THD of power angle I_1, I_2 and I_3	●	●	●
Phase-to-phase	Phase-to-phase voltage U_{12}, U_{23}, U_{31}	●	●	●
	Average phase-to-phase voltage U_{ff}	●	●	●
	Phase-to-phase angle φ_{12}, φ_{23}, φ_{31}	●	●	●
	Voltage unbalance U_u	●	●	●
	THD of phase−to−phase voltage	●	●	●
Energy	Counter 1	●	●	●
	Counter 2	●	●	●
	Counter 3	●	●	●
	Counter 4	●	●	●
	Total	●	●	●
	Active tariff	●	●	●
	Cost by counters	●	●	●
	Total cost	●	●	●

● – serial × − not supported

	Other measurements	**MT540 UMT540**	**MT550 UMT550**	**MT560 UMT560**
Min / Max	Voltage U_1, U_2, U_3	●	●	●
	Phase-to-phase voltage U_{12}, U_{23}, U_{31}	●	●	●
	Phase current I_1, I_2, I_3	●	●	●
	Active power P_1, P_2, P_3, P	●	●	●
	Apparent power S_1, S_2, S_3, S	●	●	●
	Frequency f	●	●	●
	Internal temperature	●	●	●
MD values	Phase current I_1, I_2, I_3	●	●	●
	Active power P (Positive)	●	●	●
	Active power P (Negative)	●	●	●
	Reactive power Q − L	●	●	●
	Reactive power Q − C	●	●	●
	Apparent power S	●	●	●

● – serial × − not supported

	Other measurements	MT540 UMT540	MT550 UMT550	MT560 UMT560
Measurement	Frequency	●	●	●
	Internal temperature	●	●	●
	Date & Time	●	●	●
	Time graphs (I_1, I_2, I_3,U_1, U_2, U_3, U_{12}, U_{23} and U_{31})	●	●	●
	FFT graphs (I_1, I_2, I_3,U_1, U_2, U_3, U_{12}, U_{23} and U_{31})	●	●	●
	Phase voltage harmonics	●*	●*	●
	Phase−to−phase voltage harmonics	●*	●*	●
	Current harmonics	●*	●*	●
	Analysis in compliance with SIST EN 50160	×	×	●

● – serial × − not supported

* (U)MT540 & (U)MT550 support harmonic analysis up to 31st harmonic, (U)MT560 up to 63rd

3. CONNECTION

3.1 Introduction

This chapter deals with the instructions for measuring transducer and remote display 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 MIS 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.

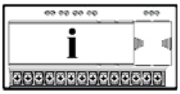
Before use: Check voltages and phase rotation, supply voltage and nominal frequency.

Check protective fuse rating (the recommended maximum rating of the external protective fuse for this equipment is 6A - Red Spot type or equivalent).

Warning!

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

Note



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

3.2 Mounting

UMT5xx measuring transducer is designed for DIN rail 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.

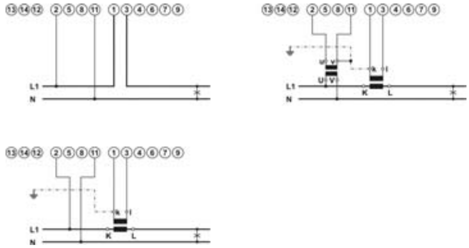
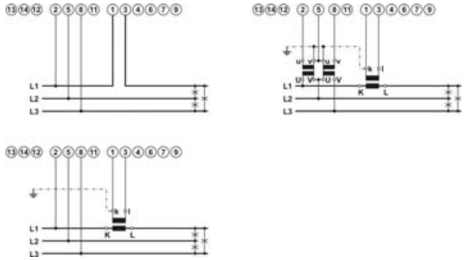
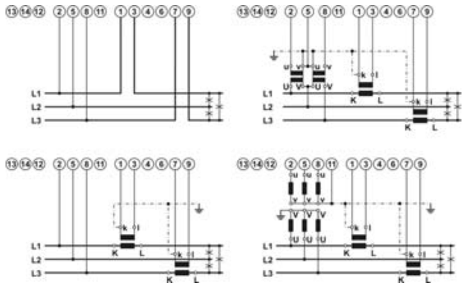
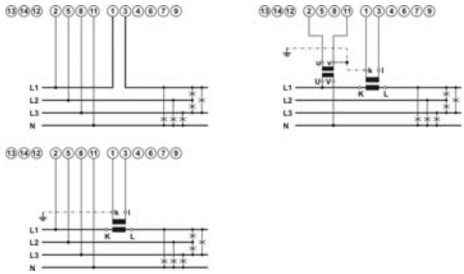
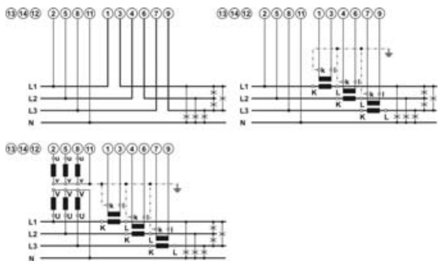
RD500 remote display is designed for panel mounting. Before inserting the device into the panel cut-out, removes four nuts and flat washers, insert it and position the nuts and flat washers. Fix device to the panel. Recommended panel cut out is 4 inches (10.16 cm).

3.3 Electric 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 on page 66.

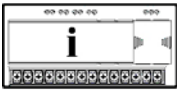
System/ connection	Terminal assignment
Connection 1b (1W) *Single-phase connection*	
Connection 3b (1W3) *Three-phase – three-wire connection with balanced load*	
Connection 3u (2W3) *Three-phase – three-wire connection with unbalanced load*	
Connection 4b (1W4) *Three-phase – four-wire connection with balanced load*	
Connection 4u (3W4) *Three-phase – four-wire connection with unbalanced load*	

3.4 Connection of input/output modules ●●●

Warning!

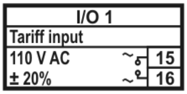
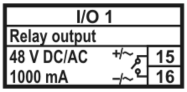
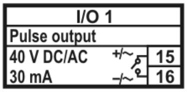
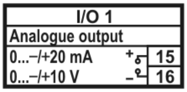
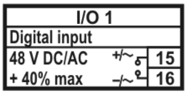
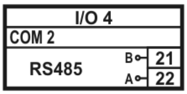
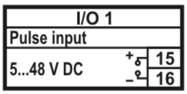
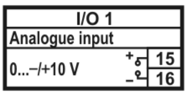
Check the module features that are specified on the label, before connecting module contacts. Wrong connection can cause damage or destruction of module and/or device.

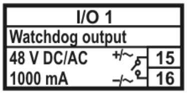
Note



Frequency of the tariff input voltage signal should not essentially deviate from the frequency of the measuring input signal. At no signal on the measuring inputs the tariff triggering is not reliable.

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 on page 67.

	Tariff input module for changeover between up to four tariffs. (Example of tariff module as I/O module 1)
	Alarm (relay) module. (Example of alarm module as I/O module 1)
	Pulse output (solid state) module for energy counters. (Example of pulse module as I/O module 1)
	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)
	Digital input module enables reception of digital signal. (Example of 48V digital module as I/O module 1)
	2nd communication module, for connection of RS485 communication (COM2). Only on I/O4!
	Pulse input module enables reception of pulses from various counters (water, gas, heat, flow…). (Example of pulse input module as I/O module 1)
	Analoge input module enables measurements of DC U, I, R or temp. (PT100, PT1000) values from external sources.

	Watchdog output (relay) module enables proper instrument operation supervision

3.5 Communication connection

(U)MT5xx has a wide variety of communication possibilities to suit specific demands. It is equipped with one standard (COM1) and one optional communication port (COM2). 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 (U)MT5xx simultaneously and by using Ethernet communication, data can be accessed worldwide. Additional (COM2) port is available (optional), when two independent serial communications are required.
(U)MT5xx can be connected to the same network using COM1 or COM2 (if available).
Different configurations are possible (to be specified with an order):

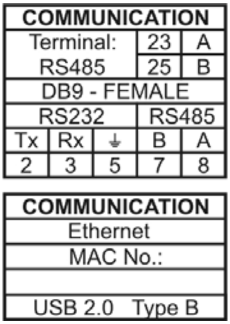
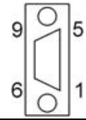
Configuration	COM1A	COM1B	COM2[2]
1	RS232/485[3]	/	/
2	RS232/485[3]	/	RS485
3	USB	/	/
4	USB	/	RS485
5[1]	Ethernet	USB	/
6[1]	Ethernet	USB	RS485

[1] Galvanic separation between COM1A and COM1B is 1 kVAC
[2] COM2 (RS485 only) uses connection terminals of I/O4 module in case of secondary communication or RJ11 connector in case of remote display communication
[3] 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 on page 68.

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

<u>RS232</u>

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).

<u>RS485</u>

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 MIS communication interfaces for best compatibility!

Correct connection of individual terminals of the DB9 connector shall be provided (see a table on the next page).

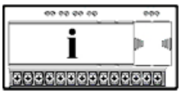
<u>Ethernet</u>

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.

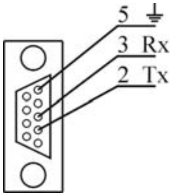
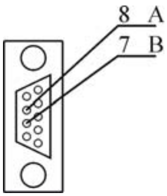
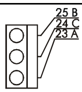
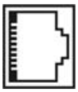
<u>USB</u>

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.

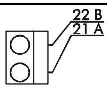
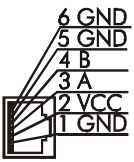
Note

	When (U)MT5xx 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 MIS web page www.iskra-mis.si. With this driver installed, USB is redirected to a serial port, which should be selected when using MiQen software.

Survey of communication connection

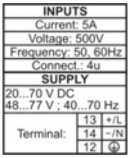
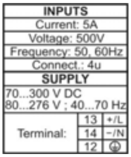
	Connector	Terminals	Position	Data direction	Description
RS232	DB9		1	Not connected	–
			2	From	Data transmission (Tx)
			3	To	Data reception (Rx)
			4	Not connected	–
			5	–	Grounding (⏚)
			6	Not connected	–
			7	–	Do not connect!
			8	–	Do not connect!
			9	Not connected	–
RS485	DB9		1	Not connected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

Survey of secondary communication connections

	Connector	Terminals	Positi on	Data direction	Description
RS485 COM2	SCREW -IN		21	To/From	A
			22	To/From	B
RS485 Remote display	RJ–11		1	–	Grounding (⏚)
			2	–	Vcc
			3	To/From	A
			4	To/From	B
			5	–	Grounding (⏚)
			6	–	Grounding (⏚)

3.6 Connection of auxiliary power supply

Measuring transducer has universal (AC/DC) auxiliary power supply. Information on electric consumption is given in chapter Technical data on page 64. 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.

	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!

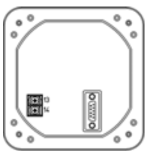
For safety purposes it is important that all three wires (Line, Neutral and Protective Earth) are firmly connected. They should be connected only to the designated terminals as shown on the label above as well as on the front foil.

3.7 Remote display connection

RD500 remote display has a wide range universal (AC/DC) auxiliary power supply (20 VDC – 300 VDC; 48 VAC – 276 VAC 40 – 70 Hz). Information on electric consumption is given in chapter Technical data on page 64.

For a proper connection of serial RS485 (DB9 connector) communication see Survey of communication connection table on page 19 and Survey of secondary communication connections on page 19. More detailed information on remote display is given in chapter Remote display features on page 58.

For a quick access to a single MT5xx transducer, RD500 communication cable should be plugged to a dedicated connector (RJ11 type) under the transparent cover. In case of a RS485 bus connection where RD500 is intended for supervision and reading of several (up to 32) MT5xx transducers, RD500 should be connected to the same bus as MT5xx transducers by means of screw-in connection.

	Connection of universal power supply to terminals 13, 14 and connection of RS485 communication (DB9) at the rear side of RD500

4. SETTINGS

4.1 Introduction

Instrument settings can be remotely modified with communication (COM1 and/or COM2 if available) and MiQen software, when connected to a PC, or with the use of the keyboard on the Remote display. When using Remote display, modified settings are applied only after confirmation (OK).

4.2 MiQen software

MiQen is a software tool for complete monitoring of measuring instruments, connected to a PC via serial or TCP/IP communication. A user-friendly interface consists of five segments: devices management, instrument settings, real-time measurements, data analysis and software upgrading.

Two editions of MiQen software are available:

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

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 are 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.

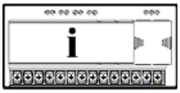
Data analysis

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 or a report on supply voltage quality can be made. All data can be exported to an Access data base, Excel worksheets or as a text file.

Software upgrading

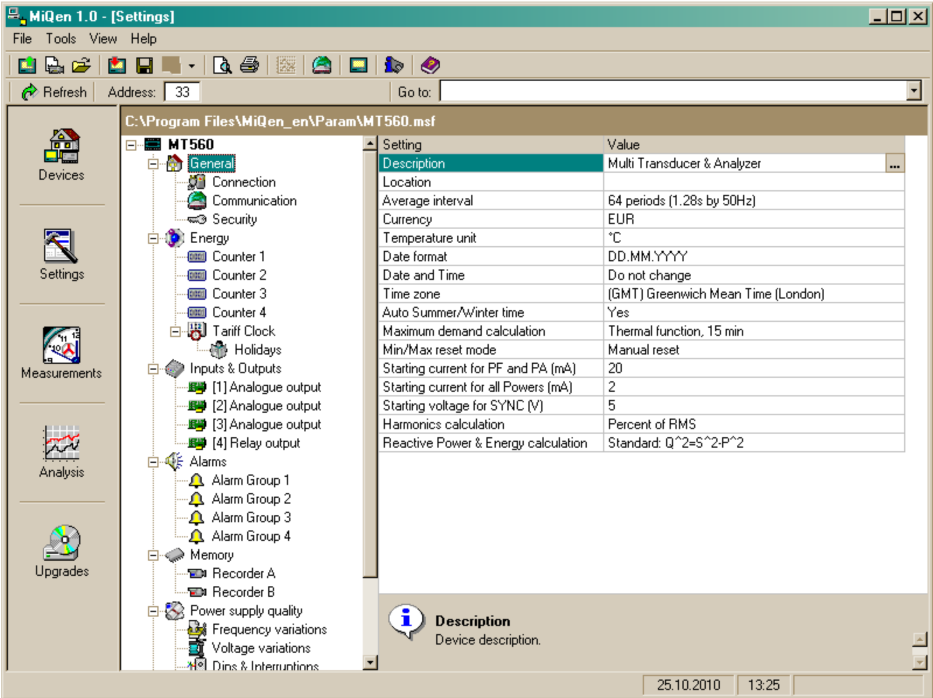
Always use the latest version of software, both MiQen and software in the instrument. The program automatically informs you on available upgrades that can be transferred from the web site and used for upgrading.

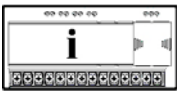
Note



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

PC MiQen user interface



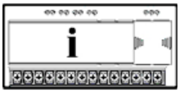


You can download freeware MiQen (standard edition) from: www.iskra-mis.si

4.3 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.

Note



Supported settings and functions depend on the type of device. For a survey of supported measurements and functions see chapter Type differences, pages 10 to 12.

4.4 General settings ●●●

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

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.

Average interval PC

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

Currency PC OK

Choose currency for evaluating energy cost (see chapter Energy on page 32). A currency designation consists of up to four letters taken from the English or Russian alphabet and numbers and symbols stated in table 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
	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
Symbols		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/	0 to 9			:	;	<	=	>	?	@
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
	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

Temperature unit PC OK

Choose a unit for temperature display.

Date format PC OK

Set a date format.

Date and time PC OK

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

Auto Summer/Winter time PC OK

If Yes is chosen, time will be automatically shifted to a winter or a summer time, regarding the time that is momentarily set.

Maximum demand calculation (MD mode)

The instrument provides maximum demand values from a variety of average demand values:

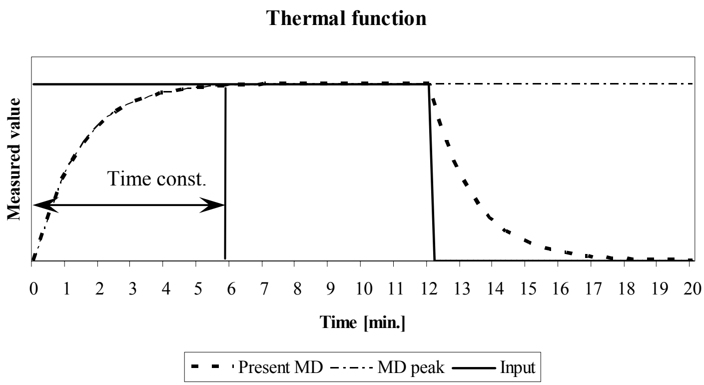
- Thermal function
- Fixed window
- Sliding windows (up to 15)

Thermal function

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.
Current MD and maximal MD: Reset at 0 min.



Fixed window

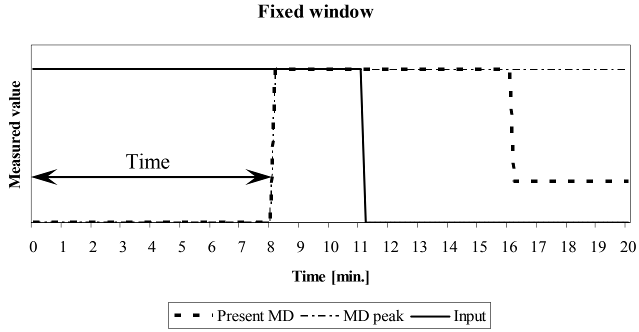
A fixed window is a mode that calculates average value over a fixed time period. This (t. c. – time constant) can be set from 1 to 255 min.

»TIME IN A PERIOD« will actively show the remaining time until the end of the period, until a current MD and maximal MD from the last reset are calculated. When displays for Pt(+/−), Qt(L/C), St, I1, I2 and I3 are updated, a new period and measurement of new average values are started. »TIME IN A PERIOD« then shows 0 of X min.

A new period also starts after a longer interruption of power supply (more than 1 s). If time constant is set to one of the values of 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes, »TIME IN A PERIOD« is set to such value that one of the following intervals will be terminated at a full hour. In other cases of time constants, »TIME IN A PERIOD« is set to 0.

Example:

Mode: Fixed window
Time constant: 8 min.
Current MD and maximal MD: Reset at 0 min.



Sliding windows

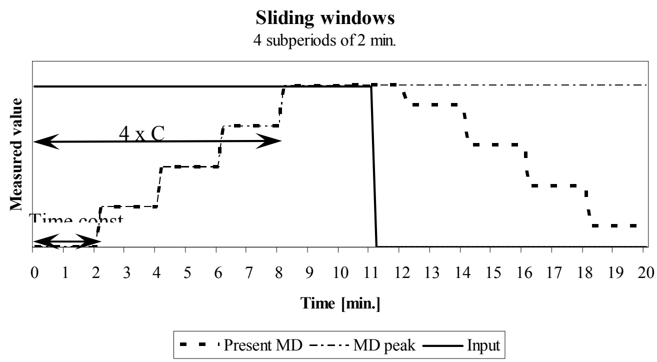
A mode of sliding windows enables multiple calculation of average in a period and thus more frequent regeneration of measuring results. Average value over a complete period is displayed. A current MD is updated every sub period for average of previous sub periods.

A number of sub periods can be set from 2 to 15.
A time period (t. c.) can be set from 1 to 255 minutes.

A new period also starts after a longer interruption of power supply (more than 1 s). If time constant is set to one of the values of 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes, »TIME IN A PERIOD« is set to such value that one of the following intervals will be terminated at a full hour. In other cases of time constants, »TIME IN A PERIOD« is set to 0.

Example:

Mode: Sliding windows
Time constant: 2 min.
No. of sub periods: 4
Current MD and maximal MD: Reset at 0 min.



A complete period lasts for 8 minutes and consists of 4 sub periods that are 2 minutes long. A current MD and a maximal MD are reset at 0 min. "TIME IN A PERIOD" is data for a sub period so that the values for a current MD and a maximal MD are regenerated every two minutes. After 4 sub periods (1 complete period) the oldest sub period is eliminated when a new one is added, so that average (a window) always covers the last 4 sub periods.

Resetting Min/Max

A mode of stored values deletion of Min/Max values is set. It can be set to a manual (see chapter Reset on page 42) or automatic mode (daily, weekly, monthly or yearly reset). Resets are performed at the beginning of a certain term at midnight. Daily – every day, weekly on Monday at 00:00, monthly − the first day in a month at 00:00, and yearly − the first day in a year 1.1. at 00:00.

Starting current for PF and PA (mA)

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.

Starting current for all powers (mA)

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

Minimum synchronization voltage

If all phase voltages are smaller than this (noise limit) setting, instrument uses current inputs for synchronization. If also all phase currents are smaller than *Starrting current for PF and PA* setting, synchronization is not possible and frequency displayed is 0.

Calculation of harmonics

Selection of reference for calculation is important for calculation of absolute values of harmonics. It is possible to select between a percentage of harmonic of RMS signal value (current, voltage) or relative to the fundamental (first harmonic). At percentage of RMS, a signal rate is calculated for all harmonics. At percentage of 1^{st} harmonic, all other harmonics are calculated relatively to 1^{st} harmonic.

Reactive power and energy calculation

Two different principles of reactive power and energy calculation are used:

Standard method:

With this method a reactive power and energy are calculated based on assumption that all power (energy), that is not active is reactive.

$Q^2 = S^2 – P^2$

This means also that all higher harmonics will be measured as reactive power (energy).

Delayed current method:

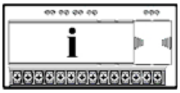
With this method, reactive power (energy) is calculated by multiplication of voltage samples and delayed current samples (see chapter Equations on page 87):

$Q = U \times I|_{+90°}$

With this method, reactive power (energy) represents only true reactive component of apparent power (energy).

4.5 Connection ●●●

Note



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

Connection

When connection is selected, load connection and the supported measurements are defined (see chapter Survey of supported measurements regarding connection mode on page 45).

Setting of current and voltage ratios

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

Used voltage and current range

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.

Nominal frequency

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

Wrong connection warning

If all phase currents (active powers) do not have same sign (some are positive and some negative) and/or if phase voltages and phase currents are mixed, the warning will be activated if this setting is set to YES. This warning is seen only on remote display. See chapter 7.

Energy flow direction

This setting allows manual change of energy flow direction (IMPORT to EXPORT or vice versa) in readings tab. It has no influence on readings sent to communication or to memory.

CT connection

If this setting is set to REVERSED it has the same influence as if CT's would be reversely connected. All power readings will also change its sign.

4.6 Communication ●●●

Serial Communication (COM1)

Define parameters (only for COM1) 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).

Data type (XML-smart, XML-logic): With this setting a required data format for sending data to receiver using PUSH communication mode is set. For more information about PUSH communication mode and XML data format see chapter 6 on page 55 and appendix D on page 91.

Response time: With this setting a maximum waiting time for acknowledgement of sent data in PUSH communication mode is set.

Time synchronization: Which type of communication is used for synchronization of time for PUSH communication mode purpose.

USB Communication

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

Ethernet communication

Device Address: Each device should have its unique address number when connected to the network. Usable range of addresses is from 1 to 247. Default address number is 33.

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

> *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 (dynamic) 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.

Local Port: 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

Sending data: When PUSH communication mode is used, data can be send (pushed) to two different servers. Within this setting, all parameters relevant to used servers should be set, as well as data type for sent data, time synchronization source and server response time.
For more information about PUSH communication mode and XML data format see chapter 6 on page 55 and appendix D on page 91.

4.7 Security ●●●

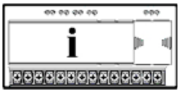
Settings parameters are divided into four groups regarding security level:

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 MIS, 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 MIS.

Note



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

<u>Password setting</u>

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.

Passwords are the same regardless of communication port (COM1 or COM2) by which the user is accessing restricted settings. But unlocking the access with COM1 doesn't unlock the access with COM2 and vice versa.

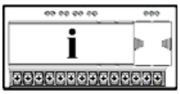
Password modification

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

Password disabling

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

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

4.8 Energy

Warning!

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

Active tariff

When active tariff is set, one of the tariffs is defined as active; switching between tariffs is done either with a tariff clock or a tariff input. For the operation of the tariff clock other parameters of the tariff clock that are accessible only via communication must be set correctly.

Common energy exponent

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.

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

Counter divider

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

Common exponent of energy cost

Setting enables resolving the cost display. On the basis of this and a diving constant, a basic calculation prefix for energy cost is defined.

Common exponent of tariff price and energy price in tariffs [PC]

Exponent and price represent energy price (active, reactive, common) in a tariff. The price exponent is used for recording the price without decimal places. For example, to set a price for tariff 1 to 0,1567 €/kWh, the number in Price for energy in tariff 1 field should be 1567 and common tariff price exponent should be -4 (1567 x 1E-4 = 0,1567)

An example for 12.345kWh of consumed active energy in the first tariff (price 0,1567 €/kWh):

Common energy exponent	0	2	2
Counter divider	1	1	100
Common energy cost exponent	−3	−2	0
Common tariff price exponent	−4	−4	−4
Price for energy in tariff 1	1567	1567	1567
Unit	EUR	EUR	EUR
Example of result, displayed	12.345 kWh 1,934 EUR	12.3 kWh 1.93 EUR	0.01 MWh 1 EUR

Tariff clock [PC]

Basic characteristics of a program tariff clock:

- 4 tariffs (T1 to T4)
- Up to 4 time spots in each Day program for tariff switching
- Whichever combination of valid days in a week or holidays for each program
- Combining of day groups (use of over 4 time spots for certain days in a week)
- Separate settings for 4 seasons a year
- Up to 20 settable dates for holidays

Day program sets up to 4 time spots (rules) for each day group in a season for tariff switching.

A date of real time clock defines an active period. An individual period is active from the period starting date to the first next date of the beginning of other periods.

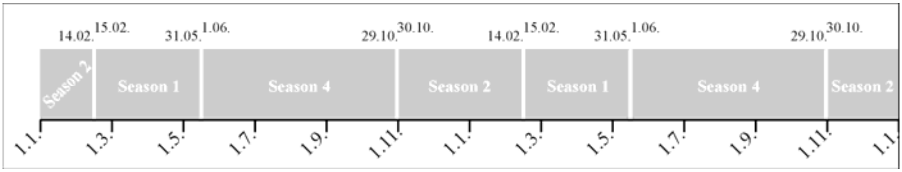
The order of seasons and starting dates is not important, except when two dates are equal. In that case the season with a higher successive number has priority, while the season with a lower number will never be active.

If no starting date of a season is active, the active period is 1.

If the present date is before the first starting date of any period, the period is active with the last starting date.

Example of settings:

Season	Season start day
Season 1:	15.02
Season 2:	30.10
Season 3:	–
Season 4:	01.06
Date	**Active season**
01.01. − 14.02.	2 (last in the year)
15.02. − 31.05.	1
01.06. − 29.10.	4
30.10. − 31.12.	2



Days in a week and selected dates for holidays define time spots for each daily group in a period for tariff switching. Dates for holidays have priority over days in a week.

When the real time clock date is equal to one of a date of holidays, tariff is switched to holiday, within a period of active daily group with a selected holiday.

If there is no date of holidays that is equal to the real time clock date, all daily groups with the selected current day in a week are active.

Several daily groups can be active simultaneously, which enables more than 4 time spots in one day (combine of day programs). **If the time spot is not set for a certain day, tariff T1 is chosen**.

Time of a real time clock defines an active tariff regarding currently active day program. A selected tariff T1 to T4 of individual time spot is active from the time of the time spot to the first next time of the remaining time spots.

The order of time spots is not important, except when two times are equal. In that case the time with a higher successive number has priority (if several time spots are active, times of higher time spots have higher successive numbers), while the time spot with a lower number will never be active.

If current time is before the first time of any time spot of active spots, the time spot with the last time is chosen.

If no time spot of active programs is valid, tariff T1 is chosen.

Time selected tariff T1 to T4 or fixed selected tariff (via communication) defines activity of an energy counter.

4.9 Inputs and outputs ●●●

Module settings depend on built-in modules.

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:

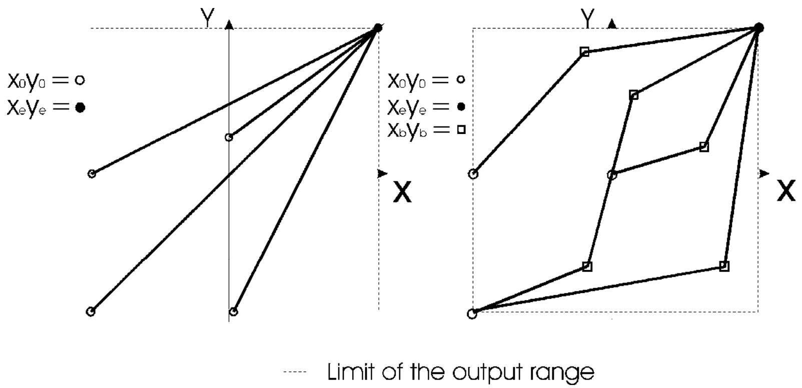
DC current output	DC voltage output
-1…0…1 mA	-1…0…1 V
-5…0…5 mA	
-10...0...10 mA	-10…0…10 V
-20...0...20 mA	

Output range

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 $c = 1$	$x_{b-1} \leq x \leq x_b$ 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:



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 50Hz) up to 128 periods (2.56 sec by 50Hz).

Analogue input module

Three types of analogue inputs are suitable for acquisition of low voltage DC signals from different sensors. According to application requirements it is possible to choose current, voltage or resistance (temperature) analogue input. They all use the same output terminals. MiQen software allows setting an appropriate calculation factor, exponent and required unit for representation of primary measured value (temperature, pressure, flux…)

DC current range:

Range setting allows bipolar ±20 mA or ±2 mA max. input value

DC voltage range:

Range setting allows bipolar ±10 V or ±1 V max. input value

Resistance / temperature range:

Range setting allows 2000Ω or 200 Ω max. input value

It is also possible to choose temperature sensor (PT100 or PT1000) with direct translation into temperature (-200°C to +850°C). Since only two-wire connection is possible it is recommended that wire resistance is also set, when long leads are used.

Alarm/Digital output module

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.

2nd Communication module (COM2)

Module is preset for RS485 communication on I/O 4 terminals.

Module settings define parameters that are important for the operation in RS485 network. 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). By default, addresses of COM1 and COM2 are the same (#33). In this case, change of COM1 address sets COM2 to the same address. When COM1 and COM2 addresses are not equal, change of COM1 address has no influence on COM2 address. Change of COM2 address has no influence on COM1 address. (U)MT5xx can be connected to the same network using COM1 or COM2 (if available).

Pulse output module

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:

$$1{,}5\ldots15\ \text{eW} \rightarrow 100\ \text{p}/1\ \text{eWh}$$

Examples:

Expected power	→	Pulse output settings
150 − 1500 kW	→	1 p/1kWh
1,5 − 15 MW	→	100 p/1MWh
15 − 150 MW	→	10 p/1MWh
150 − 1500 MW	→	1 p/1MWh

Tariff input module

No setting. It operates by setting active tariff at a tariff input (see chapter *Tariff clock* on page 33). With the combination of 2 tariff inputs maximal 4 tariffs can be selected.

Digital input module

No setting. General purpose digital input can be used for various alarms function (unauthorized access notification, switch ON or OFF…).

Pulse input module

No setting. General purpose pulse counter from external meters (water, gas, heat…). Its value can be assigned to any of four energy counters. See chapter *Energy* on page 32.

Watchdog output module

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.

4.10 Alarms ◖●●

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

◖ − (U)MT540 no supported alarms recording into memory

Alarms setting

When PUSH communication mode is active, all alarms can be sent (pushed) to a predefined location inside local or wide area network. Settings allow choosing an appropriate destination for data to be sent, time interval of sent data and a delay time for sending data if they can not be sent immediately due to restrictions in network.

For more information about PUSH communication mode see chapter 6 on page 55.

Measuring transducer supports recording and storing of 32 alarms in 4 groups. For each group of alarms a time constant of maximal values in thermal mode, a delay time and alarm deactivation hysteresis can be defined.

Quantity, value (a current value or a MD – thermal function) 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.

Types of alarms

Visual alarm

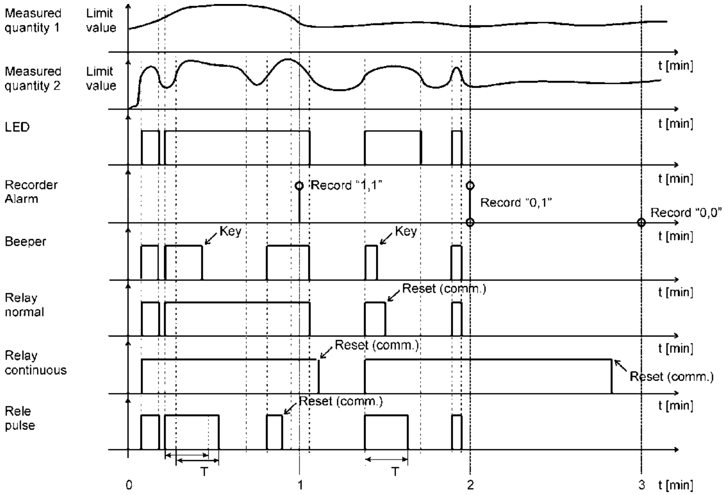
Available ONLY with remote display! When alarm is switched on, a red LED on the remote display front side is blinking (see figure shown on next page).

Audible alarm

Available ONLY with remote display! When alarm is switched on, an audible alarm is given by the remote display (a beep). It can be switched off by pressing any key on the front plate (see figure shown on next page).

Alarm output (pulse)

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



4.11 Memory ○●●

Measurements, alarms, reports and details of supply voltage quality are stored in a built in memory in the (U)MT550 / (U)MT560 - 8MB flash. All records stored in memory are accessible via communication with MiQen software.

○ – (U)MT540 no memory

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. (U)MT560 has 2 additional partitions for recording reports and details on the quality of supply voltage (see chapter Quality of supply, next page). Each of those partitions can be enabled or disabled by the user.

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.

Memory clearing 🖳

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.

Recoders A and B setting 🖳

Separately, for each of two recorders (A and B), settings can be set:

Sampling time sets a time interval for readings to be written to a recorder

Time constant for maximal value in thermal mode for values 1-8 and 9-16 sets a period for maximal value in thermal mode calculation.

When PUSH communication mode is active, all measurements which are set to be written to the memory (max. 32 in both recorders), can be sent (pushed) to a predefined location inside local or wide area network. Settings allow choosing an appropriate destination for data to be sent, time interval of sent data and a delay time for sending data if they can not be sent immediately due to restrictions in network.

For more information about PUSH communication mode see chapter 6 on page 55.

For each of 16 measurements, which are to be recorded it is possible to set a required value and its representation (min., max.,avg…).

4.12 Conformity of voltage with SIST EN 50160 standard ○○●

The SIST EN 50160 standard deals with voltage characteristics of electricity supplied by public distribution systems. This specifies the limits or values within which a customer can expect voltage characteristics to lie. Within this definition the Network analyzer is adapted for supervising the compliance of distribution systems with the SIST EN 50160 standard.

● − Only (U)MT560 enables supervision of network compliance with the SIST EN 50160 standard

Based on requirements stated in the standard, default parameters are set in the meter according to which supervision of all required parameters is done. Parameters can also be changed in detailed setting of individual characteristic.

Quality of power supply

Basic parameters are defined that influence other settings.

User information

Un − Nominal supply voltage with which network is marked and to which individual operation parameters refer.

Uc − Agreed supply voltage is usually network voltage (Un). If a client and a supplier agree about voltage that is different from nominal voltage, that voltage is considered as agreed supply voltage.

Monitoring mode

It defines if the instrument performs measurements for network compliance with the standard.

Electric energetic system

Public distribution system and, if necessary, all default settings are selected.

Nominal supply voltage

A value that is usually equal to nominal network voltage is entered.

Nominal power frequency

Nominal frequency of supply voltage is selected.

Monitoring period

For a report of electric voltage quality, a monitoring period is defined. A number of monitored weeks are entered.

Monitoring start day

A starting day in a week is selected. It starts at 00:00 (midnight). The selected day will be the first day in a report.

Voltage hysteresis

Hysteresis for voltage dips, interruptions and overvoltages is set in percentage from nominal voltage.

Sending reports and report details

When PUSH communication mode is active, reports about quality and report details for each parameter, can be sent (pushed) to a predefined location inside local or wide area network. Settings allow choosing an appropriate destination for data to be sent, time interval of sent data and a delay time for sending data if they can not be sent immediately due to restrictions in network.

For more information about PUSH communication mode see chapter 6 on page 55.

Frequency variations PC

All frequency measurements are performed in 10−second intervals of averaging. For both required quality variations a range of variation is defined in percentage. Percentage of required measurements within the limits (required quality) in the monitored period is also defined.

Voltage variations PC

All voltage measurements are performed in 10−minute intervals of averaging. For all required variations a range of deviation is defined in percentage. Percentage of required measurements (required quality) within the limits in the monitored period is also defined.

Interruptions and dips PC

A limit for voltage dip and interruption is defined in percentage with regard to nominal voltage. A limit between short-term and long-term interruption is defined in seconds. Other parameters define limits of events in a monitored period.

Rapid voltage changes PC

A change limit in percentage of nominal voltage and permitted number of events in a monitored period are defined.

Temporary overvoltages, flickers PC

There are two types of flickers: short-term flicker intensity (P_{st}) and long-term flicker intensity (P_{lt}). Required quality in a monitored period is defined for flickers. A number of allowed events in the period are defined for temporary overvoltages.

Harmonics and THD PC

Permitted limits for the first 25 harmonic components and required quality in a monitored period are defined.

4.13 Reset operations ◖●●

◖ − (U)MT540 does not support some measurements for reset (see chapter Type differences, pages 10 to 12)

Reset Min / Max values PC OK

All Min / Max values are reset.

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

All or individual energy meters are reset.

Reset energy counters costs (E1, E2, E3, E4) PC OK

All or individual energy costs are reset.

Reset maximal MD values

Thermal mode

Current and stored MDs are reset.

Fixed interval / Sliding windows

The values in the current time interval, in all sub-windows for sliding windows and stored MD are reset. In the same time, synchronization of time interval to the beginning of the first sub-window is also performed.

Reset the last MD period

Thermal mode

Current MD value is reset.

Fixed interval / Sliding windows

Values in the current time interval and in all sub-windows for sliding windows are reset. In the same time, synchronization of the time interval is also performed.

MD synchronization

Thermal mode

In this mode, synchronization does not have any influence.

Fixed interval / Sliding windows

Synchronization sets time in a period or a sub-period for sliding windows to 0 (zero). If the interval is set to 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes, time in a period is set to such value that some intervals will be terminated at completed hour.

Example:

Time constant (interval)	15 min	10 min	7 min
Synchronization start time	10:42	10:42	10:42
Time in a period	12 min	2 min	0 min
First final interval	10:45	10:50	10:49

Reset alarm output

All alarms are reset.

5. MEASUREMENTS

5.1 Introduction

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

5.2 Supported measurements

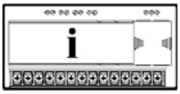
Measurements support regarding the device type is described in chapter Type differences, pages 10 to 12. Selection of supported measurements of individual instrument type is changed with the connection settings. All supported measurements could be read via communication (MiQen) or displayed on Remote display.

5.3 Available connections

Different electric connections are described more in detail in chapter Electric connection on page 14. Connections are marked as follows:

−Connection 1b (1W) − Single phase connection
−Connection 3b (1W3) − Three-phase – three-wire connection with balanced load
−Connection 4b (1W4) − Three-phase – four-wire connection with balanced load
−Connection 3u (2W3) − Three-phase – three-wire connection with unbalanced load
−Connection 4u (3W4) − Tree-phase – four-wire connection with unbalanced load

Note



Measurements support depends on connection mode the instrument type. Calculated measurements are only informative.

Survey of supported measurements regarding connection mode

	Basic measurements	Designat.	Unit	1b	3b	3u	4b	4u
Phase	Voltage U_1	U1	V	●	×	×	●	●
	Voltage U_2	U2	V	×	×	×	○	●
	Voltage U_3	U3	V	×	×	×	○	●
	Average voltage $U^{\sim}$	U⅄	V	×	×	×	○	●
	Current I_1	I1	A	●	●	●	●	●
	Current I_2	I2	A	×	○	●	○	●
	Current I_3	I3	A	×	○	●	○	●
	Current I_n	Inc	A	×	○	○	○	●
	Total current I_t	I	A	●	○	○	○	●
	Average current I_a	Iavg	A	×	○	○	○	●
	Active power P_1	P1	W	●	×	×	●	●
	Active power P_2	P2	W	×	×	×	○	●
	Active power P_3	P3	W	×	×	×	○	●
	Total active power P_t	P	W	●	●	●	○	●
	Reactive power Q_1	Q1	var	●	×	×	●	●
	Reactive power Q_2	Q2	var	×	×	×	○	●
	Reactive power Q_3	Q3	var	×	×	×	○	●
	Total reactive power Q_t	Q	var	●	●	●	○	●

● – supported ○ − calculated × − not supported

	Basic measurements	Designat.	Unit	1b	3b	3u	4b	4u
Phase	Apparent power S_1	S1	VA	●	×	×	●	●
	Apparent power S_2	S2	VA	×	×	×	○	●
	Apparent power S_3	S3	VA	×	×	×	○	●
	Total apparent power S_t	S	VA	●	●	●	○	●
	Power factor PF_1	PF1/ePF1		●	×	×	●	●
	Power factor PF_2	PF2/ePF2		×	×	×	○	●
	Power factor PF_3	PF3/ePF3		×	×	×	○	●
	Total power factor $PF^{\sim}$	PF/ePF		●	●	●	○	●
	Power angle φ_1	φ1	°	●	×	×	●	●
	Power angle φ_2	φ2	°	×	×	×	○	●
	Power angle φ_3	φ3	°	×	×	×	○	●
	Total power angle $\varphi^{\sim}$	φ	°	●	●	●	○	●
	THD of phase voltage U_{f1}	U1%	%THD	●	×	×	●	●
	THD of phase voltage U_{f2}	U2%	%THD	×	×	×	○	●
	THD of phase voltage U_{f3}	U3%	%THD	×	×	×	○	●
	THD of phase current I_1	I1%	%THD	●	●	●	●	●
	THD of phase current I_2	I2%	%THD	×	○	●	○	●
	THD of phase current I_3	I3%	%THD	×	○	●	○	●
Phase-to-phase	Phase-to-phase voltage U_{12}	U12	V	×	●	●	○	●
	Phase-to-phase voltage U_{23}	U23	V	×	●	●	○	●
	Phase-to-phase voltage U_{31}	U31	V	×	●	●	○	●
	Average phase-to-phase voltage (U_{ff})	U△	V	×	●	●	○	●
	Phase-to-phase angle φ_{12}	φ12	°	×	×	×	○	●
	Phase-to-phase angle φ_{23}	φ23	°	×	×	×	○	●
	Phase-to-phase angle φ_{31}	φ31	°	×	×	×	○	●
	Voltage unbalance U_u	Uu	%	×	●	●	×	●
	THD of phase-to-phase voltage THD_{U12}	U12%	%THD	×	●	●	○	●
	THD of phase-to-phase voltage THD_{U23}	U23%	%THD	×	●	●	○	●
	THD of phase-to-phase voltage THD_{U31}	U31%	%THD	×	●	●	○	●
Energy	Counters 1−4 (phase 1, 2, 3, total)	E1, E2, E3, E4	Wh VAh varh	●	●	●	●	●
	Active tariff	Atar		●	●	●	●	●
	Cost by meters	E1$, E2$, E3$, E4$	XXXX	●	●	●	●	●
	Total cost	E$	XXXX	●	●	●	●	●
Max. values MD	MD current I_1	I1	A	●	●	●	●	●
	MD current I_2	I2	A	×	○	●	○	●
	MD current I_3	I3	A	×	○	●	○	●
	MD active power P (positive)	P+	W	●	●	●	●	●
	MD active power P (negative)	P−	W	●	●	●	●	●
	MD reactive power Q−L	Q≣	var	●	●	●	●	●
	MD reactive power Q−C	Q‡	var	●	●	●	●	●
	MD apparent power S	S	VA	●	●	●	●	●

● – supported ○ − calculated × − not supported

	Flicker measurement	Designat.	Unit	1b	3b	3u	4b	4u
Flickers Pst / Plt	Short term f. 1. phase voltage	Plt1		●	×	×	●	●
	Short term f. 2. phase voltage	Plt2		×	×	×	○	●
	Short term f. 3. phase voltage	Plt3		×	×	×	○	●
	Short term f. 1. phase-to-phase voltage	Pst1		×	●	●	×	×
	Short term f. 2. phase-to-phase voltage	Pst2		×	●	●	×	×
	Short term f. 3. phase-to-phase voltage	Pst3		×	●	●	×	×
	Long term f. 1. phase voltage	Plt1		●	×	×	●	●
	Long term f. 2. phase voltage	Plt2		×	×	×	○	●
	Long term f. 3. phase voltage	Plt3		×	×	×	○	●
	Long term f. 1. phase-to-phase voltage	Pst1		×	●	●	×	×
	Long term f. 2. phase-to-phase voltage	Pst2		×	●	●	×	×
	Long term f. 3. phase-to-phase voltage	Pst3		×	●	●	×	×

	Min/max measurements	1b	3b	3u	4b	4u
Instantaneous / Maximal / Minimal values	Voltage U_1	●	×	×	●	●
	Voltage U_2	×	×	×	○	●
	Voltage U_3	×	×	×	○	●
	Phase-to-phase voltage U_{12}	×	●	●	○	●
	Phase-to-phase voltage U_{23}	×	●	●	○	●
	Phase-to-phase voltage U_{31}	×	●	●	○	●
	Phase current I_1	●	●	●	●	●
	Phase current I_2	×	○	●	○	●
	Phase current I_3	×	○	●	○	●
	Active power P_1	●	×	×	●	●
	Active power P_2	×	×	×	○	●
	Active power P_3	×	×	×	○	●
	Total active power P	×	●	●	○	●
	Apparent power S_1	●	×	×	●	●
	Apparent power S_2	×	×	×	○	●
	Apparent power S_3	×	×	×	○	●
	Total apparent power S	×	●	●	○	●
	Frequency f	●	●	●	●	●
	Internal temperature	●	●	●	●	●

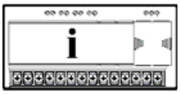
	Measurements of harmonics	1b	3b	3u	4b	4u
Harmonics up to 63rd	Phase voltage U_1	●	×	×	●	●
	Phase voltage U_2	×	×	×	○	●
	Phase voltage U_3	×	×	×	○	●
	Phase-to-phase voltage U_{12}	×	●	●	○	●
	Phase-to-phase voltage U_{23}	×	●	●	○	●
	Phase-to-phase voltage U_{31}	×	●	●	○	●
	Phase current I_1	●	●	●	●	●
	Phase current I_2	×	○	●	○	●
	Phase current I_3	×	○	●	○	●

● – supported ○ – calculated × – not supported

	Voltage quality measurements	1b	3b	3u	4b	4u
Quality parameters	Frequency variations 1 / 2	●	●	●	●	●
	Voltage variations 1 / 2	●	●	●	●	●
	Voltage unbalances	×	●	●	×	●
	Voltage dips	●	●	●	○	●
	Voltage interruptions	●	●	●	○	●
	Long interruptions	×	●	●	○	●
	Rapid voltage changes	×	●	●	○	●
	Flickers Pst / Plt	×	●	●	○	●
	Temporary overvoltages	●	●	●	●	●
	THD's	×	○	●	○	●
	Harmonics	×	○	●	○	●

● – supported ○ − calculated × − not supported

Note



For 3b and 3u connection mode, only phase to phase voltages are measured. Because of that factor √3 is applied to calculation of quality considering nominal phase voltage.
For 4u connection mode measurements support is same as for 1b.

5.4 Explanation of basic concepts

<u>Sample factor − MV</u>

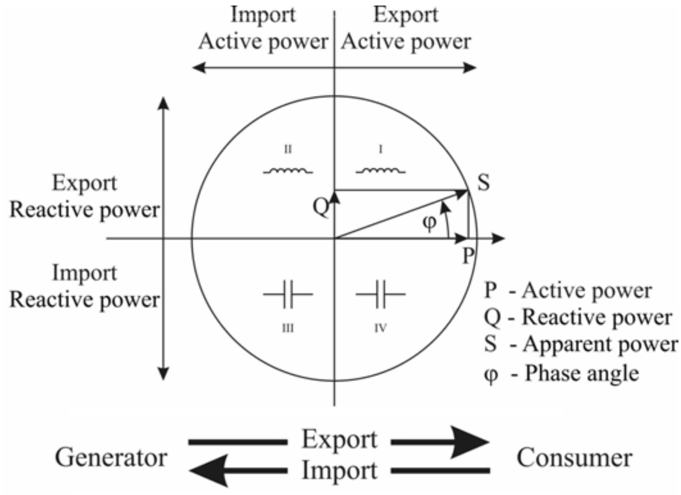
A meter measures all primary quantities with sample frequency which can not exceed a certain number of samples in a time period. Based on these limitations (65Hz·128 samples) a sample factor is calculated. A sample factor (M_V), depending on frequency of a measured signal, defines a number of periods for a measurement calculation and thus a number of harmonics considered in calculations.

<u>Average interval − MP</u>

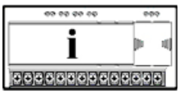
Due to readability of measurements from communication, an Average interval (M_P) is calculated with regard to the measured signal frequency. The Average interval (see chapter Average interval on page 25) defines refresh rate of displayed measurements based on a sampling factor.

Power and energy flow

Figures below show a flow of active power, reactive power and energy for 4u connection.



Note



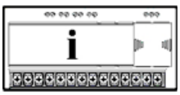
Display of energy flow direction can be adjusted to connection and operation requirements by changing the *Energy flow direction* settings in general / connection (see page 29).

5.5 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 on page 87 with additional descriptions and explanations.

◖ − (U)MT540 do not have all described measurements supported (see chapter Type differences on pages 10 to 12)

Note



Calculation and display of measurements depend on the device type and connection used. For more detailed information see chapters Survey of supported measurements regarding connection mode on page 45.

5.6 Present values

Voltage

Instrument measures real effective (rms) value of all phase voltages (U_1, U_2, U_3), connected to the meter. Phase-to-phase voltages (U_{12}, U_{23}, U_{31}), average phase voltage (U_f) and average phase-to-phase voltage (U_a) are calculated from measured phase voltages (U_1, U_2, U_3). Voltage unbalance is calculated from phase-to-phase voltages (U_{12}, U_{23}, U_{31}).

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

All voltage measurements are available via communication, standard and customized displays on remote display.

Current

Instrument measures real effective (rms) value of phase currents, connected to current inputs. Neutral current (I_n), average current (I_a) and a sum of all phase currents (I_t) are calculated from phase currents.

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

All current measurements are available via communication, standard and customized displays on remote display.

Active, reactive and apparent power

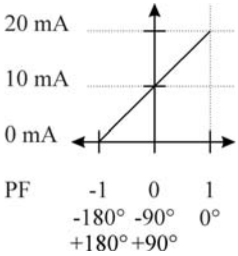
Active power is calculated from instantaneous phase voltages and currents. All measurements are seen via communication or are displayed on remote display. For more detailed information about calculation see chapter Equations on page 87.

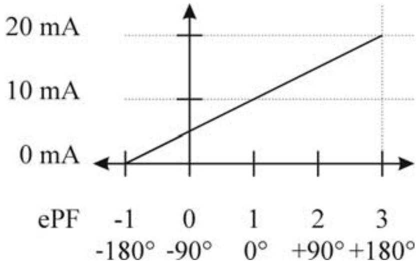
Power factor and power angle

Power factor is calculated as quotient of active and apparent power for each phase separately ($\cos\varphi_1$, $\cos\varphi_2$, $\cos\varphi_3$) and total power angle ($\cos\varphi_t$). A symbol for a coil represents inductive load and a symbol for a capacitor represents capacitive load. 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. For a display on the remote display both of them have equal display function: between −1 and −1 with the icon for inductive or capacitive load.

Load	C	→		←	L
Angle [°]	−180	−90	0	+90	+180 (179.99)
PF	−1	0	1	0	−1
ePF	−1	0	1	2	3

Example of analogue output for PF and ePF:





Power angle represents angle between first voltage harmonic and first current harmonic for each individual phase. Total power angle is calculated from total active and reactive power (see equation for Total power angle, chapter Equations on page 87). A positive sign shows inductive load, and a negative sign shows capacitive load.

Frequency

Network frequency is calculated from time periods of measured voltage. Additionally frequency with 10−second averaging interval is calculated.

Energy

Three groups of energy measurements are available: by individual counters, by tariffs for each counter separately and energy cost by counters.

MD values

Measurements of MD values and time of recording (time stamp).

THD − Total harmonic distortion

THD is calculated for phase currents, phase and phase−to−phase voltages and is expressed as percent of high harmonic components regarding RMS value or relative to first harmonic (see chapter Calculation of harmonics on page 28).

Instrument uses measuring technique of real effective (rms) value that assures exact measurements with the presence of high harmonics up to 63rd harmonic.

Flickers

Measurements of current Short term and Long term flickers for phase or phase-to-phase voltage (depending on mode of connection). Until the flicker value is calculated the symbol − is displayed.

5.7 Min/Max values ●●●

Phase voltage

Measurements of phase voltages U_1, U_2 and U_3.

Phase-to-phase voltage

Measurements of phase-to-phase voltages U_{12}, U_{23} and U_{13}.

Current

Measurements of currents I_1, I_2 and I_3.

Active power

Measurements of active power P_1, P_2, P_2 and P_t.

Apparent power

Measurements of apparent power S_1, S_2, S_2 and S_t.

Frequency

Measurements of current frequency (f) and frequency with 10−second averaging

Date and time of reset

Last reset of Min/Max values date and time.

5.8 Alarms ●●●

Four groups of 8 alarms with alarm conditions are measured.

5.9 Power supply quality ○○●

For evaluation of voltage quality, the (U)MT560 can store main characteristics in the internal memory. The reports are made on the basis of stored data. Data of the last 7 years and up to 170,000 variations of the measured quantities from the standard values are stored in the report, which enables detection of eventual reasons for troubles on network. The MiQen software offers a complete survey of reports with a detailed survey of individual measured quantities. Via the communication a survey of compliance of individual measured quantities in previous and actual monitored periods are also possible.

● − (U)MT560 enables supervision of voltage compliance with the SIST EN 50160 standard.

Monitoring periods

Instrument measures status, compliance and quality of individual parameters without details for actual and previous monitoring period. MiQen supports survey of actual and previous quality reports with all the details for past 7 years that have been registered. Compliance of voltage, status, start and end date, as well as exact monitoring time is register for each report. Displayed status for each report states if whole period was monitored.

User information

To make the complete quality report the aux. power supply for the device should not be interrupted during the whole period for which the report is requested. If firmware is updated or power supply is interrupted within a monitoring period, quality report is incomplete − Status: Not complete.

Actual monitoring period

A survey of compliance of voltage quality by measured quantities in actual period.

Previous monitoring period

A survey of compliance of voltage quality by measured quantities in previous period.

Monitoring parameters [PC]

Frequency variations 1 & 2

Average value is calculated in 10 second intervals and is according to nominal values compared with quality requirements. Frequency measurement is performed from first phase voltage (U_1) and is switched to the next if it is to low. At three phase connections the phase to phase voltages are calculated to phase voltages. If voltage signals are too low the measurement is performed from current signals. Depending on disturbance signals switch limit is between 1 and 4 V. Measurement performed from current signals requires at leas 30 mA current. Frequency accuracy is better than ± 0.01 Hz.

Voltage variations 1 & 2

Average value of RMS phase voltage is calculated in 10 minute and is compared to allowed range of deviation. Start, stop and average voltage value (absolute and relative) for each phase is recorded in the internal memory. Voltage accuracy is better than ± 0.2 % of nominal value for voltages of over 100 V.

Voltage unbalances

Average value is calculated in 10 minute intervals of periodical calculations via evasion stated in chapter Equations on page 87.

Voltage dips / Temporary overvoltages

Within a period RMS value is monitored and recorded in 1 second periods for both measurements. Phase to phase or phase voltages are monitored when three-wire or four-wire connection is used. Lowest dip and highest overvoltage are monitored for in each second interval respectively for each phase. In case of succession of several second events are detected one longer lasting event is recorded. All events are calculated in respect to fixed (nominal) voltage. In details of quality report start, stop and highest / lowest voltage value (absolute and relative) is recorded for each phase. Measuring uncertainty of monitored voltage is less than 1 % and uncertainty of event detection is 20 ms (1 period).

Voltage interruptions and Long interruptions

According to the upper limit of nominal supply voltage stated relatively interrupts are detected in 1 second periods for each phase. The interruption limit is set between 1 and 25 % of nominal voltage. Each second with at least one interrupt detected is recorded as an interrupt. Succession of several seconds with interrupts detected is recorded as one longer interrupt. After the interrupt ends, duration is compared to Short interrupt setting and is recorded as long or short interrupt in quality report. 2 % hysteresis is used for interrupts detection with 20 ms (2 periods) duration uncertainty.

Rapid voltage changes

RMS value of two subsequent samples is compared for each phase. For each phase in one second interval in which the limit is exceeded, an event is recorded. Measuring uncertainty of monitored voltage is less than 1%.

Flickers Pst / Plt

Intensity of a flicker is set by UIE−IEC measuring method and is evaluated as short-term or long-term flicker. Equations for calculating flickers are stated in chapter Equations on page 87. Intensity of a short term flicker is measured in 10 minute intervals and of informative nature.

Intensity of a long term flicker is based on 2 hour intervals of short term flicker and is recorded in respect to required quality in quality report.

THD's

Contribution of harmonics to the fundamental component is calculated from THD limit and nominal voltage. Average contribution of harmonic components is calculated in 10 minute intervals and compared to THD limit converted in to voltage value.

Harmonics

10 minute average is calculated for each harmonic in each phase and is compared to Harmonic limit. All harmonic components should be within the limit, or it will be recorded in quality report in internal memory.

Reseting quality parameter reports PC

Some quality parameter reports are made on a weekly basis and other on yearly basis. These parameters reset at the end of each observed period. Weekly based reports will reset every week. Even if instruments' location or mode of operation is altered, weekly report will reset at the end of the week. But yearly reports will not reset till the end of the year. Therefore when 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.

6. COMMUNICATION MODES

(U)MT5x0 series transducers in general support two different communication modes to suit all demands about connectivity and flexibility.

6.1 PULL communication mode

This is most commonly used communication mode. It services data-on-demand and is therefore suitable for direct connection of setting and / or supervising software to a single instrument or for a network connection of multiple instruments, which requires setting up an appropriate communication infrastructure.
Data is sent from instrument when it is asked by external software according to MODBUS RTU or MODBUS TCP protocol.
This type of communication is normally used for a real-time on-demand measurement collection for control purposes.

To set up PULL communication mode, only basic communication settings are required according to communication type (serial, USB, ETHERNET). See chapter *communication* on page 29.

6.2 PUSH communication mode

Explanation

When in this communication mode, instrument(s) (client) are sending values of predefined quantities in predefined time intervals to two independent servers (data collectors - master), who collect data into data base for further analysis.
This mode of communication is very useful for a periodic monitoring of readings in systems where real-time operation is not required, but on the other side, reliability for collecting data is essential (e.g. for billing purposes, post processing and issuing trend warnings).

Protocol and data format

Protocol used for data transmission is MODBUS or TCP/IP, depends on used communication network. Data uses XML format, which allows additional information about sent data. All sent readings are time-stamped for accurate reconstruction of received data (if communication is lost and data is sent afterwards). Therefore time synchronization of client and server is essential. For that purpose, server sends synchronization data (for setting see page 29) within every response to received data. For more information about used XML format see appendix D on page 91.

Data transmission

Every transmission from client's side (instrument) must be acknowledged from master's side (server) to verify successful data transmission. In case client fails to receive acknowledgment after predefined response time (for setting see page 29) it will retry to send it in next time interval. This repeating of sending data will last until master responses to sent data. After that, client will send all available data from the moment it lost response from the master.

It is possible for PULL and PUSH communication mode to be active at the same time. Since POLL is used in real-time applications it has priority over PUSH. If PUSH is sending data when request for POLL arrives, instrument pauses current transmission and services POLL. In a next time interval it will continue to send PUSH data.

Supported quantities and settings

Sending data in PUSH communication mode is closely related with storing measurements in a recorder. Quantities, which will be sent to master are the same quantities that are set to be stored in a recorders (recorders A and B, alarms recorder and quality reports with details recorder).

Step 1: In menu general/communication set proper PUSH communication settings (see page 29), where time synchronization source, response time, data format and receiving server's parameters are defined.

Step 2: Define data (quantities) for transmission. Sources for data can be alarms, quantities defined to be written in recorders (A and B) or electric quality reports and its details. In each of those three groups setting menu the following must be defined:

- *Communication channel*, which will be used for data transmission. It can be serial bus (COM1, COM2) if RS485 network is used or one of two TCP/IP connections.
- *Transmission period*, which set how often data shall be sent to master. This can either at every new reading, or at predefined time intervals (hourly, daily, weekly). When one of those intervals is used all data recorded between two time intervals is sent.
- *Transmission delay* sets a delay time according to regular transmission period. This is useful in RS485 networks to avoid simultaneous transmissions of multiple devices (data collisions). Transmission delay can be disabled, set to default value, which is unique for every device in RS485 network (MODBUS address in milliseconds) or user defined.

7. REMOTE DISPLAY FEATURES

7.1 Remote display

Remote display start-up begins after electrical connection directly to a single (U)MT5xx (RJ11 jack under the transparent cover) or to the RS485 network with several (U)MT5xx measuring transducers. (U)MT5xx can be connected to the same network using COM1 or COM2 (if available). Navigation keys and LCD display enable remote application and remote display settings. By choosing different RD500 target communication addresses it is possible to track measurements and change settings for up to 32 (U)MT5xx measuring transducers.

7.2 Remote display settings

Settings of the remote display are divided into 3 sublevels: General settings, Communication and Display.

General settings

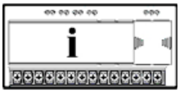
Language

Set language on the remote display. When language is changed from or to Russian, characters of the password are changed as well. 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

Main menu ⇒ Settings ⇒ General ⇒ Language

Note



If a wrong language is set, a menu of languages is displayed by simultaneous pressing up and down keys.

Communication

Communication parameters are important for the operation in RS485 network.

Main menu ⇒ Settings ⇒ Communication ⇒

Device address

IMPORTANT! The address of the remote display itself must be different than the address of the measuring transducer. We recommend address number 247 for remote display address.

Bits per second, Parity, Stop bits

Those settings of the remote display must match settings of the measuring transducer. Default settings are: Bits per second = 115200 b/s, Parity = None, Stop bits = 2

Display

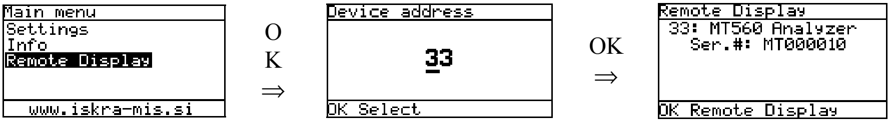
A combination of setting of the contrast and back light defines visibility and legibility of a display. Display settings shall be defined in compliance with the conditions in which it will be monitored. Economizing mode switches off back light according to the set time of inactivity.

Main menu ⇒ Settings ⇒ LCD ⇒ Contrast / Back light / Back light time off

7.3 Remote mode

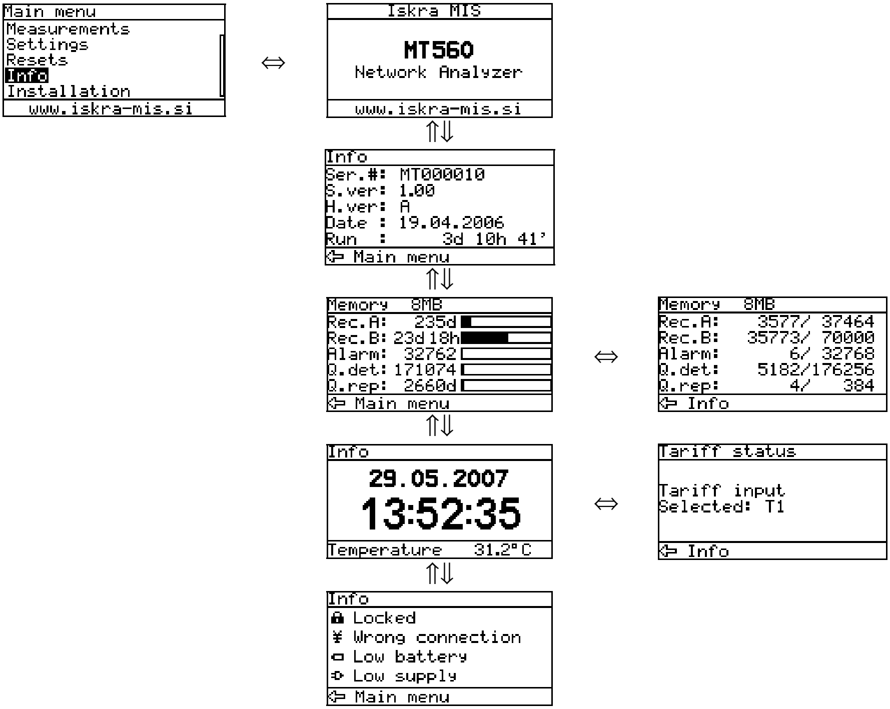
Entering to remote mode

Select Remote Display from Main menu and enter measuring transducer address. Device type and serial number should appear on next screen. Press OK button to enter in remote mode.



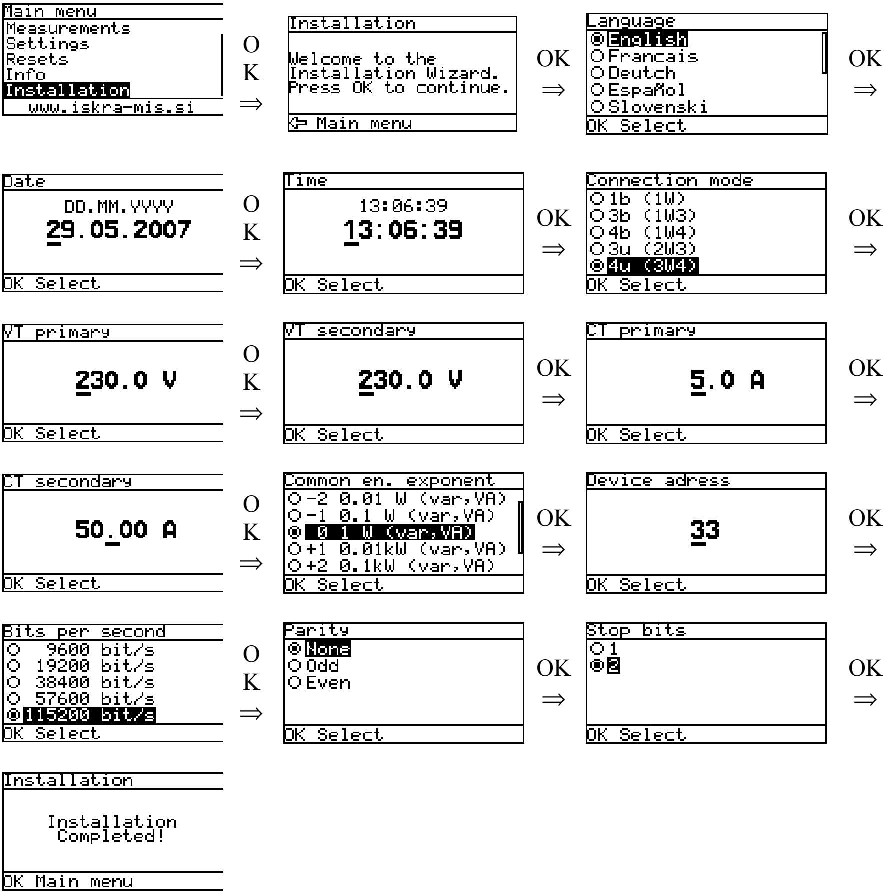
Displaying device information's

To display information's from remote device (measuring transducer) select Info from Main menu.



Installation wizard

After installation and electrical connection of measuring transducer, basic parameters have to be set in order to assure correct operation. The easiest way to achieve that is use the Installation wizard with Remote display. When entering the Installation menu, settings follow one another when the previous one is confirmed. All required parameters shall be entered and confirmed. Exit from the menu is possible when all required settings are confirmed or with interruption (key ⇐ several times) without changes.



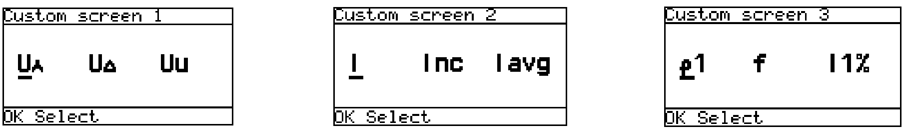
Device settings

All settings of measuring transducer can be set via communication and MiQen software. Settings marked with in chapter "4. Settings" could be also set via Remote display keyboard. Setting done via Remote display keyboard comes in to function after confirmation (OK).

Example of setting custom screens:

Main menu ⇒ Settings ⇒ LCD ⇒ Custom screen 1 / 2 / 3

Custom screen 1 | Custom screen 2 | Custom screen 3

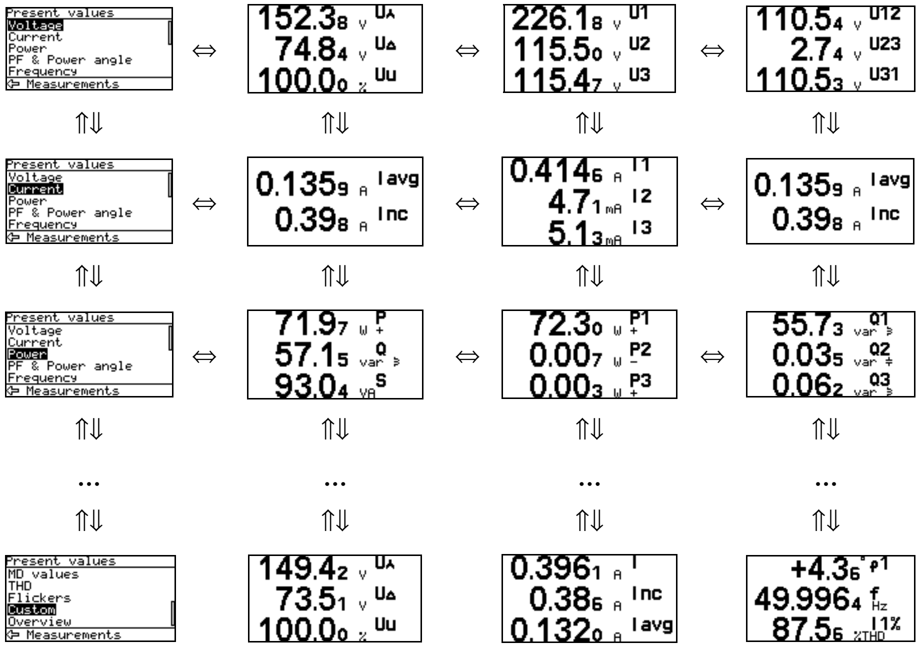


Device measurements

For entry and quitting measurement display menu, the OK key is used. Direction keys (left / right / up / down) are used for passing between displays as show in example below.

Example for MT560 at 4u connection mode:

Main menu ⇒ Measurements ⇒ Present values ⇒ Voltage OK



Exiting from remote mode / changing the target device

To exit from remote mode simultaneously press up and down keys. Return to Remote display Main menu by pressing left key twice.

After that begin the procedure for entering to remote mode (as described above) and enter the address of required device.

8. BATTERY REPLACEMENT

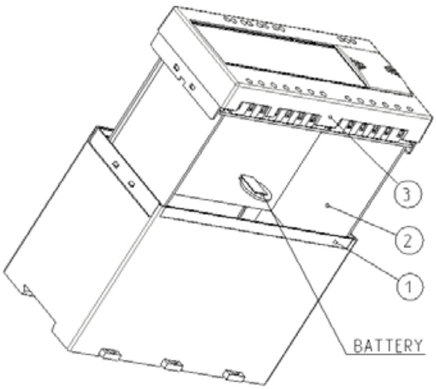
The Measuring transducer contains a lithium battery. It is used to preserve data (date and time) in the device memory when if the power supply is off. Life time of battery is app.6 years (typical). High temperature and humidity shortens the battery's functionality. Battery has no effect on other functionality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

If remote display is connected to the measuring transducer then when the battery is expired and the power supply was interrupted, flashing battery indicator appears in the up-right corner of the remote display.

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 MIS does not take on responsibility for any injuries, dysfunction of the instrument or mechanical damage.

Instructions for replacement

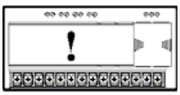
1 Disconnect the instrument from measuring grid and power supply (read the safety section) and take it out of the mounting rail.
2 With flat screwdriver remove the cover [3] from instrument [1] (see picture 7.1)
3 Pull out printed circuit board (PCB) assembly [2]
4 Remove the battery from its holder on the PCB and replace it with the same model (Varta, type 6032 CR2032 SLF)



Picture 8.1

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.

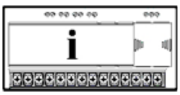
9. TECHNICAL DATA

9.1 Accuracy

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

Measured values	**Range**		**Accuracy class***
Rms current (I_1, I_2, I_3, Iavg, I_n)	5 A		0.2 (0.05)**
Maximum current	12.5 A		0.2 (0.05)**
Rms phase voltage (U_1, U_2, U_3, Uavg)	500 V_{L-N}		0.2 (0.05)**
Maximum voltage	600 V_{L-N}		0.2 (0.05)**
Rms phase-to-phase voltage (U_{12}, U_{23}, U_{31}, Uavg)	800 V_{L-L}		0.2 (0.05)**
Frequency (f) − actual	50 / 60Hz		0.02
Frequency (10 s average)	50 / 60 Hz		0.02
Nominal frequency range	16…400 Hz		0.02
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…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 (0.1)**
Reactive power			0.5 (0.2)**
Apparent power			0.5 (0.2)**
Active energy			Class 1 (Option 0.5S)
Reactive energy			Class 2
Real time clock (RTC)	−		1 min/month
Analogue output (internal supply)	0…20 mA		± 20 µA

Note



* − All measurements are calculated with high harmonic signals. For voltage up to 65 Hz or less, harmonics up to 63rd are measured.

** − Accuracy on communication

9.2 Inputs

Voltage input		
	Rated voltage (U_N)	57.7…500 V_{L-N}, 100…866 V_{L-L}
	Max. allowed value	1.2 × U_N permanently, 2 × U_N 10s
	Minimal measurement	2 V sinusoidal
	Maximal measurement	600 V_{L-N}, 1000 V_{L-L}
	Input impedance	4.2MΩ per phase
	Consumption	< U^2 / 4.2MΩ per phase
Current input		
	Rated current (I_N)	0,31…5 A
	Max. allowed value	15 A continuous
	(thermal)	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 per phase
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	< 8VA
	Power-on transient current	< 20 A; 1 ms
Universal LOW	AC Rated voltage	48 … 77 V
	AC Rated frequency	40 … 70 Hz
	DC Rated voltage	19 … 70 V
	Consumption	< 8VA
	Power-on transient current	< 20 A ; 1 ms

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

9.3 Connection

Permitted conductor cross-sections

Terminals	**Max. conductor cross-sections DIN / ANSI housing**	
	DIN housing	**ANSI housing**
Voltage inputs (4)	2,5 mm^2 with pin terminal 4 mm^2 solid wire	12 AWG with ring or spade terminals
Current inputs (6)	2,5 mm^2 with pin terminal 4 mm^2 solid wire	12 AWG with ring or spade terminals
Supply (3)	2,5 mm^2 with pin terminal 4 mm^2 solid wire	12 AWG with ring or spade terminals
Modules (2 x 4)	2,5 mm^2 with pin terminal 4 mm^2 solid wire	14 AWG with pin terminal 12 AWG solid wire

9.4 I/O modules

Alarm/Watchdog /Digital output module	Type	Relay switch
	Rated voltage	48 V AC/DC (+40% max)
	Max. switching current	1000 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 input module	Rated voltage	5 - 48 V DC (± 20%)
	Max. current	8 mA (at 48 VDC + 20%)
	Min. pulse width	0.5 ms
	Min. pulse periode	2 ms
	SET voltage	40...120 % of rated voltage
	RESET voltage	0...10 % of rated voltage
Pulse output module	Type	Solid state
	Max. voltage	40 V AC/DC
	Max. current	30 mA (R_{ONmax} = 8Ω)
	Pulse length	programmable 1…999 ms
Tariff input module	Rated voltage	230 or 110 V_{AC} ± 20 %
	Max. current	< 0.6 mA
	Frequency range	45…65 Hz
	SET voltage	40...120 % of rated voltage
	RESET voltage	0...10 % of rated voltage
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
2nd Comm. module RS485	See 8.6 Communication RS485 Screw terminals only	
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	RB_{min}= U_{outN} / 5 mA

Analogue input		
DC current input	Nominal input range 1	–20…0…20 mA (±20%)
	Nominal input range 2	–2…0…2 mA (± 20%)
	input resistance	20 Ω
	accuracy	0.5 % of range
	temperature drift	0.1% / °C (for range 2 only)
	conversion resolution	16 bit (sigma-delta)
	Analogue input mode	internally referenced Single-ended
DC voltage input	Nominal input range1	–10…0…10 V (±20%)
	Nominal input range 2	–1…0…1 V (±20%)
	input resistance	100 kΩ
	accuracy	0.5 % of range
	temperature drift	0.1% / °C (for range 2 only)
	conversion resolution	16 bit (sigma-delta)
	Analogue input mode	internally referenced Single-ended
Resistance/ temperature input	Nominal input range (low)*	0 - 200 Ω (max. 400 Ω) PT100 (-200°C–850°C)
	Nominal input range (high)*	0 – 2 kΩ (max. 4 kΩ) PT1000 (-200°C–850°C)
	connection	2-wire
	accuracy	0.5 % of range
	conversion resolution	16 bit (sigma-delta)
	Analogue input mode	internally referenced Single-ended
	* Low or high input range and primary input value (resistance or temperature) are set by the MiQen setting software	

9.5 Communication

Type	Ethernet	RS232[1]	RS485[1][2]	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 / DNP3 (auto detect)	MODBUS RTU / DNP3 (auto detect)		
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

[2] Specifications are identical for COM2 and RD500

9.6 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.	
Battery		
Manufacturer	Varta	
Type	CR2032 Li-battery	
Battery lifetime	Approx. 6 years (at 23°C − typical)	
Memory	(U)MT550	(U)MT560
Capacity	8 MB	8 MB
Divisions	Recorder A Recorder B Alarms recorder	Recorder A Recorder B Alarms recorder Q reports, details
Selection of limit values	Minimal Maximal Average Minimal (thermal function) Maximal (thermal function)	
Sampling period	1 to 60 min	
Status LED's		
COM	Green	Communication in progress
PWR	Red	Instrument power ON

9.7 Safety features

Protection	Protection class I
⚠ ⏚	(protective earth terminal due to touchable metal parts (USB-B, RJ-45, DB9), current limiting fuse 1A 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 Operating temperature Storage temperature Average annual humidity	 usage group III -10…0…45…55 °C Acc. to IEC/EN 60 688 -30 to +70 °C -40 to +70 °C ≤ 93% r.h.
Enclosure DIN ANSI RD500 Enclosure protection Flammability Mounting Dimensions Weight	 ABS & PC (transparent sliding cover; PC) − self-extinguishability, in compliance with UL 94 V0 IP 40 (IP 20 for terminals) Acc. to UL 94 V-0 Rail mounting 35 × 15 mm acc. to DIN EN 50 022 160 × 123 ×75 mm 500 g

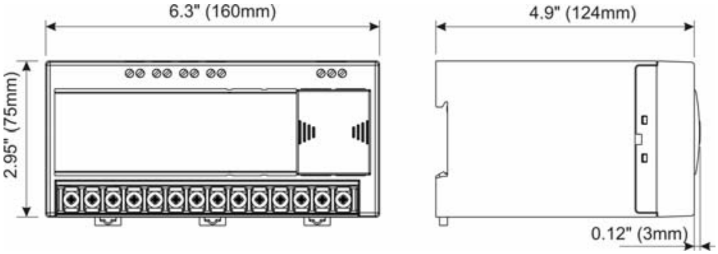
9.8 Remote display

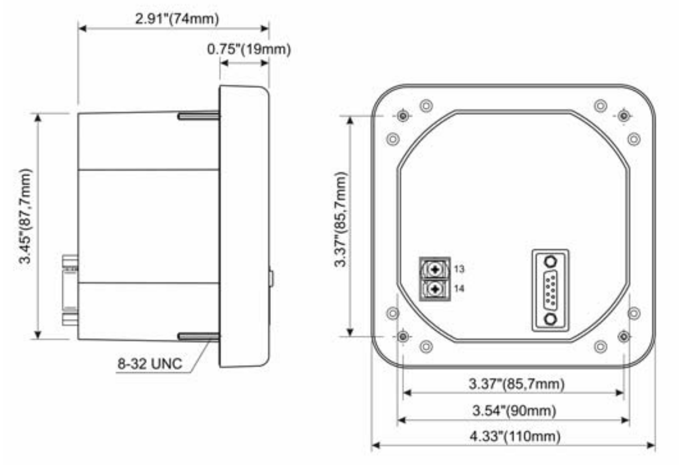
Electronic features	
LCD Type	Graphic LCD
LCD Size	128 x 64 dots
LCD refreshing	Every 200 ms
Response time	
Input → display	All calculations are averaged over an interval of between 8 to 256 periods. Preset interval is 64 periods, which is 1.28 second at 50 Hz.
LED's	
Communication	Green — Communication in progress
Alarm	Red — Fulfilled condition for alarm
Communication	
Type	RS485
Connection terminals	DB9 connector
Power supply	
Universal	AC Rated voltage 48…276 V AC Rated frequency 45…65 Hz DC Rated voltage 20…300V Consumption < 5 VA
Safety features	
Safety	In compliance with SIST EN 61010−1 300 V rms, installation category III Pollution degree 2
EMC	Directive on electromagnetic compatibility 2004/108/ES In compliance with SIST EN 61000-6-2 and SIST EN 61000-6-4
Protection	In compliance with SIST EN 60529 Front side: IP52 Rear side: IP20
Ambient conditions	
Temperature range of operation	−5 to +55°C
Storage temperature range	−25 to +70°C
Max. storage and transport humidity	≤ 90% r.h.
Enclosure	ABS & Polycarbonate Blend − self-extinguishability, in compliance with UL 94 V0
Weight	up to 450g

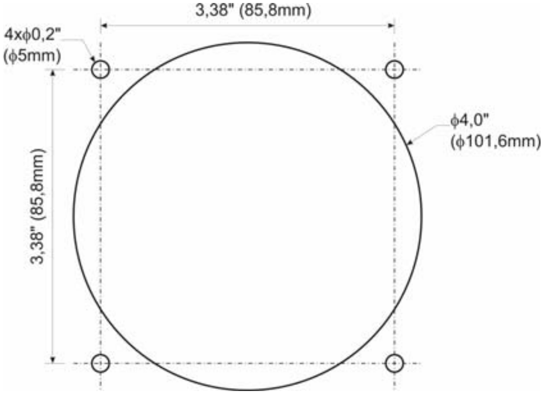
9.9 Dimensions

<table>
<tr><th>Construction</th><th>Appearance</th></tr>
<tr><td>Measuring transducers

MT5X0

UMT5X0</td><td>
</td></tr>
<tr><td>Remote display

RD500</td><td>

Panel cut out:

</td></tr>
</table>

10. APPENDIX A: MODBUS PROTOCOL

10.1 Modbus communication protocol

Modbus and DNP3 protocol are enabled via RS232 and RS485 or Ethernet communication. Both communication protocols are supported on all communication ports of the device. The response is the same type as the request.

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

Parameter	MODBUS		
	Register		Type
	Start	End	
Voltage U_1	30107	30108	T5
Voltage U_2	30109	30110	T5
Voltage U_3	30111	30112	T5
Average phase Voltage $U^{\sim}$	30113	30114	T5
Phase to phase voltage U_{12}	30118	30119	T5
Phase to phase voltage U_{23}	30120	30121	T5
Phase to phase voltage U_{31}	30122	30123	T5
Average phase to phase Voltage $U_{pp\sim}$	30124	30125	T5
Current I_1	30126	30127	T5
Current I_2	30128	30129	T5
Current I_3	30130	30131	T5
Total Current I	30138	30139	T5
Neutral current In	30132	30133	T5
Real Power P_1	30142	30143	T6
Real Power P_2	30144	30145	T6
Real Power P_3	30146	30147	T6
Total Real Power P	30140	30141	T6
Reactive Power Q_1	30150	30151	T6
Reactive Power Q_2	30152	30153	T6
Reactive Power Q_3	30154	30155	T6
Total Reactive Power Q	30148	30149	T6
Apparent Power S_1	30158	30159	T5
Apparent Power S_2	30160	30161	T5
Apparent Power S_3	30162	30163	T5
Total Apparent Power S	30156	30157	T5
Power Factor PF_1	30166	30167	T7
Power Factor PF_2	30168	30169	T7
Power Factor PF_3	30170	30171	T7
Total Power Factor PF	30164	30165	T7

Parameter	MODBUS			
	Register		Type	
	Start	End		
Power Angle U_1-I_1	30173		T2	
Power Angle U_2-I_2	30174		T2	
Power Angle U_3-I_3	30175		T2	
Power Angle atan2(Pt, Qt)	30172		T2	
Angle U_1-U_2	30115		T2	
Angle U_2-U_3	30116		T2	
Angle U_3-U_1	30117		T2	
Frequency f	30105	30106	T5	
Voltage unbalance Uu	30176		T1	
THD I_1	30188		T1	
THD I_2	30189		T1	
THD I_3	30190		T1	
THD U_1	30182		T1	
THD U_2	30183		T1	
THD U_3	30184		T1	
THD U_{12}	30185		T1	
THD U_{23}	30186		T1	
THD U_{31}	30187		T1	
Max Demand Since Last RESET				
MD Real Power P (positive)	30542	30543	T6	
MD Real Power P (negative)	30548	30549	T6	
MD Reactive Power Q − L	30554	30555	T6	
MD Reactive Power Q − C	30560	30561	T6	
MD Apparent Power S	30536	30537	T5	
MD Current I_1	30518	30519	T5	
MD Current I_2	30524	30525	T5	
MD Current I_3	30530	30531	T5	
Dynamic Demand Values				
MD Real Power P (positive)	30510	30511	T6	
MD Real Power P (negative)	30512	30513	T6	
MD Reactive Power Q − L	30514	30515	T6	
MD Reactive Power Q −	30516	30517	T6	
MD Apparent Power S	30508	30509	T5	
MD Current I_1	30502	30503	T5	
MD Current I_2	30504	30505	T5	
MD Current I_3	30506	30507	T5	
Energy				
Energy Counter 1 Exponent	30401		T2	
Energy Counter 2 Exponent	30402		T2	
Energy Counter 3 Exponent	30403		T2	Actual counter value is calculated: Counter * 10^{Exponent}
Energy Counter 4 Exponent	30404		T2	
Counter E1	30406	30407	T3	
Counter E2	30408	30409	T3	
Counter E3	30410	30411	T3	
Counter E4	30412	30413	T3	

Parameter	MODBUS		
	Register		
	Start	End	Type
Counter E1, Cost	30446	30447	T3
Counter E2, Cost	30448	30449	T3
Counter E3, Cost	30450	30451	T3
Counter E4, Cost	30452	30453	T3
Active tariff	30405		T1
Internal Temperature	30181		T2

Actual counter value is calculated: Counter * 10^{Exponent}

Register table for the normalized actual measurements

Parameter	MODBUS		100% value
	Register	Type	
Voltage U_1	30801	T16	Un
Voltage U_2	30802	T16	Un
Voltage U_3	30803	T16	Un
Average phase Voltage $U^{\sim}$	30804	T16	Un
Phase to phase voltage U_{12}	30805	T16	Un
Phase to phase voltage U_{23}	30806	T16	Un
Phase to phase voltage U_{31}	30807	T16	Un
Average phase to phase Voltage $U_{pp\sim}$	30808	T16	Un
Current I_1	30809	T16	In
Current I_2	30810	T16	In
Current I_3	30811	T16	In
Total Current I	30812	T16	It
Neutral current In	30813	T16	In
Average Current $I^{\sim}$	30815	T16	In
Real Power P_1	30816	T17	Pn
Real Power P_2	30817	T17	Pn
Real Power P_3	30818	T17	Pn
Total Real Power P	30819	T17	Pt
Reactive Power Q_1	30820	T17	Pn
Reactive Power Q_2	30821	T17	Pn
Reactive Power Q_3	30822	T17	Pn
Total Reactive Power Q	30823	T17	Pt
Apparent Power S_1	30824	T16	Pn
Apparent Power S_2	30825	T16	Pn
Apparent Power S_3	30826	T16	Pn
Total Apparent Power S	30827	T16	Pt
Power Factor PF_1	30828	T17	1
Power Factor PF_2	30829	T17	1
Power Factor PF_3	30830	T17	1
Total Power Factor PF	30831	T17	1
CAP/IND P.F. Phase 1 (PF_1)	30832	T17	1
CAP/IND P.F. Phase 2 (PF_2)	30833	T17	1
CAP/IND P.F. Phase 3 (PF_3)	30834	T17	1
CAP/IND P.F. Total (PFt)	30835	T17	1
Power Angle $U_1 - I_1$	30836	T17	100°
Power Angle $U_2 - I_2$	30837	T17	100°

Parameter	MODBUS		100% value
	Register	Type	
Power Angle U_3–I_3	30838	T17	100°
Power Angle atan2(Pt, Qt)	30839	T17	100°
Angle U_1–U_2	30840	T17	100°
Angle U_2–U_3	30841	T17	100°
Angle U_3–U_1	30842	T17	100°
Frequency	30843	T17	Fn+10Hz
Voltage unbalance Uu	30844	T16	100%
THD I_1	30845	T16	100%
THD I_2	30846	T16	100%
THD I_3	30847	T16	100%
THD U_1	30848	T16	100%
THD U_2	30849	T16	100%
THD U_3	30850	T16	100%
THD U_{12}	30851	T16	100%
THD U_{23}	30852	T16	100%
THD U_{31}	30853	T16	100%
Max Demand Since Last Reset			
MD Real Power P (positive)	30854	T16	Pt
MD Real Power P (negative)	30855	T16	Pt
MD Reactive Power Q − L	30856	T16	Pt
MD Reactive Power Q − C	30857	T16	Pt
MD Apparent Power S	30858	T16	Pt
MD Current I_1	30859	T16	In
MD Current I_2	30860	T16	In
MD Current I_3	30861	T16	In
Dynamic Demand Values			
MD Real Power P (positive)	30862	T16	Pt
MD Real Power P (negative)	30863	T16	Pt
MD Reactive Power Q − L	30864	T16	Pt
MD Reactive Power Q − C	30865	T16	Pt
MD Apparent Power S	30866	T16	Pt
MD Current I_1	30867	T16	In
MD Current I_2	30868	T16	In
MD Current I_3	30869	T16	In
Energy			
Energy Counter 1	30870	T17	Actual counter value MOD 20000 is returned
Energy Counter 2	30871	T17	
Energy Counter 3	30872	T17	
Energy Counter 4	30873	T17	
Energy Counter 1 Cost	30874	T17	
Energy Counter 2 Cost	30875	T17	
Energy Counter 3 Cost	30876	T17	
Energy Counter 4 Cost	30877	T17	
Total Energy Counter Cost	30878	T17	
Active Tariff	30879	T1	
Internal Temperature	30880	T17	100°

100% values calculations for normalized measurements

Un =	(R40147 / R40146) * R30015 * R40149	
In =	(R40145 / R40144) * R30017 * R40148	
Pn =	Un*In	
It =	In	Connection Mode: 1b
It =	3*In	Connection Modes: 3b, 4b, 3u, 4u
Pt =	Pn	Connection Mode: 1b
Pt =	3*Pn	Connection Modes: 3b, 4b, 3u, 4u
Fn =	R40150	

All other MODBUS regiters are a subject to change. For the latest MODBUS register defenitions go to ISKRA MIS's web page www.iskra-mis.si

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 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*102 = 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)

11. APPENDIX B: DNP3 PROTOCOL

11.1 DNP3 communication protocol

Communication protocols:

Modbus and DNP3 protocol are enabled via RS232 and RS485 or Ethernet communication. Both communication protocols are supported on all communication ports of the device. The response is the same type as the request.

DNP3

DNP3 protocol enables operation of MC on DNP3 networks. For device with serial communication the DNP3 protocol enables point to point (for example device to PC) communication via RS232 communication and multi drop communication via RS485.

Object			Request		Response	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
30	2	16-Bit Analogue Input with flag	1	00, 01, 02, 06	129	00, 01, 02, 00
30	4	16-Bit Analogue Input without flag	1	00, 01, 02, 06	129	00, 01, 02, 00

Register table for the actual measurements

DNP3 Point	Parameter	Type	100% value
0	Voltage U1	T16	Un
1	Voltage U2	T16	Un
2	Voltage U3	T16	Un
3	Average phase Voltage U~	T16	Un
4	Phase to phase voltage U12	T16	Un
5	Phase to phase voltage U23	T16	Un
6	Phase to phase voltage U31	T16	Un
7	Average phase to phase Voltage Upp~	T16	Un
8	Current I1	T16	In
9	Current I2	T16	In
10	Current I3	T16	In
11	Total Current I	T16	In
12	Neutral current In	T16	In
13	Reserved	T16	In
14	Average Current I~	T16	In
15	Real Power P1	T17	Pn
16	Real Power P2	T17	Pn

DNP3 Point	Parameter	Type	100% value
17	Real Power P3	T17	Pn
18	Total Real Power P	T17	Pt
19	Reactive Power Q1	T17	Pn
20	Reactive Power Q2	T17	Pn
21	Reactive Power Q3	T17	Pn
22	Total Reactive Power Q	T17	Pt
23	Apparent Power S1	T16	Pn
24	Apparent Power S2	T16	Pn
25	Apparent Power S3	T16	Pn
26	Total Apparent Power S	T16	Pt
27	Power Factor PF1	T17	1
28	Power Factor PF2	T17	1
29	Power Factor PF3	T17	1
30	Total Power Factor PF	T17	1
31	CAP/IND P. F. Phase 1 (PF1)	T17	1
32	CAP/IND P. F. Phase 2 (PF2)	T17	1
33	CAP/IND P. F. Phase 3 (PF3)	T17	1
34	CAP/IND P. F. Total (PFt)	T17	1
35	Power Angle U1−I1	T17	100°
36	Power Angle U2−I2	T17	100°
37	Power Angle U3−I3	T17	100°
38	Power Angle atan2(Pt, Qt)	T17	100°
39	Angle U1−U2	T17	100°
40	Angle U2−U3	T17	100°
41	Angle U3−U1	T17	100°
42	Frequency	T17	Fn+10Hz
43	Voltage unbalance Uu	T16	100%
44	THD I1	T16	100%
45	THD I2	T16	100%
46	THD I3	T16	100%
47	THD U1	T16	100%
48	THD U2	T16	100%

DNP3 Point	Parameter	Type	100% value
49	THD U3	T16	100%
50	THD U12	T16	100%
51	THD U23	T16	100%
52	THD U31	T16	100%
	Max Demand Since Last Reset		
53	MD Real Power P (positive)	T16	Pt
54	MD Real Power P (negative)	T16	Pt
55	MD Reactive Power Q − L	T16	Pt
56	MD Reactive Power Q − C	T16	Pt
57	MD Apparent Power S	T16	Pt
58	MD Current I1	T16	In
59	MD Current I2	T16	In
60	MD Current I3	T16	In
	Dynamic Demand Values		
61	MD Real Power P (positive)	T16	Pt
62	MD Real Power P (negative)	T16	Pt
63	MD Reactive Power Q − L	T16	Pt
64	MD Reactive Power Q − C	T16	Pt
65	MD Apparent Power S	T16	Pt
66	MD Current I1	T16	In
67	MD Current I2	T16	In
68	MD Current I3	T16	In
69	Energy Counter 1	T17	Actual counter value MOD 20000 is returned
70	Energy Counter 2	T17	
71	Energy Counter 3	T17	
72	Energy Counter 4	T17	
73	Energy Counter 1 Cost	T17	
74	Energy Counter 2 Cost	T17	
75	Energy Counter 3 Cost	T17	
76	Energy Counter 4 Cost	T17	
77	Total Energy Counter Cost	T17	
78	Active Tariff	T1	

Data types decoding

See Data types decoding in Appendix A: Modbus protocol on page 79.

100% values calculations

See 100% values calculations for normalized measurements in Appendix A: Modbus protocol on page 78.

12. APPENDIX C: CALCULATIONS & EQUATIONS

12.1 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	U_{ff}	Phase-to-phase voltage (U_{12}, U_{23} or U_{31})
5	N	Total number of samples in a period
6	n	Sample number ($0 \leq n \leq N$)
7	x, y	Phase number (1, 2 or 3)
8	i_n	Current sample n
9	u_{fn}	Phase voltage sample n
10	u_{fFn}	Phase-to-phase voltage sample n
11	φ_f	Power angle between current and phase voltage f (φ_1, φ_2 or φ_3)
12	U_u	Voltage unbalance
13	U_c	Agreed supply voltage

12.2 Equations

Voltage

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

Phase voltage

N – 128 samples in one period (up to 65 Hz)
N – 128 samples in M_v periods (above 65Hz)
Example: 400 Hz → N = 7

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

Phase-to-phase voltage

u_x, u_y – phase voltages (U_f)
N – a number of samples in a period

$$U_u = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \cdot 100\%$$

$$\beta = \frac{U_{12fund}^4 + U_{23fund}^4 + U_{31fund}^4}{\left(U_{12fund}^2 + U_{23fund}^2 + U_{31fund}^2\right)^2}$$

Voltage unbalance

U_{fund} – first harmonic of phase-to-phase voltage

Current

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

Phase current

N – 128 samples in a period (up to 65 Hz)
N – 128 samples in more periods (above 65 Hz)

$$I_n = \sqrt{\frac{\sum_{n=1}^{N} \left(i_{1n} + i_{2n} + i_{3n}\right)^2}{N}}$$

Neutral current

i – n sample of phase current (1, 2 or 3)
N = 128 samples in a period (up to 65 Hz)

Power

$P_f = \frac{1}{N} \cdot \sum_{n=1}^{N} (u_f N_n \times i_f N_n)$	**Active power by phases** N − a number of periods n − a number of samples 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
$\text{SignQ}_f(\varphi)$ $\varphi \in [0° - 180°] \Rightarrow \text{SignQ}_f(\varphi) = +1$ $\varphi \in [180° - 360°] \Rightarrow \text{SignQ}_f(\varphi) = -1$	**Reactive power sign** Q_f − reactive power (by phases) φ − power angle
$S_f = U_f \times I_f$	**Apparent power by phases** U_f − phase voltage I_f − phase current
$S_t = S_1 + S_2 + S_3$	**Total apparent power** S_f − apparent power by phases
$Q_f = \text{SignQ}_f(\varphi) \times \sqrt{S_f^2 - P_f^2}$	**Reactive power by phases** S_f − apparent power by phases P_f − active power by phases
$Q_t = Q_1 + Q_2 + Q_3$	**Total reactive power** Q_f − reactive power by phases
$\varphi_s = a\tan 2(P_t, Q_t)$ $\varphi_s = [-180°, 179{,}99°]$	**Total power angle** P_t − total active power S_t − total apparent power
$PF = \frac{P}{S}$	**Distortion factor** P − total active power S − total apparent power
$PF_f = \frac{P_f}{S_f}$	**Distortion factor** P_f − phase active power S_f − phase apparent power

THD

$$I_f THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} In^2}}{I_1} \cdot 100$$	**Current THD** I_1 − value of first harmonic n − number of harmonic
$$U_f THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} Un^2}}{U_1} \cdot 100$$	**Phase voltage THD** U_1 − value of first harmonic n − number of harmonic
$$U_{ff} THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} Un^2}}{U_1} \cdot 100$$	**Phase-to-phase voltage THD** U_1 − value of first harmonic n − number of harmonic

Flickers

$$P_{50S} = (P_{30} + P_{50} + P_{80})/3$$ $$P_{10S} = (P_6 + P_8 + P_{10} + P_{13} + P_{17})/5$$ $$P_{3S} = (P_{2,2} + P_3 + P_4)/3$$ $$P_{1S} = (P_{1,7} + P_1 + P_{1,5})/3$$ $$P_{st} = \sqrt{\begin{matrix}0{,}0314P_{0,1} + 00525P_{1S} + 0{,}0657P_{3S} \\ + 0{,}28P_{10S} + 0{,}08P_{50S}\end{matrix}}$$	**P_{st} − Short-term flicker intensity** Short-term flicker intensity is measured in 10 minute periods. P_x − flicker levels that are exceeded by x% in a 10-minute period (e.g. $P_{0,1}$ represents a flicker level that is exceeded by 0.1% samples)
$$P_{lt} = \sqrt[3]{\sum_{i=1}^{12} \frac{P_{sti}^3}{12}}$$	**P_{lt} − Long-term flicker intensity** Calculated from twelve successive values of short-term flicker intensity in a two-hour period

Energy

$$\text{Price in tariff} = \text{Price} \cdot 10^{\text{Tarif price exponent}}$$	Total exponent of tariff price and energy price in all tariffs

13. APPENDIX D: DATA FORMATS

13.1 XML data format

Currently, two XML formats are available. XML-smart is general purpose XML format whereas XML-logic is more proprietary, suitable for special customers. For this purpose only XML-smart format will be explained.

Explanation of XML data format

All data, which is prepared to be sent at next time interval is combined into element <*data*>. It comprises of elements <*value*>, which contain all information regarding every single reading.
Attributes of element <*value*> are:

- *logId*: Identification code of data package. It is used as a confirmation key and should therefore be unique for each device.
- *app*: application type ??
- *storeType:* data type ("measurement" or “alarm”) or quality report??
- *dataProvider*: "xml001" ??
- *controlUnit*: Serial number of the device that sent this data
- *part*: rekorder ??
- *datetimeUTC*: UTC date and time of the beginning of current time interval in which data was sent (yyyy-mm-dd hh:mm:ss).
- *ident*: ID code of particular reading
- *tFunc*: thermal function (1= ON / 0 = OFF)
- *cond*: condition (1 = lower than; 0 = higher then)
- *condVal*: limit value
- *almNum*: alarm serial number.
- *unit*: Measuring Parameter Unit (V, A, VA, W, VAr…)
- *tInterval:* sampling interval in minutes
- *dst: (*daylight savings time) in minutes
- *tzone:* timezone in minutes

Example of alarms <data> package


```
<data logId="033350088" app="ML" storeType="alarm"
dataProvider="xml001" controlUnit="MC004475" part="E"
datetimeUTC="2009-07-15 21:29:07" dst="60" tzone=" 60">
       <value ident="U1  " unit="V   " tFunc="0" cond="0"
       condVal="200,00" almNum="01">100</value>
       <value ident="U2  " unit="V   " tFunc="0" cond="0"
       condVal="200,00" almNum="02">101</value>
       <value ident="U3  " unit="V   " tFunc="0" cond="0"
       condVal="200,00" almNum="03">99</value>
</data>
```

Example of readings <data> package


```
<data logId="033324218" app="ML" storeType="measurement"
dataProvider="xml001" controlUnit="MC004475" part="B"
datetimeUTC="2009-09-16  3:00:00" dst="60" tzone=" 60"
tInterval="015">
      <value ident="U1  " unit="V   ">234,47</value>
      <value ident="U2  " unit="V   ">234,87</value>
      <value ident="U3  " unit="V   ">234,52</value>
      <value ident="I1  " unit="A   ">1,14</value>
      <value ident="I2  " unit="A   ">1,50</value>
      <value ident="I3  " unit="A   ">3,58</value>
      <value ident="P1  " unit="W ">-0,063e+03</value>
      <value ident="P2  " unit="W ">-0,101e+03</value>
      <value ident="P3  " unit="W ">0,281e+03</value>
      <value ident="P   " unit="W ">0,11e+03</value>
      <value ident="Q   " unit="var ">-1,37e+03</value>
      <value ident="E1  " unit="Wh">19620e+01</value>
      <value ident="E2  " unit="varh">6e+01</value>
      <value ident="E3  " unit="Wh">1303391e+01</value>
      <value ident="E4  " unit="varh">2999595e+01</value>
      <value ident="ePF " unit="    ">0,0820</value>
      </data>
```


Example of acknowledgement package:


```
<ack logId="033220002" datetimeUTC ="2008-01-31
23:00:50:000"></ack>
```

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Printed in Slovenia • Subject to change without notice • Version 9.00 / Sep. 2011 • GB K 22.496.100