User 's Manual

EN

Power Quality Analyzer iMC784A

July 2021• Version 1.00

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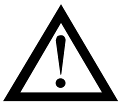
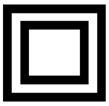
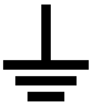
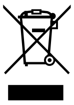
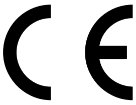
POWER QUALITY ANALYZER
iMC784A

WARNINGS, INFORMATION AND NOTES REGARDING DESIGNATION OF PRODUCT

Used symbols:

	See Power Quality Analyzer iMC784A documentation.
	Double insulation in compliance with the EN 61010−1 standard.
	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.

BEFORE SWITCHING THE DEVICE ON

Check the following before switching on the Power Quality Analyzer iMC784A:

- Nominal voltage,
- Supply voltage,
- Nominal frequency,
- Voltage ratio and phase sequence,
- Current transformer ratio and terminals integrity,
- Protection fuse for voltage inputs (recommended maximal external fuse size is 6 A)
- External switch or circuit-breaker must be included in the installation for disconnection of the devices' aux. power supply. It must be suitably located and properly marked for reliable disconnection of the device when needed.
- Integrity of earth terminal
- Proper connection and voltage level of I/O modules

Important: A current transformer secondary should be short circuited before connecting the Power Quality Analyzer iMC784A.

DEVICE SWITCH OFF WARNING

Auxiliary supply circuits for (external) relays can include capacitors between supply and ground. In order to prevent electrical shock hazard, the capacitors should be discharged via external terminals after having completely disconnected auxiliary supply (both poles of any DC supply).

HEALTH AND SAFETY

The purpose of this chapter is to provide a user with information on safe installation and handling with the Power Quality Analyzer iMC784A in order to assure its correct use and continuous operation.
We expect that everyone using the product will be 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.

REAL TIME CLOCK

As a backup power supply for Real time clock super-cap is built in. Support time is up to 2 days (after each power supply down).

DISPOSAL

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

BASIC DESCRIPTION AND OPERATION

This chapter presents all relevant information about the Power Quality Analyzer iMC784A required to understand its purpose, applicability and basic features related to its operation.

Apart from this, it also contains navigational tips, description of used symbols and other useful information for understandable navigation through this manual.

Regarding the options of this Power Quality Analyzer iMC784A, different chapters should be considered since a particular sub variant might vary in functionality. More detailed description of Power Quality Analyzer iMC784A functions is given in chapters Main Features, Supported options and Functionality.

Power Quality Analyzer iMC784A is available in 144mmx144mm panel mounting enclosure. Specifications of housing and panel cut out for housing is specified in chapter

Contents

Packaging contains the following items:

- Power Quality Analyzer iMC784A
- Fixation screws
- Pluggable terminals for connection of inputs, aux. Power supply and I/O modules
- Short installation manual

All related documentation on this product can be found at www.ISKRA.eu/products/. The instrument desktop based setting software – MiQen2, together with accompanying drivers can be found on our web page https://www.iskra.eu/en/Iskra-Software/. Due to environmental reasons, all this information is longer provided on a separate CD.

CAUTION

Please examine the equipment carefully for potential damage which might have occurred during transport!

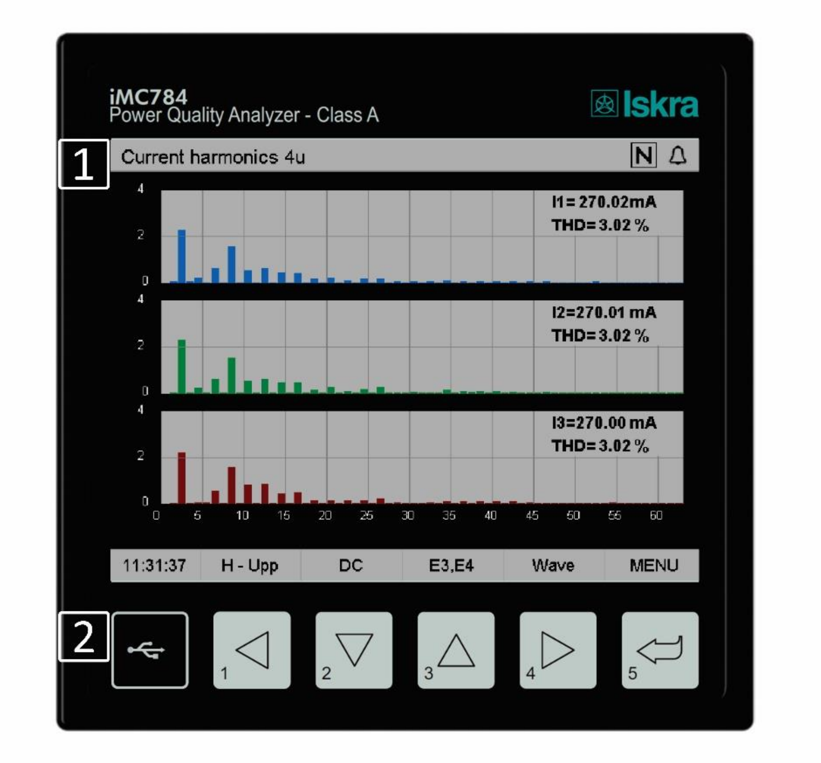
Description of the Power Quality Analyzer iMC784A

iMC784A with TFT LCD

Power Quality Analyzer iMC784A is a comprehensive device intended for permanent monitoring of power quality from its production, transmission, distribution all the way to the final consumers, who are most affected by inadequate voltage quality. It is mostly applicable in medium and low voltage applications.

Lack of information regarding supplied voltage quality can lead to unexplained production problems and malfunction or can even damage equipment being used during factory production process. Therefore, this device can be used for the needs of electrical utilities (evaluation against standards) as well as for industrial purposes (e.g. for monitoring the level of supplied power quality).

Appearance



1 – Color TFT LCD display
2 – Navigation keyboard

Color TFT LCD display:

5.7 inch color TFT LCD display is used for displaying measuring quantities and for a display of selected functions when setting the Power Quality Analyzer iMC784A.

Navigation keyboard:

The "Enter" key is used for confirming/selecting the settings. Direction keys are used for navigating between screens and menus. Function of individual key may vary depending on the selected screen.

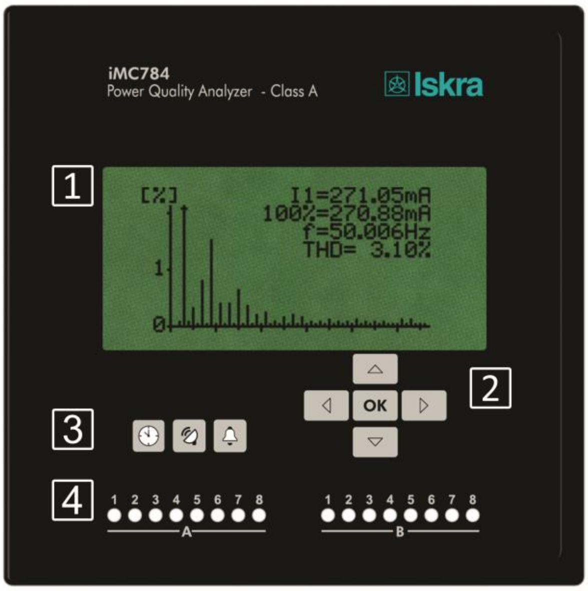
iMC784A with graphical LCD display

Power Quality Analyzer iMC784A is a comprehensive device intended for permanent monitoring of power quality from its production, transmission, distribution all the way to the final consumers, who are most affected by inadequate voltage quality. It is mostly applicable in medium and low voltage applications.

Lack of information regarding supplied voltage quality can lead to unexplained production problems and malfunction or can even damage equipment being used during factory production process. Therefore, this device can be used for the needs of electrical utilities (evaluation against standards) as well as for industrial purposes (e.g. for monitoring the level of supplied power quality).

Appearance

1 – Graphical LCD
2 – Navigation keyboard
3 – General operation LED indicators (clock synchro./comm./alarm)
4 – I/O status LED indicators



Graphical LCD:

A graphical LCD with back-light is used for displaying measuring quantities and for a display of selected functions when setting the Power Quality Analyzer iMC784A.

Navigation keyboard:

The "OK" key is used for confirming the settings, selecting and exiting the display. Direction keys are used for shifting between screens and menus.

LED indicators:

There are two types of LED indicators positioned on the front panel. General operation LED indicators and I/O status LED indicators.

General operation LED indicators warn on certain device status. The left-most (red) indicator indicates that the device internal clock is synchronized (via GPS, IRIG-B or NTP protocol). The middle (green) one is blinking when transmitting MC data via communication to the server. The right-most (red) one is blinking when any of the alarm conditions is fulfilled.

I/O state LED indicators are in operation when additional Modules A and/or B are built-in. These modules can have the functionality of Digital input or Relay output. They are indicating the state of a single I/O. Red LED is lit in either of the following conditions:

- Relay output is activated
- Signal is present on Digital input

Abbreviation/Glossary

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

Term	Explanation
RMS	Root Mean Square value
TRMS	True 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
Memory card	Multimedia memory card. Type MMC and SD supported.
MiQen	Setting Software for ISKRA instruments
PA total	Power Angle calculated from total active and apparent power
PA_{phase}	Angle between fundamental phase voltage and phase current
PF_{phase}	Power factor, calculated from apparent and active power (affected by harmonics)
THD (U, I)	Total harmonic distortion
TDD (I)	Total demand distortion (according to IEEE Std. 519-1992). Indicates harmonic distortion at full load.
K factor (I)	Indicates a weighting of the harmonic load currents according to their effects on transformer heating. (according to IEEE C57.110)
CREST factor (I)	Indicates a ratio between the peak amplitude of the waveform and the TRMS value of the waveform.
MD	Max. Demand; 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
Interharmonic voltage – interharmonics	Sine voltage with frequency NOT equal to integer multiple of basic frequency
Flicker	Voltage fluctuation causes changes of luminous intensity of lamps, which causes the so-called flicker
RTC	Real Time Clock
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
Hysteresis [%]	Percentage specifies increase or decrease of a measurement from a certain limit after exceeding it.
IRIG-B	Serial Inter-range instrumentation group time code
GPS	Satellite navigation and time synchronization system
PO	Pulse output module
TI	Tariff input module
RO	Relay output module
BO	Bistable alarm output module
AO	Analogue output module
DI	Digital input module
PI	Pulse input module
AI	Analogue input module
WO	Status (watchdog) module – for supervision of proper operation
PQDIF	Power Quality Data Interchange Format, which is a binary file format (according to IEEE Std 1159.3-2003) that is used to exchange power quality data among different SW products.
COMTRADE	Common format for Transient Data Exchange for power systems is a file format for storing oscillography and status data related to transient power system disturbances.
Waveform	Represents the detailed time-dependent shape and form of a voltage, current or logical input signal
Transient	Represents power quality disturbances that involve destructive high magnitudes of current and voltage or even both. They exist in a very short duration from less than 50 nanoseconds to as long as 50 milliseconds.
Disturbance	These are used for monitoring long-term disturbances. Every half/full cycle, TRMS value is calculated, based on the previous cycle.
PQ	Power Quality

List of common abbreviations and expressions

Purpose and use of the Power Quality Analyzer iMC784A

Power Quality Analyzer iMC784A performs measurements in compliance with regulatory requested standard EN 61000-4-30 and evaluates recorded parameters for analysis according to parameters defined in European power quality standard EN50160. It enables storage of a wide variety of highly detailed oscillography data in 8GB of internal flash memory based on a sophisticated trigger settings mechanism. Data can be stored in standardized PQDIF (IEEE 1159-3) and COMTRADE (IEEE C37.111) file formats which can easily be exchanged with third party PQ analysis SW systems.

Moreover Power Quality Analyzer iMC784A stores measurements and quality reports in internal memory for further analysis. By accessing recorded or real time values from multiple instruments installed on different locations it is possible to gain the overall picture of the complete systems' behavior. This can be achieved with regard to Power Quality Analyzer iMC784A accurate internal real time clock and wide range of synchronization sources support, which assure accurate, time-stamped measurements from dislocated units.

Stored data can then be transferred to a PC or server for post analysis. The simplest way this is done is by directly connecting a PC with installed MiQen Setting Studio SW via USB cable.

The following characteristics are measured and recorded:

Monitored Power Quality indices as defined by EN 50160

Phenomena	PQ Parameters
Frequency variations	Frequency distortion
Voltage variations	Voltage fluctuation
	Voltage unbalance
Voltage changes	Rapid voltage changes
	Flicker
Voltage events	Voltage dips
	Voltage interruptions
	Voltage swells
Harmonics & THD	THD
	Harmonics
	Inter-harmonics
	Signaling voltage

Power Quality Analyzer iMC784A application and benefits

Power Quality Analyzer iMC784A can be used as a standalone PQ monitoring device for detection and analysis of local PQ deviations, transients, alarms and periodic measurements. For this purpose it is normally positioned at the point-of-common-coupling (PCC) of industrial and commercial energy consumers to monitor quality of delivered electric energy or at medium or low voltage feeders to monitor, detect and record possible disturbances caused by operation of consumers.

Identifying relevant fixed measuring points is the most important task prior to complete system installation. The implementation of a PQ system itself will not prevent disturbances in network but rather help diagnose their origins and effects by comparing and scrutinizing data from multiple time synchronized measurement points.

Server database records (with a copy in device memory) include numerous parameters of three-phase systems, which have been setup in the device (PQ parameters, over 700 evaluated electrical quantities, I/O module related physical parameters (e.g. temp., pressure, wind speed…). On the other hand the database also holds data on alarms and detailed time-stamped transient, waveform, disturbance PQ data and fast trend trigger records with complete oscillography data in standardized PQDIF/COMTRADE file formats.

Main Features, supported options and functionality of Power Quality Analyzer iMC784A

Power Quality Analyzer iMC784A is a perfect tool for monitoring and analyzing medium or low voltage systems in power distribution and industrial segments. It can be used as a standalone PQ monitoring device for detection of local PQ deviations. For this purpose it is normally positioned at the point-of-common-coupling (PCC) of small and medium industrial and commercial energy consumers to monitor quality of delivered electric energy or at medium or low voltage feeders to monitor, detect and record possible disturbances caused by (unauthorized) operation of consumers.

User can select different hardware modules that can be implemented in device. Wide range of variants can cover practically every user's requirements.

Power Quality Analyzer iMC784A is a compact, user friendly and cost effective device that offers various features to suit most of the requirements for a demanding power system management:

- Evaluation of the electricity supply quality in compliance with EN50160 with automatic report generation
- Class A (0.1%) accuracy in compliance with EN61000-4-30 Ed.3
- Instantaneous evaluation of over 700 electrical measurement quantities values including PQ related parameters, harmonics (voltage/current THDs, TDDs, up to 63rd voltage(PP, PN)/current harmonics and inter-harmonics)
- Automatic range selection of 4 current and 4 voltage channels (max. 12.5 A_{TRMS} and 1000 V_{TRMS}) with 32 kHz sampling rate
- Oscillography capability for recording waveforms with up to 625 samples/cycle sampling frequency
- Recording of disturbance, trend and Power Quality (PQ) events in trigger related recorders
- All trigger related recorder data available on-demand through FTP
- A sophisticated triggering mechanism to register and record events of various nature:
  - Current and voltage transient event generated triggers based on hold-off time (in ms), absolute peak value (in % of Un) and fast change (in %Un/µs)
  - PQ event generated triggers based on the following events: voltage dip, voltage swell, voltage interruption, end of voltage interruption, rapid voltage change and inrush current
  - External Ethernet triggers enabling trigger events with up to 8 different devices within the network
  - External Digital triggers based on logical/digital inputs
  - Up to 16 combined triggers enabling logical operation on previously configured triggers of various nature
- Recording a wide variety of data in the internal device 8GB flash memory based on trigger settings:
  - All activated triggers together with timestamp, duration, condition as well as a reference to an (optionally) generated transient, waveform, disturbance and fast trend record
  - Waveform recorder with PQDIF/COMTRADE data format selection, selectable recorded channels (4×Voltage, 4×Current, 16×Digital input), 19 samples/cycle to 625 samples/cycle resolution, pre-trigger time from 0,01s up to 1s, post-trigger time from 0,01s up to 40s (20s for 625 samples/cycle)
  - Disturbance recorder with PQDIF/COMTRADE data format selection, selectable recorded channels (4×P-N Voltage, 3×P-P Voltage, 4×Current, 8×Logical inputs), half/full cycle averaging interval, pre-trigger time up to 3000 cycles, post trigger time up to 60000 cycles
  - Periodic measurements in 4 standard trend recorders A through D each containing up to 32 arbitrarily evaluated (maximum, minimum, average, maximum demand, minimum demand, actual) quantities with periods ranging from 1min to 60min
  - Periodic measurements in advanced fast trend recorders 1 through 4 each containing over 700 arbitrarily evaluated (maximum, minimum, average, actual) quantities with periods ranging from 1s to 60min. The recorder can be set to PQDIF data format selection
  - 32 adjustable alarms in 4 alarm groups each containing up to 8 alarms. Alarms relate to a particular quantity over/under threshold and serve the purpose of controlling on-device relay outputs as well as informing the server about the occurrence of alarm events
  - Recording and on-board evaluation of PQ anomalies and PQ reports based on EN50160

- Four quadrant energy measurement in 8 programmable counters with class 0.2S accuracy with up to four tariffs and an advanced tariff clock. Every Counters' resolution and range can be defined. The counter content can be configured as:

  - Active energy (Wh) import
  - Active energy (Wh) export
  - Reactive energy (varh) import
  - Reactive energy (varh) export
  - Total absolute active energy (Wh)
  - Total absolute reactive energy (varh)
  - Total absolute apparent energy (VAh)
  - Custom settings (phase dependent, four quadrant – P/Q/import/export selection)

- Automatic range selection of 4 current and 4 voltage channels (max. 12.5 A and 1000 VRMS) with 32 kHz sampling rate
- Measurements of 40 minimal and maximal values in different time intervals (from 1 to 256 periods)
- Frequency range from 16 Hz to 400 Hz
- Ethernet and USB 2.0 communication support
- Communication - MODBUS, DNP3, FTP, MQTT, upgradeable to EN61850 Ed.2 (optionally – see Appendix G)
- Support for GPS, IRIG-B (modulated and digital) and NTP real time clock synchronization
- Up to 4 inputs/outputs on I/O module 1/2 and 3/4 (analogue inputs/outputs, digital inputs/outputs, alarm/watchdog outputs, pulse input/outputs, tariff inputs, bistable alarm outputs, relay output)
- Up to 20 inputs/outputs on I/O module A and B (relay output, digital input)
- MiQen Setting studio User-friendly setting and analysis software with FTP communication feasibility for seamless device settings and single device advanced analysis
- On-board Web server support for basic measurement overview
- Multilingual support (iMC784A graphic pixel display only)
- Auxiliary power supply
- 144 mm square panel mounting
- Available with:
  - 5.7 inch color TFT LCD display (iMC784A with color TFT LCD display)
  - 128x64 pixel display (iMC784A graphic pixel display)

General hardware Features		**Default / Optional**
General		
Class A measuring accuracy (0.1%) according to EN 61000-4-30 Ed.3		●
Voltage auto range up to 1000Vp-p$_{RMS}$		●
Current auto range up to 12.5 A		●
4 voltage and 4 current channels with 32 us sampling time		●
Auxiliary power supply		●
Two independent communication ports (see data below)		○
Support for GPS / IRIG-B / NTP real time synchronization		● / ● / ●
Up to 20 additional inputs and outputs (see data below)		○
Internal flash memory (8MB+8GB)		●
Real time clock (RTC)		●
standard 144 mm DIN square panel mounting		●
Front panel		
Graphical LCD display with back light – iMC784A		●
LED indicator (sync/com./alarm) – iMC784A		●
I/O status LED indicator – iMC784A		●
Control keys on front panel (5 keys)		●
Communication		
COM1: Ethernet +USB		●
COM2: Serial (RS232/ RS485 on slot C if other synchronization modes are in use)		●
Input and output modules		
Input / output module 1		
2×AO / 2×AI / 2×RO / 2×PO / 2×PI / 2×TI / 1×BO / 2×DI / WO+RO		○/○/○/○/○/○/○/○/○
Input / output module 2		
2×AO / 2×AI / 2×RO / 2×PO / 2×PI / 2×TI / 1×BO / 2×DI / WO+RO		○/○/○/○/○/○/○/○/○
Auxiliary input / output module A		
I/O A	(1-8) DI / RO	○ / ○
Auxiliary input / output module B		
I/O B	(1-8) DI	○
Synchronization module C		
I/O C	GPS + 1pps / IRIG-B / COM2	● / ● / ●

●	Function is supported (default)
○	Optional (to be specified with an order)
PO	Pulse output module
TI	Tariff input module
RO	Relay output module
BO	Bistable relay output module
AO	Analogue output module
DI	Digital input module
PI	Pulse input module
AI	Analogue input module – U, I or R (PT100/1000)
WO	Status (watchdog) module – for supervision of proper operation

General hardware Features	**Default / Optional**
EN 50160 power quality evaluation	●
Automatic PQ report generation	●
Disturbance, trend & PQ event recording	●
Waveform recorder with programmable sampling time (max 625 samples / cycle)	●
Standardized PQDIF and COMTRADE format support	●
MiQen user friendly setting & analysis software	●
Setup wizard	●
Wrong connection warning	●
Custom screen settings (3 user defined screens on LCD)	●
Demonstration screen cycling	●
Programmable refresh time	●
MODBUS and DNP3 communication protocols	●
Tariff clock	●
MD calculation (TF, FW, SW)	●
Wide frequency measurement range 16 – 400 Hz	●
Programmable alarms (32 alarms)	●
Alarms recording	●
Measurements recording (128 quantities)	●
Measurements graphs (time / FFT)	●
Evaluation of voltage quality in compliance with EN 50160	●
Real time clock synchronization (GPS/IRIG-B/NTP)	●
5.7 inch color TFT LCD display (iMC784A)	○
EN61850 Ed.2 Server	○

●	Function is supported (default)
○	Optional (to be specified with an order)

CONNECTION

This chapter deals with the instructions for measuring instrument connection. Both the use and connection of the Power Quality Analyzer iMC784A includes handling with dangerous currents and voltages. Connection shall therefore be performed ONLY a by a qualified person using an appropriate equipment. ISKRA d.o.o. does not take any responsibility regarding the use and connection. If any doubt occurs regarding connection and use in the system which device is intended for, please contact a person who is responsible for such installations.
A person qualified for installation and connection of a device should be familiar with all necessary precaution measures described in this document prior to its connection.

Before use please check the following:

- Nominal voltage ($U_{P\text{-}Pmax}$ = 1000VAC$_{rms}$; $U_{P\text{-}Nmax}$ = 600VAC$_{rms}$).
- Supply voltage (rated value).
- Nominal frequency.
- Voltage ratio and phase sequence.
- Current transformer ratio and terminals integrity.
- Protection fuse for voltage inputs (recommended maximal external fuse size is 6 A).
- External switch or circuit-breaker must be included in the installation for disconnection of the devices' aux. power supply. It must be suitably located and properly marked for reliable disconnection of the device when needed. See CAUTION below.
- Integrity of earth terminal.
- Proper connection and voltage level of I/O modules.

⚠ WARNING

Wrong or incomplete connection of voltage or other terminals can cause non-operation or damage to Power Quality Analyzer iMC784A.

⚠ WARNING

It is imperative that terminal 12 which represents fourth voltage measurement channel is connected to earth pole ONLY. This terminal should be connected to EARTH potential at all times! This input channel is used only for measuring voltage between neutral end earth line.

ⓘ CAUTION

Aux. Supply inrush current can be as high as 20 A for short period of time (<1 ms). Please choose an appropriate MCB for disconnection of aux. supply.

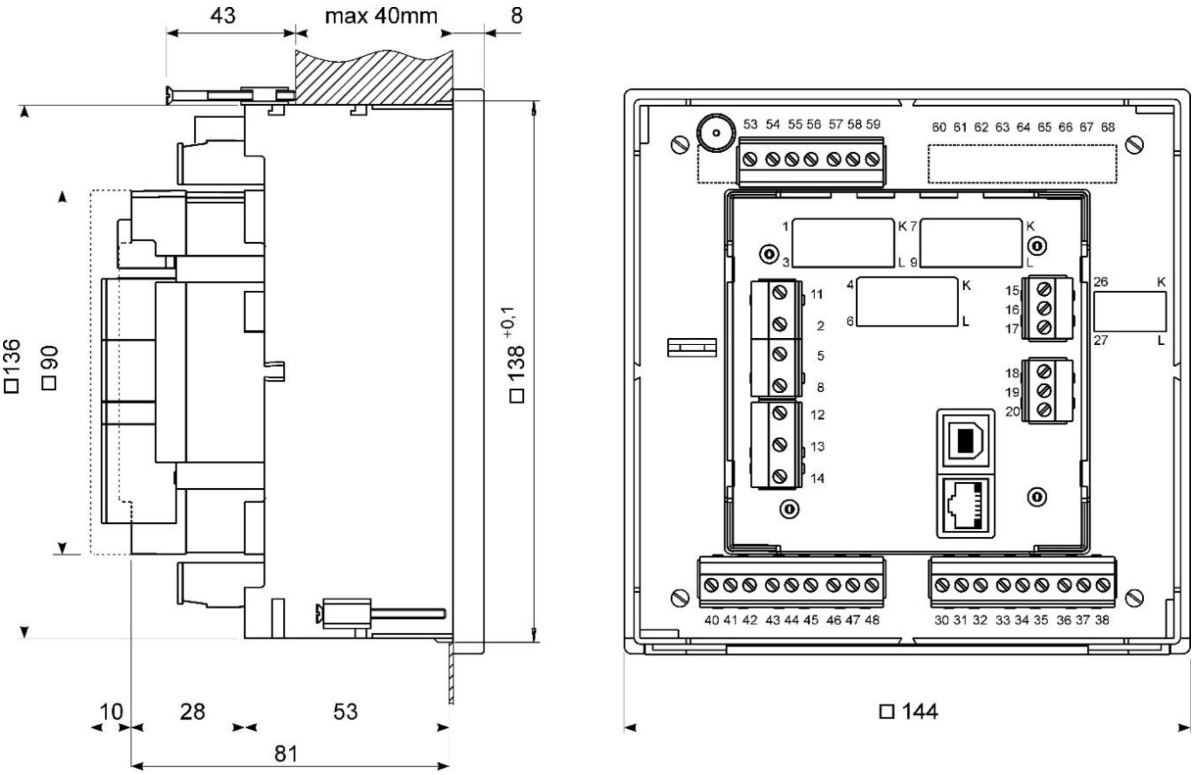
⚠ **PLEASE NOTE**

After connection, settings have to be performed via a keyboard on the front side of the device that reflects connection of device to voltage network (connection mode, current and voltage transformers ratio …). Settings can also be done via communication or a memory card (where available).

Mounting

Power Quality Analyzer iMC784A is intended only for panel mounting. Pluggable connection terminals allow easier installation and quick replacement should that be required.

This device is not intended for usage as portable equipment and should be used only as a fixed panel mounted device.



Dimensional drawing and rear connection terminals position

Recommended panel cut out is:

138 mm x 138 mm + 0.8

Please remove protection foil from the screen.

Electrical connection for Power Quality Analyzer iMC784A

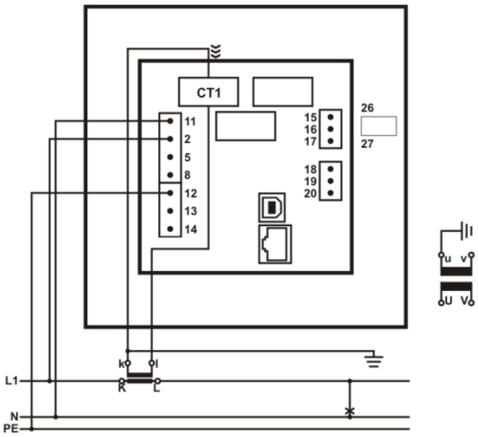
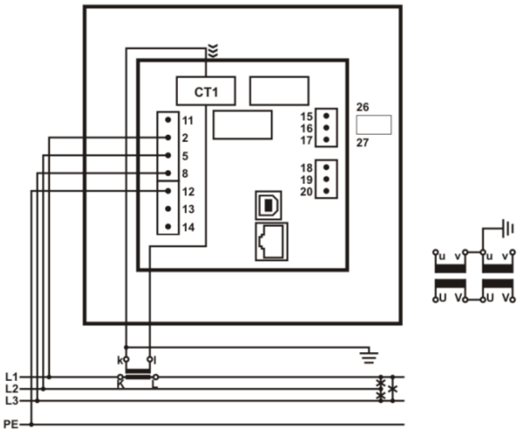
Voltage inputs of Power Quality Analyzer iMC784A can be connected directly to low-voltage network or via a voltage measuring transformer to a high-voltage network.

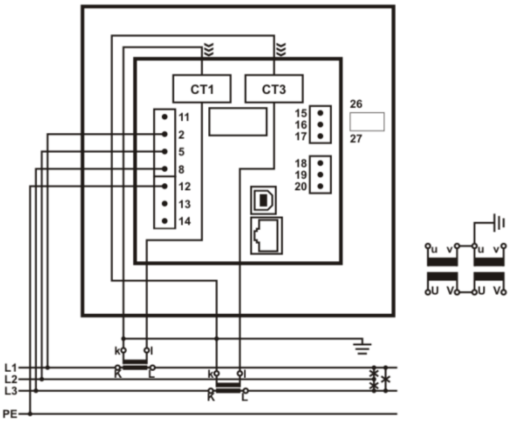
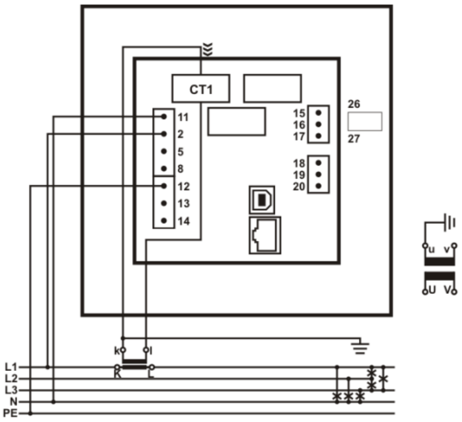
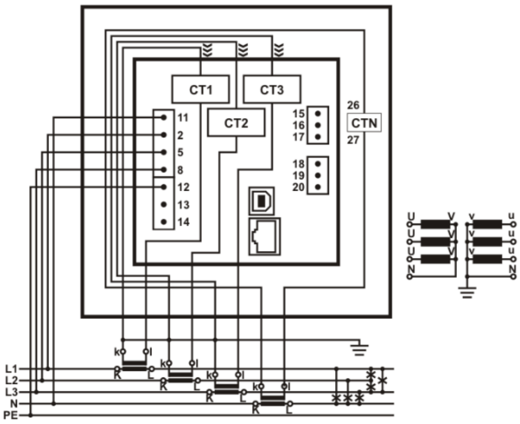
Current inputs of a device are led through a hole in current transformers to allow uninterrupted current connection. Connection to network is performed via a corresponding current transformer.

Choose corresponding connection from the figures below and connect corresponding voltages and currents. Information on electrical consumption of current and voltage inputs is given in a chapter Technical Data.

CAUTION

For accurate operation and to avoid measuring signal crosstalk it is important to avoid driving voltage measuring wires close to current measuring transformers.

System/ connection	**Terminal assignment**
Connection 1b (1W) Single phase connection	 CT1 11 2 5 8 12 13 14 15 16 17 18 19 20 26 27 u v U V k l K L L1 N PE
Connection 3b (1W3b) Three phase, three wire connection with balanced load	 CT1 11 2 5 8 12 13 14 15 16 17 18 19 20 26 27 u v u v U V U V k l K L L1 L2 L3 PE

System/ connection	Terminal assignment
Connection 3u (2W3u) Three phase, three wire connection with unbalanced load	 CT1 CT3 11 2 5 8 12 13 14 15 16 17 18 19 20 26 27 u v u v U V U V k l K L L1 L2 L3 PE
Connection 4b (1W4b) Three phase, four wire connection with balanced load	 CT1 11 2 5 8 12 13 14 15 16 17 18 19 20 26 27 u v U V k l K L L1 L2 L3 N PE
Connection 4u (3W4u) Three phase, four wire connection with unbalanced load	 CT1 CT2 CT3 CTN 11 2 5 8 12 13 14 15 16 17 18 19 20 26 27 U V u N k l K L L1 L2 L3 N PE

PLEASE NOTE

With all connection schemes must be terminal 12 (PE) ALWAYS connected. Fourth voltage channel is dedicated for measuring voltage between EARTH (PE, terminal 12) and NEUTRAL (N, terminal 11).

Connection of input/output modules

WARNING

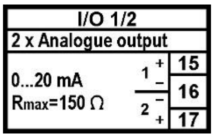
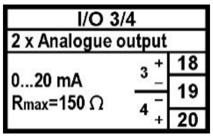
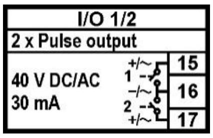
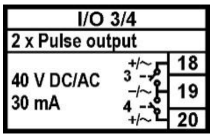
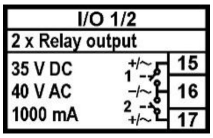
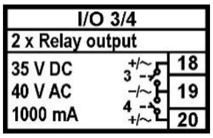
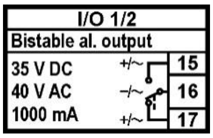
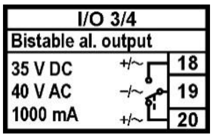
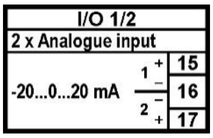
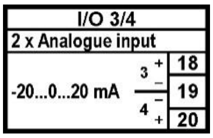
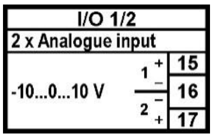
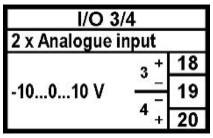
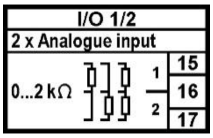
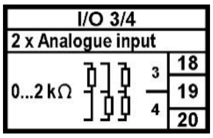
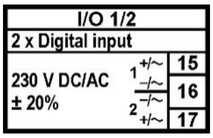
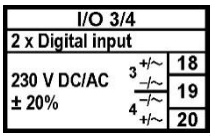
Check the module features that are specified on the label, before connecting module contacts. Wrong connection can cause damage or destruction of module and/or device.

PLEASE NOTE

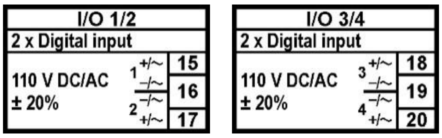
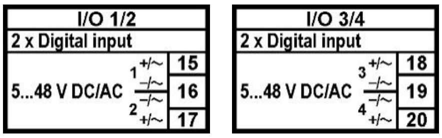
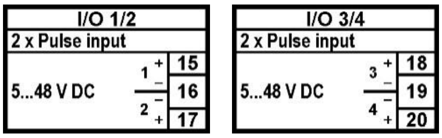
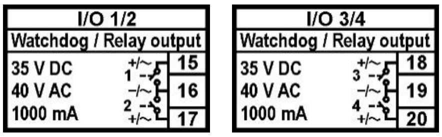
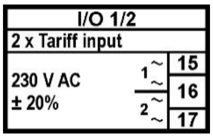
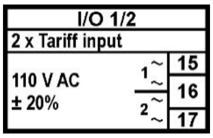
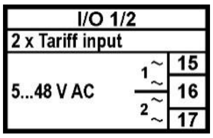
Examples of connections are given for device with built in two input/output modules and Ethernet/USB communication. Connection does not depend on a number of built-in modules and communication, and is shown on the devices' label.

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 a chapter Technical Data – Input/output modules.

I/O module 1/2 and 3/4 (terminal numbers 15-20)

 I/O 1/2 2 x Analogue output 0...20 mA Rmax=150 Ω 1 + – 2 – + 15 16 17	 I/O 3/4 2 x Analogue output 0...20 mA Rmax=150 Ω 3 + – 4 – + 18 19 20	Analogue output module with two analogue outputs (0…20mA), proportional to measured quantities.
 I/O 1/2 2 x Pulse output 40 V DC/AC 30 mA 1 +/~ –/~ 2 –/~ +/~ 15 16 17	 I/O 3/4 2 x Pulse output 40 V DC/AC 30 mA 3 +/~ –/~ 4 –/~ +/~ 18 19 20	Pulse output (solid state) module with two pulse outputs for energy counters.
 I/O 1/2 2 x Relay output 35 V DC 40 V AC 1000 mA 1 +/~ –/~ 2 –/~ +/~ 15 16 17	 I/O 3/4 2 x Relay output 35 V DC 40 V AC 1000 mA 3 +/~ –/~ 4 –/~ +/~ 18 19 20	Relay output module with two outputs.
 I/O 1/2 Bistable al. output 35 V DC 40 V AC 1000 mA +/~ –/~ +/~ 15 16 17	 I/O 3/4 Bistable al. output 35 V DC 40 V AC 1000 mA +/~ –/~ +/~ 18 19 20	Bistable alarm output module; keeps the state also in case of device power supply failure.
 I/O 1/2 2 x Analogue input -20...0...20 mA 1 + – 2 – + 15 16 17	 I/O 3/4 2 x Analogue input -20...0...20 mA 3 + – 4 – + 18 19 20	Analogue input module enables measurements of DC I or temp. (PT100, PT1000) values from external sources. Modules have different hardware, so programming is possible within one quantity.
 I/O 1/2 2 x Analogue input -10...0...10 V 1 + – 2 – + 15 16 17	 I/O 3/4 2 x Analogue input -10...0...10 V 3 + – 4 – + 18 19 20	Analogue input module enables measurements of DC U or temp. (PT100, PT1000) values from external sources. Modules have different hardware, so programming is possible within one quantity.
 I/O 1/2 2 x Analogue input 0...2 kΩ 1 2 15 16 17	 I/O 3/4 2 x Analogue input 0...2 kΩ 3 4 18 19 20	Analogue input module enables measurements of R or temp. (PT100, PT1000) values from external sources. Modules have different hardware, so programming is possible within one quantity.
 I/O 1/2 2 x Digital input 230 V DC/AC ± 20% 1 +/~ –/~ 2 –/~ +/~ 15 16 17	 I/O 3/4 2 x Digital input 230 V DC/AC ± 20% 3 +/~ –/~ 4 –/~ +/~ 18 19 20	Digital input module with two digital inputs enables reception of impulse signals.

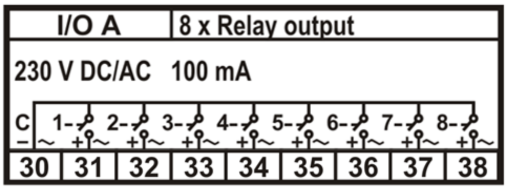
I/O module 1/2 and 3/4 (terminal numbers 15-20)

 I/O 1/2 2 x Digital input 110 V DC/AC ± 20% 1 2 +/~ -/~ 15 16 17 I/O 3/4 2 x Digital input 110 V DC/AC ± 20% 3 4 18 19 20	Digital input module with two digital inputs enables reception of impulse signals.
 I/O 1/2 2 x Digital input 5...48 V DC/AC 1 2 +/~ -/~ 15 16 17 I/O 3/4 2 x Digital input 5...48 V DC/AC 3 4 18 19 20	Digital input module with two digital inputs enables reception of impulse signals.
 I/O 1/2 2 x Pulse input 5...48 V DC 1 2 + - 15 16 17 I/O 3/4 2 x Pulse input 5...48 V DC 3 4 18 19 20	Pulse input module enables reception of pulses from various counters (water, gas, heat, flow …).
 I/O 1/2 Watchdog / Relay output 35 V DC 40 V AC 1000 mA 1 2 +/~ -/~ 15 16 17 I/O 3/4 Watchdog / Relay output 35 V DC 40 V AC 1000 mA 3 4 18 19 20	Watchdog output and alarm (relay) module enables proper device operation supervision
 I/O 1/2 2 x Tariff input 230 V AC ± 20% 1 2 ~ 15 16 17	Tariff input module with two tariff inputs for changeover between up to four tariffs.
 I/O 1/2 2 x Tariff input 110 V AC ± 20% 1 2 ~ 15 16 17	Tariff input module with two tariff inputs for changeover between up to four tariffs.
 I/O 1/2 2 x Tariff input 5...48 V AC 1 2 ~ 15 16 17	Tariff input module with two tariff inputs for changeover between up to four tariffs.

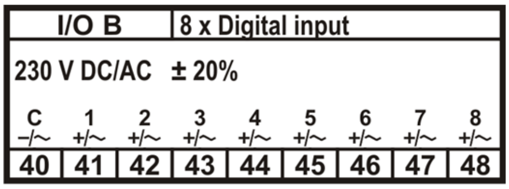
⚠ WARNING

In case when only one resistance-temperature analogue input is used, the other must be short-circuited.

Auxiliary I/O module A and B – output options



Relay output module with eight outputs enables alarm functionality.

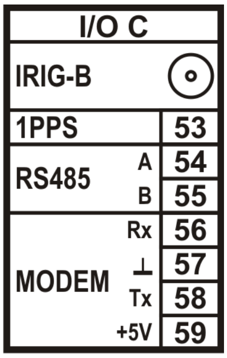


Digital input module with eight digital inputs enables reception of digital signals.

PLEASE NOTE

Relay output only possible on I/O module A.

Synchronization module C



Synchronization module is equipped with support for two different synchronization methods IRIG-B and GPS modem.
When modulated IRIG-B signal is used it should be connected to BNC terminal. When level-shift IRIG-B signal is used it should be connected to 1PPS terminal.
In case of GPS modem, 1pps signal should be connected to 1PPS terminal and serial RS232 signal should be connected to RS232 terminals.
When IRIG-B (modulated or level-shift) or 1PPS signal is used for time synchronization serial communication interface (RS232 or RS485) can be used as a devices' secondary communication port (COM2).

PLEASE NOTE

Communication port on Module C is primarily dedicated to receive serial coded date and time telegram from a GPS receiver in order to synchronize internal real time clock (RTC). When other methods are used for synchronizing RTC this communication port can be used as a secondary general purpose communication port.

Please note that either RS232 or RS485 should be used and not both at a time. Connector terminals that are not used should remain unconnected otherwise the communication could not work properly.

CAUTION

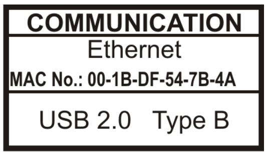
RTC synchronization is essential part of Class A instrument. If no proper RTC synchronization is provided device operates as Class S instrument.

CAUTION

Max consumption of +5V supply terminal is 100mA. When GPS with consumption greater the 100 mA is used it is advisable to use external power supply.

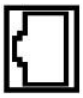
Communication connection

Primary communication interface (COM1) type is normally specified when placing an order. Power Quality Analyzer iMC784A supports Ethernet communication designed as standard RJ-45 terminal and USB communication designed as standard USB-B type terminal
Beside primary communication port, Power Quality Analyzer iMC784A has built in a secondary communication port (COM2) as a part of a real time synchronization module C. Its operation is described in a chapter referring to a real time synchronization Serial communication via Synchronization module C (COM2).
Connect a communication line by means of a corresponding terminal. Communication parameters are stated on the device label, regarding the selected/equipped type of communication. Connector terminals are marked on the label on a devices' rear side. More detailed information on communication is given in chapter Settings – Communications.


COMMUNICATION
Ethernet
MAC No.: 00-1B-DF-54-7B-4A
USB 2.0 Type B

Example of a label for Ethernet/USB communication module equipped with RJ−45 and USB-B type connector

Survey of communication connection

	Connector	Terminals	Description
Ethernet	RJ−45		100BASE-T CAT5 cable recommended
USB	USB-B		Standard USB 2.0 compatible cable recommended (Type B plug)

Connection of Real Time Synchronization module C

Synchronized real-time clock (RTC) is an essential part of any Class A analyzer for proper chronological determination of various events. To distinct cause from consequence, to follow a certain event from its origin to manifestation in other parameters it is very important that each and every event and recorded measurement on one instrument can be compared with events and measurements on other devices. Even if instruments are dislocated, which is normally the case in electro distribution network events have to be time-comparable with accuracy better than a single period.
Synchronization module is used to synchronize RTC of the device and to maintain its accuracy for correct aggregation intervals and time stamps of recorded events appearing in monitored electro distribution network.
Different types of RTC synchronization are possible:

- IRIG-B modulated; 1 kHz modulation with <1ms resolution.
- IRIG-B unmodulated (level shift)
- 1PPS + RS232 Date & Time telegram (from GPS)

⚠ **PLEASE NOTE**

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.

GPS time synchronization:

1pps and serial RS232 communication with NMEA 0183 sentence support. GPS interface is designed as 5 pole pluggable terminal (+5V for receiver supply, 1pps input and standard RS232 communication interface). Proposed GPS receiver is GARMIN GPS18x+.

IRIG time code B (IRIG-B):

Unmodulated (DC 5V level shift) and modulated (1 kHz) serial coded format with support for 1pps, day of year, current year and straight seconds of day as described in standard IRIG-200-04. Supported serial time code formats are IRIG-B007 and IRIG-B127

Interface for modulated IRIG-B is designed as BNC-F terminal with 600 Ohm input impedance. Interface for unmodulated IRIG-B is designed as pluggable terminal.

Network time protocol (NTP):

Synchronization via Ethernet requires access to a NTP server.

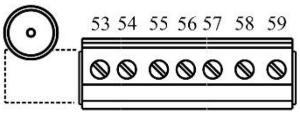
PLEASE NOTE

NTP can usually maintain time to within tens of milliseconds over the public Internet, but the accuracy depends on infrastructure properties - asymmetry in outgoing and incoming communication delay affects systematic bias. It is recommended that dedicated network rather than public network is used for synchronization purposes.

CAUTION

RTC synchronization is essential part of Class A instrument. If no proper RTC synchronization is provided device operates as Class S instrument.

Survey of synchronization connection

Terminals	Connector type
	BNC for modulated IRIG-B and Pluggable screw terminals for level-shift IRIG-B, GPS modem or serial RS232 or RS485

Connector	Position	Data direction	Description
BNC connector	600 Ohm input impedance: standard Coaxial cable (55 Ohm) recommended		
Screw terminal	53	1PPS (GPS) or IRIG-B (level shift)	Synchronization pulse
	54	To/From (A)	RS485
	55	To/From (B)	RS485
	56	To	Data reception (Rx)
	57	GND	Grounding
	58	From	Data transmission (Tx)
	59	+5V	AUX voltage +5V (supply for GPS modem)

When IRIG-B or 1PPS signal is used for time synchronization serial communication interface (RS232 or RS485) can be used as a devices' secondary communication port (COM2).

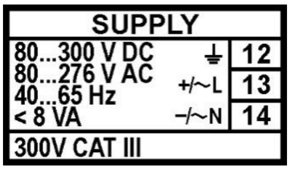
More information regarding use of Synchronization module C please see chapter Inputs and Outputs – RTC Synchronization module C.

Connection of aux. Power supply

Power Quality Analyzer iMC784A is equipped with auxiliary power supply.

Voltage range: 80 V DC...300 V DC
80 V AC...276 V AC;
40 Hz...65 Hz

Information on electric consumption is given in chapter Technical Data – Auxiliary Power Supply. Choose and connect the power supply voltage according to power supply voltage specification on the label:



SUPPLY
80...300 V DC ⏚ 12
80...276 V AC +/~L 13
40...65 Hz
< 8 VA −/~N 14
300V CAT III

Connection of auxiliary power supply to terminals 13 and 14.

CAUTION

Aux. supply inrush current can be as high as 20A for short period of time (<1 ms). Please choose an appropriate MCB for connection of aux. supply.

FIRST STEPS

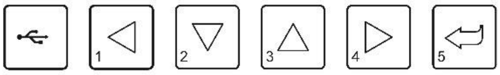
Programming Power Quality Analyzer iMC784A is very transparent and user friendly. Numerous settings are organized in groups according to their functionality.

Programming device can be performed using the keypad and display on the front panel. Due to representation of certain settings not all settings can be programmed this way. All settings can be programmed using MiQen software.

In this chapter you will find basic programming steps which can be accessed by using keypad and display.

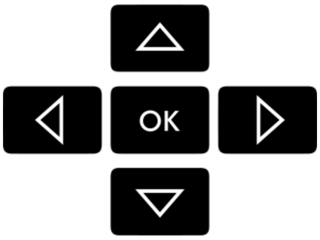
Keyboard navigation

iMC784A with color TFT LCD display



The Enter key (5) is used for confirming/selecting the settings. Direction keys (1 … 4) are used for navigating between screens and menus. Function of individual key may vary depending on the selected screen.

iMC784A with graphic pixel display

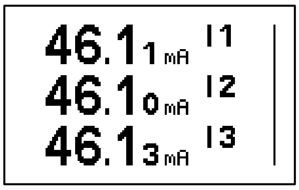


The "OK" key is used for confirming the settings, selecting and exiting the display. Direction keys are used for shifting between screens and menus.

Hold function:

Screen displaying measurements can be frozen using hold function. When measurements screen is selected, pressing OK button activates Hold function. Screen is frozen for 1 min. To exit hold function Press OK button again. Screen will return to previous menu.

Vertical line on the right side of the screen indicates frozen screen – hold function:



46.11 mA I1
46.10 mA I2
46.13 mA I3

Installation wizard

iMC784A with graphic pixel display

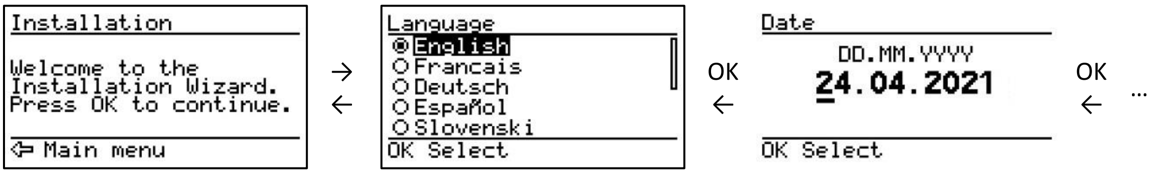
After installation and electrical connection, basic parameters have to be set in order to assure correct operation. The easiest way to achieve that is use the Installation wizard. When entering the Installation menu, settings follow one another when the previous one is confirmed. All required parameters 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.

Installation wizard menu may vary, depending on built in communication modules. In description below is marked which menu appears for specific option.

PLEASE NOTE

All settings that are performed through the Installation wizard can be subsequently changed by means of the Settings menu or via MiQen software.

When entering installation wizard following display is shown:



Installation

Welcome to the Installation Wizard. Press OK to continue.

⇐ Main menu

Language

◉ English
○ Francais
○ Deutsch
○ Espaňol
○ Slovenski

OK Select

Date

DD.MM.YYYY

24.04.2021

OK Select

Language

Set device language.

Date

Set device date.

Time

Set device time. If instrument is connected to one of supported time synchronization sources, date and time are automatically set.

Connection mode

Choose connection from a list of supported connection modes.

Primary voltage

Set primary voltage of monitored system if a device is connected indirectly by means of a voltage transformer. If device is connected to directly to a low voltage enter this value.

Secondary voltage

Set secondary voltage if a voltage transformer is used; set voltage of low voltage network if connection is direct.

Primary current

Set primary current of monitored system if a device is connected indirectly by means of a current transformer. Otherwise primary and secondary current should remain the same.

Secondary current

Set secondary current of current transformer or the value of nominal current if connection is direct.

Common energy counter resolution

Define Common energy counter resolution as recommended in table below, where Individual counter resolution is at default value 10. Values of primary voltage and current determine proper Common energy counter resolution. For detailed information about setting energy parameters see chapter
Suggested Common energy counter resolutions:

Current / Voltage	1 A	5 A	50 A	100 A	1000 A
110 V	100 mWh	1 Wh	10 Wh	10 Wh	100 Wh
230 V	1 Wh	1 Wh	10 Wh	100 Wh	1 kWh
1000 V	1 Wh	10 Wh	100 Wh	1 kWh	10 kWh
30 kV	100 Wh	100 Wh	1 kWh	10 kWh	10 kWh *

* − Individual counter resolution should be at least 100

Device address

Set MODBUS address for the device. Default address is 33.

IP Address

Set correct IP address of the device. Default setting is 0.0.0.0 and represents DHCP addressing. This setting is available only when Ethernet communication is built in.

TCP Port

Set TCP communication Port. Default value is 10001. This setting is available only when Ethernet communication is built in.

Subnet mask

Set network subnet mask. Default value is 255.255.255.0. This setting is available only when Ethernet communication is built in.

iMC784A with color TFT LCD display

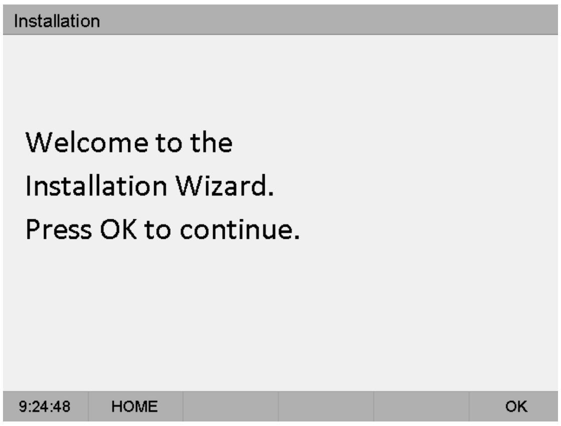
After installation and electrical connection, basic parameters have to be set in order to assure correct operation. The easiest way to achieve that is use the Installation wizard. When entering the Installation menu, settings follow one another when the previous one is confirmed. All required parameters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

Installation wizard menu may vary, depending on built in communication modules. In description below is marked which menu appears for specific option.

⚠ **PLEASE NOTE**

All settings that are performed through the Installation wizard can be subsequently changed by means of the Settings menu or via MiQen software.

When entering installation wizard following display is shown:



Welcome to the
Installation Wizard.
Press OK to continue.

Language

Set device language.

Date

Set device date.

Time

Set device time. If instrument is connected to one of supported time synchronization sources, date and time are automatically set.

Connection mode

Choose connection from a list of supported connection modes.

Primary voltage

Set primary voltage of monitored system if a device is connected indirectly by means of a voltage transformer. If device is connected to directly to a low voltage enter this value.

Secondary voltage

Set secondary voltage if a voltage transformer is used; set voltage of low voltage network if connection is direct.

Primary current

Set primary current of monitored system if a device is connected indirectly by means of a current transformer. Otherwise primary and secondary current should remain the same.

Secondary current

Set secondary current of current transformer or the value of nominal current if connection is direct.

Common energy counter resolution

Define Common energy counter resolution as recommended in table below, where Individual counter resolution is at default value 10. Values of primary voltage and current determine proper Common energy counter resolution. For detailed information about setting energy parameters see chapter

Suggested Common energy counter resolutions:

Current Voltage	1 A	5 A	50 A	100 A	1000 A
110 V	100 mWh	1 Wh	10 Wh	10 Wh	100 Wh
230 V	1 Wh	1 Wh	10 Wh	100 Wh	1 kWh
1000 V	1 Wh	10 Wh	100 Wh	1 kWh	10 kWh
30 kV	100 Wh	100 Wh	1 kWh	10 kWh	10 kWh *

* − Individual counter resolution should be at least 100

Device address

Set MODBUS address for the device. Default address is 33.

IP Address

Set correct IP address of the device. Default setting is 0.0.0.0 and represents DHCP addressing. This setting is available only when Ethernet communication is built in.

TCP Port

Set TCP communication Port. Default value is 10001. This setting is available only when Ethernet communication is built in.

Subnet mask

Set network subnet mask. Default value is 255.255.255.0. This setting is available only when Ethernet communication is built in.

Notification icons

Navigation keys and LCD enable application and basic instrument settings. During the operation some icons can be displayed in upper part of LCD. The significance of icons (from right to left) is explained in the table below.

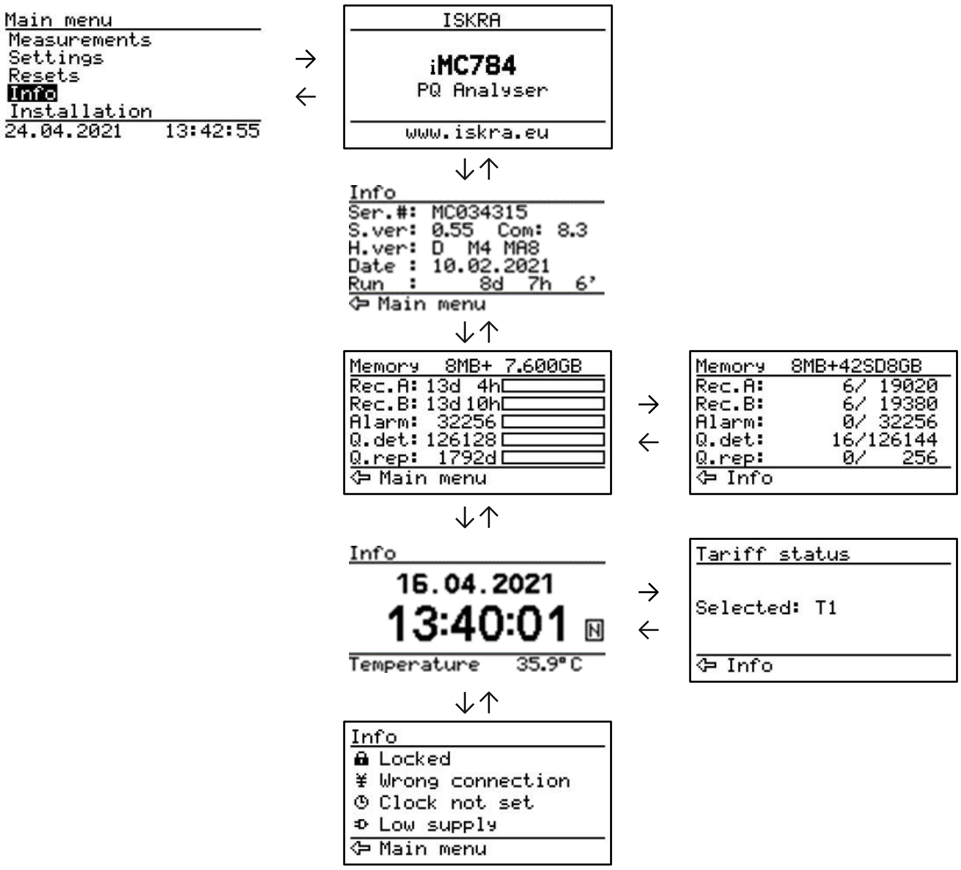
Icon	Meaning
🔒	Power Quality Analyzer iMC784A is locked with a password of the second level (L2). The first level (L1) can be unlocked.
⇅	Power Quality Analyzer iMC784A can be wrongly connected at 4u connection. Energy flow direction is different by phases.
🔋	A built-in battery (for RTC) shall be replaced. A battery test is carried out at power supply connection (for devices with built in battery).
🔌	The Power Quality Analyzer iMC784A supply is too low.
🕒	Clock not set (for devices with built in super cap). (when disconnected from aux. supply for more than 2 days)

⚠ **PLEASE NOTE**

Notification icons only apply to Power Quality Analyzer iMC784A graphic pixel display.

LCD Navigation

iMC784A Graphic pixel display



```
Main menu
 Measurements
 Settings
 Resets
 Info
 Installation
24.04.2021    13:42:55
```

```
ISKRA
iMC784
PQ Analyser
www.iskra.eu
```

```
Info
Ser.#: MC034315
S.ver: 0.55  Com: 8.3
H.ver: D  M4 MA8
Date : 10.02.2021
Run  :     8d  7h  6'
⇦ Main menu
```

```
Memory  8MB+ 7.600GB
Rec.A: 13d  4h
Rec.B: 13d 10h
Alarm:  32256
Q.det: 126128
Q.rep:  1792d
⇦ Main menu
```

```
Memory  8MB+42SD8GB
Rec.A:       6/ 19020
Rec.B:       6/ 19380
Alarm:       0/ 32256
Q.det:     16/126144
Q.rep:       0/   256
⇦ Info
```

```
Info
16.04.2021
13:40:01 N
Temperature    35.9°C
```

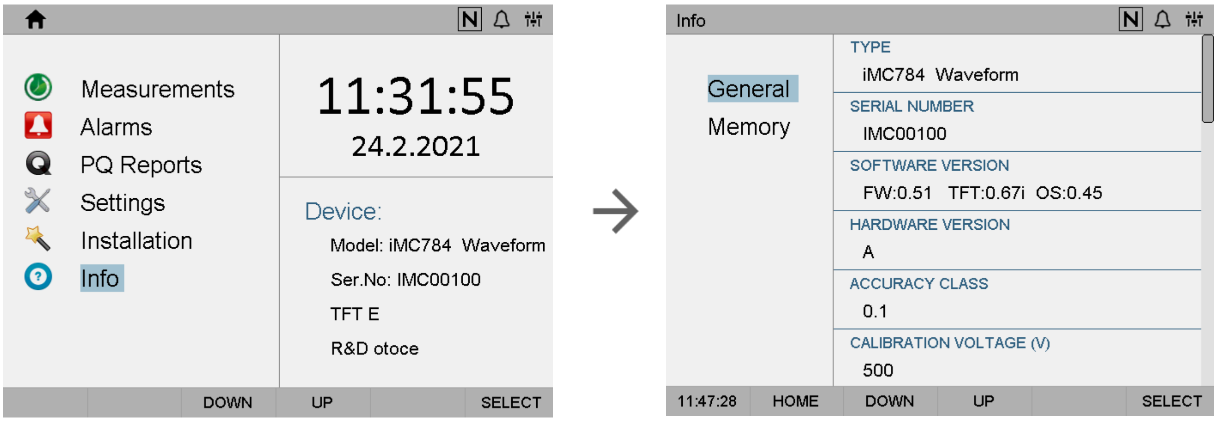
```
Tariff status

Selected: T1

⇦ Info
```

```
Info
🔒 Locked
¥ Wrong connection
◷ Clock not set
➪ Low supply
⇦ Main menu
```

iMC784A color TFT LCD display



11:31:55
24.2.2021
Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce

11:47:28

TYPE
iMC784 Waveform
SERIAL NUMBER
IMC00100
SOFTWARE VERSION
FW:0.51 TFT:0.67i OS:0.45
HARDWARE VERSION
A
ACCURACY CLASS
0.1
CALIBRATION VOLTAGE (V)
500

Main menu > Settings > General:

- TYPE
- SERIAL NUMBER
- SOFTWARE VERSION
- HARDWARE VERSION
- ACCURACY CLASS
- CALIBRATION VOLTAGE (V)

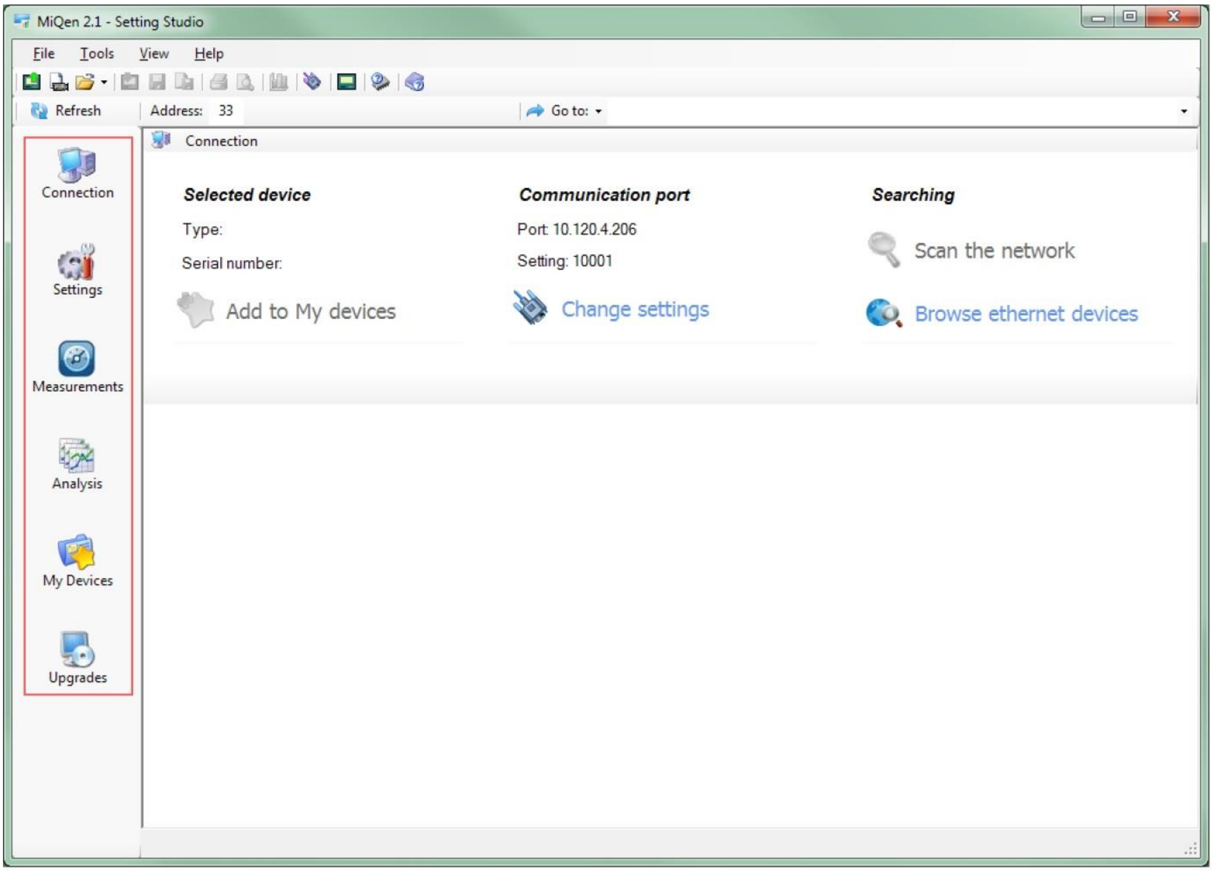
SETTINGS

Settings of Power Quality Analyzer iMC784A can be performed via the front keypad and display or remotely using communication and MiQen software version 2.1 or higher.

Via navigation keypad basic and simpler settings are available. Complete setting of the device can be done using MiQen software. In this case they can be applied to the device via.

MiQen software

MiQen software is a tool for a complete programming and monitoring of ISKRA measuring instruments. Remote operation is possible by means of serial (RS485/RS232), USB or TCP/IP communication. A user-friendly interface consists of six segments: Connection, settings, measurements, analysis, my devices and upgrades. These segments are easily accessed by means of six icons on the left side:



Address: 33

Type:

Serial number:

Port: 10.120.4.206

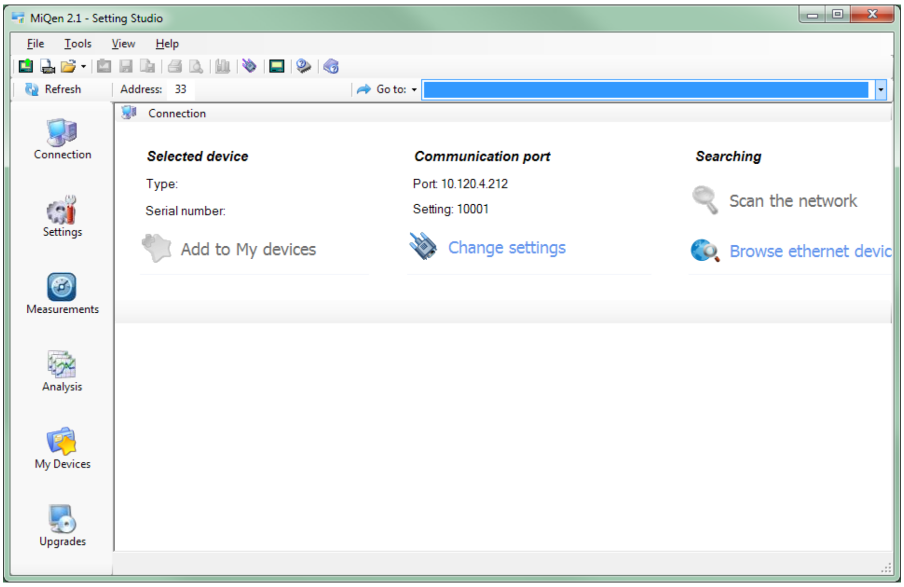
Setting: 10001

Latest version of MiQen software can be downloaded from ISKRA d.o.o. website www.ISKRA.eu.

PLEASE NOTE

MiQen has very intuitive help system. All functions and settings are described in Info window on the bottom of MiQen window. In MiQen Help file, detailed instructions about software usage, connection and communication with different type of devices, driver installation,… are described.

Devices management



Address: 33

Connection

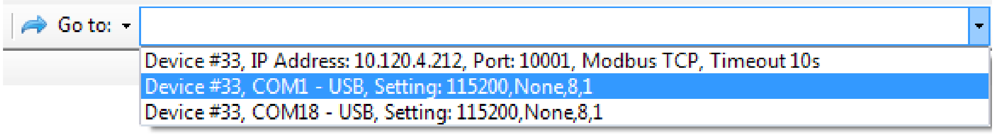
Selected device
Type:
Serial number:

Communication port
Port: 10.120.4.212
Setting: 10001

Searching

MiQen Device Management window

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



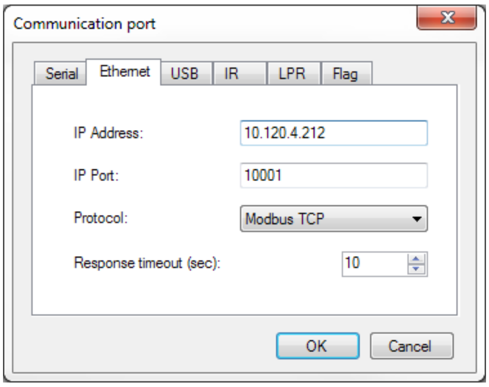
Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s
Device #33, COM1 - USB, Setting: 115200,None,8,1
Device #33, COM18 - USB, Setting: 115200,None,8,1

This way is Communication port set automatically as it was during last access.
To communicate with new device follow below instructions:
Connect a device to a communication interface (Depending on type of device):

- Directly to a PC using RS232 cable
- To comm. adapter RS485 / RS232
- Directly to a PC using USB cable
- Network connection using Ethernet cable

Set Communication port parameters

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



IP Address: 10.120.4.212
IP Port: 10001
Protocol: Modbus TCP
Response timeout (sec): 10

To activate desired communication select proper communication tab, set communication parameters and confirm selection with OK button.

PLEASE NOTE

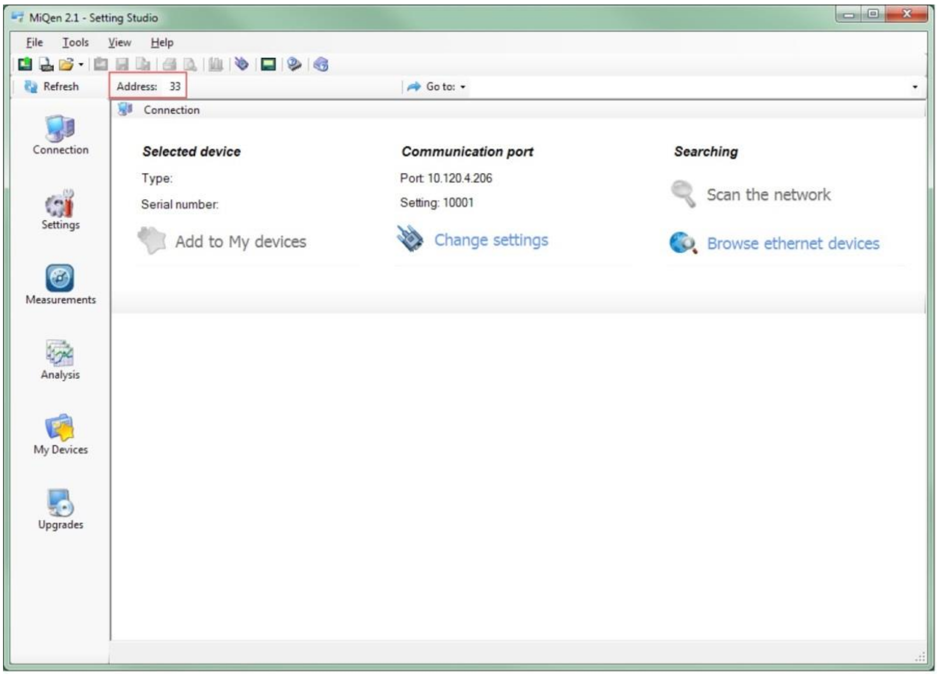
When device with USB communication is connected to a computer for the first time, device driver will be installed automatically. If installation is correct device presents its self in an operating system (Device manager - Ports (COM and LPT)) as a Measuring device. If device is not recognized automatically or wrong driver is installed, valid installation drivers are located in MiQen installation directory, subdirectory Drivers.

With this driver installed, USB is redirected to a serial port, which should be selected when using MiQen software.

For more information regarding communication parameters, please see chapter Communications.

Set device Modbus address number

Each device connected to a network has its unique Modbus address number. In order communicate with that device an appropriate address number should be set.



Address: 33

Selected device

Type:

Serial number:

Communication port

Port: 10.120.4.206

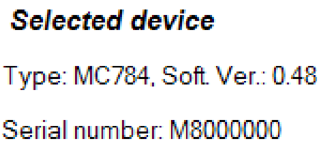
Setting: 10001

Searching

Factory default Modbus address for all devices is 33. If devices are connected in to communication network, all should have the same communication parameters, but each of them should have its own unique address.

Start communicating with a device

Click on Refresh button and devices information will be displayed:



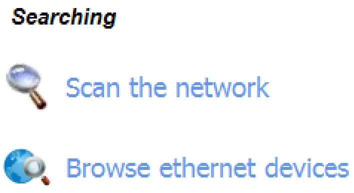
Selected device

Type: MC784, Soft. Ver.: 0.48

Serial number: M8000000

When devices are connected to a network and a certain device is required it is possible to browse a network for devices. For this purpose choose:

- **Scan the network** when device is connected to a RS485/RS232 bus
- **Browse Ethernet devices** when device is connected to the Ethernet



Searching

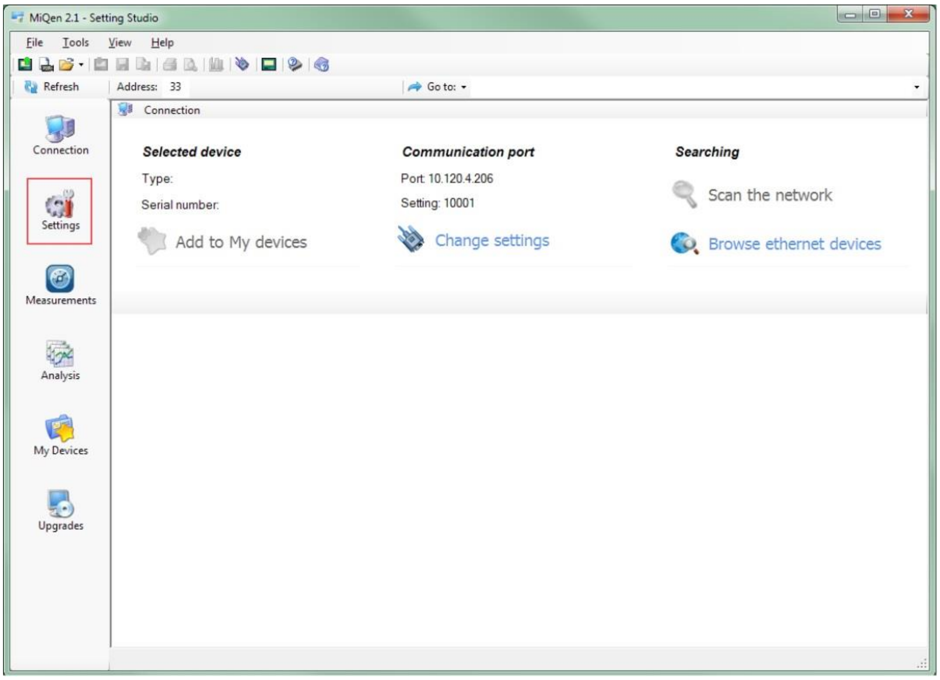
Settings

Programming Power Quality Analyzer iMC784A can be performed ONLINE when device is connected to aux. power supply and is communicating with MiQen. When device is not connected it is possible to adjust settings OFFLINE.

Online programming

After communication with Power Quality Analyzer iMC784A is established, choose icon Settings from a list of MiQen functions on a left side.

MiQen Device Setting window:



Address: 33

Selected device
Type:
Serial number:

Communication port
Port: 10.120.4.206
Setting: 10001

Searching

Choose Read settings button to display all devices settings and begin adjusting them according to project requirement.

PLEASE NOTE

When finished programming, changes should be confirmed by pressing Download settings button in MiQen menu bar or with a mouse right click menu.

PLEASE NOTE

When finished programming, all settings can be saved in a setting file (*.msf file). This way it is possible to archive settings in combination with a date. It is also possible to use saved settings for offline programming or to program other devices with same settings. For more information see OFFLINE programming on next page.

Offline programming

When Power Quality Analyzer iMC784A is not physically present or is unable to communicate, it is still possible to perform OFFLINE programming. From MiQen Device Setting window choose Open setting file button.

From a list of *.msf files choose either previously stored file (a setting file, which has been used for another device and stored) or a file MXxxx.msf, which holds default settings for this device.

When confirmed all device settings are displayed similar as with ONLINE programming.

When finished programming, all settings can be saved in a setting file with a meaningful name (e.g. *MXxxx_location_date*.msf). If file will be used for setting the device via Memory card (only for devices with Memory card support), special name format needs to be used.

Settings are stored in the directory setting using two recording modes:

- With a type designation and a sequence number from 1 to 9
- With an device serial number

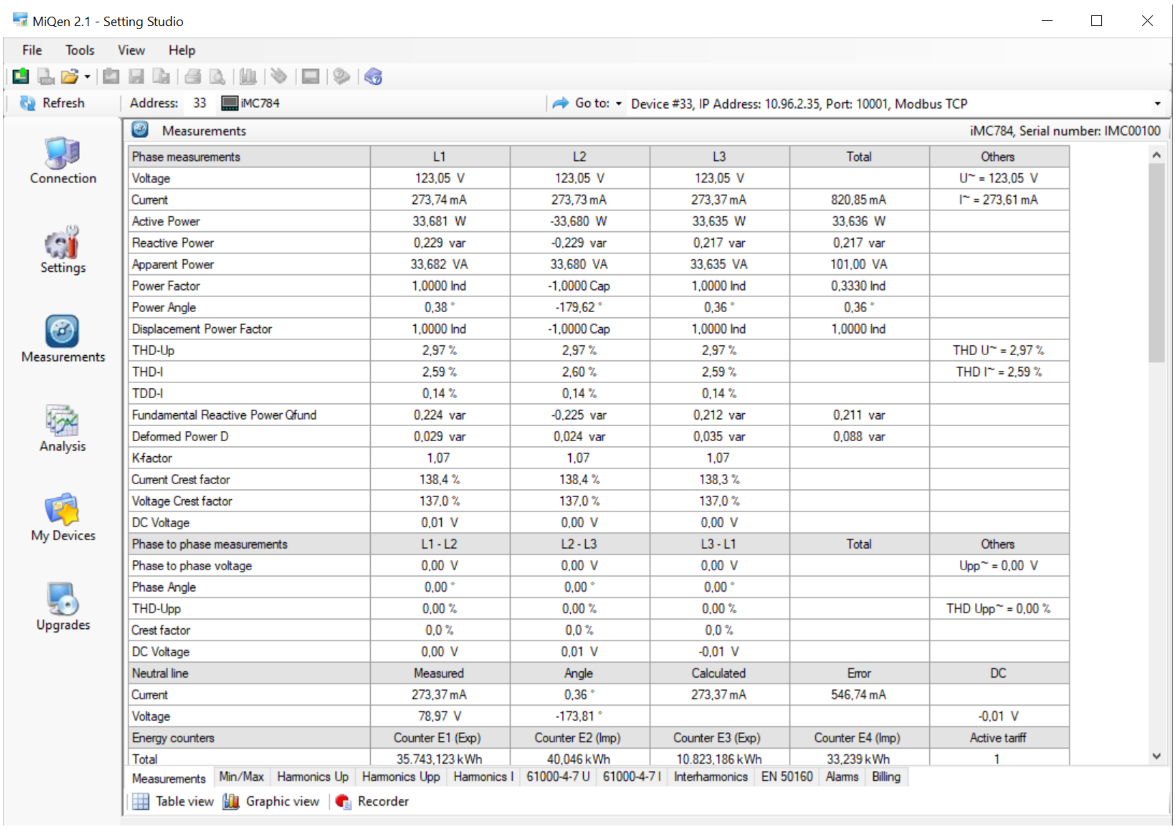
CAUTION

MXxxx.msf file or any other original device setting file should not be modified as it contains device default settings. Please save setting file under another name before adjusting it with your own project requirements.

Measurements

Measurements can be seen ONLINE when Power Quality Analyzer iMC784A is connected to aux. power supply and is communicating with MiQen. When device is not connected it is possible to see OFFLINE measurements simulation. The latter is useful for presentations and visualization of measurements without presence of actual device.

In ONLINE mode all supported measurements and alarms can be seen in real time in a Table view. For some devices also presentation in graphical form is supported.



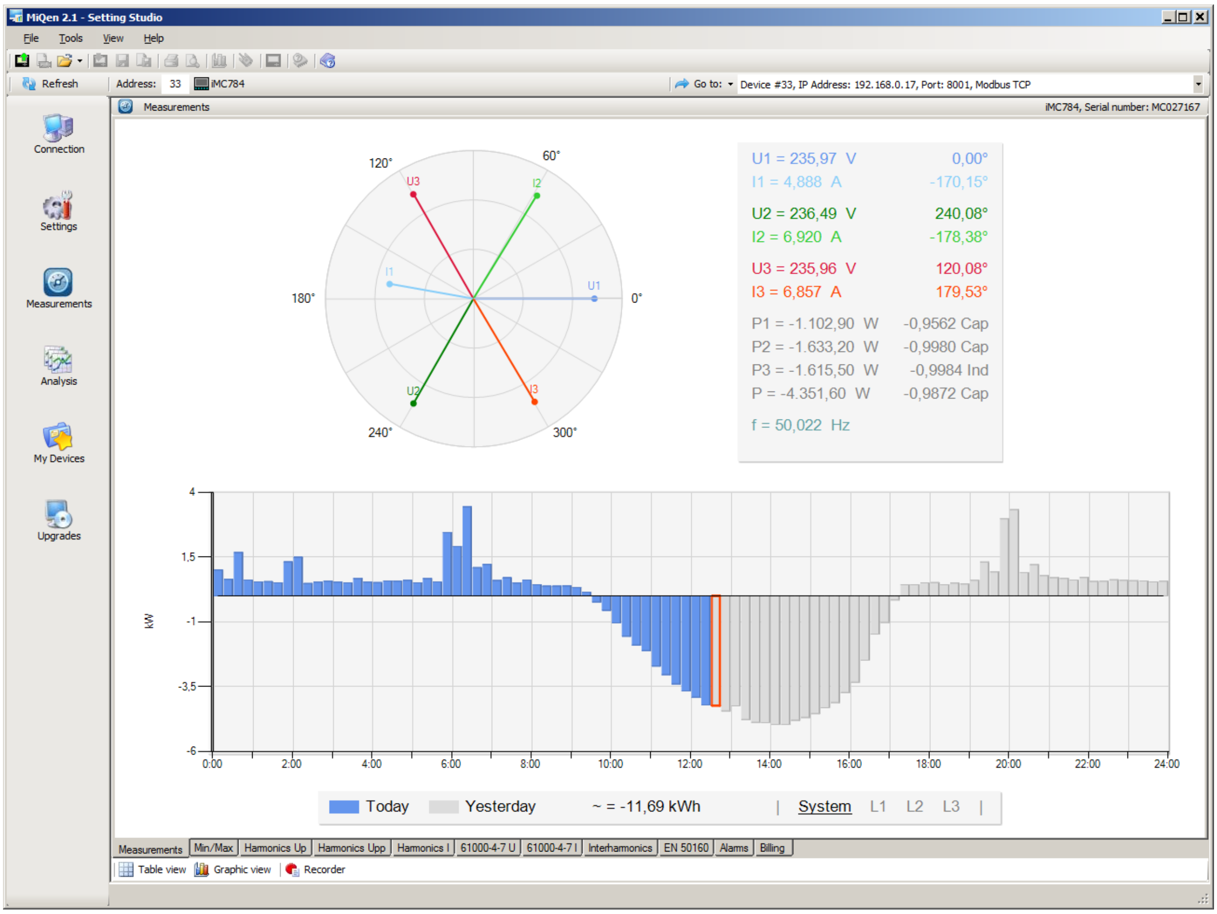
Address: 33 iMC784

Go to: Device #33, IP Address: 10.96.2.35, Port: 10001, Modbus TCP

Measurements — iMC784, Serial number: IMC00100

Phase measurements	L1	L2	L3	Total	Others
Voltage	123,05 V	123,05 V	123,05 V		U~ = 123,05 V
Current	273,74 mA	273,73 mA	273,37 mA	820,85 mA	I~ = 273,61 mA
Active Power	33,681 W	-33,680 W	33,635 W	33,636 W	
Reactive Power	0,229 var	-0,229 var	0,217 var	0,217 var	
Apparent Power	33,682 VA	33,680 VA	33,635 VA	101,00 VA	
Power Factor	1,0000 Ind	-1,0000 Cap	1,0000 Ind	0,3330 Ind	
Power Angle	0,38 °	-179,62 °	0,36 °	0,36 °	
Displacement Power Factor	1,0000 Ind	-1,0000 Cap	1,0000 Ind	1,0000 Ind	
THD-Up	2,97 %	2,97 %	2,97 %		THD U~ = 2,97 %
THD-I	2,59 %	2,60 %	2,59 %		THD I~ = 2,59 %
TDD-I	0,14 %	0,14 %	0,14 %		
Fundamental Reactive Power Qfund	0,224 var	-0,225 var	0,212 var	0,211 var	
Deformed Power D	0,029 var	0,024 var	0,035 var	0,088 var	
K-factor	1,07	1,07	1,07		
Current Crest factor	138,4 %	138,4 %	138,3 %		
Voltage Crest factor	137,0 %	137,0 %	137,0 %		
DC Voltage	0,01 V	0,00 V	0,00 V		
Phase to phase measurements	**L1 - L2**	**L2 - L3**	**L3 - L1**	**Total**	**Others**
Phase to phase voltage	0,00 V	0,00 V	0,00 V		Upp~ = 0,00 V
Phase Angle	0,00 °	0,00 °	0,00 °		
THD-Upp	0,00 %	0,00 %	0,00 %		THD Upp~ = 0,00 %
Crest factor	0,0 %	0,0 %	0,0 %		
DC Voltage	0,00 V	0,01 V	-0,01 V		
Neutral line	**Measured**	**Angle**	**Calculated**	**Error**	**DC**
Current	273,37 mA	0,36 °	273,37 mA	546,74 mA	
Voltage	78,97 V	-173,81 °			-0,01 V
Energy counters	**Counter E1 (Exp)**	**Counter E2 (Imp)**	**Counter E3 (Exp)**	**Counter E4 (Imp)**	**Active tariff**
Total	35.743,123 kWh	40,046 kWh	10.823,186 kWh	33,239 kWh	1

Online measurements in Table view



Address: 33 iMC784

Device #33, IP Address: 192.168.0.17, Port: 8001, Modbus TCP

iMC784, Serial number: MC027167

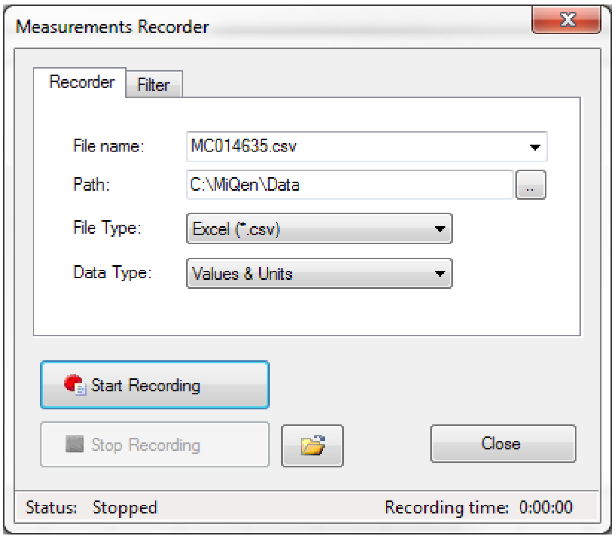
U1 = 235,97 V 0,00°
I1 = 4,888 A -170,15°
U2 = 236,49 V 240,08°
I2 = 6,920 A -178,38°
U3 = 235,96 V 120,08°
I3 = 6,857 A 179,53°
P1 = -1.102,90 W -0,9562 Cap
P2 = -1.633,20 W -0,9980 Cap
P3 = -1.615,50 W -0,9984 Ind
P = -4.351,60 W -0,9872 Cap
f = 50,022 Hz

~ = -11,69 kWh

Online measurements in graphical form – phasor diagram and daily total active power consumption histogram

Different measuring data can be accessed by means of tabs (Measurements, Min/Max…) in the lower part of MiQen window.

For further processing of real time measuring results, it is possible to set a recorder (Recorder button) on active device that will record and save selected measurements to MS Excel .csv file format. Data can then be analyzed and processed in any program that supports files in CSV format.



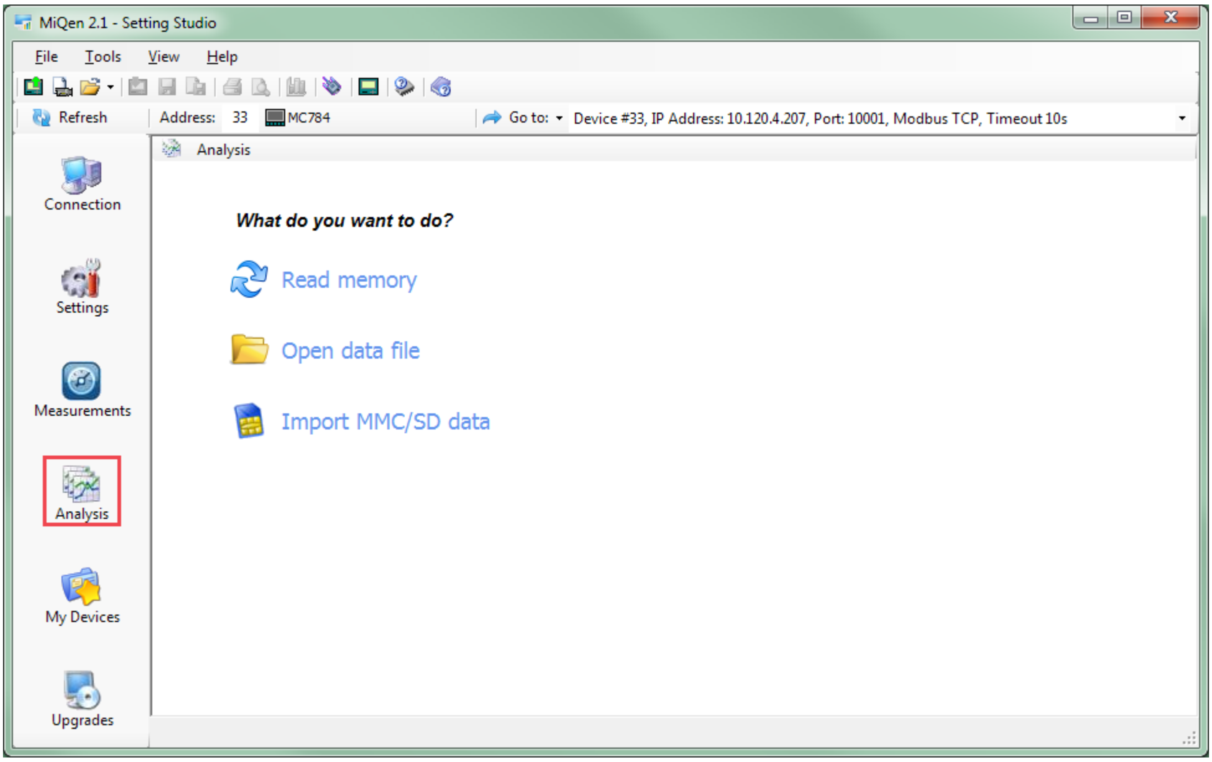
File name: MC014635.csv
Path: C:\MiQen\Data
File Type: Excel (*.csv)
Data Type: Values & Units

Status: Stopped
Recording time: 0:00:00

Window for setting local database recording parameters

Data analysis

MiQen enables also analysis of the historical data stored in Power Quality Analyzer iMC784A internal memory (for devices with built in memory only). In order to perform analysis data source has to be defined first. Data source can be one of the selected:



Read memory

This option should be selected to download and analyze the data from currently active device. Data is read directly from a devices internal memory.

Open data file

This option should be selected to analyze the data already stored on the computer. Data is read from a local database.

My Devices

In My Devices user can store connections to devices that are used more often. Each device can be assigned to user defined group and equipped with user defined description and location for easier recognition. By selecting device from the list, access to device settings and downloaded and recorded files is much easier.

Upgrade

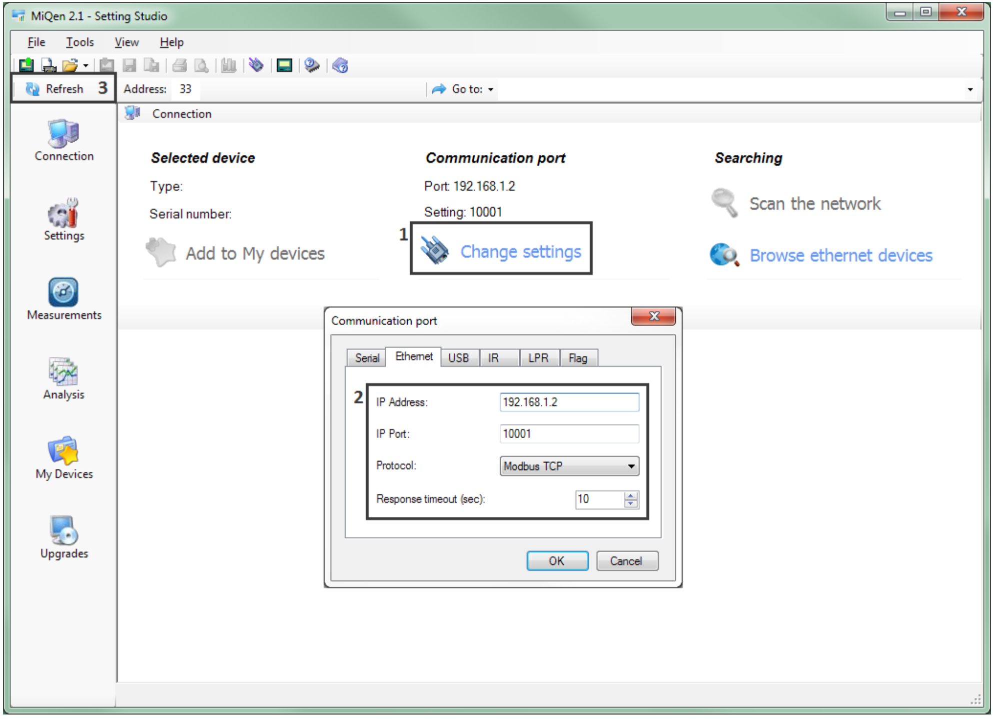
In Upgrades section latest software, both for MiQen and ISKRA measuring devices can be found. The latest version should always be used to assure full functionality. Manual or automatic checking for upgrades is available. Internet connection is required.

List of available updates is divided in to various sections for easier navigation. Each section is named by software or family of devices (MiQen software, Measuring centres’, Measuring transducers...). History file with data about corrections and added functionality is also available.

Software upgrading

After downloading all necessary firmware upgrade files you can perform upgrade using MiQen software. Device first needs to be added to My devices. To do this the device you want to upgrade should first be selected from the list of available devices or by directly entering its' communication settings:

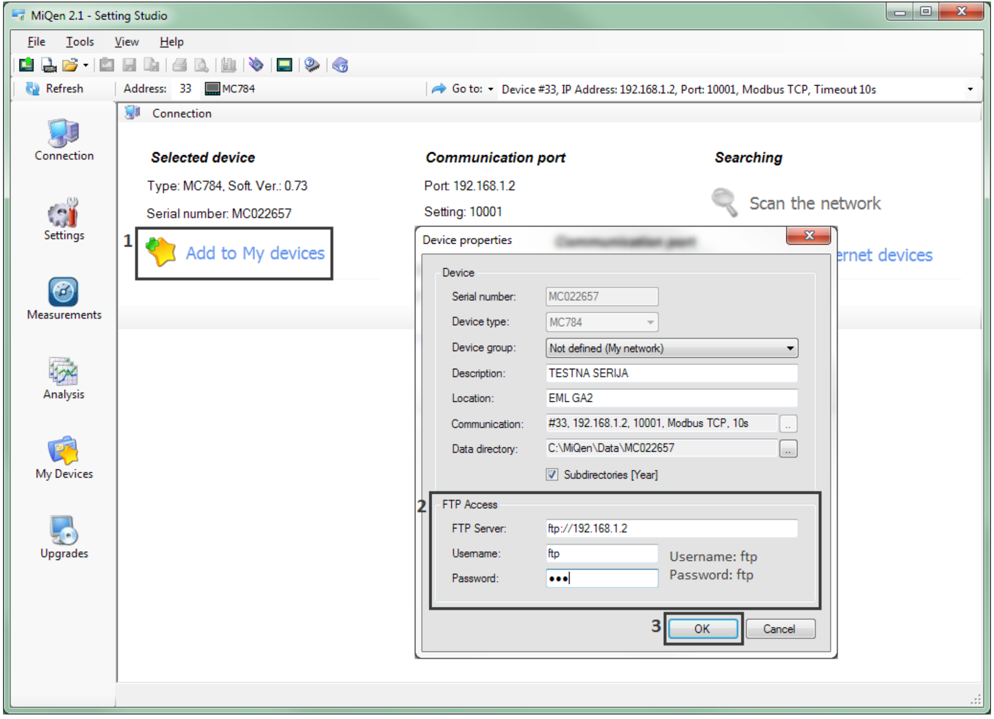
- Connect to your device via Ethernet communication:



Port: 192.168.1.2
Setting: 10001

IP Address: 192.168.1.2
IP Port: 10001
Protocol: Modbus TCP
Response timeout (sec): 10

- Add your device to My Devices:



Device #33, IP Address: 192.168.1.2, Port: 10001, Modbus TCP, Timeout 10s

Type: MC784, Soft. Ver.: 0.73
Serial number: MC022657
Port: 192.168.1.2
Setting: 10001

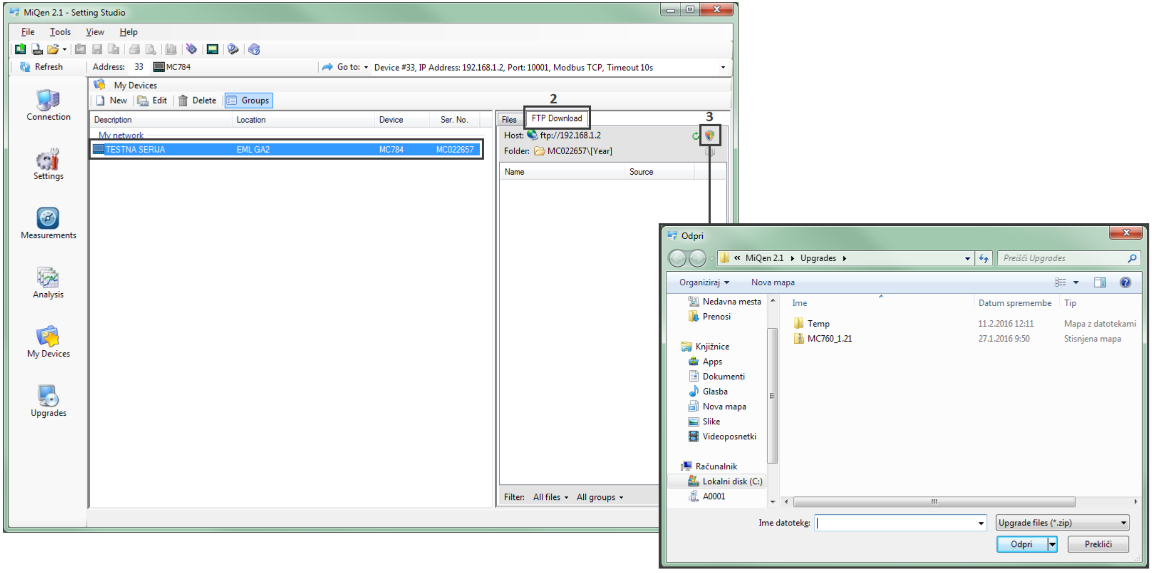
Serial number: MC022657
Device type: MC784
Device group: Not defined (My network)
Description: TESTNA SERIJA
Location: EML GA2
Communication: #33, 192.168.1.2, 10001, Modbus TCP, 10s
Data directory: C:\MiQen\Data\MC022657
☑ Subdirectories [Year]

FTP Server: ftp://192.168.1.2
Username: ftp
Password: •••

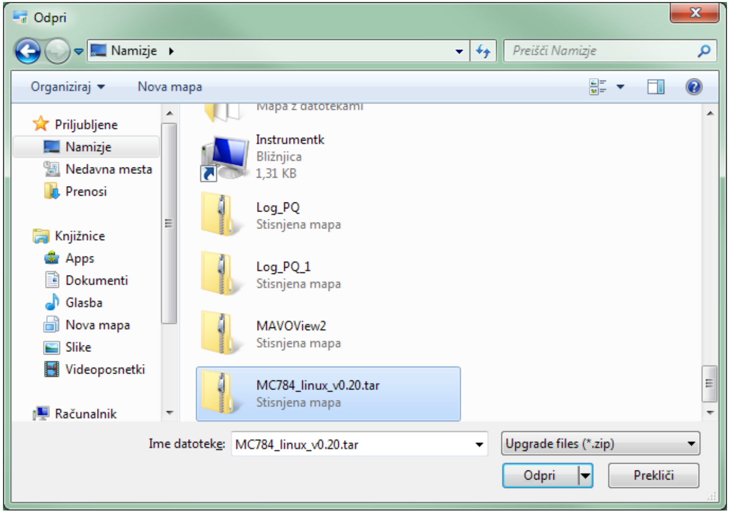
Username: ftp
Password: ftp

Username: ftp
Password: ftp

- My Devices tab will open (select your device by double-clicking on it):



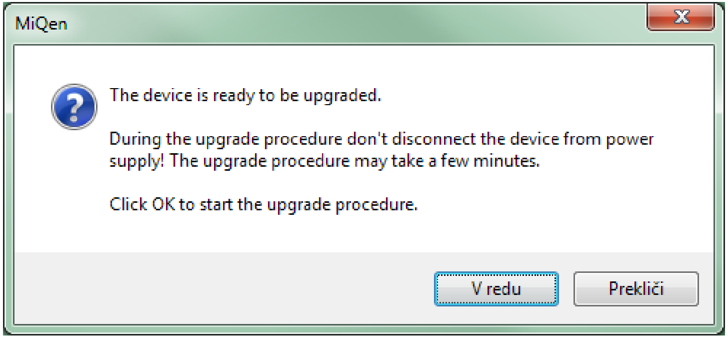
- Browse to already downloaded upgrade file; Firmware/Linux OS/TFT LCD - iMC784A color TFT LCD display only:



Ime datoteke: MC784_linux_v0.20.tar

Click Open.

- Following window will pop up:



The device is ready to be upgraded.

During the upgrade procedure don't disconnect the device from power supply! The upgrade procedure may take a few minutes.

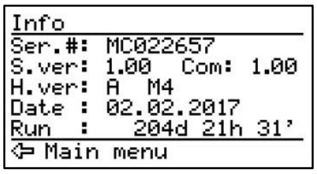
Click OK to start the upgrade procedure.

Click Ok to start upgrade procedure.

Upgrade file will get transferred to ftp. Upgrade procedure will initiate at first open window.

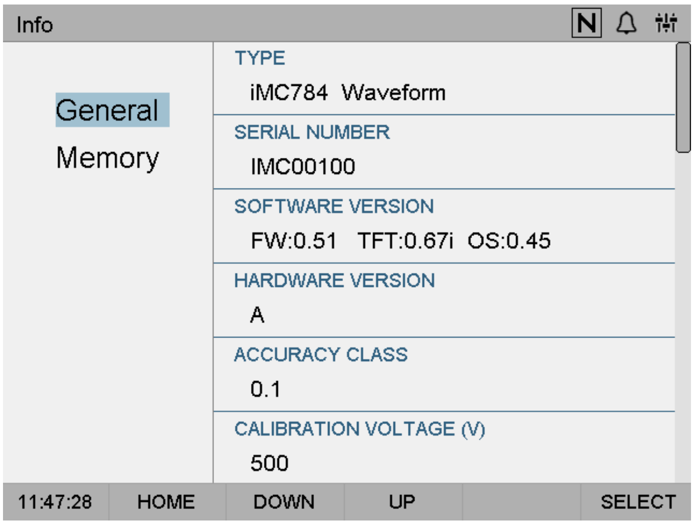
Check version:

iMC784A: LCD screen navigation - Main menu > Info > down arrow ⇩:



```
Info
Ser.#: MC022657
S.ver: 1.00  Com: 1.00
H.ver: A  M4
Date : 02.02.2017
Run  :    204d 21h 31’
⇦ Main menu
```

iMC784A: TFT LCD screen navigation - Main menu > Info:



TYPE
iMC784 Waveform

SERIAL NUMBER
IMC00100

SOFTWARE VERSION
FW:0.51 TFT:0.67i OS:0.45

HARDWARE VERSION
A

ACCURACY CLASS
0.1

CALIBRATION VOLTAGE (V)
500

PLEASE NOTE

FW upgrade – start of upgrade procedure will show up on device screen, after transferring upgrade file to ftp. It takes around 5 min to finish upgrade procedure. Do not disconnect device during upgrade. Communication to device is lost during upgrade.

OS upgrade – upgrade procedure will run in background, after transferring upgrade file to ftp. It takes around 5min to finish upgrade procedure. Do not disconnect device during upgrade. Communication to device is lost during upgrade.

TFT LCD upgrade (iMC784A color TFT LCD display only) – upgrade procedure start is indicated on device screen, after transferring upgrade file to ftp. It takes around 5min to finish upgrade procedure. Do not disconnect device during upgrade. Communication to device is lost during upgrade.

Setting procedure

Before configuring Power Quality Analyzer iMC784A with MiQen software, current settings should be read first. Reading is available either via communication or from a file (stored on a local disk). A setting structure that is similar to a file structure in an explorer is displayed in the left part of the MiQen setting window. Available settings of that segment are displayed in the right part by clicking any of the stated parameters.

PLEASE NOTE

Some settings may not be available due to unsupported measurements and/or functions that depend on the device type.

General Settings

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

Description and Location

Description is intended for easier recognition of a certain unit in a network.
It is especially used for identification of Power Quality Analyzer iMC784A on which measurements are performed.

Average interval

The averaging interval defines a refresh rate of measurements on display, communication. It is used also as averaging interval for minimum and maximum values stored in recorder and actual alarm value calculation for alarm triggering.

Average interval for measurements

The averaging interval defines a refresh rate of measurements on display, communication and analogue outputs. It also defines response time for alarms set to Normal response (see chapter Alarms).
- Shorter average interval means better resolution in minimum and maximum value in to recorded period detection and faster alarm response. Also data presented in display will refresh faster.
- Longer average interval means lower minimum and maximum value in recorded period detection and slower alarm response (alarm response can be delayed also with Compare time delay setting – See chapter Alarms). Also data on display will refresh slower.
Interval can be set from 0.1 to 5 s. Default value is 1 s.

Average interval for Min/Max values

The averaging interval for Min/Max values defines an interval on which values will be averaged to track Min and Max values. By choosing shorter interval also very fast changes in the network will be detected. Interval can be set form 1 to 256 periods.

PLEASE NOTE

This setting applies only for min. and max. values displayed on LCD and accessible on communication. These values are not used for storing into internal recorder.

Language

Set language for display.

Currency

Choose currency for evaluating energy cost. A currency designation consists of up to four letters taken from the English alphabet, 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			:	;	<	=	>	?	@

Temperature unit

Choose a unit for temperature display. Degrees Celsius or degrees Fahrenheit are available.

Date format

Set a date format for time stamped values.

Date and Time

Set date and time of Power Quality Analyzer iMC784A. Setting is important for correct memory operation, maximal values (MD), etc. If instrument is connected to one of supported time synchronization sources, date and time are automatically set.

Time Synchronization source

Synchronized real-time clock (RTC) is an essential part of any Class A analyzer for proper chronological determination of various events. To distinct cause from consequence, to follow a certain event from its origin to manifestation in other parameters it is very important that each and every event and recorded measurement on one device can be compared with events and measurements on other Power Quality Analyzer iMC784A. Even if Power Quality Analyzers iMC784A are dislocated, which is normally the case in electro distribution network events have to be time-comparable with accuracy better than a single period.

For this purpose, Power Quality Analyzers iMC784A normally support highly accurate internal RTC. Still this is not enough, since temperature is location dependent and it influences its precision. For that reason it is required to implement periodical RTC synchronization.

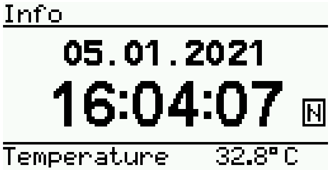
CAUTION

RTC synchronization is essential part of Class A instrument. If no proper RTC synchronization is provided, Power Quality Analyzer iMC784A operates as Class S instrument.

This setting is used to choose primary synchronization source.

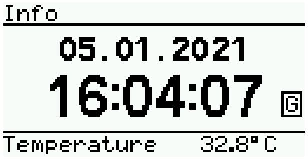
- NO synchronization (not advisable, see CAUTION above)
- NTP synchronization
- MODULE C synchronization

Synchronization status can be checked on display when set to INFO display.



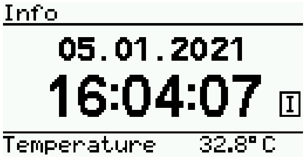
Info
05.01.2021
16:04:07 N
Temperature 32.8°C

Notification icon N shows successful NTP synchronization



Info
05.01.2021
16:04:07 G
Temperature 32.8°C

Notification icon G shows successful GPS synchronization. If only 1pps signal is present (without date and time feed) notification icon G is present



Info
05.01.2021
16:04:07 I
Temperature 32.8°C

Notification icon I shows successful IRIG synchronization

Time Zone

Set time zone in which device is mounted. Time zone influences internal time and time stamps. When UTC time is required, time zone 0 (GMT) should be chosen.

Auto Summer/Winter time

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 device provides maximum demand values from a variety of average demand values:

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

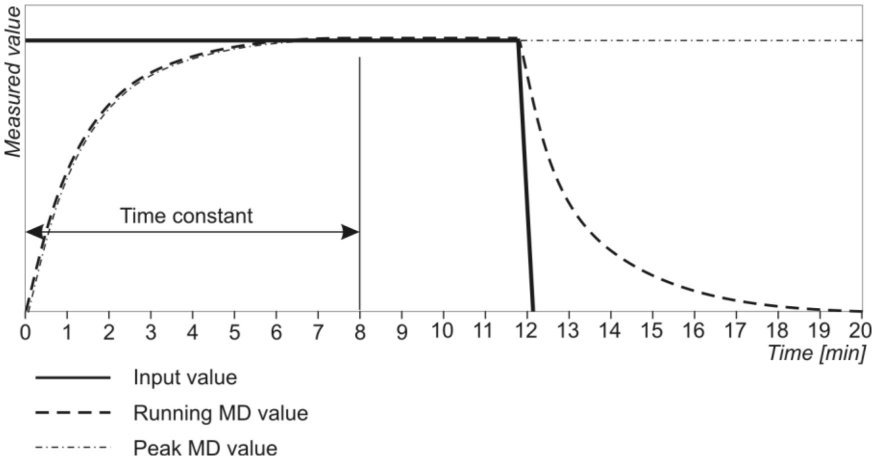
Default setting is thermal function. In case of setting new function reset of MD values should be done.

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 Power Quality Analyzer iMC784A. A time constant can be set from 1 to 255 minutes and is 6 times thermal time constant (t. c. = 6 × thermal time constant).

Example:

Mode:	Thermal function
Time constant:	8 min
Running MD and maximal MD:	Reset at 0 min

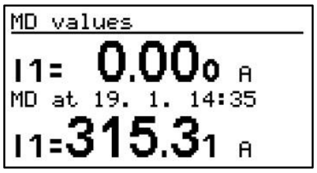


Operation of thermal MD function

Fixed window

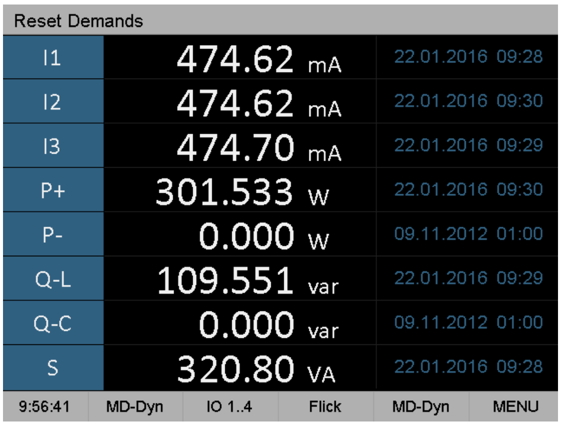
A fixed window is a mode that calculates average value over a fixed time period. Time constant can be set from 1 to 255 min.
»Time into period« as displayed in MiQen – help tip actively shows the remaining time until the end of the period in which current MD and maximal MD from the last reset are calculated.
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 INTO PERIOD« then shows 0 of X min where X is Time Constant.

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 INTO 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 INTO PERIOD« is set to 0.



MD values
I1= 0.000 A
MD at 19. 1. 14:35
I1=315.31 A

Figure above shows display of MD measurement for current I1. Running MD is displayed (0 mA), max. value of MD since last reset is displayed and its time of occurrence.



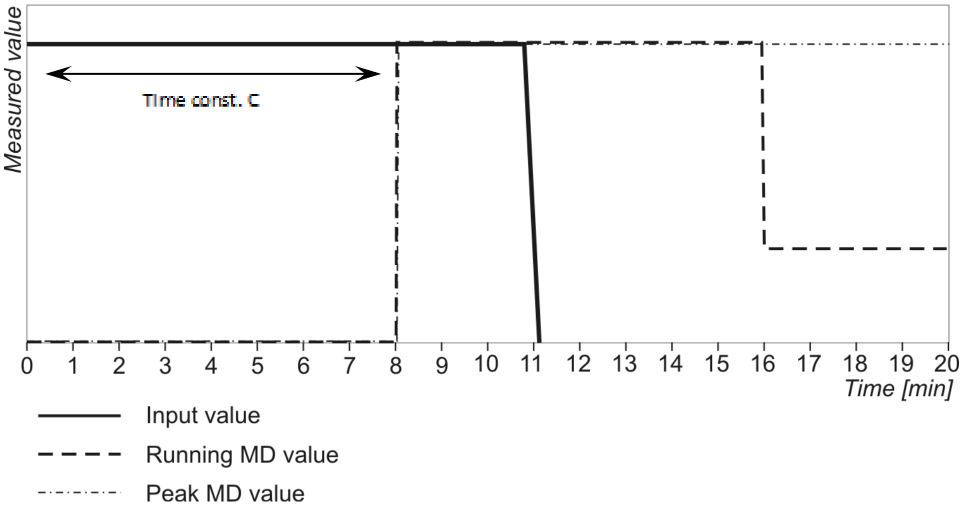
Reset Demands

I1	474.62 mA	22.01.2016 09:28
I2	474.62 mA	22.01.2016 09:30
I3	474.70 mA	22.01.2016 09:29
P+	301.533 W	22.01.2016 09:30
P-	0.000 W	09.11.2012 01:00
Q-L	109.551 var	22.01.2016 09:29
Q-C	0.000 var	09.11.2012 01:00
S	320.80 VA	22.01.2016 09:28

Figure above shows display of MD measurements. Max. value of MD since last reset is displayed and its time of occurrence.(Only supported by iMC784A with color TFT LCD display).

Example:

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



Operation of Fixed window MD function

Sliding windows

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

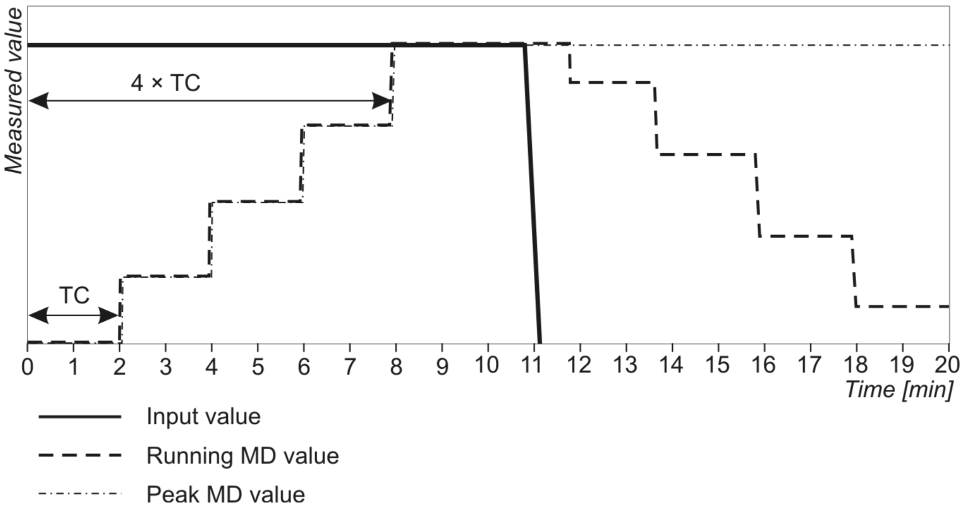
A number of sub-periods can be set from 2 to 15. A time constant can be set from 1 to 255 minutes.

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 INTO 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 INTO PERIOD« is set to 0.

Example:

Mode: Sliding windows
Time constant: 2 min.
No. of sub-periods: 4
Running 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 running MD and a maximal MD are reset at 0 min. "Time into period" is data for a sub period so that the values for a running MD and a maximal MD are refreshed 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.



Operation of sliding window MD function

Maximum demand reset mode

This setting defines a mode of resetting Max demand values. It can be set to:

Manual: User resets max demand value with keypad or setting software.

Automatic:

- Daily: every day at 00:00,
- Weekly: on Monday at 00:00,
- Monthly: the first day in a month at 00:00,
- Yearly: the first day in a year 1.1. at 00:00

Min/Max reset mode

This setting defines a mode of resetting stored Min/Max values. It can be set to.

Manual: User resets min/max values with keypad or setting software.

Automatic:

- Daily: every day at 00:00,
- Weekly: on Monday at 00:00,
- Monthly: the first day in a month at 00:00,
- Yearly: the first day in a year 1.1. at 00:00

Starting Current for PF and PA (mA)

All measuring te are influenced by noise of various frequencies. It is more or less constant and its influence to the accuracy is increased by decreasing measuring signals. It is present also when measuring signals are not present or are very low. It causes very sporadic measurements.
This setting defines the lowest current that allows regular calculation of Power Factor (PF) and Power Angle (PA). The value for starting current should be set according to conditions in a system (level of noise, random current fluctuation …)

Starting current for all powers (mA)

Noise is limited with a starting current also at measurements and calculations of powers. The value for starting current should be set according to conditions in a system (level of noise, random current fluctuation …)

Starting voltage for all Powers (V)

Noise is limited with a starting voltage also at measurements and calculations of powers. Until voltage reaches user defined starting voltage limit, all powers are set to 0. Using three wire electrical connections, virtual phase voltage is used in calculations.

Starting voltage for SYNC

Power Quality Analyzer iMC784A needs to synchronize its sampling with measuring signals period to accurately determine its frequency. For that purpose, input signal has to large enough to be distinguished from a noise.
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 Starting current for PF and PA setting, synchronization is not possible and frequency displayed is 0.
The value for starting voltage should be set according to conditions in a system (level of noise, random voltage fluctuation …)

Harmonics calculation

Relative harmonic values can be different according to used base unit. According to requirements relative harmonics can be calculated as:

- percentage of TRMS signal value (current, voltage) or
- percentage of the fundamental (first harmonic).

Reactive power & energy calculation

Harmonic distortion can significantly influence reactive power and energy calculation. In absence of harmonic distortion both described methods will offer the same result. In reality harmonics are always present. Therefore it is up to project requirements, which method is applicable.
User can select between two different principles of reactive power and energy calculation:

Standard method:

With this method a reactive power and energy are calculated based on assumption that all power (energy), which is not active, is reactive.
Q2 = S2 – P2
This means also that all higher harmonics (out of phase with base harmonic) will be measured as reactive power (energy).

Displacement method:

With this method, reactive power (energy) is calculated by multiplication of voltage samples and by 90° displaced current samples.
Q = U × I|+90°
With this method, reactive power (energy) represents only true reactive component of apparent power (energy).

LCD navigation

iMC784A with graphic LCD display

Main menu	
Measurements	
Settings	
Resets	
Info	
Installation	
14.5.2021	16:53:36

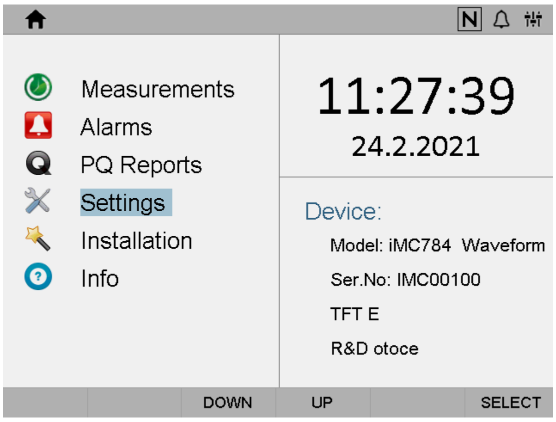
→

Settings
General
Date & Time
Connection
Communication
LCD
Security
Energy
Inputs/Outputs
⇦ Main menu

Main menu > Settings > General > Language / Currency / Temperature unit / MD mode / MD time constant / Average interval / Min/Max reset mode

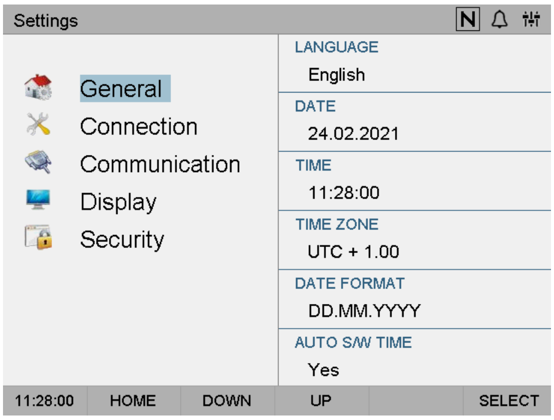
Main menu > Settings > Date & Time > Date / Time / Date format / automatic S/W time

iMC784A with color TFT LCD display



11:27:39
24.2.2021

Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce



LANGUAGE
English
DATE
24.02.2021
TIME
11:28:00
TIME ZONE
UTC + 1.00
DATE FORMAT
DD.MM.YYYY
AUTO S/W TIME
Yes

Main menu > Settings > General:

- LANGUAGE
- DATE
- TIME
- TIME ZONE
- DATE FORMAT
- AUTO S/W TIME

Connection

CAUTION

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

Connection mode

When connection is selected, load connection and the supported measurements are defined.

Setting of current and voltage ratios

Before setting current and voltage ratios it is necessary to be familiar with the conditions in which Power Quality Analyzer iMC784A will be used. All other measurements and calculations depend on these settings. Up to five decimal places can be set (up / down). To set decimal point and prefix (up / down) position the cursor (left /right) to last (empty) place or the decimal point.
Aux CT transformer ratios can be set separately from phase CT ratios since Aux CT could differ from phase CTs.
Range of CT and VT ratios:

Settings range	VT primary	VT secondary	CT, Aux CT primary	CT, Aux CT secondary
Max value	1638,3 kV	13383 V	1638,3 kA	13383 A
Min value	0,1 V	0,1 V	0,1 A	0,1 A

Neutral line Primary/Secondary current (A)

Primary/Secondary current of neutral line current transformer.

Used voltage/current range (V/A)

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. In case of subsequent change of the range, alarms settings shall be correspondingly changed, as well.

CAUTION

In case of subsequent change of those ranges shall be alarm and analogue output settings correspondingly changed as well.
Already recorded values will not be valid after change of used voltage and current range!

Frequency nominal value (Hz)

Nominal frequency range can be selected from a set of predefined values. A valid frequency measurement is within the range of nominal frequency ±32 Hz.
This setting is used for alarms and recorders only.

Max. demand current for TDD (A)

Select maximum current (CT or fuse rating) at a point of instrument connection for proper TDD calculation. TDD is unlike THD a measure of harmonics relative to fixed value of max. demand current. Therefore TDD is a demand independent measure of current harmonics.

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.

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

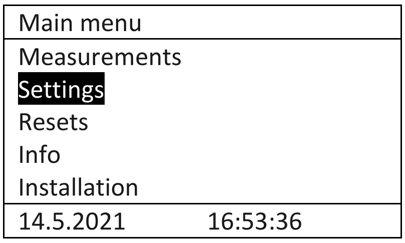
If this setting is set to REVERSED it has the same influence as if CT’s would be reversely connected. All power readings will also change its sign.
This setting is useful to correct wrong CT connections.

Measuring input channel mapping

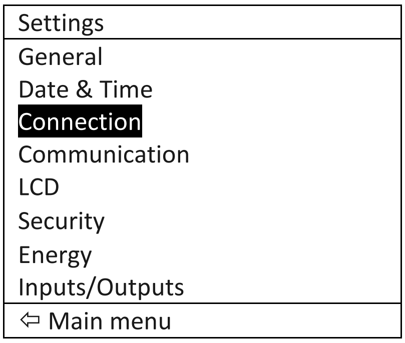
Select the terminals for measuring channels of voltages and currents.

LCD navigation

iMC784A Graphic pixel display



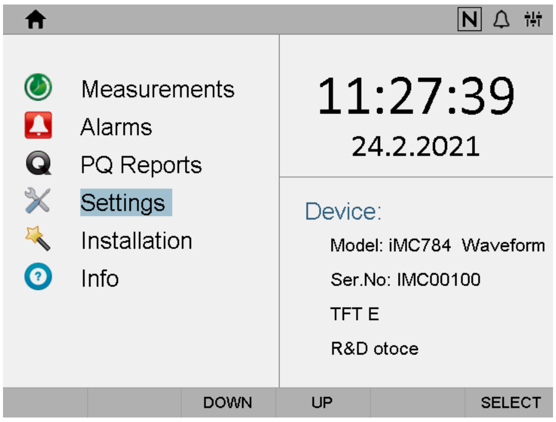
→



Main menu > Settings > Connection > Connection mode

Main menu > Settings > Connection > VT primary/VT secondary/CT primary/CT secondary/Aux CT primary/Aux CT secondary

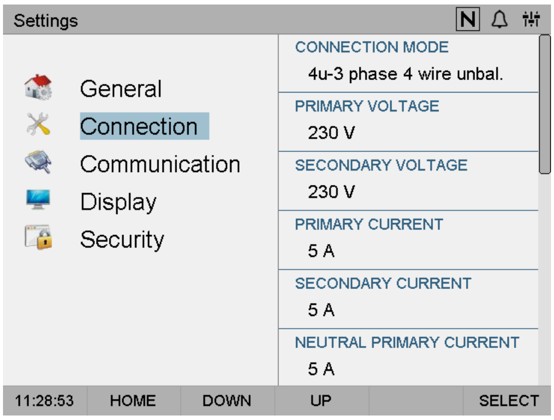
iMC784A color TFT LCD display



11:27:39
24.2.2021

Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce

→



CONNECTION MODE
4u-3 phase 4 wire unbal.
PRIMARY VOLTAGE
230 V
SECONDARY VOLTAGE
230 V
PRIMARY CURRENT
5 A
SECONDARY CURRENT
5 A
NEUTRAL PRIMARY CURRENT
5 A

Main menu > Settings > Connection:

- CONNECTION MODE
- PRIMARY VOLTAGE
- SECUNDARY VOLTGE
- PRIMARY CURRENT
- SECUNDARY CURRENTT
- NEUTRAL PRIMARY CURRENT
- NEUTRAL SECUNDARY CURRENT
- USED VOLTAGE RANGE
- USED CURRENT RANGE

Communication

USB Communication

There is no special setting for USB communication. For more detailed information how to handle Power Quality Analyzer iMC784A with USB communication use Help section in MiQen software.

PLEASE NOTE

Power Quality Analyzer iMC784A supports only a single communication input (USB or Ethernet) at a time when using primary communication port COM1. USB communication has priority. If communication using Ethernet is in progress, do not connect to USB since it will terminate Ethernet connection. When USB cable is unplugged from the device Ethernet communication is again available.

PLEASE NOTE

When Power Quality Analyzer iMC784A is connected to a PC through USB communication for the first time, it will get recognized by windows environment and a driver will get automatically installed. With driver installed, USB is redirected to a serial port, which should be selected when using MiQen software. If experiencing problems with driver installation you can find drivers in MiQen installation folder – in subfolder Drivers (example: C (root):\Program Files (x86)\MiQen 2.1\Drivers), for manual install.

Ethernet communication

Ethernet communication is used for connection of device to the Ethernet network for remote operation. Each Power Quality Analyzer iMC784A has its own MAC address that at some cases needs to be provided and is printed on the label on the device.

MAC Address

Read only information about Power Quality Analyzer iMC784A MAC address.

Device Address

Power Quality Analyzer iMC784A Address: Device address is important when user is trying to connect to device via MiQen software. Usable range of addresses is from 1 to 247. Default address number is 33. (Not important when Ethernet communication is used.)

Firmware version

Read only information about communication module firmware version. (iMC784A – Read only information about Linux OS module firmware version)

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.

IP Hostname

It is the nickname that is given to Power Quality Analyzer iMC784A. Hostnames may be simple names consisting of a single word or phrase or they may be structured. The setting is used in automatic (DHCP) mode only.

Local port

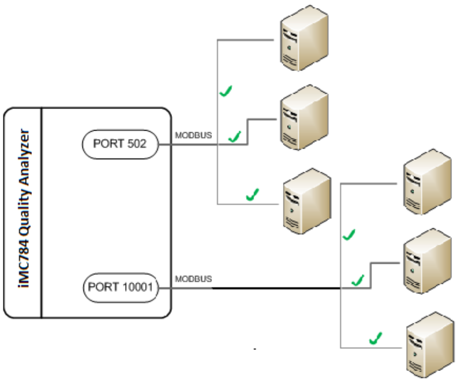
When using Ethernet communication Power Quality Analyzer iMC784A has opened two local ports.

- Fixed port number 502, which is a standard MODBUS port. Power Quality Analyzer iMC784A allows multiple connections to this port.
- User defined port. Any port number is allowed except reserved ports (table below). Only a single connection is allowed to this port. When this port is used all other connections (including connection to port 502) are disabled. This is a terminal type of connection.

Terminal type of connection is used when due to a performed function other connections are not allowed. This is the case when firmware update is performed. In other cases it is advised to use port 502.
When port 502 is used a remote application(s) can access device regardless the setting for *Local Port* in a device. This setting is applicable only when terminal access is required.

Reserved TCP Port numbers

Important port numbers	Function
1 – 1024, 9999, 30718, 33333	Reserved numbers!
502	Standard MODBUS port – fixed
33333	UDP port used for Device Discovery Service



Multiple connections to a device

Port 502

Is standardized port to communicate with the device via MODBUS/TCP communication protocol and is fixed. Communication via this port allows multiple connections to the device. Communication over this port does not block any other traffic.

Port 33333

This UDP port is reserved for Discovery Service, a service run by MiQen software, to discover devices connected in to local Ethernet communication network.

Other available Ports

Other, allowed TCP ports, are acting as terminal port and when connected to it, it blocks all other connections until it is released.

Priority, when connected to this port, has PUSH functionality of the device.

Subnet Mask

It is used to determine what subnet an IP address belongs to.

Gateway Address

It is a gateway that connects separate network segments (LAN, WAN or internet).

NTP Server

IP address of a NTP server used for time synchronization of Power Quality Analyzer iMC784A.
NTP can usually maintain time to within tens of milliseconds over the public Internet, but the accuracy depends on infrastructure properties - asymmetry in outgoing and incoming communication delay affects systematic bias.

⚠ **PLEASE NOTE**

It is recommended that dedicated network rather than public network is used for synchronization purposes.

Factory settings of Ethernet communication are:

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

Push Data Clients settings

When PUSH or MQTT (M2M, machine-to-machine) communication mode are used, data can be sent (pushed/published) to two different servers or MQTT brokers. Within this setting menu, all parameters relevant to used servers or MQTT brokers should be set, as well as the data type for sent data, time synchronization source, and server response time.
For more information about PUSH or MQTT communication mode and XML Data (PUSH) or JSON (MQTT) format data see *Appendices D and E.*

TCP Link 1 and TCP Link 2 (PUSH/MQTT data clients)

IP Address

Hostname or IP address of the server collecting data from devices.

IP Port

IP port of the serve collecting data from devices.

Push protocol

With this setting PUSH communication mode or MQTT is set. For more information about PUSH and MQTT, communication mode see *Communication modes and appendix D.*

Push Response Time (s)

With this setting, a maximum waiting time for acknowledgment of sent data in PUSH communication mode is set. If acknowledgment from a client is not sent within this time, scheduled data will be resent in the next push period. For devices connected to a communication network with slow communication speed, values over 10 seconds need to be selected. If a value lower than 10 seconds is selected, historical data from recorders are pushed immediately one after another. If the value is higher than 10 seconds, an automatic time delay length of 10% of the set value is integrated between the sent packets.

⚠ **PLEASE NOTE**

Response time applies only for Standard TCP protocol.

MQTT Username (optional, depends on MQTT broker configuration)

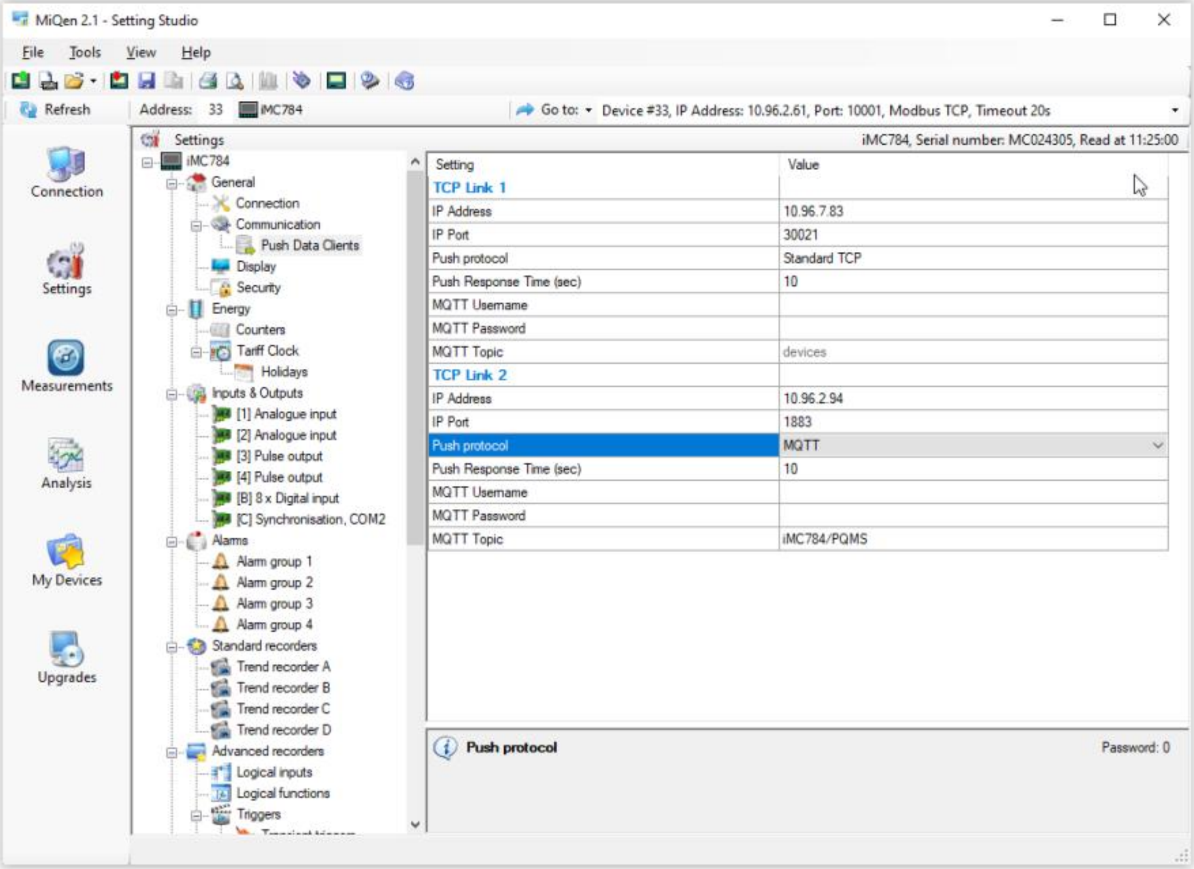
MQTT Password (optional, depends on MQTT broker configuration)

MQTT Root topic root topic for publishing. Use only printable characters without spaces. Complete publish topic consists of three topic levels:

root_topic/serial_number/measurements

Example:

If the root topic is set to power_plant_1
and serial number of the instrument is: MC012345
then measurements publish topic is:
power_plant_1/MC012345/measurement
and alarm publish topic is:
power_plant_1/MC012345/alarm
For all MQTT settings see *MQTT communication* mode *and appendix D.*



Device #33, IP Address: 10.96.2.61, Port: 10001, Modbus TCP, Timeout 20s

iMC784, Serial number: MC024305, Read at 11:25:00

Setting	Value
TCP Link 1	
IP Address	10.96.7.83
IP Port	30021
Push protocol	Standard TCP
Push Response Time (sec)	10
MQTT Username	
MQTT Password	
MQTT Topic	devices
TCP Link 2	
IP Address	10.96.2.94
IP Port	1883
Push protocol	MQTT
Push Response Time (sec)	10
MQTT Username	
MQTT Password	
MQTT Topic	iMC784/PQMS

Communication settings menu

Communication modes

Power Quality Analyzer iMC784A supports two communication modes to suit all demands about connectivity and flexibility.

Standard POLL communication mode is used for most user interaction purposes in combination with monitoring and setting software MiQen, SCADA systems and other MODBUS oriented data acquisition software.

PUSH communication mode is used for sending unsolicited data to predefined links for storing data to various data bases.

POLL 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 device or for a network connection of multiple devices, which requires setting up an appropriate communication infrastructure.
Data is sent from device 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 POLL communication mode, only basic communication settings are required according to communication type (serial, USB, ETHERNET).

PUSH communication mode

PUSH communication mode used for remote monitoring, analysis and reporting.
The most extensive benefits when using Power Quality Analyzer iMC784A is achieved when device is used as a part of an energy monitoring system comprising of strategically positioned meters connected to software solution.

Explanation

When in this communication mode, device (master) is sending values of predefined quantities in predefined time intervals to two independent servers (data collectors - slave), 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 data are not required, but on the other side, reliability for collecting data is essential (e.g. for billing purposes, post processing and issuing trend warnings).
On the other hand, when operating in this mode, the device will send information about alarms immediately as they occur (real time alarm monitoring).
This type of communication also optimizes communication traffic.

Protocol and data format

Power Quality Analyzer iMC784A uses XML format to send the data, which is very common and easy to use also for third party software solutions. Protocol used for data transmission is TCP/IP.
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 packet to the device within every response to received data. If time difference is higher than +/- 2s, device resets its internal clock. For more information about used XML format see Appendix D.

CAUTION

Time synchronization with push system has the lowest priority. If any of other time synchronization sources is available (GPS, NTP, IRIG-B) they have priority to synchronize RTC.
By using time synchronization with push functionality device does not meet requirements for Class A Measuring device and can be used only as a Class S measuring device.

Data transmission

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

It is possible for POLL and PUSH communication mode to be active at the same time. Both communication modes can be handled at the same time if POLL communication is made over COM2 or over Ethernet module through port reserved for communication over MODBUS communication protocol (see chapter Local port on page 63).

Supported quantities and settings

Sending data in PUSH communication mode is closely related with storing measurements in a recorder. Device can sent to the selected server(s) a block of measure quantities that are stored in memory. For each memory division (advanced recorders, recorders A to D, alarms recorder and quality reports with details recorder) separate settings can be made.

Step 1

With MiQen software set proper PUSH Communication settings where time synchronization source, response time, data format and receiving server's parameters are defined.

Step 2

Define data (quantities) for recorder / transmission. For each part of the recorder select to which of the server(s) data will data be sent. This setting can be made for Advanced recorders, Alarms, Recorder A to D, Quality reports and details.

MQTT communication mode

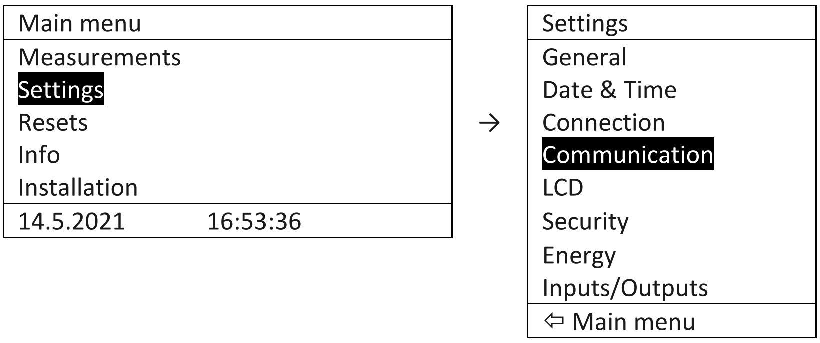
MQTT is a widely accepted transport protocol used in many IoT solutions. It provides a standard way to send measuring data and alarms from the instrument to the MQTT broker.
MQTT client in iMC7xx is intended to publish the same payload as push protocol. Payload configuration is described in chapter "Push communication mode"
MQTT communication mode is activated by setting Push protocol to MQTT.

MQTT Configuration

There are two MQTT clients: TCP Link 1 and TCP Link 2. Both can be used for PUSH protocol or MQTT protocol.

LCD navigation

iMC784A Graphic pixel display

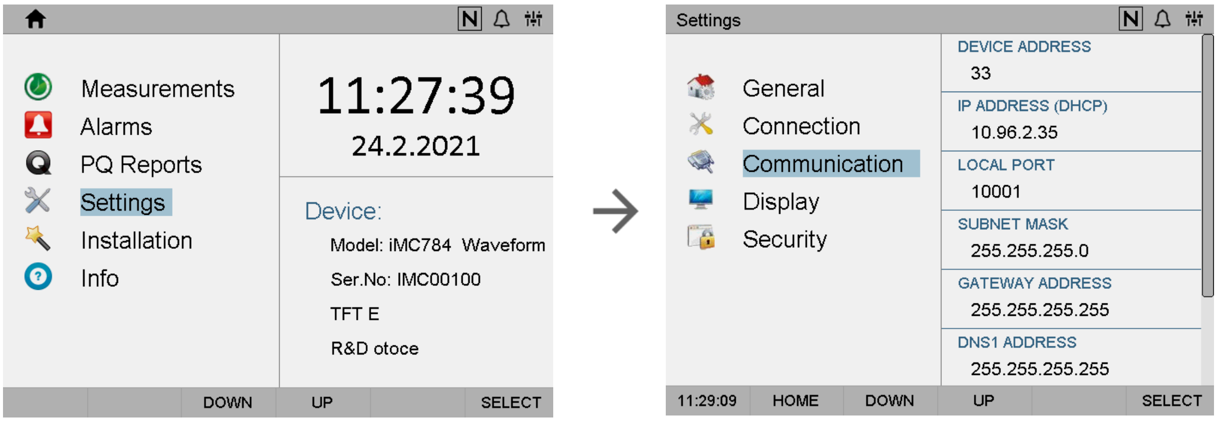


Main menu > Settings > Communication

Main menu > Settings > Communication

Main menu > Settings > Communication > (all settings are not supported on keypad)

iMC784A color TFT LCD display



11:27:39
24.2.2021

Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce

DEVICE ADDRESS
33
IP ADDRESS (DHCP)
10.96.2.35
LOCAL PORT
10001
SUBNET MASK
255.255.255.0
GATEWAY ADDRESS
255.255.255.255
DNS1 ADDRESS
255.255.255.255

11:29:09

Main menu > Settings > Communication:

- DEVICE ADDRESS
- IP ADDRESS
- LOCAL PORT
- SUBNET MASK
- GETWAY ADDRESS
- MAC ADDRESS

Display

Contrast/Black light intensity

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.

Saving mode (min)

Defines the time in minutes, for the instrument to get into energy saving mode (backlight off). Enter value 0 if you don’t want to use energy saving mode.

Demo cycling period (sec)

For demonstration purposes it is useful for device to automatically switch between different displays of measurements.
This setting defines time in seconds for each displayed screen of measurements.

Custom screen 1/2/3

For easier and faster survey of measurements that are important for the user, three settings of customized screens are available. Each customized screen displays three measurements. When setting customized screens the designations are displayed in shorter form, with up to 4 characters. For survey of all designations see chapter Selection of available quantities.

Example:

Customized screen 1	Customized screen 2	Customized screen 3	Combined customized screen 4
U1	I_{TOT}	$\varphi_{1\text{-}3\_RMS}$	U1
$U_{P\text{-}P\_avg}$	I_{NM}	f	$U_{P\text{-}P\_avg}$
$U_{UNBALANCE}$	I_{AVG}	THD-I1	$U_{UNBALANCE}$
-	-	-	I_{TOT}
-	-	-	I_{NM}

PLEASE NOTE

Customized screens defined here are selected in menu.

Main menu > Measurements > Present values > Custom

Setting can be made only for 3 customized screens. 4th customized screen is showing 5 parameters, three from Customized screen 1 and first two from Customized screen 2. See example above.

PLEASE NOTE

Custom screens for iMC784A can only be set in MiQen software. Customized screens defined in MiQen are then selected in menu:

Main menu > Measurements > Custom > CS 1/ CS 2/ CS 3

Setting can be made only for 3 customized screens.

LCD navigation

iMC784A Graphic pixel display

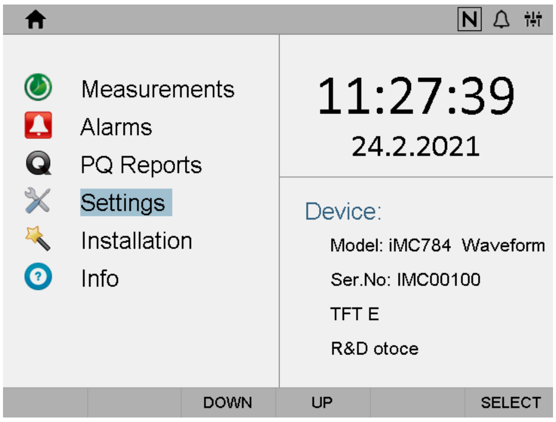
Main menu
Measurements
Settings
Resets
Info
Installation
14.11.2021 16:53:36

→

Settings
General
Date & Time
Connection
Communication
LCD
Security
Energy
Inputs/Outputs
⇦ Main menu

Main menu > Settings > LCD > Contrast / Back light / Back light time off
Main menu > Settings > LCD > Demo cycling period
Main menu > Settings > LCD > Custom screen 1 / 2 / 3 / (4)

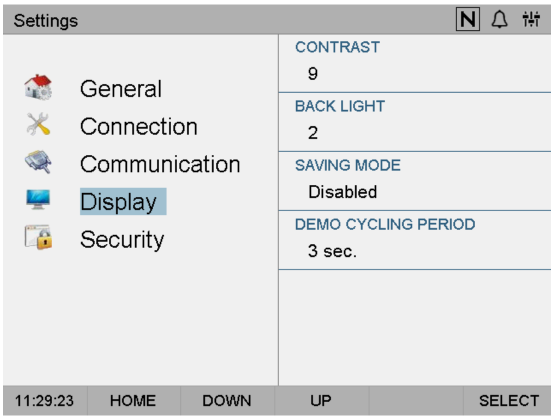
iMC784A color TFT LCD dispaly



11:27:39
24.2.2021

Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce

→



CONTRAST
9
BACK LIGHT
2
SAVING MODE
Disabled
DEMO CYCLING PERIOD
3 sec.

Main menu > Settings > General:

- CONTRAST
- BACK LIGHT
- SAVING MODE
- DEMO CYCLING PERIOD

Security

Settings parameters are divided into four groups regarding security level: PL0 >password level 0), PL1 >password level 1), PL2 >password level 2) and BP >a backup password).

PLEASE NOTE

A serial number of Power Quality Analyzer iMC784A is stated on the label and is also accessible with MiQen software.

Password - Level 0 >PL0)

Password is not required.
Available settings:

- language
- contrast and
- LCD back light.

Password - Level 1 >PL1)

Password for first level is required.
Available settings:

- RTC settings
- Energy meters reset
- Max. Demand reset
- Active tariff setting

Password - Level 2 >PL2)

Password for second level is required. Available settings:

- All settings are available

A Backup Password->BP)

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

Password lock time >min)

Defines the time in minutes for the instrument to activate password protection. Enter value 0 if you want to use manual password activation.

Password setting

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 others are hidden.
A password of the first >PL1) and the second >PL2) level is entered, and time of automatic activation is set.

Password modification

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

Password disabling

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

PLEASE NOTE

A factory set password is "AAAA" at both access levels >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.

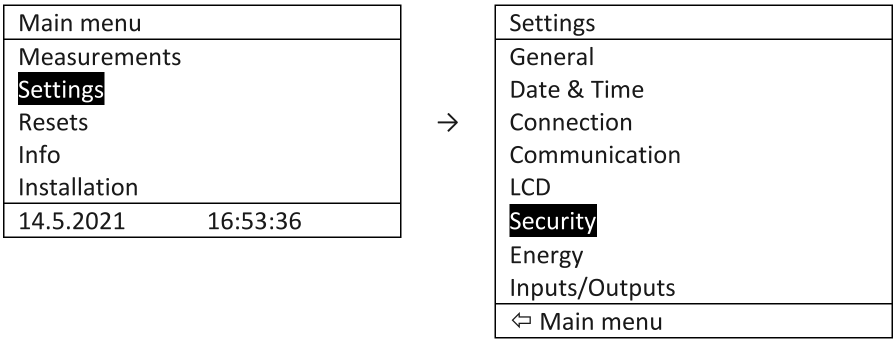
English	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Russian	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О	П	Р	С	Т	У	Ф	Х	Ц	Ч	Ш	Щ

PLEASE NOTE

Power Quality Analyzer iMC784A does not support Russian characters.

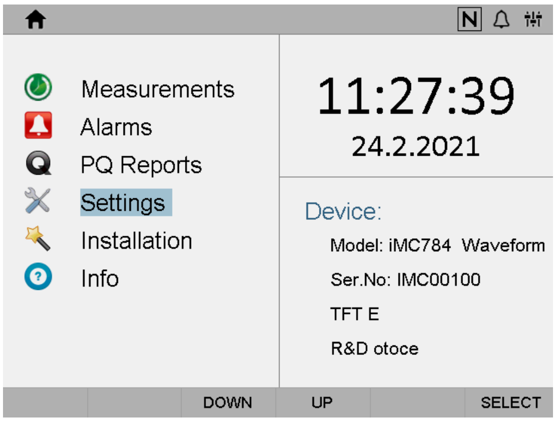
LCD navigation

iMC784A Graphic pixel display



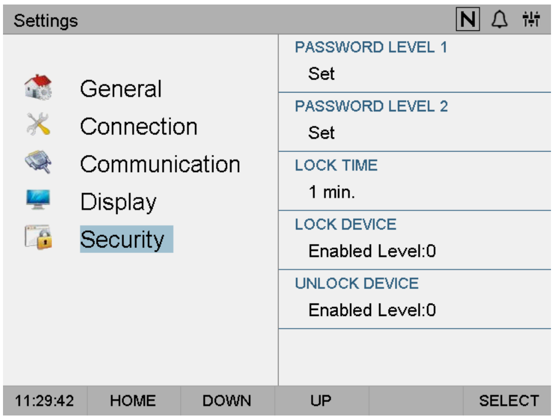
Main menu > Settings > Security > Password level 1 / Password level 2 / Password lock time / Lock instrument / Unlock instrument

iMC784A color TFT LCD display



11:27:39
24.2.2021

Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce



PASSWORD LEVEL 1: Set
PASSWORD LEVEL 2: Set
LOCK TIME: 1 min.
LOCK DEVICE: Enabled Level:0
UNLOCK DEVICE: Enabled Level:0

Main menu > Settings > Security:

- PASSWORD LEVEL 1
- PASSWORD LEVEL 2
- LOCK TIME
- ACTIVATION
- DEACTIVATION

Energy

⚠ WARNING

Before modification, all energy counters should be read or if energy values are stored in recorders, recorder should be read with MiQen software to assure data consistency for the past.

After modification of energy parameters, the energy meters (counters) should be reset. All recorded measurements from this point back might have wrong values so they should not be transferred to any system for data acquisition and analysis. Data stored before modification should be used for this purpose.

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 Counter Resolution

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	100 mWh	1 Wh	10 Wh	10 Wh	100 Wh
230 V	1 Wh	1 Wh	10 Wh	100 Wh	1 kWh
1000 V	1 Wh	10 Wh	100 Wh	1 kWh	10 kWh
30 kV	100 Wh	100 Wh	1 kWh	10 kWh	10 kWh *

* − Individual counter devider should be at least 100.

Common Energy Cost Exponent

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

Counter divider

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

An example for 12.345kWh of consumed active energy:

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

Common Tariff Price Exponent

Exponent and price represent energy price (active, reactive, common) in a tariff. The tariff 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 Counter Resolution	1 Wh	100 Wh	100 Wh
Individual Energy Counter Resolution	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

1 kWh Price in Tariff (1,2,3,4)

The price for 1kWh active energy in selected tariff. The entered value is multiplied with tariff price exponent: Tariff price = Price * 10 ^ Exponent.

1 kvarh Price in Tariff (1,2,3,4)

The price for 1 kvarh reactive energy in selected tariff. The entered value is multiplied with tariff price exponent: Tariff price * 10 ^ Exponent.

1 kVAh Price in Tariff (1,2,3,4)

The price for 1 kvarh reactive energy in selected tariff. The entered value is multiplied with tariff price exponent: Tariff price * 10 ^ Exponent.

LED Number of pulses

Number of pulses per energy unit for LED. (There is no LED indication on iMC784A)

LED Pulse Length (ms)

Pulse length for LED in milliseconds. (There is no LED indication on iMC784A)

Counters

Measured Energy

For each of eight (8) counters different measured quantities can be selected. User can select from a range of predefined options referring to measured total energy or energy on single phase. Or can even select its own option by selecting appropriate quantity, quadrant, absolute or inverse function.
To energy counter also pulse / digital input can be attached. In this case Energy counter counts pulses from an outside source (water, gas, energy meter).

Individual counter Resolution

The individual counter resolution additionally defines precision of a certain counter, according to settings of common energy counter resolution.

Tariff Selector

Defines tariffs where counter is active.

Tariff Clock

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.

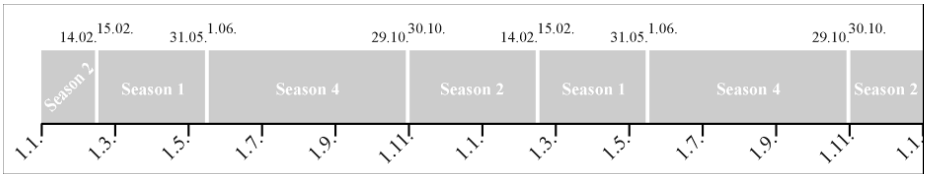
The order of seasons and starting dates is not important, except when two dates are equal. In that case the season with a higher successive number has priority, while the season with a lower number will never be active.

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.

Holidays/Holiday date 1-20

Year days (holidays) with the special cost management rules.

LCD navigation

iMC784A Graphic pixel display

Main menu
Measurements
Settings
Resets
SD card
Info
Installation
14.11.2021 16:53:36

→

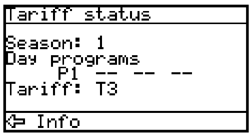
Settings
General
Date & Time
Connection
Communication
LCD
Security
Energy
Inputs/Outputs
⇦ Main menu

Main menu > Settings > Energy > Active tariff

Main menu > Settings > Energy > Common en. exponent

Example of display for selected Active tariff:

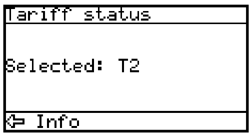
Main menu > Info OK ⇓⇓⇓⇒


```
Tariff status

Season: 1
Day programs
     P1  --  --  --
Tariff: T3

⇦ Info
```

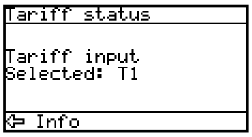
or


```
Tariff status


Selected: T2


⇦ Info
```

or

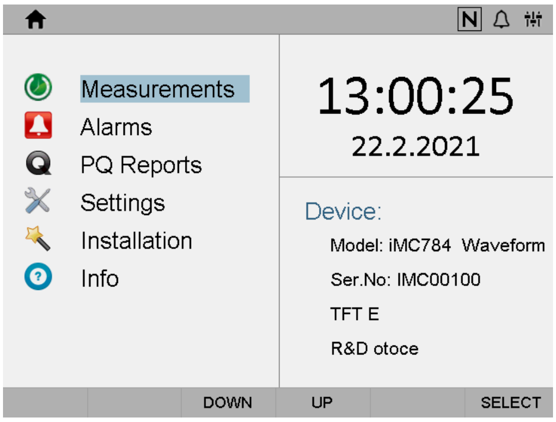

```
Tariff status

Tariff input
Selected: T1

⇦ Info
```

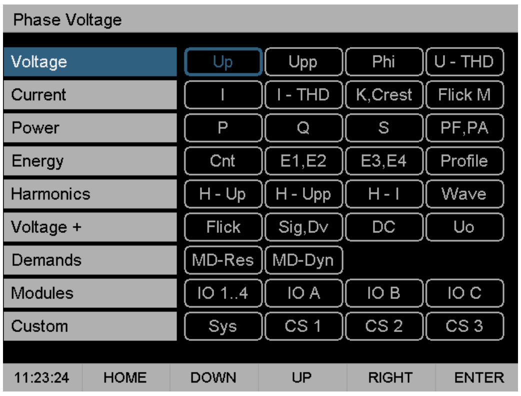
iMC784A color TFT LCD display

Energy settings for iMC784A can only be set in MiQen software. Using device TFT LCD display, you can check energy measurements and which tariff is active by following steps below:

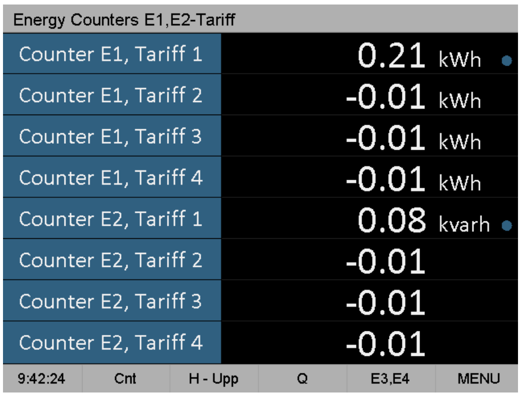


13:00:25
22.2.2021

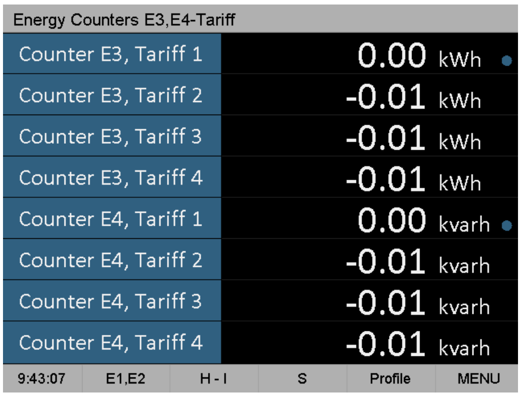
Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce


Phase Voltage

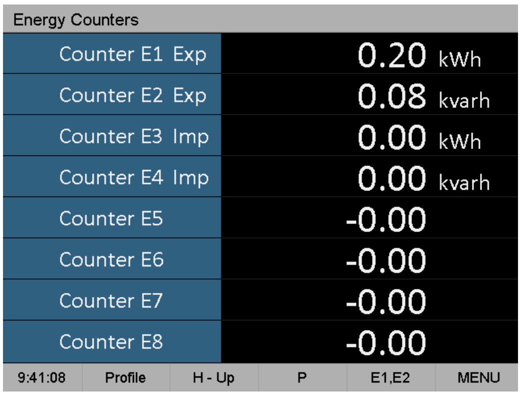
Voltage	Up	Upp	Phi	U - THD
Current	I	I - THD	K,Crest	Flick M
Power	P	Q	S	PF,PA
Energy	Cnt	E1,E2	E3,E4	Profile
Harmonics	H - Up	H - Upp	H - I	Wave
Voltage +	Flick	Sig,Dv	DC	Uo
Demands	MD-Res	MD-Dyn		
Modules	IO 1..4	IO A	IO B	IO C
Custom	Sys	CS 1	CS 2	CS 3


Energy Counters E1,E2-Tariff

Counter E1, Tariff 1	0.21 kWh ●
Counter E1, Tariff 2	-0.01 kWh
Counter E1, Tariff 3	-0.01 kWh
Counter E1, Tariff 4	-0.01 kWh
Counter E2, Tariff 1	0.08 kvarh ●
Counter E2, Tariff 2	-0.01
Counter E2, Tariff 3	-0.01
Counter E2, Tariff 4	-0.01


Energy Counters E3,E4-Tariff

Counter E3, Tariff 1	0.00 kWh ●
Counter E3, Tariff 2	-0.01 kWh
Counter E3, Tariff 3	-0.01 kWh
Counter E3, Tariff 4	-0.01 kWh
Counter E4, Tariff 1	0.00 kvarh ●
Counter E4, Tariff 2	-0.01 kvarh
Counter E4, Tariff 3	-0.01 kvarh
Counter E4, Tariff 4	-0.01 kvarh



Energy Counters

Counter E1 Exp	0.20 kWh
Counter E2 Exp	0.08 kvarh
Counter E3 Imp	0.00 kWh
Counter E4 Imp	0.00 kvarh
Counter E5	-0.00
Counter E6	-0.00
Counter E7	-0.00
Counter E8	-0.00

Inputs and outputs

I/O functionality is a powerful tool of Power Quality Analyzer iMC784A using various I/O modules device can be used not only for monitoring main electrical quantities but also for monitoring process quantities (temp., pressure, wind speed…) and for various control purposes. Power Quality Analyzer iMC784A can be equipped with different I/O modules with different functionality. For its technical specifications, see chapter Technical data.

Options for I/O module 1 and 2

Inputs:

- DC current analogue input
- DC voltage analogue input
- Resistance (temperature) analogue input
- Pulse input
- Digital input
- Tariff input

Tariff and digital input can be ordered as three different hardware types with different voltage level, but the same functionality.

Outputs:

- Analogue output
- Pulse output (solid state)
- Relay output (relay)
- Bistable alarm output (bistable relay)
- Watchdog / Relay output

All modules have double input or output, except for a Bistable alarm output module and Watchdog output module. All modules with a double input or output are in MiQen software presented as two separate modules.

An alarm output and a pulse output can also be selected via a keyboard. When selecting settings of energy and quadrants for a certain counter, only present selection is possible, while more demanding settings are accessible via communication. For other modules, information on a built-in module is available via LCD.

Options for I/O module 3 and 4:

Inputs:

- DC current analogue input
- DC voltage analogue input
- Resistance (temperature) analogue input
- Digital input
- Pulse input

Digital input can be ordered as three different hardware types with different voltage level, but the same functionality.

Outputs:
- Analogue output
- Pulse output (solid state)
- Relay output (relay)
- Bistable alarm output (bistable relay)
- Watchdog / Relay output

All modules have double input or output, except for a Bistable alarm output module and Watchdog output module. All modules with a double input or output are in MiQen software presented as two separate modules.

An alarm output and a pulse output can also be selected via a keyboard. When selecting settings of energy and quadrants for a certain counter, only present selection is possible, while more demanding settings are accessible via communication. For other modules, information on a built-in module is available via LCD.

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 order 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 …)

Signals from Analogue input can also be stored in built-in memory of a. They can also be included in alarm function (see chapter *Alarms*).

DC current range:
Range setting allows bipolar ±20 mA max. input value

DC voltage range:
Range setting allows bipolar ±10 V max. input value

Resistance / temperature range:
Range setting allows 0 … 2000Ω 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.

Pulse input module

Module has no settings. It is general purpose pulse counter from external meters (water, gas, heat …). Its value can be assigned to any of four energy counters. See chapter Energy. It can also be used as digital input and included in alarm function to monitor signals from different sensors (see chapter Alarms).
Pulse input module has only one hardware configuration (5…48 V DC).

Digital input module

Module has no settings. General purpose is to collect digital signals from various devices, such as intrusion detection relay, different digital signals in transformer station, industry ... It is available in three different hardware versions.
It can also be included in alarm function (see chapter Alarms).

Tariff input module

Module has no setting. It operates by setting active tariff at a tariff input (see chapter Tariff clock). The device can have maximal one module with 2 tariff inputs only. With the combination of 2 tariff inputs maximal 4 tariffs can be selected.

Active tariff selection table:

Active tariff	Signal presence on tariff input	
	Input T1	Input T2
Tariff 1	0	0
Tariff 2	1	0
Tariff 3	0	1
Tariff 4	1	1

Analogue output module

Analogue output module is useful for control and measurement visualization purposes. It can be connected to analogue meters, PLC controllers… It has defined output range 20mA DC. Quantity and shape (up to 6 break points) of an analogue output can be assigned by MiQen software.

Output parameter

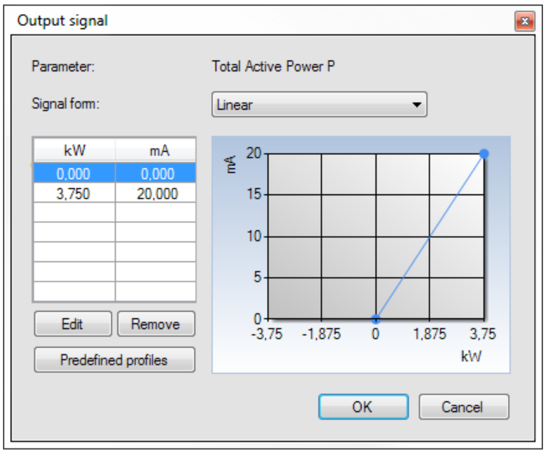
Output parameter can be any measured value that is required for monitoring, recording, visualization or control. Value is chosen from a drop-down menu.

Output signal

Output signal can be adjusted to meet all required purposes.

- Shape of output signal (linear, Quadratic)
- Number of break points for zoom function (up to 6)
- Start and End output value

For better visualization of set output signal parameters, graphical presentation of transfer function is displayed.



Output signal

Parameter: Total Active Power P

Signal form: Linear

kW	mA
0,000	0,000
3,750	20,000

Pulse output module

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

Calculation of recommended pulse parameters

Number of pulses per energy unit should be in certain limits according to expected power. Otherwise the measurement from pulse output can be incorrect. Settings of current and voltage transformer ratios can help in estimation of expected power.

Principle described below for pulse setting satisfies EN 62053−31: 2001 standards pulse specifications:

1,5…15 eW -> 100 p/1 eWh
e … exponent (k, M, G)
p … pulses

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

Bistable alarm output module

A Bistable alarm module is a relay type. The only difference between relay alarm output and bistable relay alarm output is that it keeps the condition at output in case of device power failure.

Alarm Output

If Digital output is defined as an Alarm output, its activity (trigger) is connected to Alarm groups. Multiple alarm groups can be attached to it and different signal shapes can be defined. For more information on how to define alarm groups, see chapter Alarms.
Two parameters should be defined for each alarm output:

- The source for assigned alarm (alarm group 1, 2 or both)
- Type of output signal, when alarm is detected.

Output signal types

Normal − A relay is closed as long as condition for the alarm is fulfilled.
Normal inverse − A relay is open as long as condition for the alarm is fulfilled. After that relay goes to closed state
Latched − A relay is closed when condition for the alarm is fulfilled, and remains closed until it is manually reset.
Latched inverse − A relay is open when condition for the alarm is fulfilled, and remains open until it is manually reset.
Pulsed − an impulse of the user set length is activated always when condition for the alarm is fulfilled.
Pulsed inversed – Normally relay is activated. An impulse of the user set length deactivates it 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 (general purpose digital output functionality).
Check an example in chapter Alarms for graphical demonstration of alarm functionality.

Status (Watchdog) and Relay output module

Watchdog and relay module is a combination of two functionalities. One output is used for Watchdog functionality, the other acts as a Relay output module.
The purpose of a Watchdog relay is to detect potential malfunction of device 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.

Auxiliary I/O Modules A & B

Power quality analyzer iMC784A is equipped with two auxiliary I/O slots. The biggest difference in functionality between main and auxiliary I/O modules is in response time. Digital inputs and outputs do not have as fast response time as with main I/O modules.

Following auxiliary I/O modules are available:

Module type	Number of modules per slot
Relay output (RO)	8
Digital input (DI)	8

State of the built in input and/or output module can be monitored also via LEDs on the front panel of the device (iMC784A graphic pixel display only).

PLEASE NOTE

Relay output (RO) is only available as module A.

Digital input module

Module has no settings. Their purpose is to collect digital signals from various devices, such as (intrusion detection relay, different digital signals in transformer station, industry …).
According to input voltage range it is available in three different hardware versions. For technical specifications see chapter Technical data.
Digital input can also trigger an alarm (see chapter Settings – Alarms).
State of digital inputs can also be monitored for control purposes with SCADA system by reading appropriate MODBUS registers.

Relay output module

Relay output module is a relay switch. Its main purpose is to be used as an alarm output.
For the difference to Relay output module of main I/O module ½ and 3/4, also a single alarm can be used to trigger each output (when using Relay output module of main I/O module 1/2 or 3/4 only a single or a combination of alarm groups can be used as a trigger for each output).
For additional information regarding alarms, see chapter Settings – Alarms.

RTC Synchronization module C

In order to use Module C for synchronization purposes, it has to be defined as a synchronization source. See chapter General Settings - Real time synchronization source.

CAUTION

RTC synchronization is essential part of Class A instrument. If no proper RTC synchronization is provided device operates as Class S instrument.

Power quality analyzer iMC784A supports three types of RTC synchronization:

- GPS time synchronization (via Synchronization module C)
- IRIG-B time synchronization (via Synchronization module C)
- NTP time synchronization (via Ethernet module)

Instructions regarding connection of Synchronization module C can be found in chapter Connection - Connection of Synchronization module C.

PLEASE NOTE

Serial communication built in Synchronization module C can, under certain conditions, be used as an independent secondary communication.

GPS time synchronization

For proper GPS synchronization, two signals are required.

- 1pps with TTL voltage level and
- NMEA 0183 coded serial RS232 communication sentence

GPS interface is designed as 5 pole pluggable terminal (+5V for receiver supply, 1pps input and standard RS232 communication interface). Proposed GPS receiver is GARMIN GPS18x.

⚠ **PLEASE NOTE**

When connecting GPS to serial RS232 communication interface, please take required communication parameters into consideration. For proposed GPS receiver default communication speed is 4800 b/s.

IRIG time code B (IRIG-B)

Unmodulated (DC 5V level shift) and modulated (1 kHz) serial coded format with support for 1pps, day of year, current year and straight seconds of day as described in standard IRIG-200-04.
Supported serial time code formats are IRIG-B007 and IRIG-B127. For technical specifications see chapter Technical data.

Serial communication (COM2)

If Power Quality Analyzer iMC784A uses RTC synchronization over NTP server (via Ethernet module), IRIG-B or only 1PPS without date synchronization, serial communication port of RTC Synchronization module C is free to be used as a secondary communication port COM2. Either RS232 or RS485 communication can be used. COM1 and COM2 are completely independent and can be used for the same purpose and at the same time.
Module settings define parameters, which are important for the operation in RS485 network or connections with PC via RS232 communication.

⚠ **PLEASE NOTE**

If Power Quality Analyzer iMC784A uses GPS RTC synchronization then serial communication port of RTC Synchronization module C cannot be used at the same time.

Factory settings for serial communication COM2 are:

MODBUS Address:	#33 (address range is 1 to 247)
Comm. Speed:	4800 (speed range is 2400 to 115200)
Parity:	none
Data bits:	8
Stop bits:	2

⚠ **PLEASE NOTE**

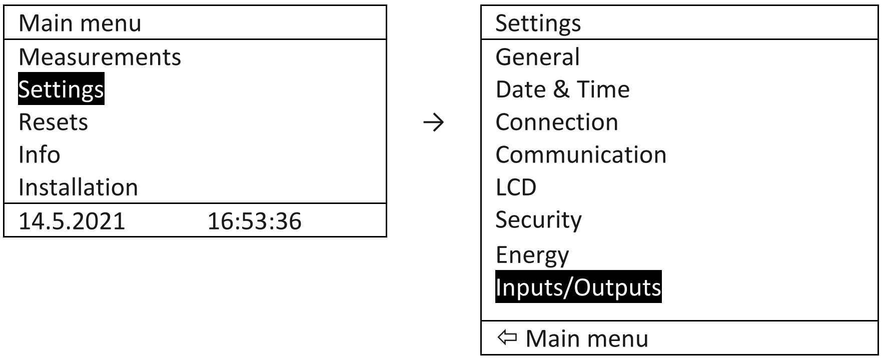
By default, addresses of COM1 and COM2 are the same (#33). In this case, change of COM1 address sets COM2 to the same address. When COM1 and COM2 addresses are not equal, change of COM1 address has no influence on COM2 address and change of COM2 address has no influence on COM1 address.

Settings of RTC Synchronization module C

In order to enable synchronization with GPS or IRIG time code a proper Real Time synchronization source should be defined as described in a chapter General settings/Real Time synchronization source.

LCD navigation

iMC784A Graphic pixel display



Main menu
Measurements
Settings
Resets
Info
Installation
14.5.2021 16:53:36

→

Settings
General
Date & Time
Connection
Communication
LCD
Security
Energy
Inputs/Outputs
⇦ Main menu

Main menu > Settings > Inputs/Outputs > I/O 1
Main menu > Settings > Inputs/Outputs > I/O 2
Main menu > Settings > Inputs/Outputs > I/O 3
Main menu > Settings > Inputs/Outputs > I/O 4
Main menu > Settings > Inputs/Outputs > I/O A
Main menu > Settings > Inputs/Outputs > I/O B
Main menu > Settings > Inputs/Outputs > I/O C

iMC784A color TFT LCD display

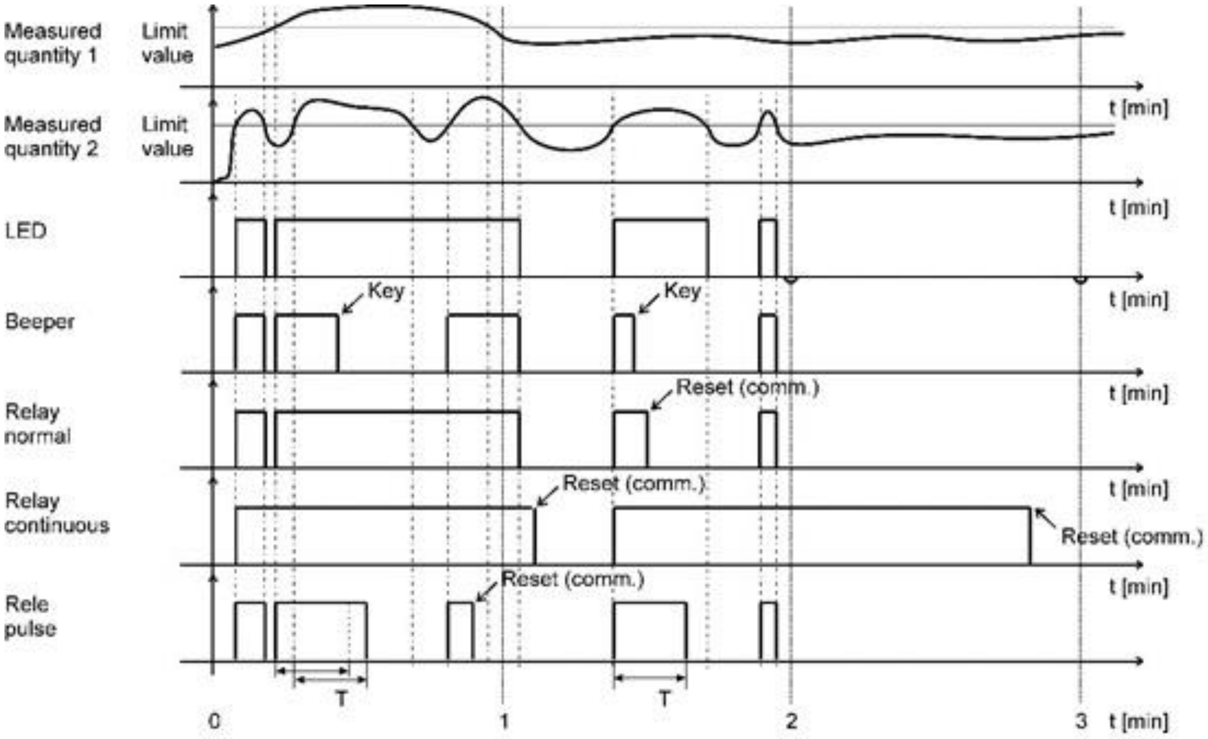
Inputs/Outputs for Power Quality Analyzer iMC784A can only be set in MiQen software. Using device TFT LCD display, you can check Inputs/Outputs status by navigating to Modules:
Main menu > Measurements > Modules > IO 1…4 / IO A / IO B / IO C

Alarms

Alarms are used for alarming exceeded set values of measured quantities and quantities from different input modules.
Alarms can also trigger different actions according to their settings:

- Visual (alarms causes special alarm LED to lit-up).
  When alarm is switched on a red LED on the device front side is blinking – only iMC784A graphic pixel display. See figure below. On iMC784A there is no dedicated LED for alarms (when alarm I present, 🔔 icon is displayed in top right corner of TFT LCD display).
- Sound (alarms can cause sound signalization)
  When alarm is switched on, an audible alarm is given by the device (a beep). It can be switched off by pressing any key on the front plate (see figure below).
- Alarm output (alarms can switch digital outputs on main and aux. I/O modules)
- According to the alarm signal shape the output relay will behave as shown on figure below.

Alarm condition can be set for any measured quantity, also for quantities measured on Analogue inputs or signals from Digital / Pulse input.



CAUTION

New values of alarms are calculated in percentage. At every modification of connection settings crosscheck if set alarm values are correct.

Alarms PUSH functionality

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 alarm data to be sent.
Alarm data is sent to the server immediately as alarm(s) occur. If they cannot be sent immediately due to communication problems, they are sent at next alarm event or data sending interval (whichever occurs first).
Alarms and time stamps of occurrence are also stored into internal memory.
For more information about PUSH functionality and XML data format see chapter PUSH Communication mode and Appendix F.

Push data to link

When PUSH communication mode is used a data receiving server (client) link should be defined. Data can be sent (according to a type of used communication interface) to COM1, TCP link 1 or TCP link 2. For definition of PUSH links see chapter PUSH communication settings. Alarms are unlike recorded values sent to chosen link immediately after occurrence. Therefore settings for pushing period and time delay are not applicable.

Pushing period

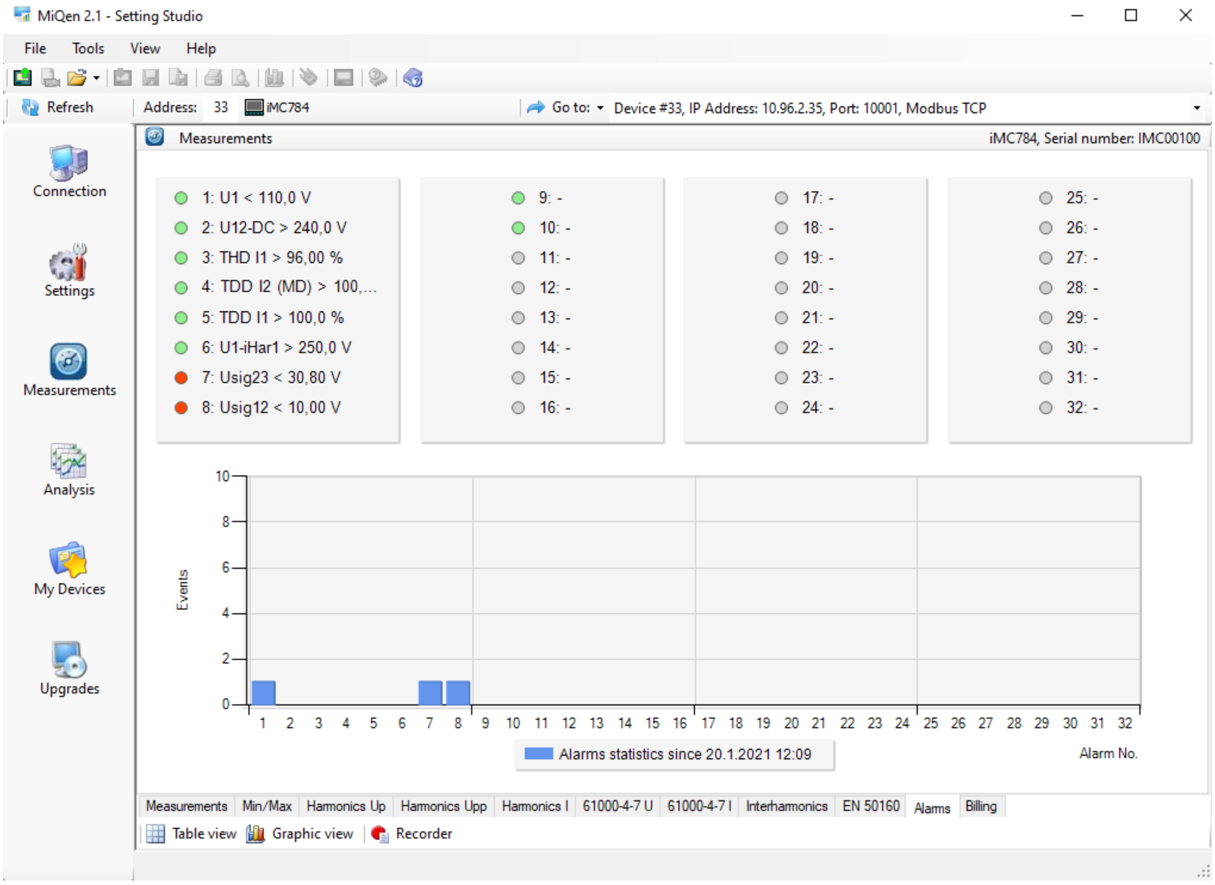
Settings for pushing period are not applicable for alarms push functionality.

Pushing time delay

Settings for pushing time delay are not applicable for alarms push functionality.

Alarm statistics reset

Power Quality Analyzer iMC784A evident all triggered alarms and stores it in internal RAM. Statistic is valid since last power supply-on and could be reset with MiQen, see chapter Reset operations.
This setting is only for resetting online alarms statistics displayed in MiQen.



1: U1 < 110,0 V
2: U12-DC > 240,0 V
3: THD I1 > 96,00 %
4: TDD I2 (MD) > 100,...
5: TDD I1 > 100,0 %
6: U1-iHar1 > 250,0 V
7: Usig23 < 30,80 V
8: Usig12 < 10,00 V
9: -
10: -
11: -
12: -
13: -
14: -
15: -
16: -
17: -
18: -
19: -
20: -
21: -
22: -
23: -
24: -
25: -
26: -
27: -
28: -
29: -
30: -
31: -
32: -

Alarms statistics for showing graphical representation of frequency of alarms occurrence.

Alarms group settings

Power Quality Analyzer iMC784A supports recording and storing of 32 alarms that are divided into 4 groups of 8 alarms. Each group of alarms has some common settings applicable for all alarms within this group:

MD Time constant (min)

Sets a thermal mode maximum demands time constant for the alarm group. When monitoring certain quantity it is possible to monitor its actual value or its max. demand value. If latter is chosen then a time constant for calculation of thermal mode max. demand value should be set. This setting is for alarm purposes only and is independent of max. demand calculation settings for monitoring and recording purposes as described in chapter Maximum demand calculation.

Compare time delay (sec)

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

Hysteresis (%)

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

Response time

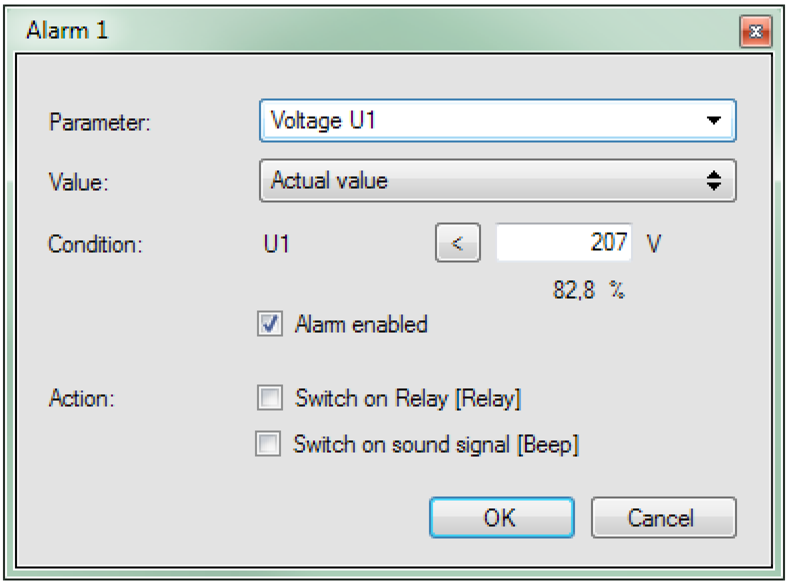
This setting defines alarm response on monitored quantity.

Normal response: In this case monitored quantity is averaged according to display averaging settings (0.1 to 5s – see chapter General settings / Average interval).

Fast response: In this case alarms react on non-averaged measurements (1 signal period). This setting should be used according to required functionality. Fast response is more prone to glitches and transient effects in a system but reaction time is fast.

Individual alarm settings

For each individual alarm different settings are possible.



Alarm 1

Parameter: Voltage U1

Value: Actual value

Condition: U1 < 207 V

82,8 %

☑ Alarm enabled

Action: ☐ Switch on Relay [Relay]

☐ Switch on sound signal [Beep]

Individual Alarms settings

Parameter

This setting defines a quantity that will be monitored. It is also possible to select process quantities from I/O modules.

Value

For chosen monitoring parameter an actual value or MD value should be set.

Condition

It is a combination of a logical operator “Higher than” or “Lower than” and a limit value of the condition. For digital / pulse input it is possible to set condition is “Is high” or “Is low”.

Action

This section is consists of checkboxes that applies different functions to individual alarms.
Switch on Relay checkbox can be selected if user wants this alarm to trigger output(s) that are connected to its group of alarms (pulse, relay or bistable output module). When using relay outputs of I/O module A or B also a single alarm can be used as a trigger. In this case Switch on Relay setting has no influence.
Switch on sound signal checkbox will activate built in beeper when alarm is active.
Alarm enabled checkbox, activates alarm.

Internal memory

Power Quality Analyzer iMC784A is able to record and store measurements, alarms, PQ records and details in a built-in memory of the device. There are two different types of records, standard and advanced. The first one can store data in an 8MB flash memory. This amount of memory suffices for storing EN 50160 compliant PQ reports with details for more than 12 months.

Advanced recorders record data in the internal 8GB flash memory. For more information see chapter *Advanced recorders on page 87*.

All records stored in memory are accessible by communication or memory card and can be displayed with MiQen software.

The device has also a built-in function that enables scheduled transmission of data, stored in memory, to remote data collecting system. For more information regarding this feature, see chapter *PUSH Communication mode on page 58*.

Standard recorders

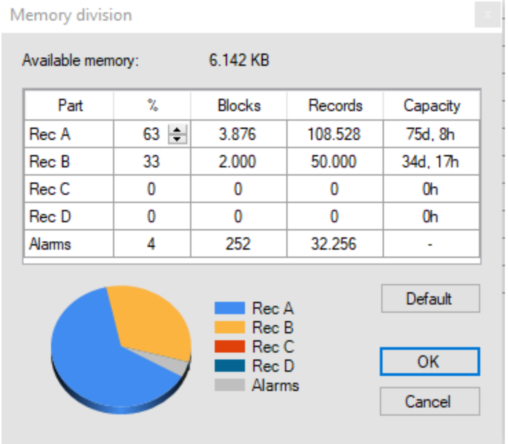
Memory organisation PC

Devices' internal memory has 8MB of total memory space. It is divided into 5 partitions which size is defined by the user and 2 fixed partitions.

User defined partitions are A, B, C and D recorders that are intended for recording of measurements (each recorder can store up to 32 parameters), while all alarms that occurred are recorded in an alarm partition.

C and D recorders can be user defined as a standard trend recorders (like recorders A and B) or can be defined as dedicated harmonic recorders. As such they will record all 65 harmonics, voltage or current depends on user setting for each of those two recorders. Settings are available in general tab of *Standard recorders* section (*see figure on next page*).

Fixed partitions are dedicated for recording PQ reports and details (see chapter *Power supply quality on page 119*).



Available memory: 6.142 KB

Part	%	Blocks	Records	Capacity
Rec A	63	3.876	108.528	75d, 8h
Rec B	33	2.000	50.000	34d, 17h
Rec C	0	0	0	0h
Rec D	0	0	0	0h
Alarms	4	252	32.256	-

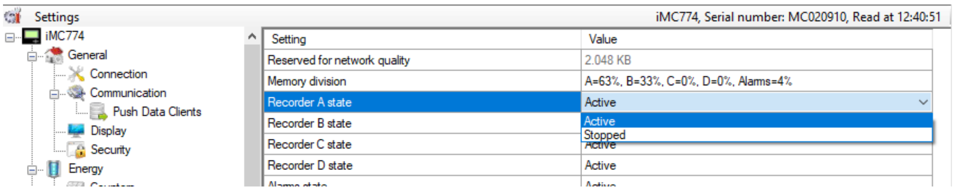
Internal memory organisation

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 size of stored data or a storing period depends on selected partition size, a number of recorded quantities and a storage interval.
Storage availability of partitions is shown in the Information menu (see chapter *LCD navigation on page 34*).

Memory clearing PC

There is usually no need to clear the memory, because it works in cyclic mode. If it is required anyway, the data storing must be stopped first. Read the device settings with MiQen and set "Recorder state" in Memory setting group to "stopped" as shown in a figure below.



iMC774, Serial number: MC020910, Read at 12:40:51

Setting	Value
Reserved for network quality	2.048 KB
Memory division	A=63%, B=33%, C=0%, D=0%, Alarms=4%
Recorder A state	Active
Recorder B state	
Recorder C state	Active
Recorder D state	Active

Enabling or disabling data storage

Download changes to the device and open Memory info form (Figure 19 on previous page) and Format tab. Choose memory partitions required to be cleared and click format button. After partitions are cleared set "Recorder state" setting back to active.

CAUTION

It is strongly advised to download recorder data before applying any changes to recorder or changes of settings for energy, type of connection, current and voltage transformer settings and used current and voltage ranges. These changes might have impact on recorded history so data might no longer be valid.

General purpose recorder settings PC

General purpose recorder consists from 4 partitions (A, B, C and D). General purpose recorder does not include alarm recorder or PQ reports and details recorder. Separately, for each of four partitions, following settings can be set:

Storage interval

Storage interval sets a time interval for readings to be recorded.
Which type of parameter should be stored each interval (avg., min., max., actual …) is defined in settings for each individual parameter described later in this chapter.

MD Time constant

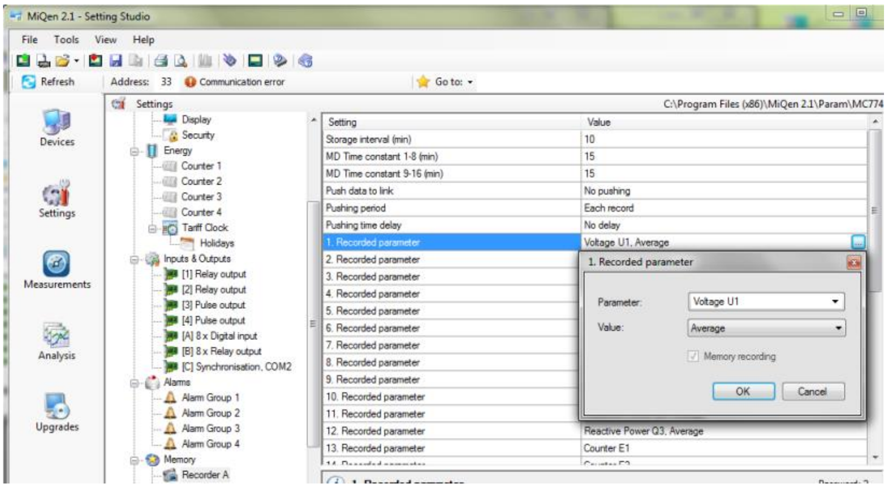
When max. demand needs to be recorded, this setting sets a period for calculation of maximum and minimum value in thermal mode (Minimum (MD) or Maximum (MD)). Different parameters can be set for Recorded parameters 1-8, 17-24 and 9-16, 25-32. This setting is only available for recorders A and B.

PUSH settings

When PUSH communication mode is active, all measurements which are set to be written to the memory can be sent (pushed) to a predefined location inside local or wide area network (from the time that PUSH functionality has been activated, not for the past records). 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 cannot be sent immediately due to restrictions in network.
For more information about PUSH functionality see chapter *PUSH Communication mode on page 58*.

Recorded quantities

For each measurement, which is to be recorded it is possible to set a required quantity and its type within storage interval.



Setting	Value
Storage interval (min)	10
MD Time constant 1-8 (min)	15
MD Time constant 9-16 (min)	15
Push data to link	No pushing
Pushing period	Each record
Pushing time delay	No delay
1. Recorded parameter	Voltage U1, Average
2. Recorded parameter	
3. Recorded parameter	
4. Recorded parameter	
5. Recorded parameter	
6. Recorded parameter	
7. Recorded parameter	
8. Recorded parameter	
9. Recorded parameter	
10. Recorded parameter	
11. Recorded parameter	
12. Recorded parameter	Reactive Power Q3, Average
13. Recorded parameter	Counter E1

1. Recorded parameter
Parameter: Voltage U1
Value: Average
☑ Memory recording

Stored parameter settings

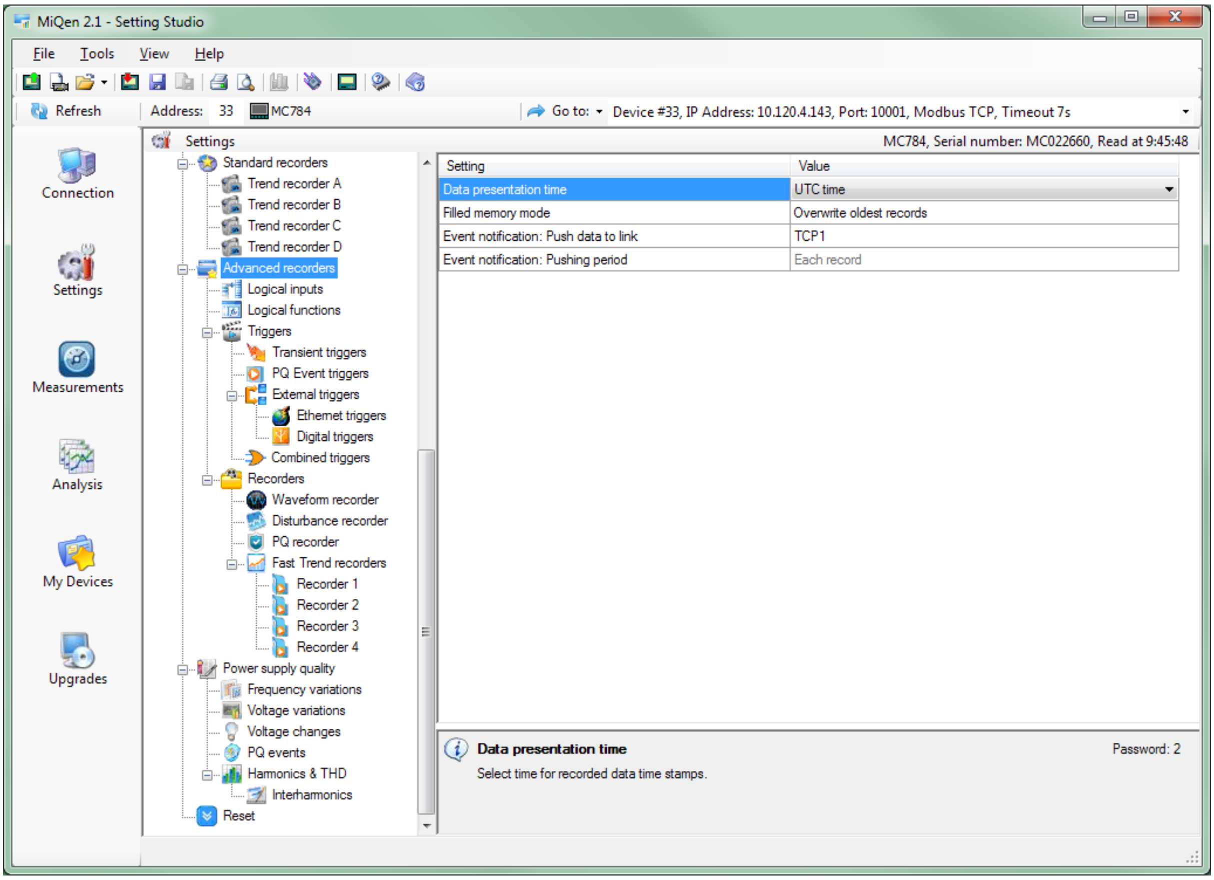
<u>Parameter</u>
Here monitoring quantity can be selected from a list of supported measurements.
Besides primary electrical quantities also auxiliary quantities from input modules can be selected.
<u>Value</u>
A type of a selected quantity within set monitoring interval can be set to different conditions.

- *Minimum and Maximum value* represents minimum or maximum of recorded averaged values within selected storage interval. Note that min./max. value is not a single period value but an average (0.1 s to 5 s; see chapter *General settings / Average interval on page 52*).
- *Minimum (MD) and Maximum (MD)* value represents calculation of a MD value with applied thermal function. Thermal function time constant is described above (MD Time constant). It applies only to recorders A and B.
- *Average value* represents calculated average value within selected storage interval.
- *Actual value* represents first momentary value within selected storage interval. Note that momentary value is not a single period value but an average (0.1 s to 5 s; see chapter *General settings/ Average interval on page 52*). It applies only to recorders C and D.
- *Minimum and Maximum (Period) values* represent min. or max. value within selected storage interval calculated <u>in a single period</u>. This function allows recording of very fast changes. It applies only to recorders C and D.

Advanced recorders

Power Quality Analyzer iMC784A enables recording of wide variety of data in the internal 8GB flash memory. All trigger related recorder data is available on-demand through FTP.

All parameters can be defined in the Settings menu (directly through LCD screen on iMC784A) or in MiQen (PC Software).



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.143, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022660, Read at 9:45:48

Setting	Value
Data presentation time	UTC time
Filled memory mode	Overwrite oldest records
Event notification: Push data to link	TCP1
Event notification: Pushing period	Each record

Data presentation time

Select time for recorded data time stamps.

Password: 2

Defining parameters in MiQen: Settings – Advance recorders.

Following parameters can be defined:

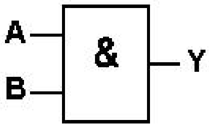
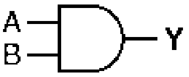
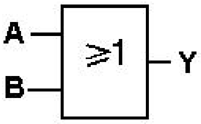
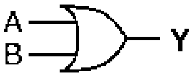
- Data presentation time:
  Select time for recorded data time stamps. Store data in UTC or local time.
- Filled memory mode:
  Define behavior of recorder when internal memory is full. ''Overwrite all records'' is a standard FIFO functionality. If it is important not to overwrite any old records ''Stop recording'' should be used.
- Event notification - Push data to link:
  Defines the communication channel for pushing data to clients. Communication parameters can be defined under Settings – Communication –Push Data Clients.
- Event notification - Pushing period:
  Defines a time period for pushing data to clients. Readings, events and PQ reports, which are recorded in internal memory, can be also periodically (user defined) sent to a client. Parameter is present so that each record is pushed to client.

Logical Inputs and Logical Functions

In electronics, a logic gate is an idealized or physical device implementing a Boolean function; it performs a logical operation on one or more logical inputs, and produces a single logical output. Boolean functions may be practically implemented by using electronic gates. The following points are important to understand:

- Electronic gates require a power supply.
- Gate INPUTS are driven by voltages having two nominal values, e.g. 0V and 5V representing logic 0 and logic 1 respectively.
- The OUTPUT of a gate provides two nominal values of voltage only, e.g. 0V and 5V representing logic 0 and logic 1 respectively. In general, there is only one output to a logic gate except in some special cases.
- There is always a time delay between an input being applied and the output responding.

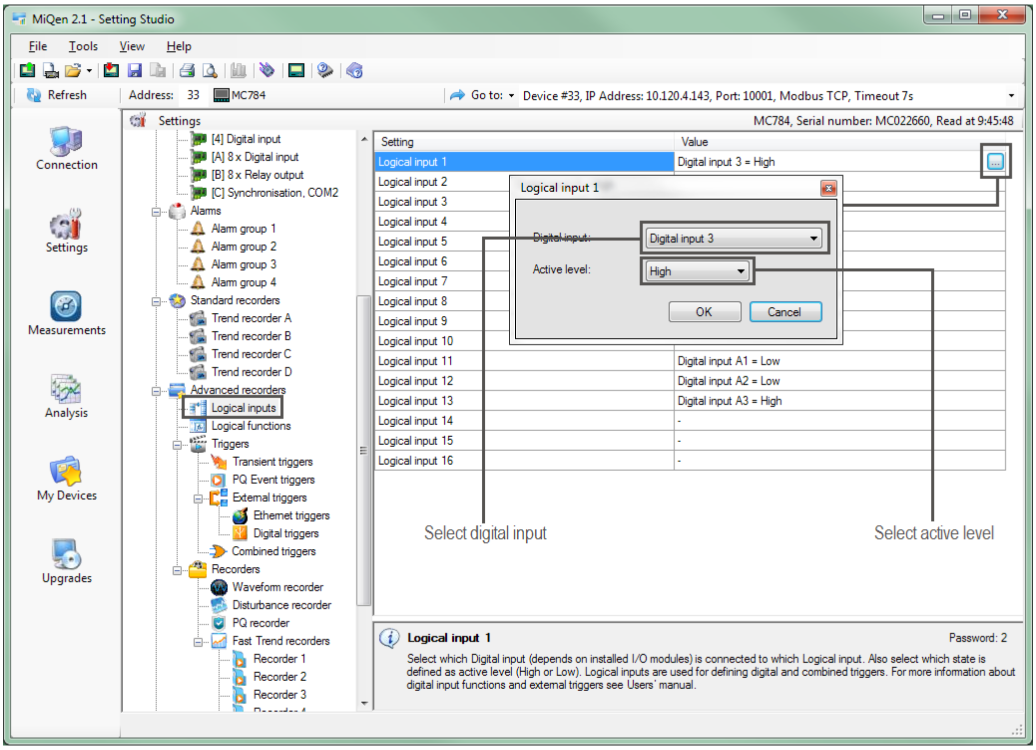
Basic logical functions are: AND, OR, XOR, NOT, NAND, NOR and XNOR. MC774 Advanced Power Quality Analyzer supports AND/OR logical functions. The effect of AND/OR functions are described in the table below. For each of the logic functions European symbol (IEC) and the American symbol (for practical reasons) are drawn. Logical Inputs are labelled with tags A and B. Truth table shows the function of a logic gate.

<table>
<tr><th>Name</th><th>IEC symbol</th><th>American symbol</th><th>Description</th><th>Truth table</th></tr>
<tr><td>AND</td><td>
</td><td>
</td><td>A HIGH output (1) results only if both the inputs to the AND gate are HIGH (1). If neither or only one input to the AND gate is HIGH, a LOW output results. In another sense, the function of AND effectively finds the minimum between two binary digits. Therefore, the output is always 0 except when all the inputs are 1.</td><td><table>
<tr><th colspan="2">Input</th><th>Output</th></tr>
<tr><td>A</td><td>B</td><td>A AND B</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
</table></td></tr>
<tr><td>OR</td><td>
</td><td>
</td><td>A HIGH output (1) results if one or both the inputs to the gate are HIGH (1). If neither input is high, a LOW output (0) results. In another sense, the function of OR effectively finds the maximum between two binary digits.</td><td><table>
<tr><th colspan="2">Input</th><th>Output</th></tr>
<tr><td>A</td><td>B</td><td>A OR B</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
</table></td></tr>
</table>

Following parameters can be defined:

- Logical input 1-16:
  Select which Digital input (depends on installed I/O modules) is connected to which Logical input. Also select which state is defined as active level (High or Low). Logical inputs are used for defining digital and combined triggers.
- Logical function 1-16:
  Select logical function over existing logical inputs and alarms to create conditional triggering functions. Logical functions can also be nested (result of one logical function can be used as an input for a logical operation of another) to achieve multiple-conditioned triggers.

Logical inputs – each of logical inputs can be defined with digital input (Input module has to be installed). Active value can be set on HIGH or LOW:



Setting	Value
Logical input 1	Digital input 3 = High
Logical input 2	
Logical input 3	
Logical input 4	
Logical input 5	
Logical input 6	
Logical input 7	
Logical input 8	
Logical input 9	
Logical input 10	
Logical input 11	Digital input A1 = Low
Logical input 12	Digital input A2 = Low
Logical input 13	Digital input A3 = High
Logical input 14	-
Logical input 15	-
Logical input 16	-

Logical input 1

Digital input: Digital input 3

Active level: High

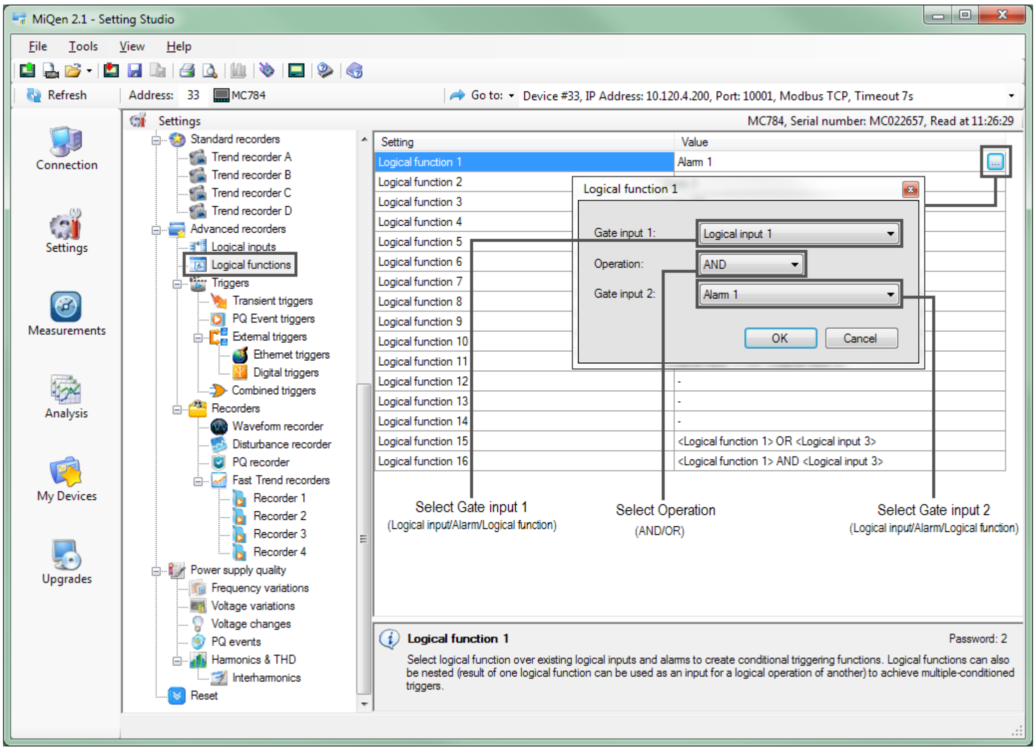
OK Cancel

Logical input 1 Password: 2

Select which Digital input (depends on installed I/O modules) is connected to which Logical input. Also select which state is defined as active level (High or Low). Logical inputs are used for defining digital and combined triggers. For more information about digital input functions and external triggers see Users' manual.

Defining Logical inputs parameters (MiQen): Settings – Advanced recorders – Advance recorders – Logical inputs.

Logical function - Select logical function over existing logical inputs and alarms:



Setting	Value
Logical function 1	Alarm 1
Logical function 2	
Logical function 3	
Logical function 4	
Logical function 5	
Logical function 6	
Logical function 7	
Logical function 8	
Logical function 9	
Logical function 10	
Logical function 11	
Logical function 12	-
Logical function 13	-
Logical function 14	-
Logical function 15	<Logical function 1> OR <Logical input 3>
Logical function 16	<Logical function 1> AND <Logical input 3>

Logical function 1

Gate input 1: Logical input 1

Operation: AND

Gate input 2: Alarm 1

OK Cancel

Logical function 1 Password: 2

Select logical function over existing logical inputs and alarms to create conditional triggering functions. Logical functions can also be nested (result of one logical function can be used as an input for a logical operation of another) to achieve multiple-conditioned triggers.

Defining Logical functions parameters (MiQen): Settings – Advanced recorders – Advance recorders – Logical functions.

Triggers

The job of any Power Quality Analyzer is to record all interesting data, and leave unrecorded the vast majority of boring, unremarkable data. The tricky part for an analyzer is deciding which events are important. A recorder that captured every 50 Hz waveform during a week's recording would never miss an event, but would present the user with billions of useless cycles. To avoid such scenario triggers are used. If trigger thresholds are set correctly, only important data will be recorded.
A sophisticated triggering mechanism is used to register and record events of various natures:

- Transient triggers
- PQ event triggers
- External Ethernet
- External digital triggers
- Combined triggers

Transient triggers

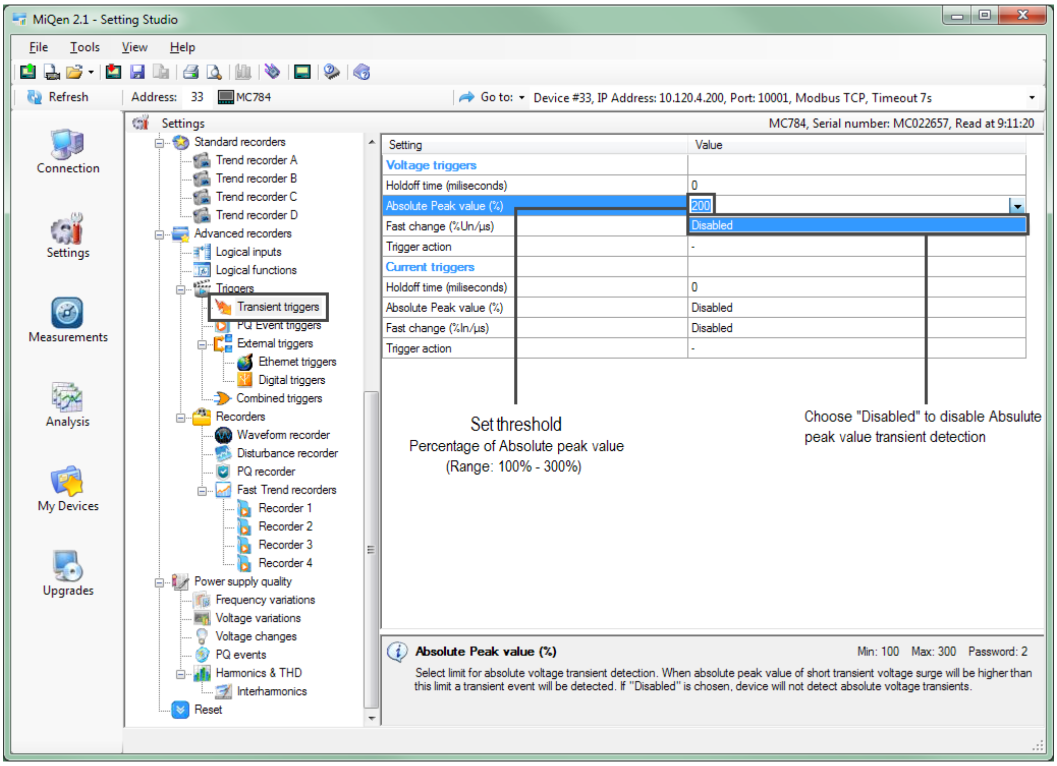
Transient is an analog signal which can reach high magnitudes in a very short duration of time. Power system transients can be caused by lightning, switching actions and faults in the power system. Signal can reach high magnitudes and depending on raise time, peak value, wave shape and frequency of occurrence the impact on power system components and end user equipment can be severe. The damages can be operational problems, accelerated ageing and immediate damage to equipment. By setting up a trigger you can start acquiring the signal once the trigger condition is satisfied.
There are two independent criteria by which transients are recognized:

- Absolute Peak value (%) – If a sampled value exceeds the set threshold, a transient is recognized.
- Fast change (%Un/µs) – If the difference between two neighboring sampled points exceeds the set threshold, a transient is recognized.

After transient has been recognized it can trigger Waveform /Disturbance recorder or/and it can send Ethernet trigger to other connected devices within network.

Absolute Peak Value (%)

In general transients are divided into two categories which are easy to identify: impulsive and oscillatory. If the mains signal is removed, the remaining waveform is the pure component of the transient. The transient is classified in the impulsive category when 77% of the peak-to-peak voltage of the pure component is of one polarity. Absolute peak value transient detection is used to detect transient of impulsive type.
Threshold is set in percentage of absolute peak value. If a sampled value exceeds the set threshold, a transient is recognized. To disable Absolute Peak Value detection choose ''Disabled'' in transient trigger menu.



Go to: Device #33, IP Address: 10.120.4.200, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022657, Read at 9:11:20

Setting	Value
Voltage triggers	
Holdoff time (miliseconds)	0
Absolute Peak value (%)	200
Fast change (%Un/µs)	Disabled
Trigger action	-
Current triggers	
Holdoff time (miliseconds)	0
Absolute Peak value (%)	Disabled
Fast change (%In/µs)	Disabled
Trigger action	-

Set threshold
Percentage of Absolute peak value
(Range: 100% - 300%)

Choose "Disabled" to disable Absulute peak value transient detection

Absolute Peak value (%) Min: 100 Max: 300 Password: 2

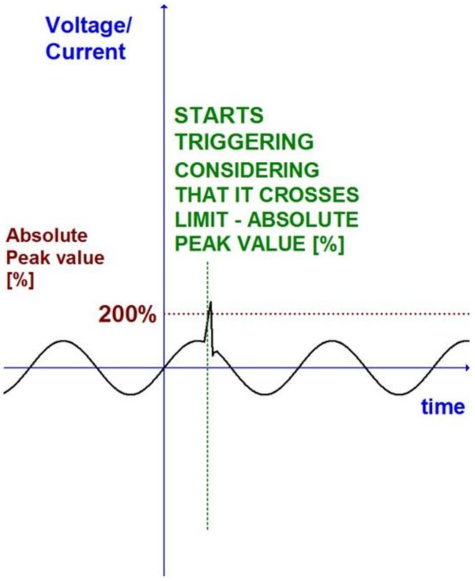
Select limit for absolute voltage transient detection. When absolute peak value of short transient voltage surge will be higher than this limit a transient event will be detected. If "Disabled" is chosen, device will not detect absolute voltage transients.

Defining Absolute peak value transient parameters (MiQen): Settings – Advanced recorders – Triggers – Transient triggers

Example:
In system with voltage range of 250 V TRMS and current range of 5 A TRMS, 100% Absolute peak value for:

- phase voltage is 353.55 V,
- interphase voltage is 612.37 V and
- current is 7,071 A

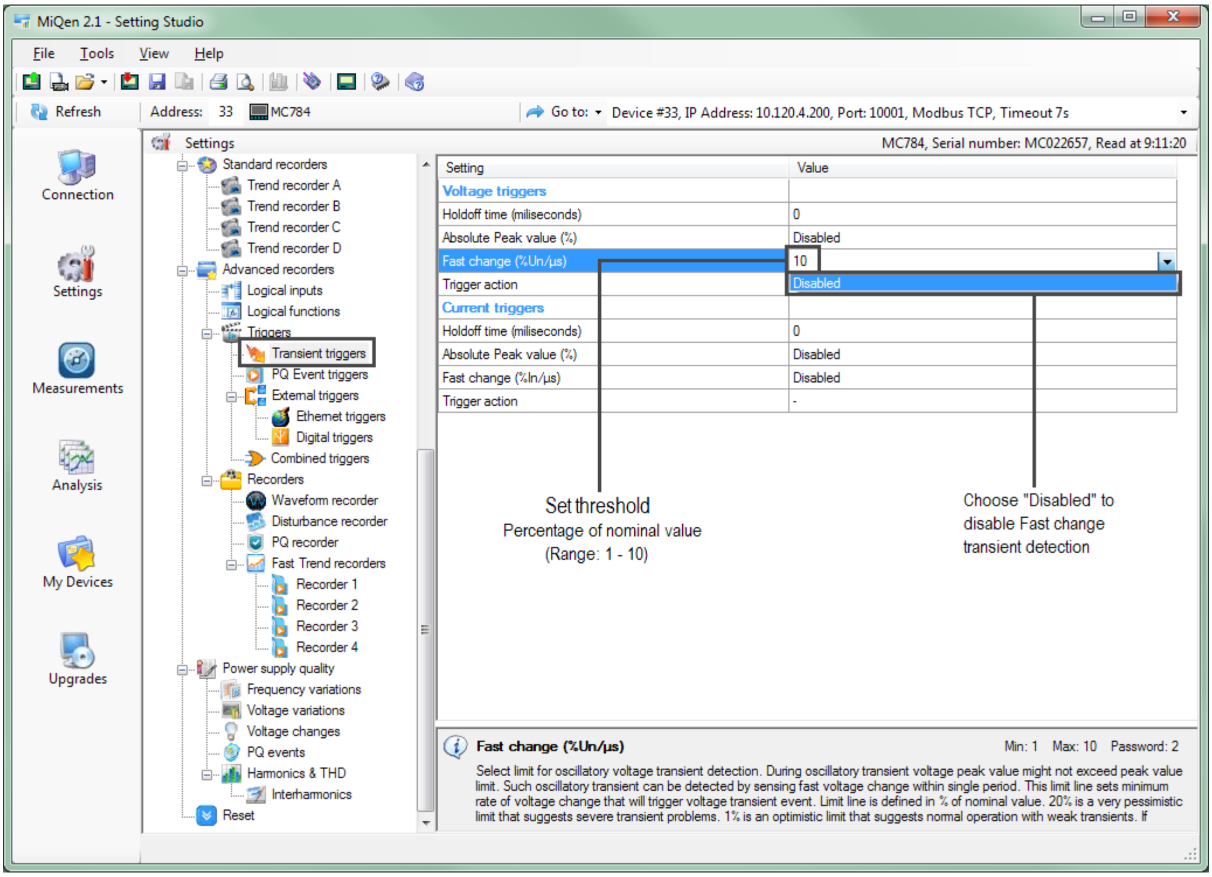
If threshold is set to 200% of Absolute peak value, transient will be detected when absolute peak value of phase voltage rises above 707.1V (See picture - *Transient value exceeds Absolute peak value threshold*).
Same principal applies to current transient triggers.



Transient value exceeds Absolute peak value threshold (%)

Fast change (%Un/µs)

Fast change transient detection is used to detect transient of oscillatory type. In order to detect transients of oscillatory type, two neighboring sampled points are compered. If a value deviation between these two sampled points exceeds predefined threshold, a transient is recognized.
Threshold is set in percentage of nominal value from 1%/µs to 10%/µs, where 10%/µs represents 320%/32µs (because of the maximum sampling time of 32 µs). To disable Fast change detection choose ''Disabled'' in transient trigger menu.



Setting	Value
Voltage triggers	
Holdoff time (miliseconds)	0
Absolute Peak value (%)	Disabled
Fast change (%Un/µs)	10 Disabled
Trigger action	
Current triggers	
Holdoff time (miliseconds)	0
Absolute Peak value (%)	Disabled
Fast change (%In/µs)	Disabled
Trigger action	-

Set threshold
Percentage of nominal value
(Range: 1 - 10)

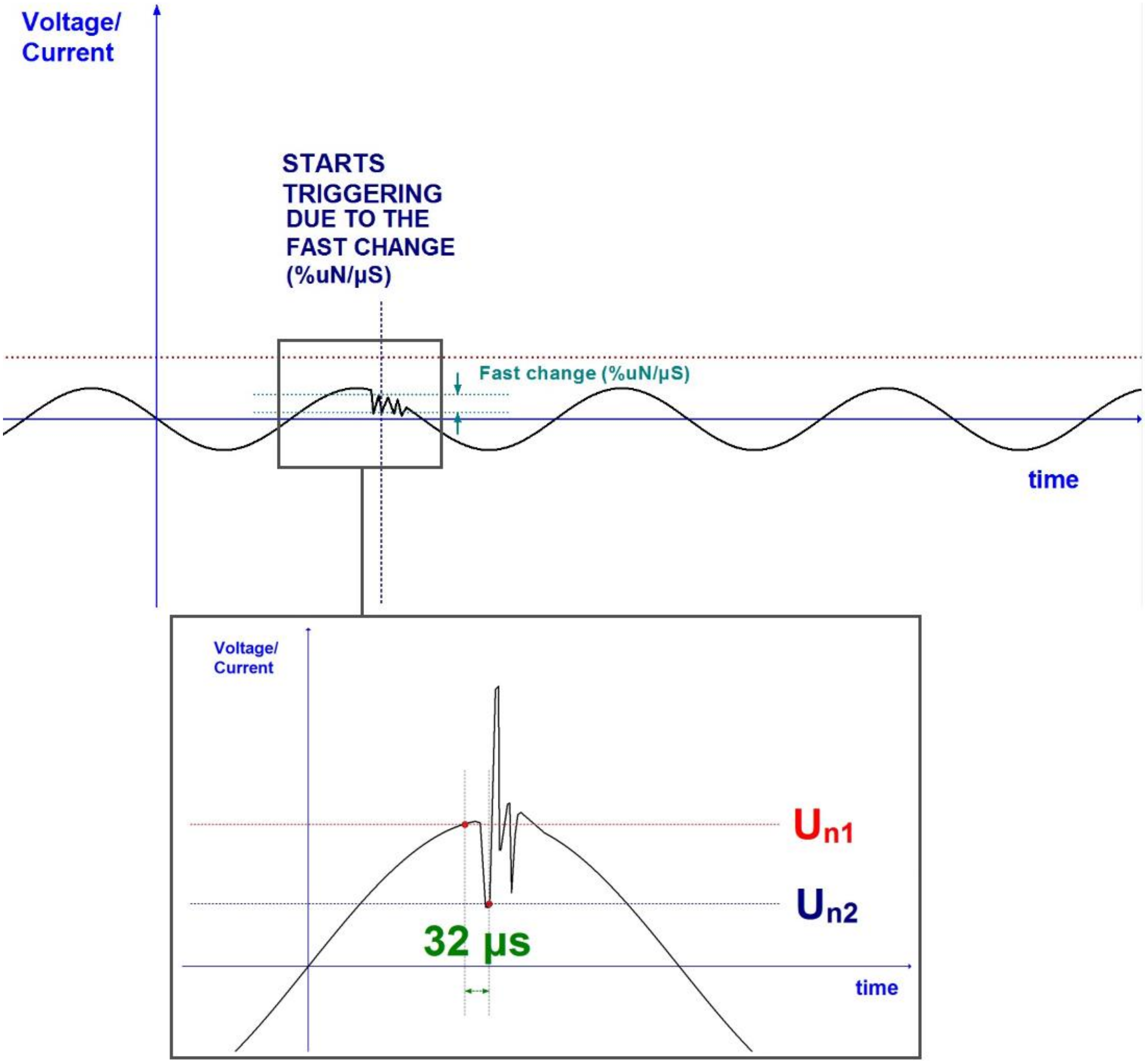
Choose "Disabled" to
disable Fast change
transient detection

Fast change (%Un/µs) Min: 1 Max: 10 Password: 2

Select limit for oscillatory voltage transient detection. During oscillatory transient voltage peak value might not exceed peak value limit. Such oscillatory transient can be detected by sensing fast voltage change within single period. This limit line sets minimum rate of voltage change that will trigger voltage transient event. Limit line is defined in % of nominal value. 20% is a very pessimistic limit that suggests severe transient problems. 1% is an optimistic limit that suggests normal operation with weak transients. If

Defining Fast change transient parameters (MiQen): Settings – Advanced recorders – Triggers – Transient triggers

Example:
Value of 10 is set as threshold for fast change transient detection, which represents 320%/32µs. Transient will be detected when current sample point value – Un2 is 320% higher/lower than the previous one – Un1 (samples are 32µs apart) – see picture: *Transient value exceeds Fast change value threshold.*

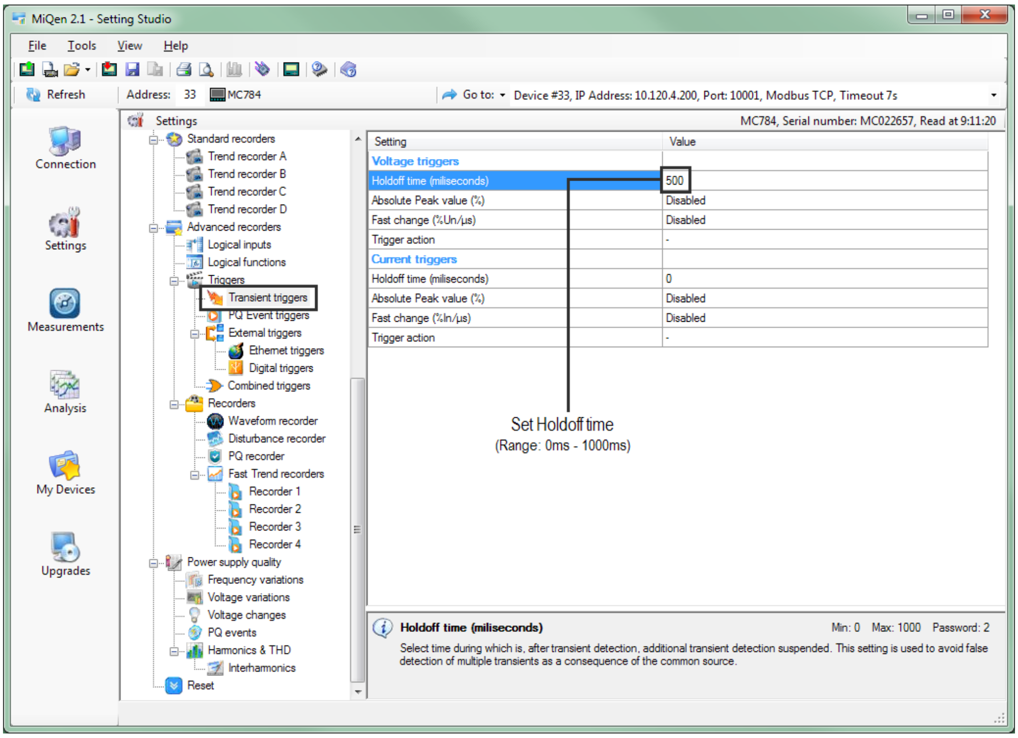


Transient value exceeds Fast change value threshold

Same principal applies to current transient triggers.

Holdoff time

Predefined Holdoff time starts when transient is detected, during this time no additional transient is detected. Setting is used to avoid false detection of multiple transients as a consequence of the common source.



Go to: Device #33, IP Address: 10.120.4.200, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022657, Read at 9:11:20

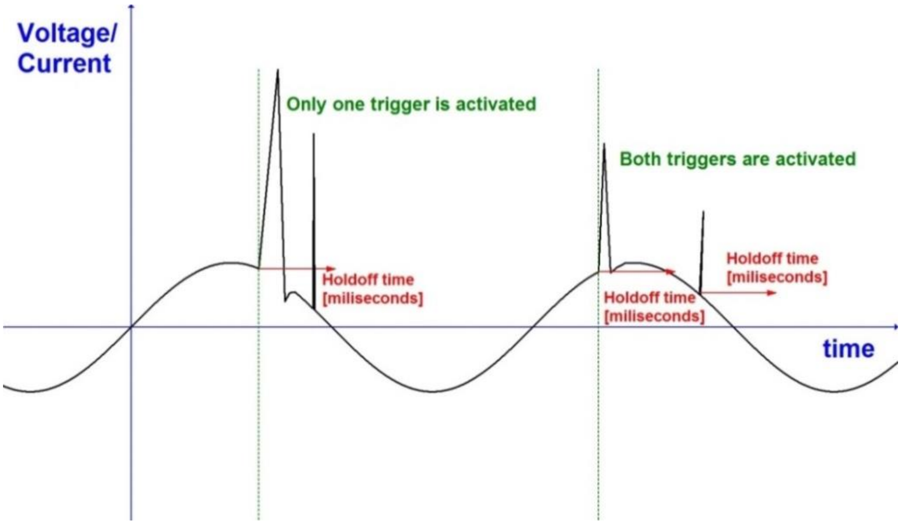
Setting	Value
Voltage triggers	
Holdoff time (miliseconds)	500
Absolute Peak value (%)	Disabled
Fast change (%Un/µs)	Disabled
Trigger action	-
Current triggers	
Holdoff time (miliseconds)	0
Absolute Peak value (%)	Disabled
Fast change (%In/µs)	Disabled
Trigger action	-

Set Holdoff time
(Range: 0ms - 1000ms)

Holdoff time (miliseconds) Min: 0 Max: 1000 Password: 2

Select time during which is, after transient detection, additional transient detection suspended. This setting is used to avoid false detection of multiple transients as a consequence of the common source.

Defining Holdoff time (MiQen): Settings – Advanced recorders – Triggers – Transient triggers


Voltage/ Current
Only one trigger is activated
Both triggers are activated
Holdoff time [miliseconds]
Holdoff time [miliseconds]
Holdoff time [miliseconds]
time

Transient trigger to Holdoff time relationship

On the first period there are two impulsive type transients, but only one trigger was activated since both transients are within Holdoff time. In this case we have avoided false detection of multiple transients since both transients are likely consequence of the common source.

On the second period there are again two impulsive type transients, but now, one of them starts just after Holdoff time ends. In this case two triggers are activated.

PLEASE NOTE

Within one period (20 ms for 50 Hz) only one transient will be recorded even though Holdoff time is set to 0.

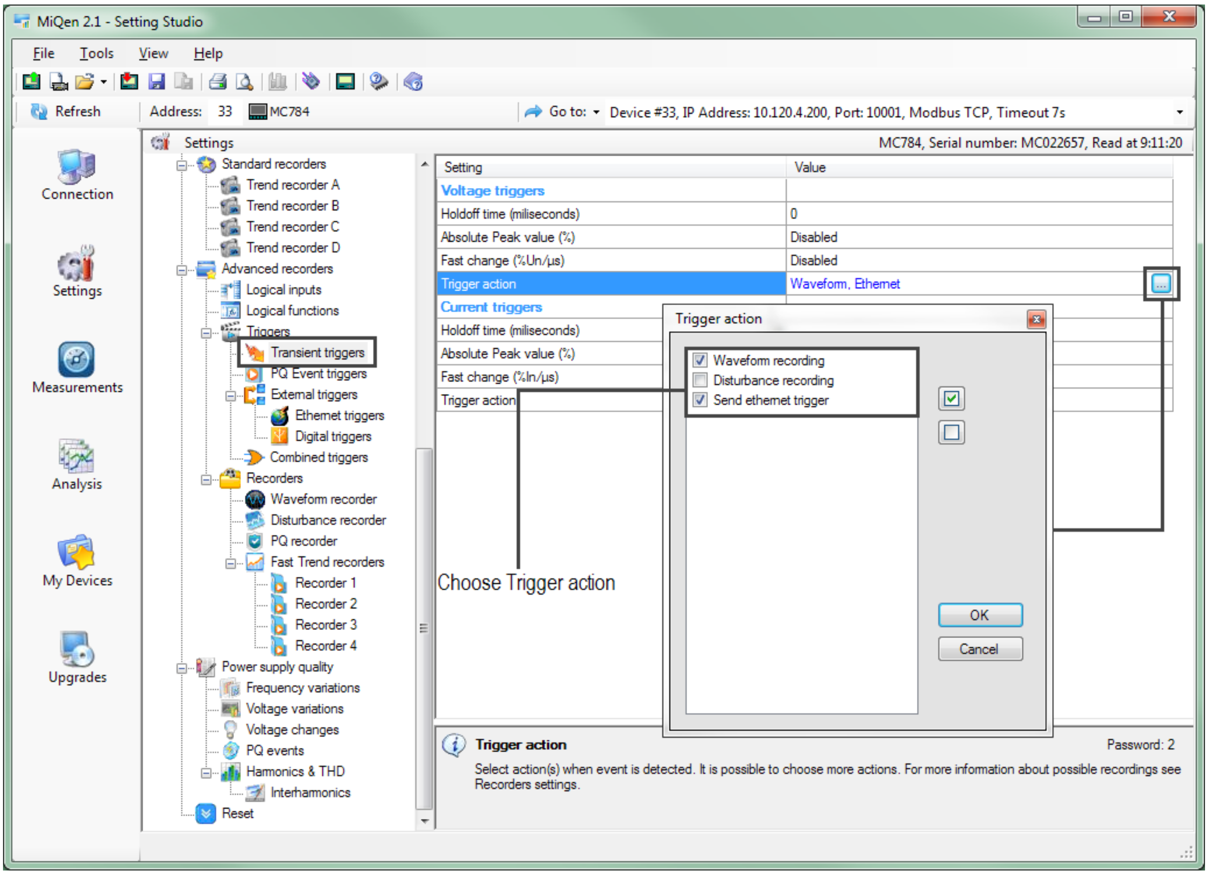
Same principal applies to current transient triggers.

Trigger action

Trigger action gives you option to choose what happens when transient is detected. There are three options available (Actions):

- Waveform recording (transient detection triggers Waveform recording)
- Disturbance recording (transient detection triggers Disturbance recording)
- Send Ethernet trigger (transient detection triggers Send Ethernet trigger)

All three options can be triggered at the same time.



MiQen 2.1 - Setting Studio

Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.200, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022657, Read at 9:11:20

Setting	Value
Voltage triggers	
Holdoff time (miliseconds)	0
Absolute Peak value (%)	Disabled
Fast change (%Un/µs)	Disabled
Trigger action	Waveform, Ethernet
Current triggers	
Holdoff time (miliseconds)	
Absolute Peak value (%)	
Fast change (%In/µs)	
Trigger action	

Trigger action

☑ Waveform recording
☐ Disturbance recording
☑ Send ethernet trigger

Choose Trigger action

Trigger action

Password: 2

Select action(s) when event is detected. It is possible to choose more actions. For more information about possible recordings see Recorders settings.

Defining Trigger action (MiQen): Settings – Advanced recorders – Triggers – Transient triggers

Same principal applies to current transient triggers.

PQ Event triggers

PQ event generated triggers based on the following events:

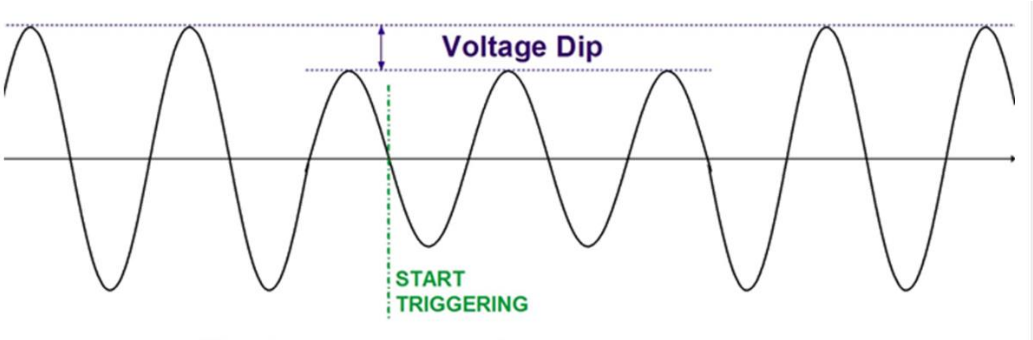
- **Voltage Dip**

A decrease of the normal voltage level between 10 and 90% of the nominal TRMS voltage for durations of 0,5 cycle to 1 minute.

Voltage dips are usually caused by faults on the transmission or distribution network (most of the times on parallel feeders), faults in consumer’s installation, connection of heavy loads and start-up of large motors.

Power Quality Analyzer iMC784A with its Voltage dip trigger is capable of detecting and recording voltage dip events. Later analysis of gathered data can help us determine the cause of event. Knowing the cause, appropriate measures can be taken to prevent similar faults in the future.

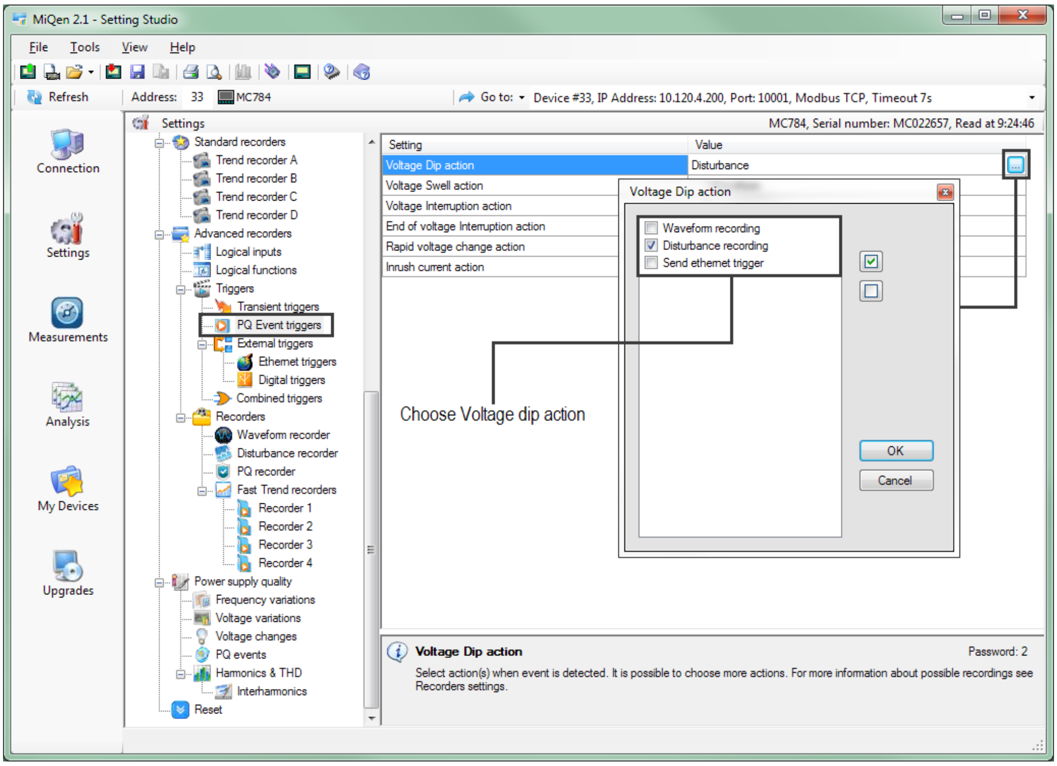
This is important since voltage dip can result in malfunction of information technology equipment, namely microprocessor-based control systems (PCs, PLCs, ASDs,…) that may lead to a process stoppage, tripping of contactors and electromechanical relays, disconnection and loss of efficiency in electric rotating machines.



Voltage dip

Voltage dip action:

- Waveform recording (detection of voltage dip triggers Waveform recording)
- Disturbance recording (detection of voltage dip triggers Disturbance recording)
- Send Ethernet trigger (detection of voltage dip triggers Send Ethernet trigger)



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.200, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022657, Read at 9:24:46

Setting	Value
Voltage Dip action	Disturbance
Voltage Swell action	
Voltage Interruption action	
End of voltage Interruption action	
Rapid voltage change action	
Inrush current action	

Voltage Dip action

☐ Waveform recording
☑ Disturbance recording
☐ Send ethernet trigger

Voltage Dip action Password: 2

Select action(s) when event is detected. It is possible to choose more actions. For more information about possible recordings see Recorders settings.

Defining Voltage dip action (MiQen): Settings – Advanced recorders – Triggers – PQ Event triggers

All three options can be triggered at the same time.

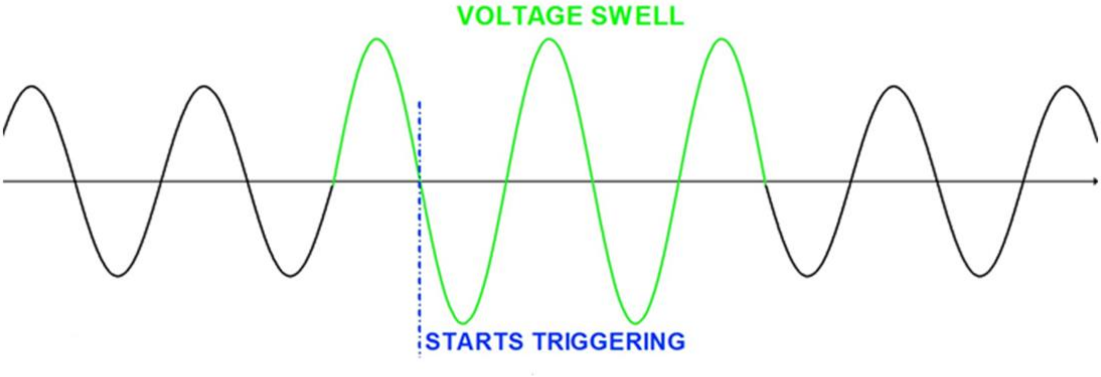
- **Voltage Swell**

Momentary increase of the voltage, outside the normal tolerances (over 110% of the nominal TRMS voltage), with duration of more than one cycle and typically less than a few seconds.

Voltage swells are usually caused by start/stop of heavy loads, badly dimensioned power sources, badly regulated transformers (mainly during off-peak hours) and a single-phase fault on a three-phase system.

Power Quality Analyzer iMC784A with its Voltage swell trigger is capable of detecting and recording voltage swell events. Later analysis of gathered data can help us determine the cause of event. Knowing the cause, appropriate measures can be taken to prevent similar faults in the future.

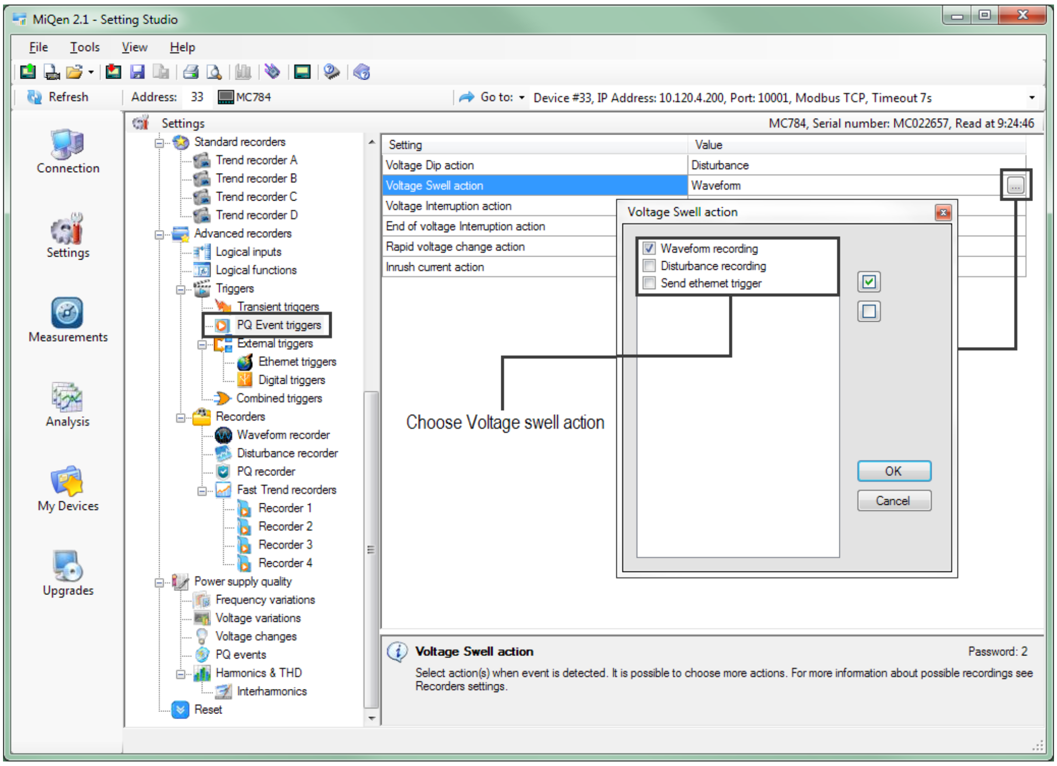
This is important since voltage swell can result in data loss, flickering of lighting and screens, stoppage or damage of sensitive equipment (semiconductors), insulation degradation,…



Voltage swell

Voltage swell action:

- Waveform recording (detection of voltage swell triggers Waveform recording)
- Disturbance recording (detection of voltage swell triggers Disturbance recording)
- Send Ethernet trigger (detection of voltage swell triggers Send Ethernet trigger)



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.200, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022657, Read at 9:24:46

Setting	Value
Voltage Dip action	Disturbance
Voltage Swell action	Waveform
Voltage Interruption action	
End of voltage Interruption action	
Rapid voltage change action	
Inrush current action	

Voltage Swell action

☑ Waveform recording
☐ Disturbance recording
☐ Send ethernet trigger

Voltage Swell action Password: 2

Select action(s) when event is detected. It is possible to choose more actions. For more information about possible recordings see Recorders settings.

Defining Voltage swell action (MiQen): Settings – Advanced recorders – Triggers – PQ Event triggers

All three options can be triggered at the same time.

- **Voltage Interruption**

There are two types of voltage interruptions:

- Short interruptions (reduction in line-voltage to less than 5% of nominal voltage for duration of up to 3 minutes - 70% of Short interruptions < 1 s; According to EN 50160)
- Long interruptions (reduction in line-voltage to less than 5% of nominal voltage for duration greater than 3 minutes; According to EN 50160)

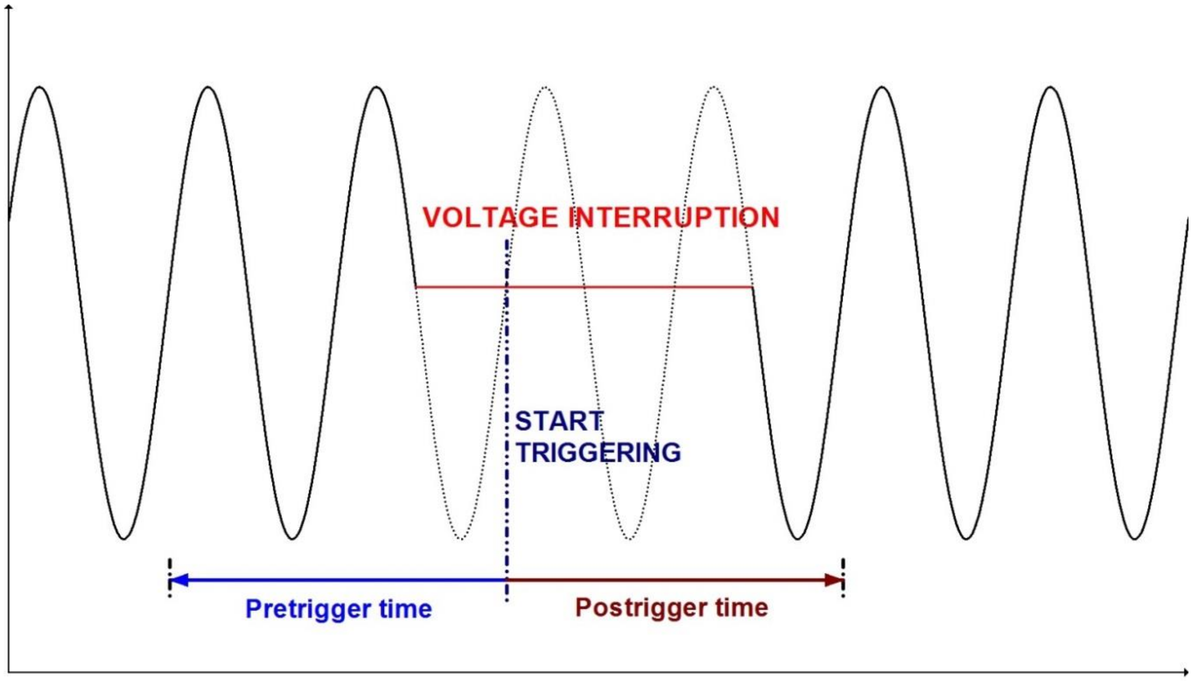
Both short and long interruptions are detected by Power Quality Analyzer iMC784A. In some cases when predefined recorder post-trigger time is shorter then interruption duration time, only start of interruption will be recorded. In cases like that End of voltage interruption trigger can be predefined so that end of voltage interruption is detected and recorded.

Short interruptions are usually caused by opening and automatic re-closure of protection devices to decommission a faulty section of the network. The main fault causes are insulation failure, lightning and insulator flashover.

Long interruptions are usually caused by Equipment failure in the power system network, storms and objects (trees, cars, etc.) striking lines or poles, fire, human error, bad coordination or failure of protection devices.

Power Quality Analyzer iMC784A with its Voltage interruption trigger is capable of detecting and recording voltage interruption events. Later analysis of gathered data can help us determine the cause of event. Knowing the cause, appropriate measures can be taken to prevent similar faults in the future.

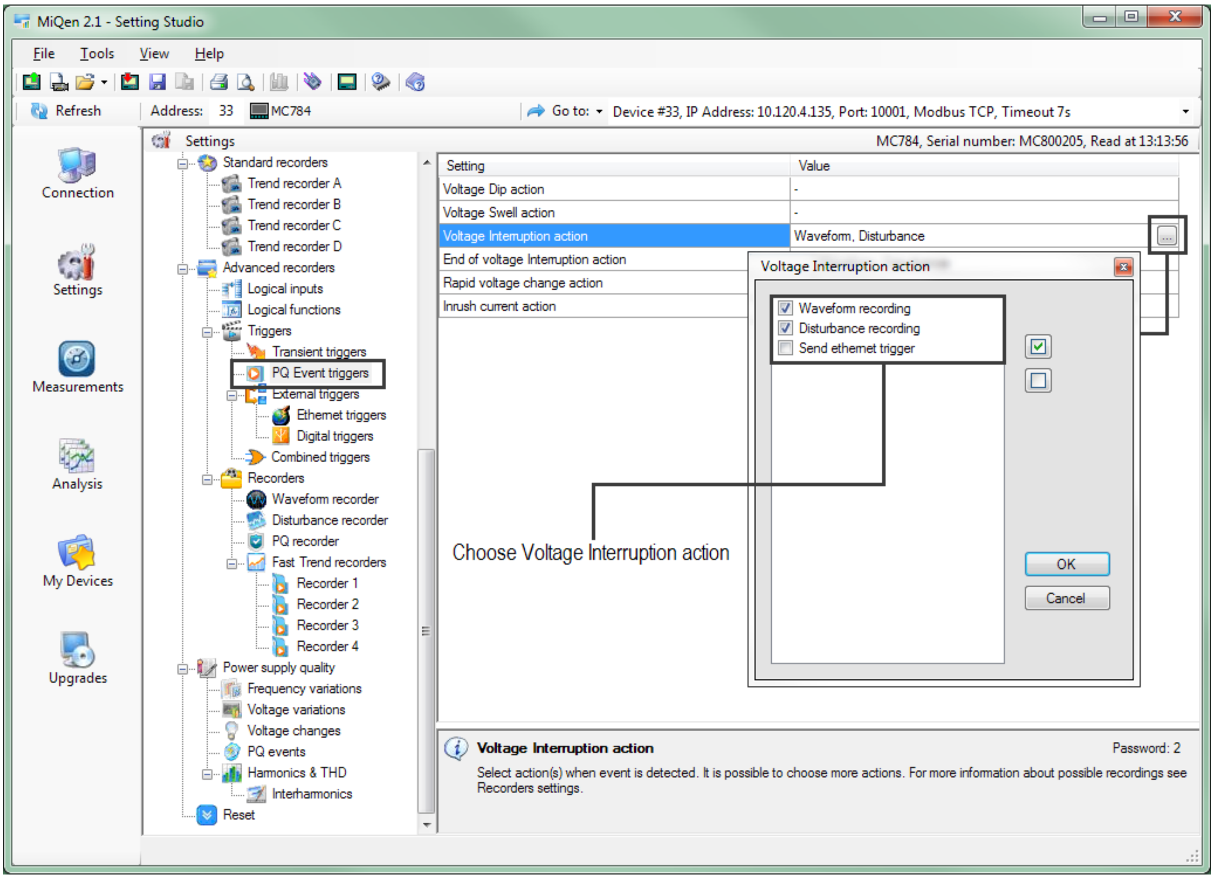
This is important since voltage interruption can result in Tripping of protection devices, loss of information and malfunction of data processing equipment, stoppage of sensitive equipment, such as ASDs, PCs, PLCs; Stoppage of all equipment.



Voltage interruption

Voltage interruption action:

- Waveform recording (voltage interruption triggers Waveform recording)
- Disturbance recording (voltage interruption triggers Disturbance recording)
- Send Ethernet trigger (voltage interruption triggers Send Ethernet trigger)



Device #33, IP Address: 10.120.4.135, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC800205, Read at 13:13:56

Setting	Value
Voltage Dip action	-
Voltage Swell action	-
Voltage Interruption action	Waveform, Disturbance
End of voltage Interruption action	
Rapid voltage change action	
Inrush current action	

Voltage Interruption action

☑ Waveform recording
☑ Disturbance recording
☐ Send ethernet trigger

Choose Voltage Interruption action

Voltage Interruption action Password: 2

Select action(s) when event is detected. It is possible to choose more actions. For more information about possible recordings see Recorders settings.

Defining Voltage interruption action (MiQen): Settings – Advanced recorders – Triggers – PQ Event triggers

All three options can be chosen simultaneously.

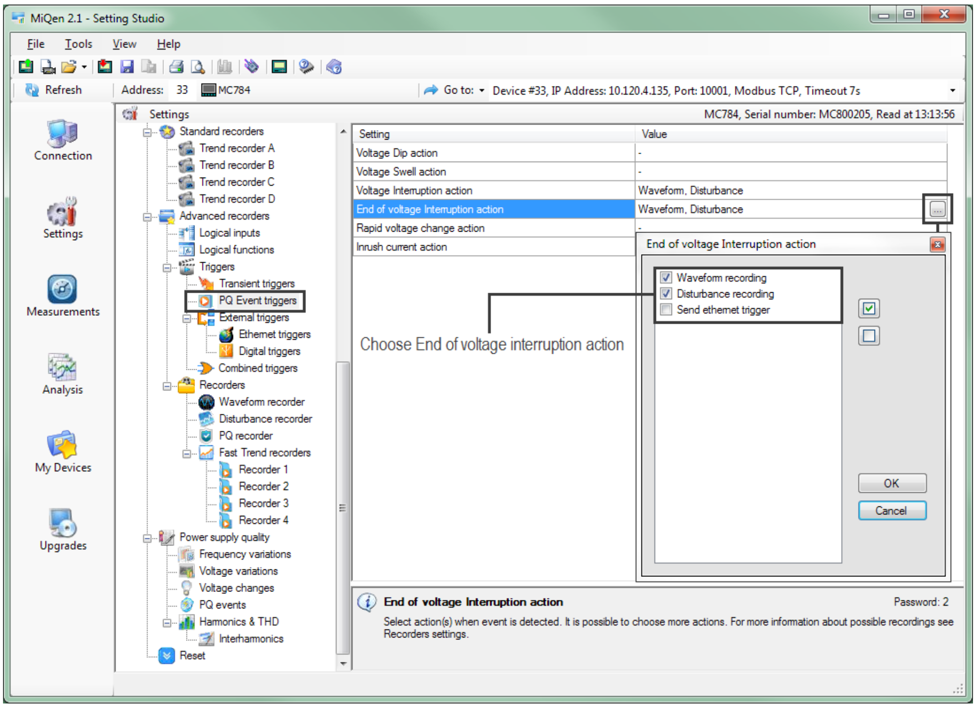
- **End Of Voltage Interruption**

In some cases when predefined recorder post-trigger time is shorter then interruption duration time, only start of interruption will be recorded. In cases like that End of voltage interruption trigger can be predefined so that end of voltage interruption is detected and recorded.

End of voltage interruption is detected when voltage rises above 7% of the nominal voltage. 5% is voltage interruption upper limit + 2% predefined hysteresis. Hysteresis is required to avoid multiple triggers following the same event.

End of voltage interruption action:

- Waveform recording (end of voltage interruption triggers Waveform recording)
- Disturbance recording (end of voltage interruption triggers Disturbance recording)
- Send Ethernet trigger (end of voltage interruption triggers Send Ethernet trigger)



Device #33, IP Address: 10.120.4.135, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC800205, Read at 13:13:56

Setting	Value
Voltage Dip action	-
Voltage Swell action	-
Voltage Interruption action	Waveform, Disturbance
End of voltage Interruption action	Waveform, Disturbance
Rapid voltage change action	-
Inrush current action	

End of voltage Interruption action

☑ Waveform recording
☑ Disturbance recording
☐ Send ethernet trigger

Choose End of voltage interruption action

End of voltage Interruption action Password: 2

Select action(s) when event is detected. It is possible to choose more actions. For more information about possible recordings see Recorders settings.

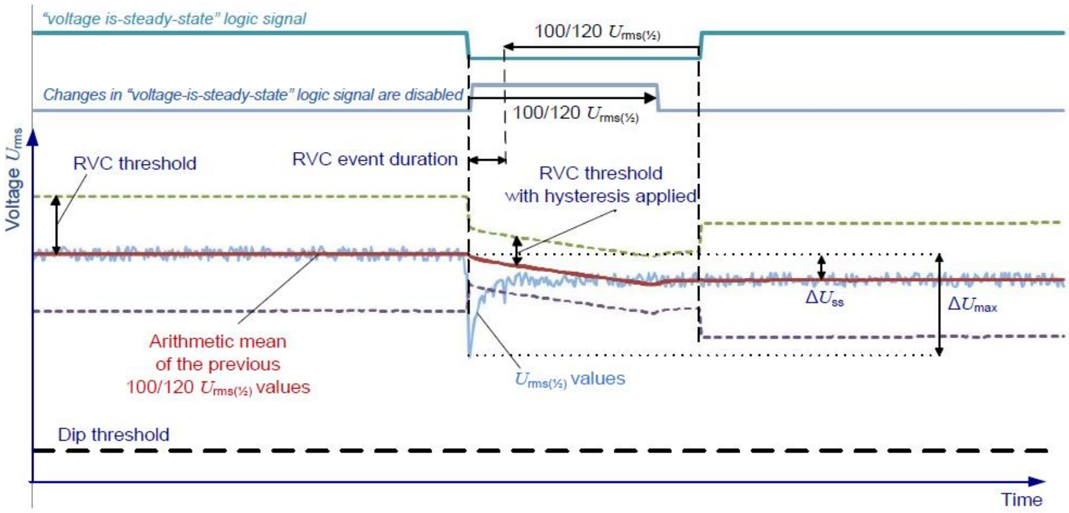
Defining End of voltage interruption action (MiQen): Settings – Advanced recorders – Triggers – PQ Event triggers

All three options can be triggered at the same time.

- **Rapid Voltage Change**

A rapid voltage change is a transition in TRMS voltage between two steady-state conditions. Every time a new half-cycle U_{rms} value is available, the arithmetic mean of the previous 100(50Hz)/120(60Hz) half-cycle U_{rms} values, including the new value, is calculated. If every one of the previous half-cycle 100/120 Urms values, including the new value, is within the RVC threshold (including the hysteresis, if applied) of the arithmetic mean, then no RVC is detected. If one of the values exceeds RVC threshold (including the hysteresis, if applied) then RVC is detected. If voltage value exceeds dip or swell thresholds is no longer consider as Rapid voltage change but as dip or swell. An RVC event is characterized by four parameters: start time, duration, ΔU_{max} and $\Delta U_{steady\text{-}state}$:

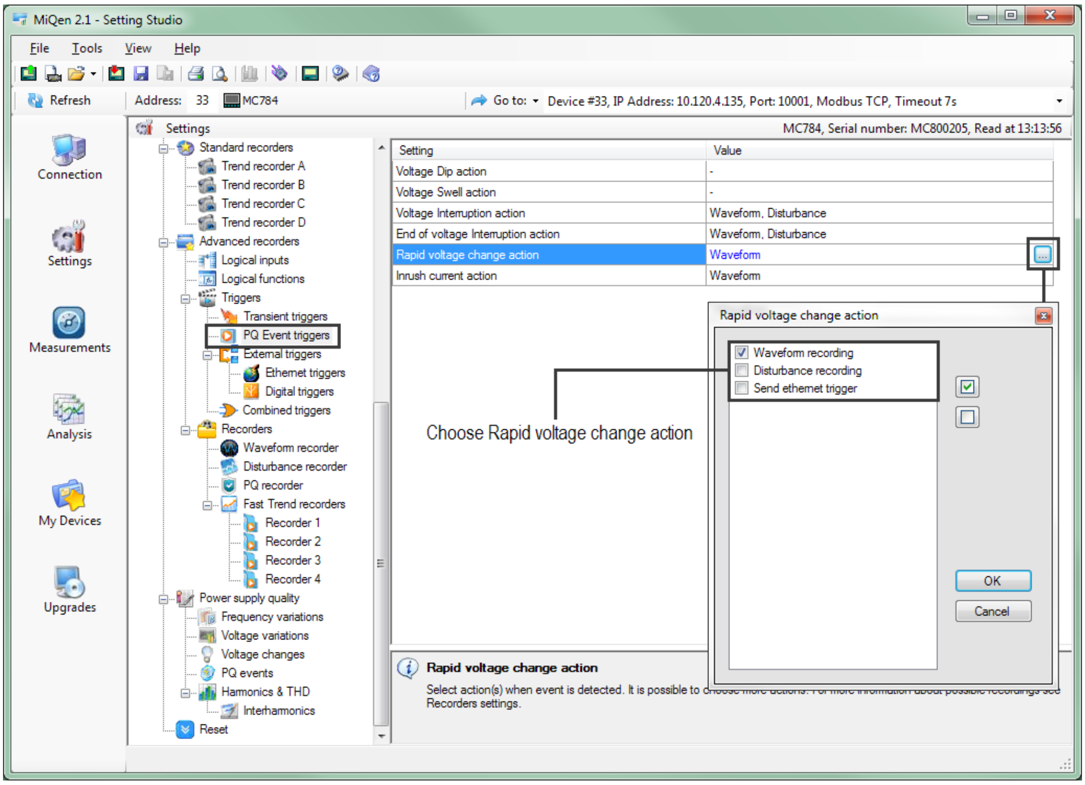
- ΔU_{max} is the maximum absolute difference between any of the half-cycle U_{rms} values during the RVC event and the final arithmetic mean 100/120 half-cycle U_{rms} value just prior to the RVC event.
- ΔU_{ss} is the absolute difference between the final arithmetic mean 100/120 half-cycle U_{rms} value just prior to the RVC event and the first arithmetic mean 100/120 half-cycle U_{rms} value after the RVC event.



Rapid voltage change (source – IEC6100-4-30 standard)

Rapid voltage change action:

- Waveform recording (detection of Rapid voltage change triggers Waveform recording)
- Disturbance recording (detection of Rapid voltage change triggers Disturbance recording)
- Send Ethernet trigger (detection of Rapid voltage change triggers Send Ethernet trigger)



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.135, Port: 10001, Modbus TCP, Timeout 7s

Settings MC784, Serial number: MC800205, Read at 13:13:56

Setting	Value
Voltage Dip action	-
Voltage Swell action	-
Voltage Interruption action	Waveform, Disturbance
End of voltage Interruption action	Waveform, Disturbance
Rapid voltage change action	Waveform
Inrush current action	Waveform

Choose Rapid voltage change action

Rapid voltage change action

☑ Waveform recording
☐ Disturbance recording
☐ Send ethernet trigger

Rapid voltage change action

Select action(s) when event is detected. It is possible to
Recorders settings.

Defining Rapid voltage change action (MiQen): Settings – Advanced recorders – Triggers – PQ Event triggers

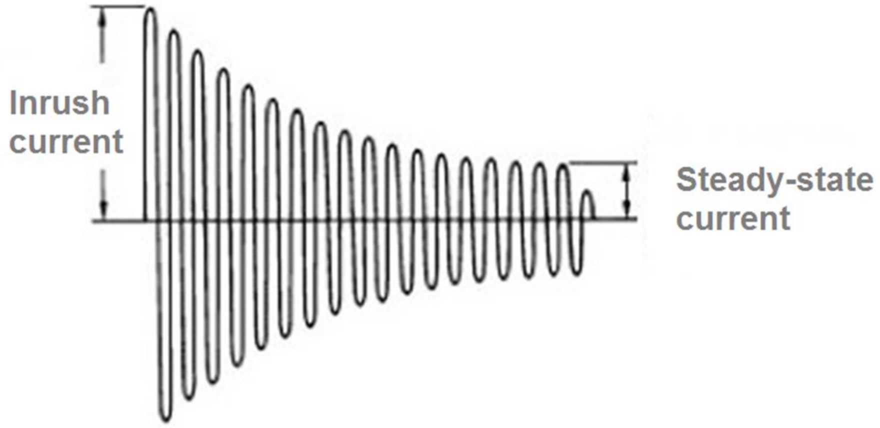
All three options can be triggered at the same time.

- **Inrush Current**

Large current flow that exceeds the steady-state current flow. It flows transiently at the time of starting of instruments (which have built-in motor), incandescent lamp, larger capacity smoothing condenser.

Power Quality Analyzer iMC784A with its Inrush current trigger is capable of detecting and recording inrush current events. Later analysis of gathered data can help us determine the cause of event. Knowing the cause, appropriate measures can be taken to prevent similar faults in the future.

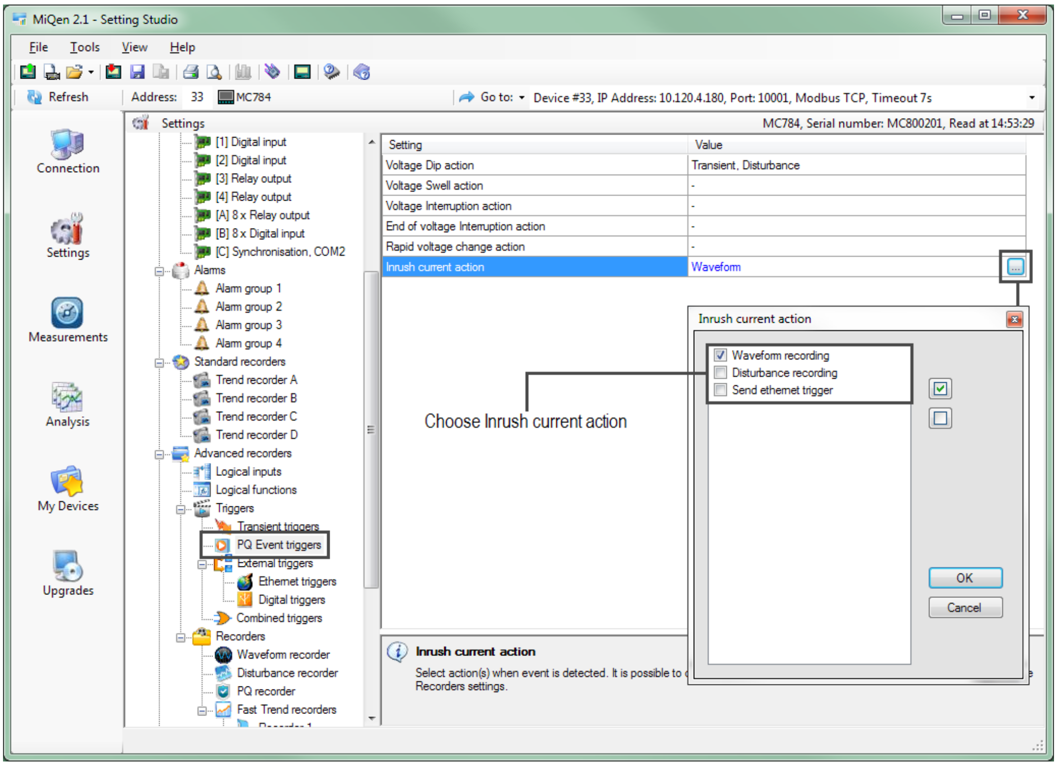
This is important since inrush current can result in bad effect to power switch's welding, fusing, breaker's trip and converter circuit etc. and also causes unstable power voltage.



Inrush Current

Inrush current action:

- Waveform recording (detection of Inrush current triggers Waveform recording)
- Disturbance recording (detection of Inrush current triggers Disturbance recording)
- Send Ethernet trigger (detection of Inrush current triggers Send Ethernet trigger)



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.180, Port: 10001, Modbus TCP, Timeout 7s

Settings

MC784, Serial number: MC800201, Read at 14:53:29

Setting	Value
Voltage Dip action	Transient, Disturbance
Voltage Swell action	-
Voltage Interruption action	-
End of voltage Interruption action	-
Rapid voltage change action	-
Inrush current action	Waveform

Inrush current action

☑ Waveform recording
☐ Disturbance recording
☐ Send ethernet trigger

Inrush current action

Select action(s) when event is detected. It is possible to
Recorders settings.

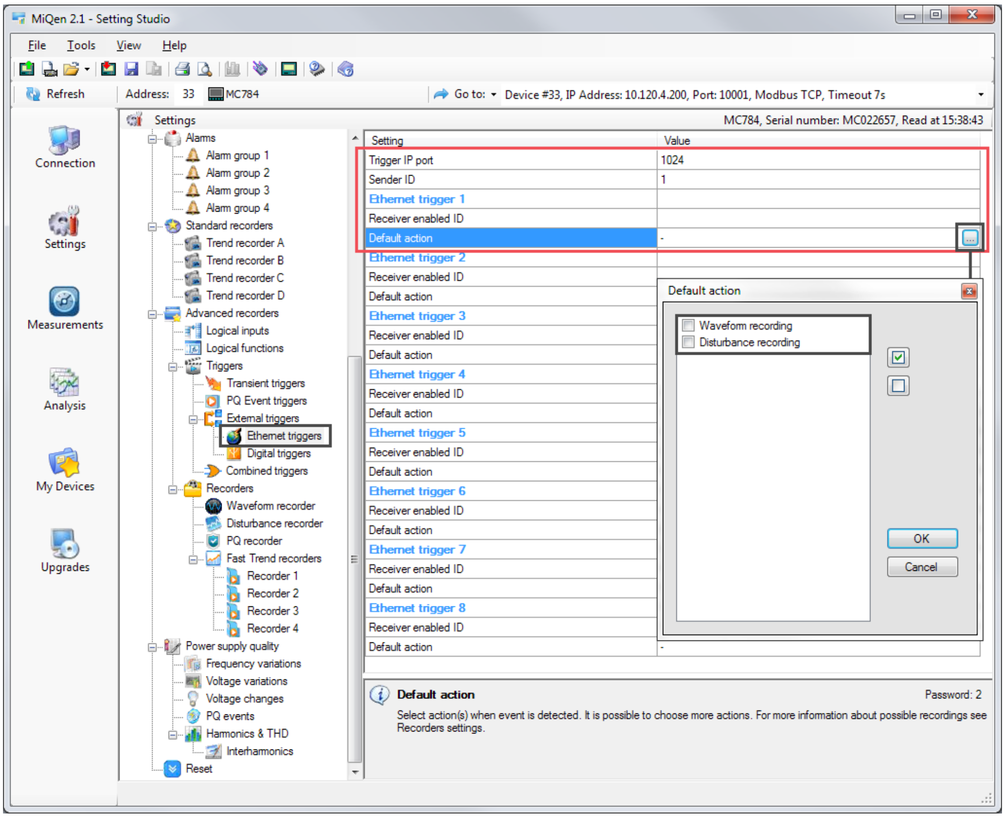
Defining Inrush current action (MiQen): Settings – Advanced recorders – Triggers – PQ Event triggers

All three options can be triggered at the same time.

External triggers

Ethernet triggers

Upon event detection trigger can be sent to other devices over Ethernet. These are termed network triggers. Devices receiving Ethernet trigger will respond accordingly, so that an event or a disturbance at one network node results in instantaneously measured values at all other network nodes. This enables simultaneous analysis of the effect of the disturbance on the complete network. Up to 8 different dislocated devices can be connected one to another and exchange Ethernet triggers.



Device #33, IP Address: 10.120.4.200, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022657, Read at 15:38:43

Setting	Value
Trigger IP port	1024
Sender ID	1
Ethernet trigger 1	
Receiver enabled ID	
Default action	-
Ethernet trigger 2	
Receiver enabled ID	
Default action	
Ethernet trigger 3	
Receiver enabled ID	
Default action	
Ethernet trigger 4	
Receiver enabled ID	
Default action	
Ethernet trigger 5	
Receiver enabled ID	
Default action	
Ethernet trigger 6	
Receiver enabled ID	
Default action	
Ethernet trigger 7	
Receiver enabled ID	
Default action	
Ethernet trigger 8	
Receiver enabled ID	
Default action	-

☐ Waveform recording
☐ Disturbance recording

Default action Password: 2

Select action(s) when event is detected. It is possible to choose more actions. For more information about possible recordings see Recorders settings.

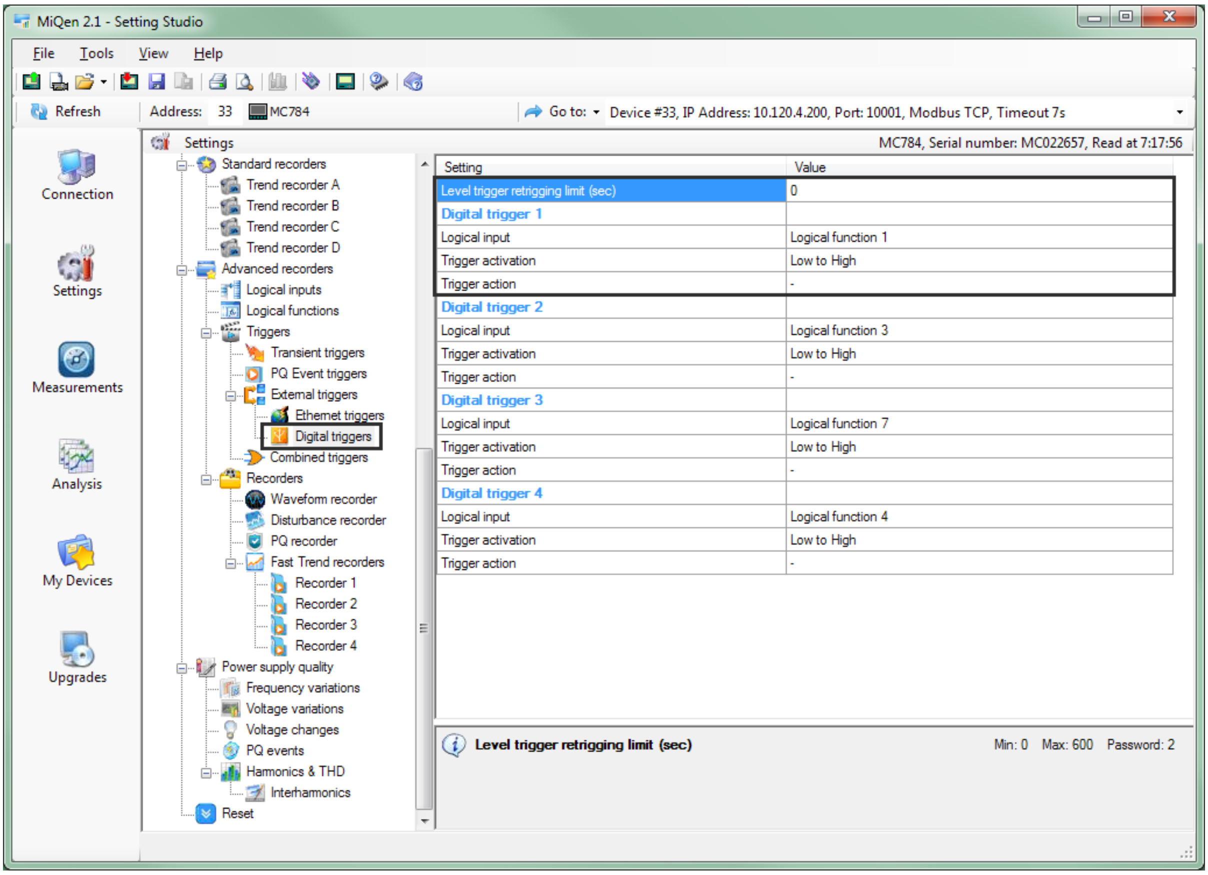
Defining Ethernet triggers parameters (MiQen): Settings – Advanced recorders – Triggers – External triggers – Ethernet triggers

Following parameters have to be defined to enable Ethernet triggers:

- Trigger IP port:
  Select port for Ethernet triggers. Devices with same port are able to exchange Ethernet triggers. When device in utility network detects anomaly and sends Ethernet trigger, other devices (with same port) will receive that trigger – up to 8 devices.
  Range: 1024 – 65535
- Sender ID:
  Select identification number of the device. Identification number enables us to distinguish between devices in order to determine which device has sent which Ethernet trigger.
  Range: 1 – 255
- Receiver enabled ID:
  Select ID number of another into utility network connected device from which Ethernet triggers shall be accepted. To disable network triggering from another device this setting should be cleared.
  Range: 0 – 255
- Default action:
  Choose what happens when Ethernet trigger is detected. Both options can be triggered at the same time.
  Options: Waveform recording and Disturbance recording.

Digital triggers

External digital triggers are based on logical/digital inputs.



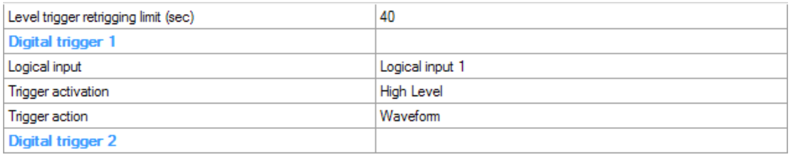
Setting	Value
Level trigger retrigging limit (sec)	0
Digital trigger 1	
Logical input	Logical function 1
Trigger activation	Low to High
Trigger action	-
Digital trigger 2	
Logical input	Logical function 3
Trigger activation	Low to High
Trigger action	-
Digital trigger 3	
Logical input	Logical function 7
Trigger activation	Low to High
Trigger action	-
Digital trigger 4	
Logical input	Logical function 4
Trigger activation	Low to High
Trigger action	-

Level trigger retrigging limit (sec) Min: 0 Max: 600 Password: 2

Defining Digital triggers parameters (MiQen): Settings – Advanced recorders – Triggers – External triggers – Digital triggers

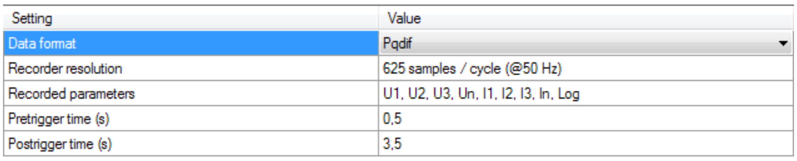
Following parameters have to be defined to enable Digital triggers:

- Level trigger re-trigging limit:
  If *High level* is chosen as *Trigger activation* then *Level trigger re-trigging limit* defines recording time for Level trigger. Range: 0 – 600s. Multiple recordings (Waveform/Disturbance recordings) will be stitched together until desired recording time is reached.
  Example:
  - Digital trigger 1 settings:



Level trigger retrigging limit (sec)	40
Digital trigger 1	
Logical input	Logical input 1
Trigger activation	High Level
Trigger action	Waveform
Digital trigger 2	

  - Waveform recorder settings:

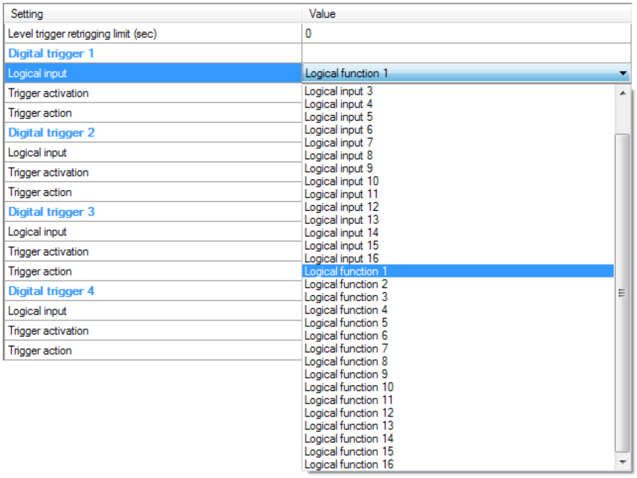


Setting	Value
Data format	Pqdif
Recorder resolution	625 samples / cycle (@50 Hz)
Recorded parameters	U1, U2, U3, Un, I1, I2, I3, In, Log
Pretrigger time (s)	0,5
Postrigger time (s)	3,5

Waveform recording time = Pre-trigger time + Post-trigger time = 4s. To achieve 40s recording time for level trigger, 10 waveform recordings are stitched together.

If any other option is selected as Trigger activation (Low to High, High to Low, Each change, Low Level) recording time will be the same as predefined recording time of Waveform/disturbance recorder. Level trigger retriggering limit does not affect these options.

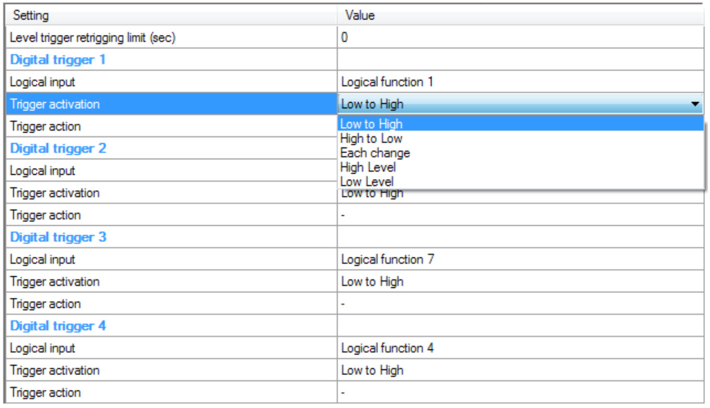
- Logical input:
  Select source for Digital trigger. Choose between logical inputs and logical functions.



Setting	Value
Level trigger retrigging limit (sec)	0
Digital trigger 1	
Logical input	Logical function 1
Trigger activation	
Trigger action	
Digital trigger 2	
Logical input	
Trigger activation	
Trigger action	
Digital trigger 3	
Logical input	
Trigger activation	
Trigger action	
Digital trigger 4	
Logical input	
Trigger activation	
Trigger action	

Logical input 3
Logical input 4
Logical input 5
Logical input 6
Logical input 7
Logical input 8
Logical input 9
Logical input 10
Logical input 11
Logical input 12
Logical input 13
Logical input 14
Logical input 15
Logical input 16
Logical function 1
Logical function 2
Logical function 3
Logical function 4
Logical function 5
Logical function 6
Logical function 7
Logical function 8
Logical function 9
Logical function 10
Logical function 11
Logical function 12
Logical function 13
Logical function 14
Logical function 15
Logical function 16

- Trigger activation:
  Select logical level transition direction for trigger activation.



Setting	Value
Level trigger retrigging limit (sec)	0
Digital trigger 1	
Logical input	Logical function 1
Trigger activation	Low to High
Trigger action	
Digital trigger 2	
Logical input	
Trigger activation	Low to High
Trigger action	-
Digital trigger 3	
Logical input	Logical function 7
Trigger activation	Low to High
Trigger action	-
Digital trigger 4	
Logical input	Logical function 4
Trigger activation	Low to High
Trigger action	-

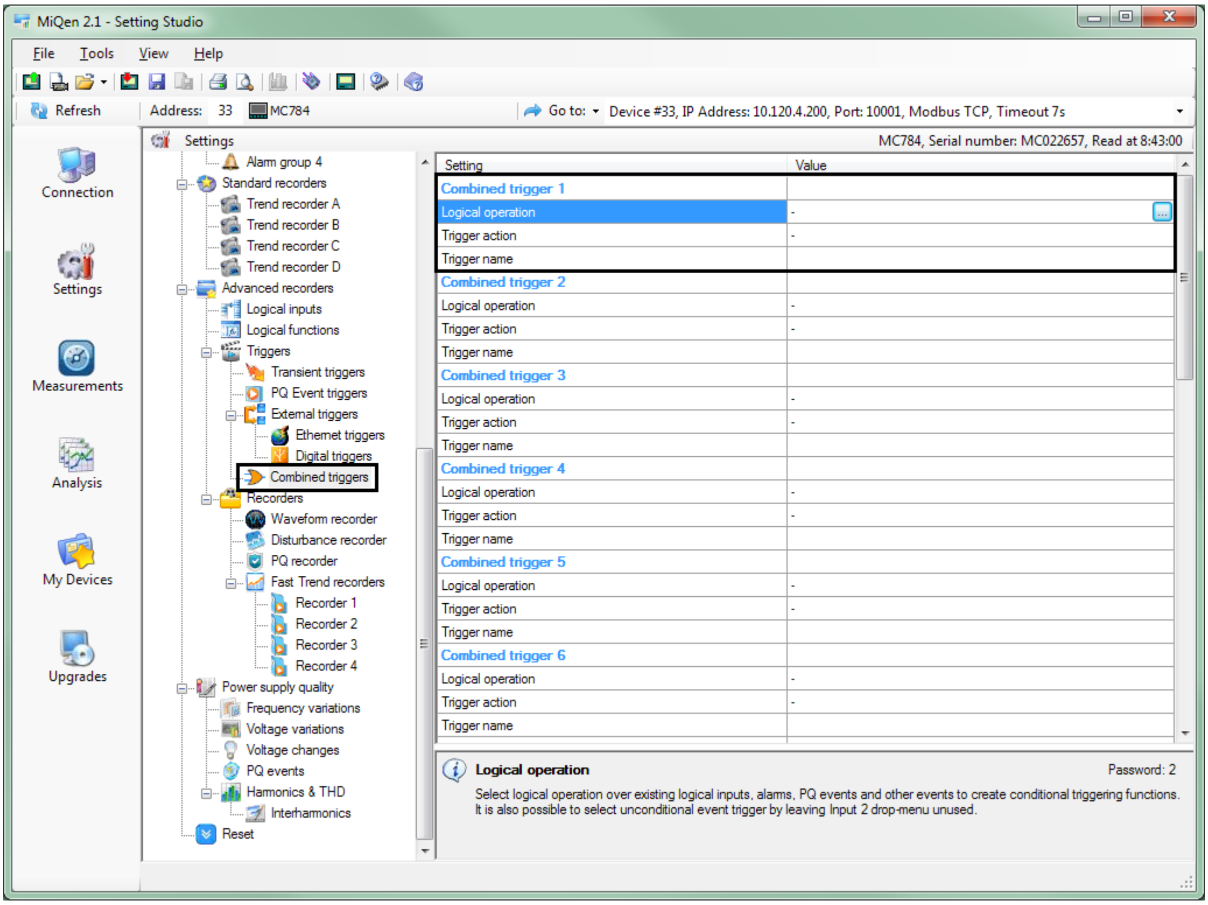
Low to High
High to Low
Each change
High Level
Low Level

- Trigger action:
  Choose what happens when Digital trigger is detected. All options can be chosen simultaneously.
  Options: Waveform recording, Disturbance recording and Send Ethernet trigger

Total of 4 Digital triggers can be defined.

Combined triggers

Combined triggers give as an option to perform AND/OR logical operations over previously configured triggers/events. Total of 16 combined triggers can be defined.



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.200, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022657, Read at 8:43:00

Setting	Value
Combined trigger 1	
Logical operation	-
Trigger action	-
Trigger name	
Combined trigger 2	
Logical operation	-
Trigger action	-
Trigger name	
Combined trigger 3	
Logical operation	-
Trigger action	-
Trigger name	
Combined trigger 4	
Logical operation	-
Trigger action	-
Trigger name	
Combined trigger 5	
Logical operation	-
Trigger action	-
Trigger name	
Combined trigger 6	
Logical operation	-
Trigger action	-
Trigger name	

Logical operation Password: 2

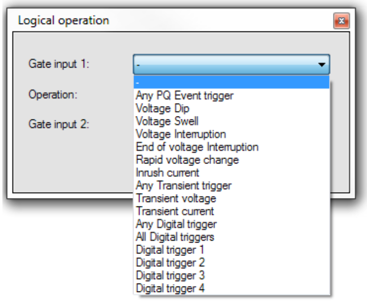
Select logical operation over existing logical inputs, alarms, PQ events and other events to create conditional triggering functions. It is also possible to select unconditional event trigger by leaving Input 2 drop-menu unused.

Defining Combined triggers parameters (MiQen): Settings – Advanced recorders – Triggers – Combined triggers

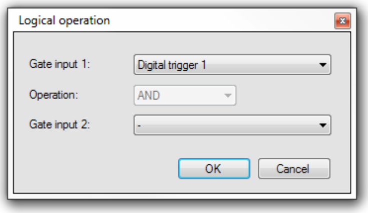
Following parameters have to be defined to enable combined trigger:

- Logical operation:
  Create logical operation over existing logical inputs, alarms, PQ events and other events to create conditional triggering functions. Both Gate input 1 and Gate input 2 must be selected from a drop down menu. If Gate input 1/Gate input 2 is left empty, nothing will get recorded.

1. Select Gate input 1

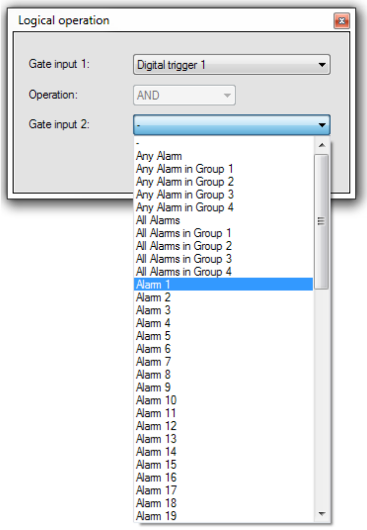


2. Select Operation



Gate input 1: Digital trigger 1
Operation: AND
Gate input 2: -

3. Select Gate input 2



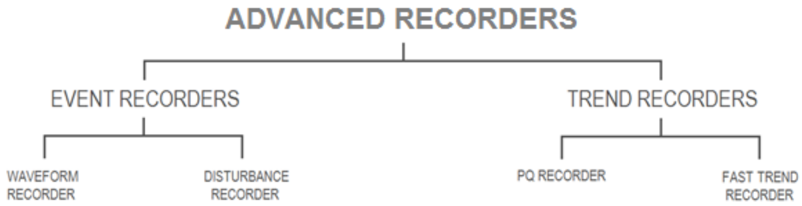
Gate input 1: Digital trigger 1
Operation: AND
Gate input 2: -

- Trigger action:
  Choose what happens when combined trigger is detected. All options can be chosen simultaneously.
  Options: Waveform recording, Disturbance recording and Send Ethernet trigger
- Trigger name:
  Select combined trigger name for presentation of (complex) conditional trigger. This name will be used within reports, where trigger condition and time stamp for each event will be recorded and presented. It should be a short and meaningful summary of combined trigger purpose or meaning.

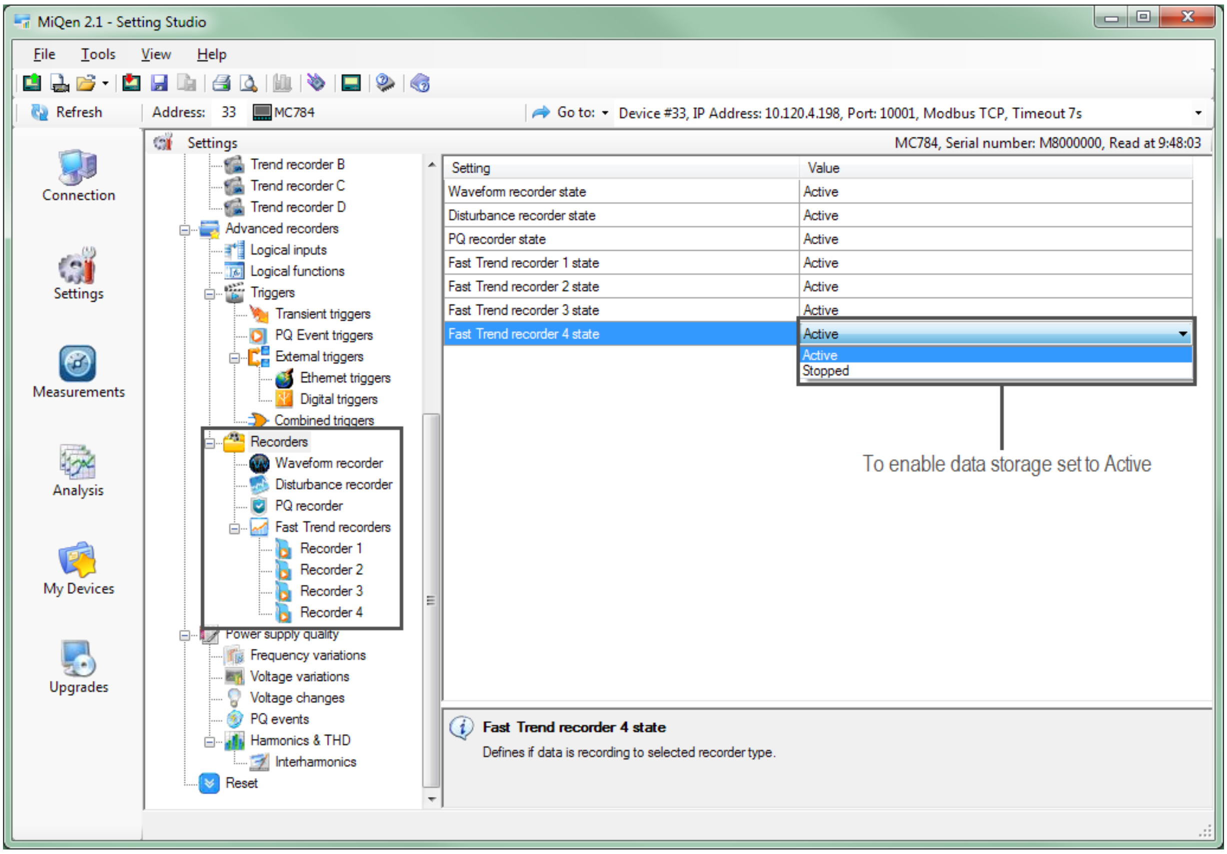
⚠ **PLEASE NOTE**

If Gate input 1/Gate input 2 is left empty, nothing will get recorded.
Gate input 2 condition must be met in time when Gate input 1 is triggered, for Combined trigger to be activated.

Recorders



Following parameters have to be defined to enable data storage to specific recorder:



Setting	Value
Waveform recorder state	Active
Disturbance recorder state	Active
PQ recorder state	Active
Fast Trend recorder 1 state	Active
Fast Trend recorder 2 state	Active
Fast Trend recorder 3 state	Active
Fast Trend recorder 4 state	Active

To enable data storage set to Active

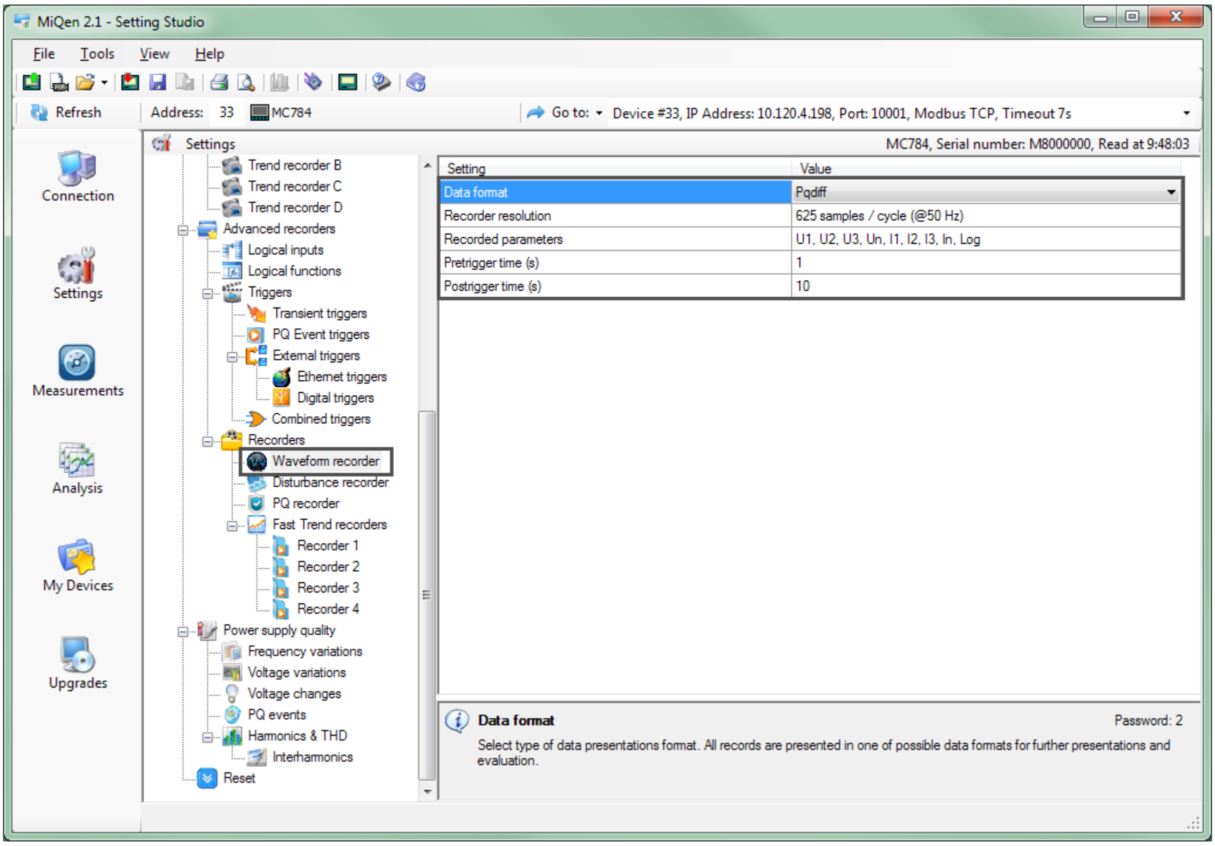
Fast Trend recorder 4 state

Defines if data is recording to selected recorder type.

Activate specific recorder

Waveform recorder

It is an event recorder. Recorder is triggered only when an event occurs. It is used for monitoring short events (transients, short power quality events).



Setting	Value
Data format	Pqdiff
Recorder resolution	625 samples / cycle (@50 Hz)
Recorded parameters	U1, U2, U3, Un, I1, I2, I3, In, Log
Pretrigger time (s)	1
Postrigger time (s)	10

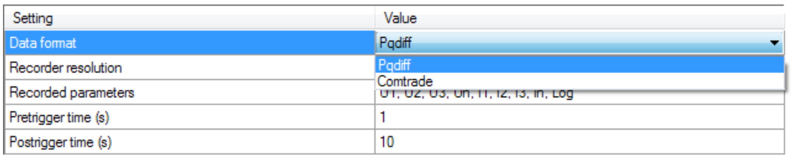
Data format

Select type of data presentations format. All records are presented in one of possible data formats for further presentations and evaluation.

Defining Waveform recorder parameters (MiQen): Settings – Advanced recorders – Recorders – Waveform recorder

Defining Waveform recorder parameters:

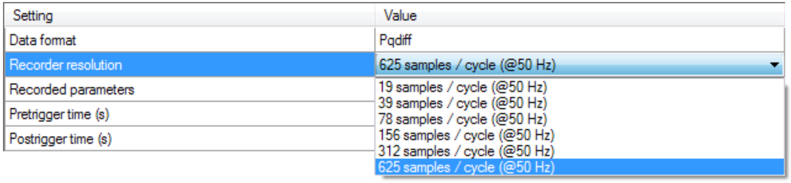
- Data format:
  Recorded data can be stored in PQDIF/COMTRADE data format. Only one can be selected for specific recorder.



Setting	Value
Data format	Pqdiff Pqdiff Comtrade
Recorder resolution	
Recorded parameters	U1, U2, U3, Un, I1, I2, I3, In, Log
Pretrigger time (s)	1
Postrigger time (s)	10

  Note: for more information on PQDIF/COMTRADE data format see chapter Measurements - PQDIF and COMTRADE files on iMC784A – concept description.

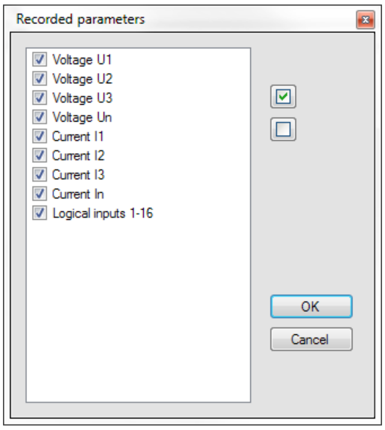
- Recorder resolution:
  Oscillography has the capability of recording waveforms with up to 625 samples per cycle (50Hz). Select among predefined resolutions.



Setting	Value
Data format	Pqdiff
Recorder resolution	625 samples / cycle (@50 Hz) 19 samples / cycle (@50 Hz) 39 samples / cycle (@50 Hz) 78 samples / cycle (@50 Hz) 156 samples / cycle (@50 Hz) 312 samples / cycle (@50 Hz) 625 samples / cycle (@50 Hz)
Recorded parameters	
Pretrigger time (s)	
Postrigger time (s)	

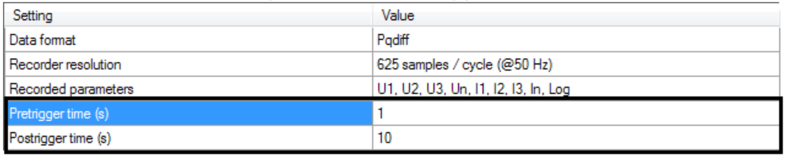
  Note: to record transients select highest resolution.

- Recorder parameters:
  Select channels to record.



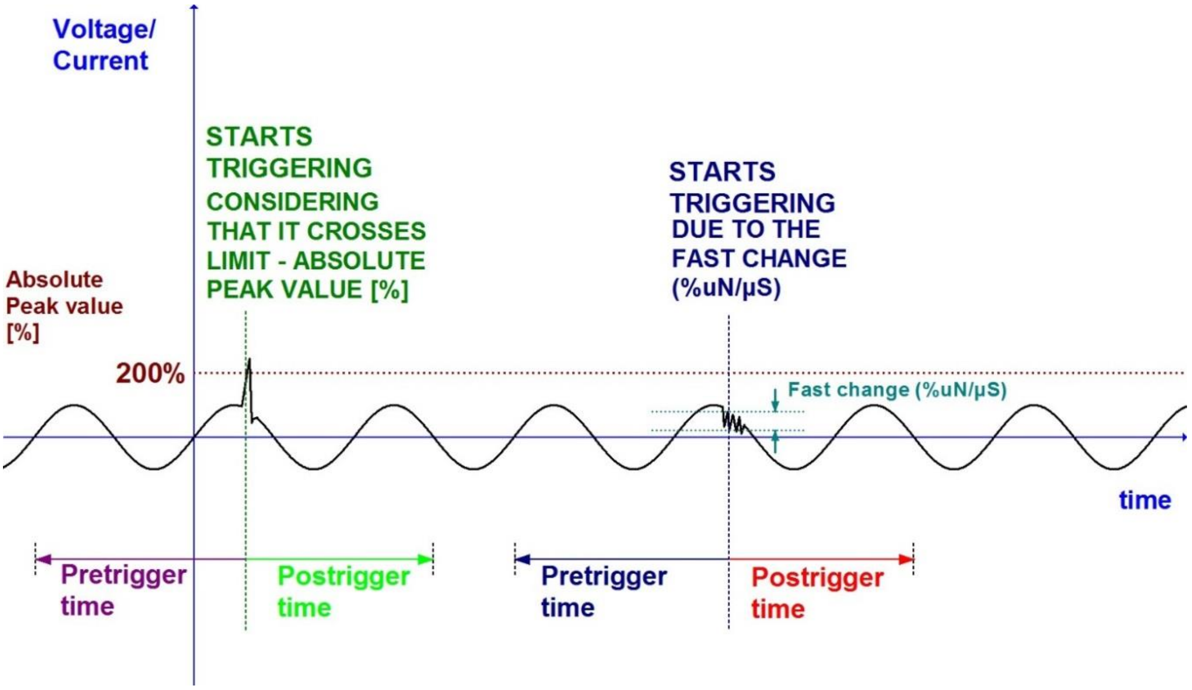
☑ Voltage U1
☑ Voltage U2
☑ Voltage U3
☑ Voltage Un
☑ Current I1
☑ Current I2
☑ Current I3
☑ Current In
☑ Logical inputs 1-16

- Pre-trigger/post-trigger time:
  In some cases it is necessary to capture signal before and/or after a trigger occurs to analyze the behavior of the signal. In such cases you can use the pre-trigger or post-trigger feature to specify duration of the recording after/before trigger.



Setting	Value
Data format	Pqdiff
Recorder resolution	625 samples / cycle (@50 Hz)
Recorded parameters	U1, U2, U3, Un, I1, I2, I3, In, Log
Pretrigger time (s)	1
Postrigger time (s)	10

Range:
Pre-trigger time: 0.01s – 1s
Post-trigger time: 0.01s – 40s (up to 20s for 625 samples/cycle)

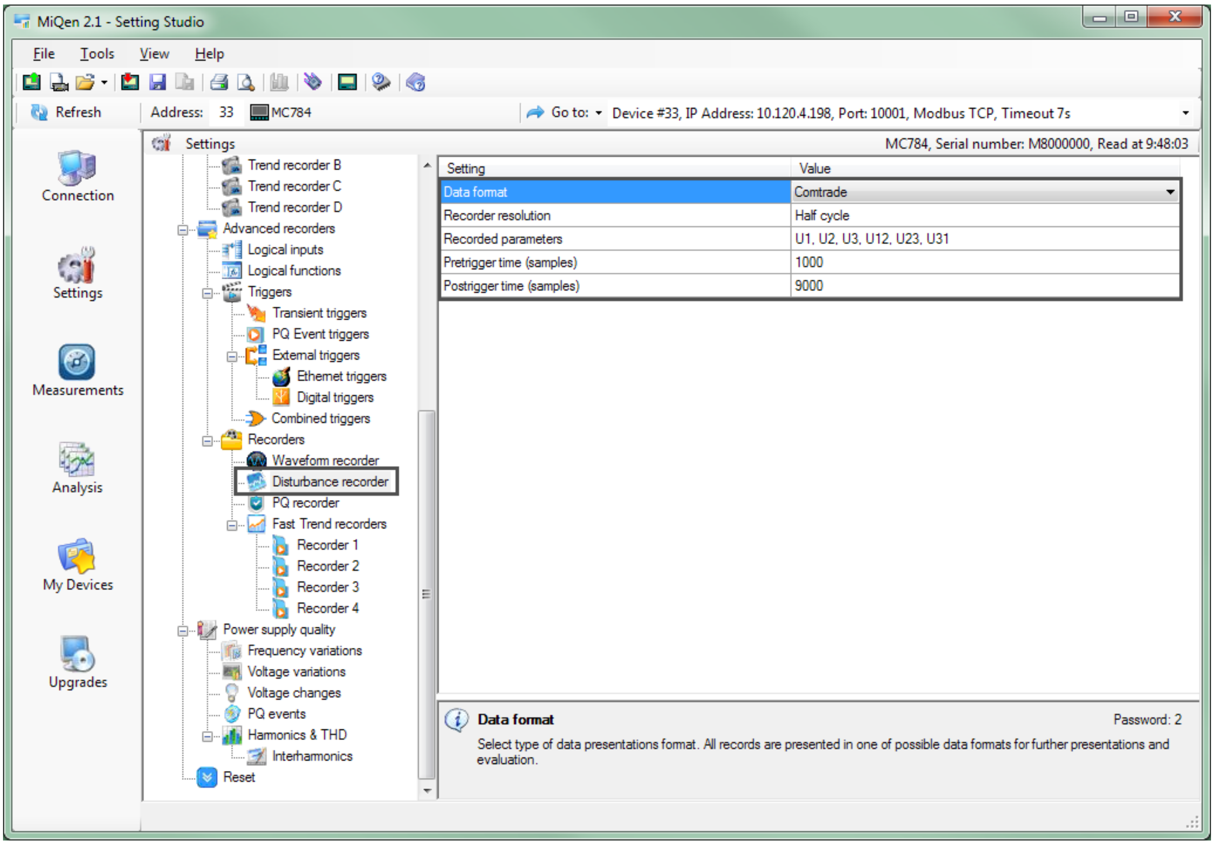


Pre-trigger and post-trigger time

Note: In some cases when predefined recorder post-trigger time is shorter then interruption duration time, only start of interruption will be recorded. In cases like that End of voltage interruption trigger will activate another recording that will capture end of event.

Disturbance recorder

Disturbance recorder is an event recorder used for monitoring long term disturbances. Every half/full cycle, TRMS value is calculated based on previous cycle.



Setting	Value
Data format	Comtrade
Recorder resolution	Half cycle
Recorded parameters	U1, U2, U3, U12, U23, U31
Pretrigger time (samples)	1000
Postrigger time (samples)	9000

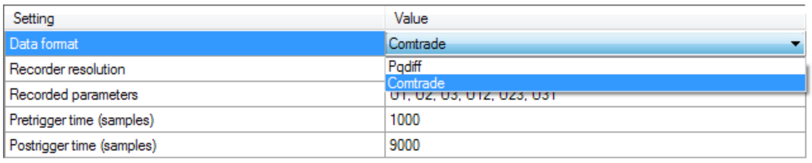
Data format

Select type of data presentations format. All records are presented in one of possible data formats for further presentations and evaluation.

Defining Disturbance recorder parameters (MiQen): Settings – Advanced recorders – Recorders – Disturbance recorder

Defining Disturbance recorder parameters:

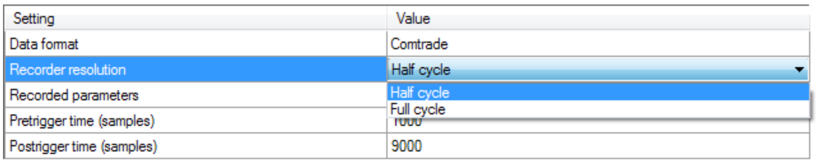
- Data format:
  Recorded data can be stored in PQDIF/COMTRADE data format. Only one can be selected for specific recorder.



Setting	Value
Data format	Comtrade
Recorder resolution	
Recorded parameters	
Pretrigger time (samples)	1000
Postrigger time (samples)	9000

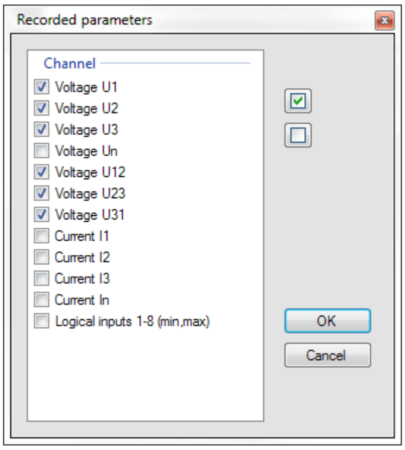
  Note: for more information on PQDIF/COMTRADE data format see chapter Measurements - PQDIF and COMTRADE files on iMC784A – concept description.

- Recorder resolution:
  Every half/full cycle, TRMS value is calculated based on previous cycle. Select among predefined resolutions.

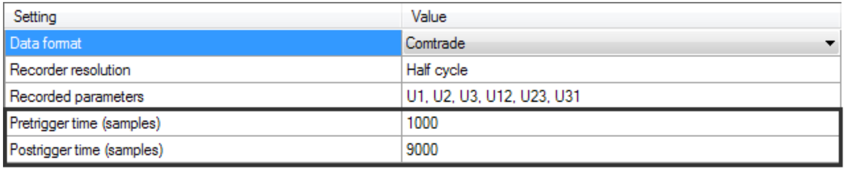


Setting	Value
Data format	Comtrade
Recorder resolution	Half cycle
Recorded parameters	
Pretrigger time (samples)	
Postrigger time (samples)	9000

- Recorder parameters:
  Select channels to record.



- Pre-trigger/post-trigger time:
  In some cases it is necessary to capture signal before and/or after a trigger occurs to analyze the behavior of the signal. In such cases you can use the pre-trigger or post-trigger feature to specify duration of the recording after/before trigger.



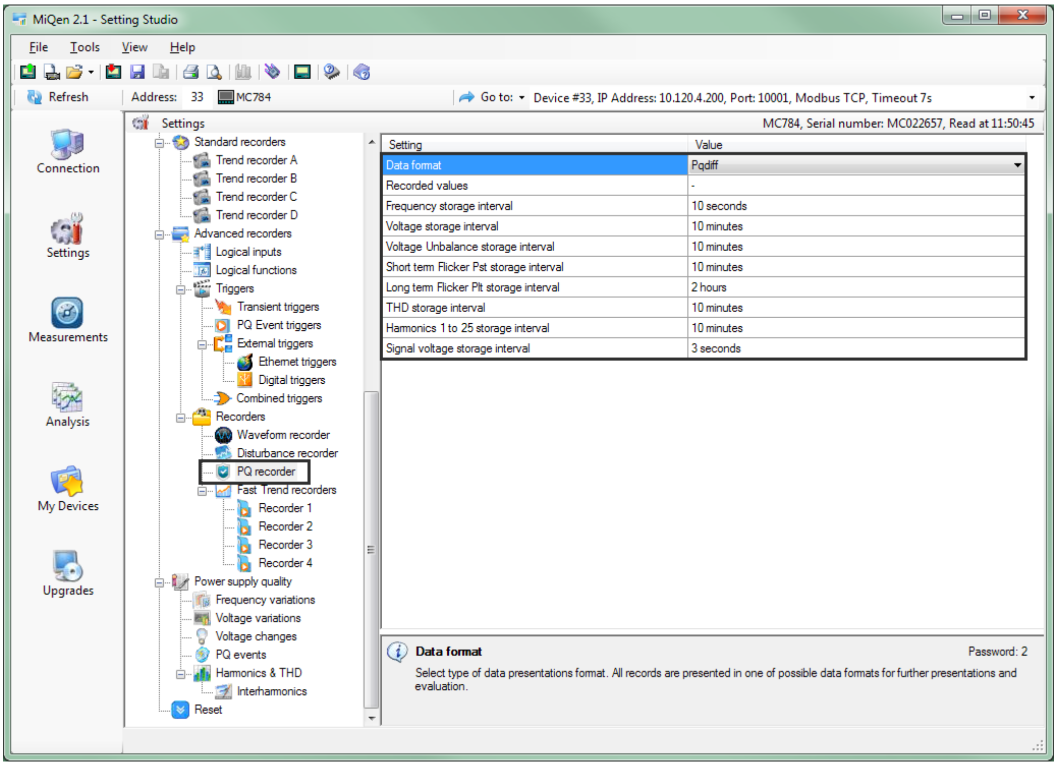
Setting	Value
Data format	Comtrade
Recorder resolution	Half cycle
Recorded parameters	U1, U2, U3, U12, U23, U31
Pretrigger time (samples)	1000
Posttrigger time (samples)	9000

Range:

- Pre-trigger time: 1 – 3000 samples
- Post-trigger time: 1 – 60000 samples

PQ recorder

PQ recorder is trend recorder used for monitoring PQ events. PQ records are stored for later analysis and generated based on a PQ event triggering mechanism. Event parameters are stored at predefined time intervals.



Device #33, IP Address: 10.120.4.200, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022657, Read at 11:50:45

Setting	Value
Data format	Pqdiff
Recorded values	-
Frequency storage interval	10 seconds
Voltage storage interval	10 minutes
Voltage Unbalance storage interval	10 minutes
Short term Flicker Pst storage interval	10 minutes
Long term Flicker Plt storage interval	2 hours
THD storage interval	10 minutes
Harmonics 1 to 25 storage interval	10 minutes
Signal voltage storage interval	3 seconds

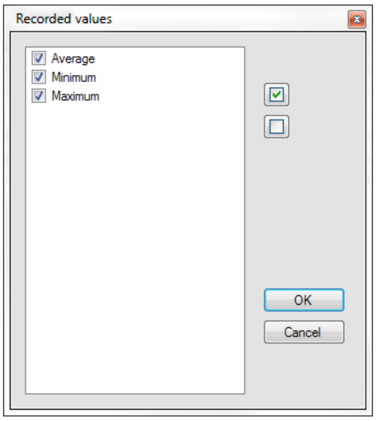
Data format Password: 2

Select type of data presentations format. All records are presented in one of possible data formats for further presentations and evaluation.

Defining PQ recorder parameters (MiQen): Settings – Advanced recorders – Recorders – PQ recorder

Defining PQ recorder parameters:

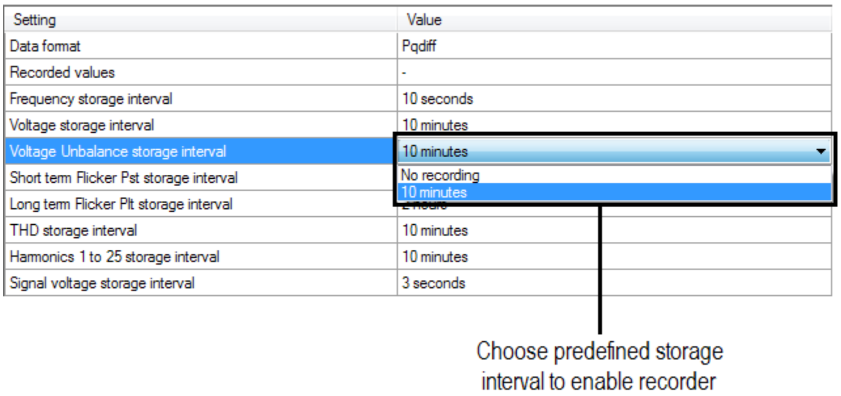
- Data format:
  Recorded data can only be stored in PQDIF data format.
- Recorded values
  Values can be recorded as average/minimum/maximum TRMS values. All three options can be selected at the same time.



☑ Average
☑ Minimum
☑ Maximum

- Storage intervals for parameters below are specified in standard IEC EN 61000-4-30 (see chapter Power supply quality):
  - Frequency storage interval (10 seconds/No recording),
  - Voltage storage interval (10 minutes/No recording),
  - Voltage Unbalance storage interval (10 minutes/No recording),
  - Short term Flicker Pst storage interval (10 minutes/No recording),
  - Long term Flicker Plt storage interval (2 hours/No recording),
  - THD storage interval (10 minutes/No recording),
  - Harmonics 1 to 25 storage interval (10 minutes/No recording) and
  - Signal voltage storage interval (3 seconds/No recording).

Specific recorder is activated by choosing predefined storage interval.

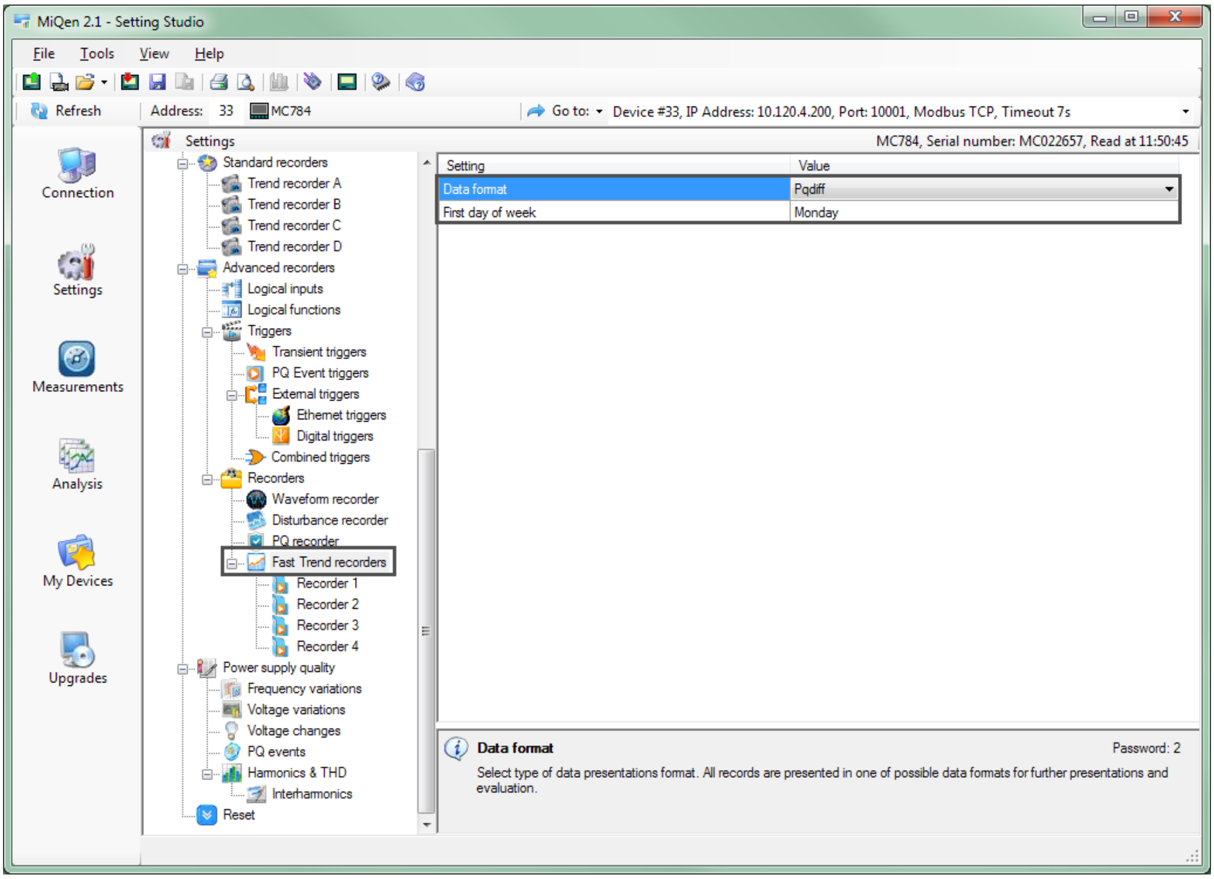


Setting	Value
Data format	Pqdiff
Recorded values	-
Frequency storage interval	10 seconds
Voltage storage interval	10 minutes
Voltage Unbalance storage interval	10 minutes
Short term Flicker Pst storage interval	
Long term Flicker Plt storage interval	2 hours
THD storage interval	10 minutes
Harmonics 1 to 25 storage interval	10 minutes
Signal voltage storage interval	3 seconds

Choose predefined storage interval to enable recorder

Fast Trend recorders

Fast trend recorder is trend recorder used for continuous recording of selected parameters.



Setting	Value
Data format	Pqdiff
First day of week	Monday

Data format

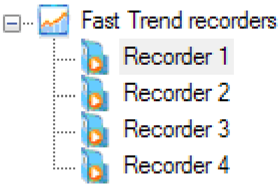
Select type of data presentations format. All records are presented in one of possible data formats for further presentations and evaluation.

Defining Fast trend recorder parameters (MiQen): Settings – Advanced recorders – Recorders – Fast trend recorder

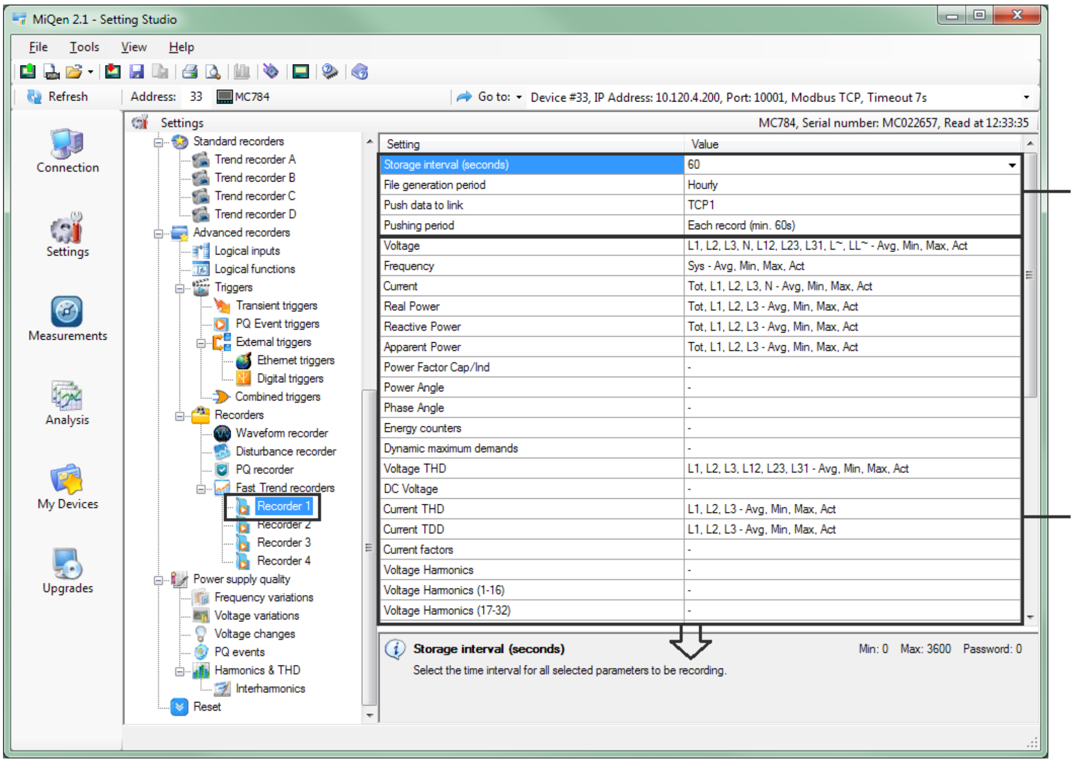
Defining Fast trend recorder parameters:

- Data format:
  Recorded data can only be stored in PQDIF data format.
- First day of week:
  Define on which day of week data files will be generated (when selected file generation period is weekly).

Total of 4 recorders can be defined. Each with its own set of specific settings.



Defining Fast trend recorder – Recorder 1 parameters:



MC784, Serial number: MC022657, Read at 12:33:35

Setting	Value
Storage interval (seconds)	60
File generation period	Hourly
Push data to link	TCP1
Pushing period	Each record (min. 60s)
Voltage	L1, L2, L3, N, L12, L23, L31, L~, LL~ - Avg, Min, Max, Act
Frequency	Sys - Avg, Min, Max, Act
Current	Tot, L1, L2, L3, N - Avg, Min, Max, Act
Real Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Reactive Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Apparent Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Power Factor Cap/Ind	-
Power Angle	-
Phase Angle	-
Energy counters	-
Dynamic maximum demands	-
Voltage THD	L1, L2, L3, L12, L23, L31 - Avg, Min, Max, Act
DC Voltage	-
Current THD	L1, L2, L3 - Avg, Min, Max, Act
Current TDD	L1, L2, L3 - Avg, Min, Max, Act
Current factors	-
Voltage Harmonics	-
Voltage Harmonics (1-16)	-
Voltage Harmonics (17-32)	-

Storage interval (seconds) Min: 0 Max: 3600 Password: 0

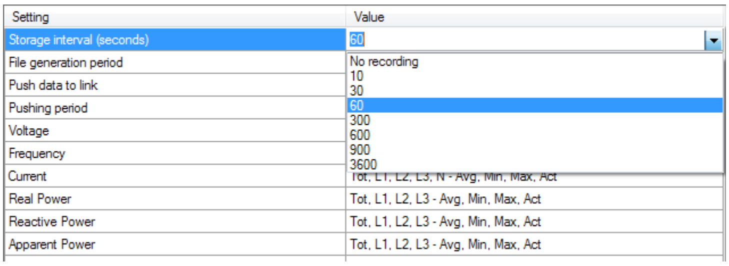
Select the time interval for all selected parameters to be recording.

Define Recorder 1 settings

Define parameters you want to record

Defining Fast trend recorder – Recorder 1 parameters: Settings – Advanced recorders – Recorders – Fast trend recorder – Recorder 1

- Storage interval:
  Range: 1 – 3600 s
  Select among predefined storage intervals or manually enter storage interval of value lower than 10 s. Example – storage interval of 60 s means every 60 s TRMS value of each selected parameter will be stored.



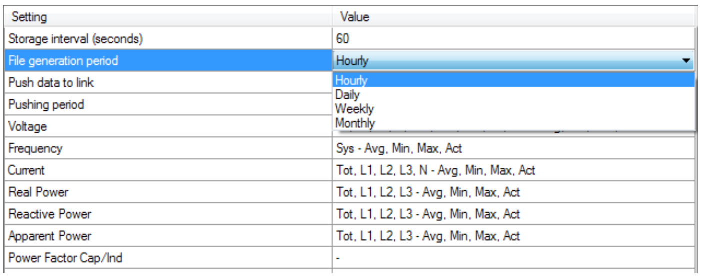
Setting	Value
Storage interval (seconds)	60
File generation period	
Push data to link	
Pushing period	
Voltage	
Frequency	
Current	Tot, L1, L2, L3, N - Avg, Min, Max, Act
Real Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Reactive Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Apparent Power	Tot, L1, L2, L3 - Avg, Min, Max, Act

Select *No recording* to disable recorder.

PLEASE NOTE

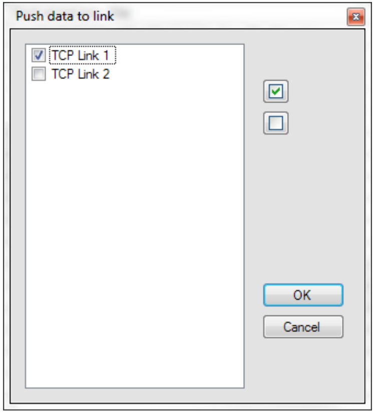
When 1 s storage interval is chosen it is advised not to select all measurements. This especially applies to harmonics/interharmonic measurements whit large amount of measurements.

- File generation period:
  Select among predefined periods:
  - Hourly – data files are generated every hour
  - Daily – data files are generated every day at midnight
  - Weekly – data files are generated every week on previously selected day at midnight (*Settings – Advanced recorders – Recorders – Fast trend recorders – First day of week*)
  - Monthly - data files are generated every month on previously selected day at midnight (*Settings – Advanced recorders – Recorders – Fast trend recorders – First day of week*)

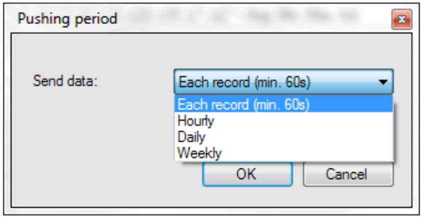


Setting	Value
Storage interval (seconds)	60
File generation period	Hourly
Push data to link	
Pushing period	
Voltage	
Frequency	Sys - Avg, Min, Max, Act
Current	Tot, L1, L2, L3, N - Avg, Min, Max, Act
Real Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Reactive Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Apparent Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Power Factor Cap/Ind	-

- Push data to link:
  Defines the communication channel for pushing data to clients. Communication parameters can be defined under Settings – Communication –Push Data Clients.

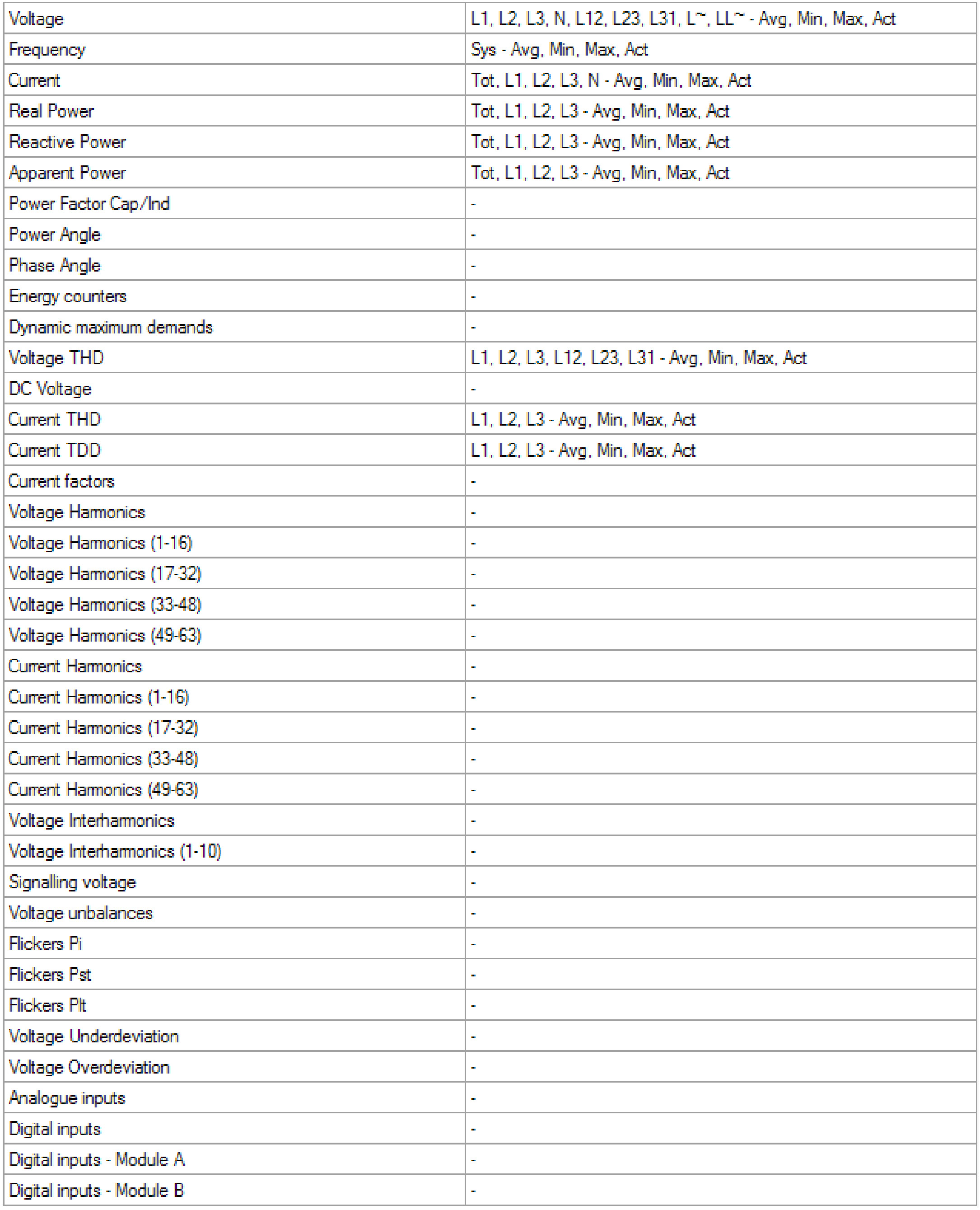


- Pushing period:
  Defines a time period for pushing data to clients. Readings which are recorded can be also periodically (user defined) sent to a client.



Send data: Each record (min. 60s)

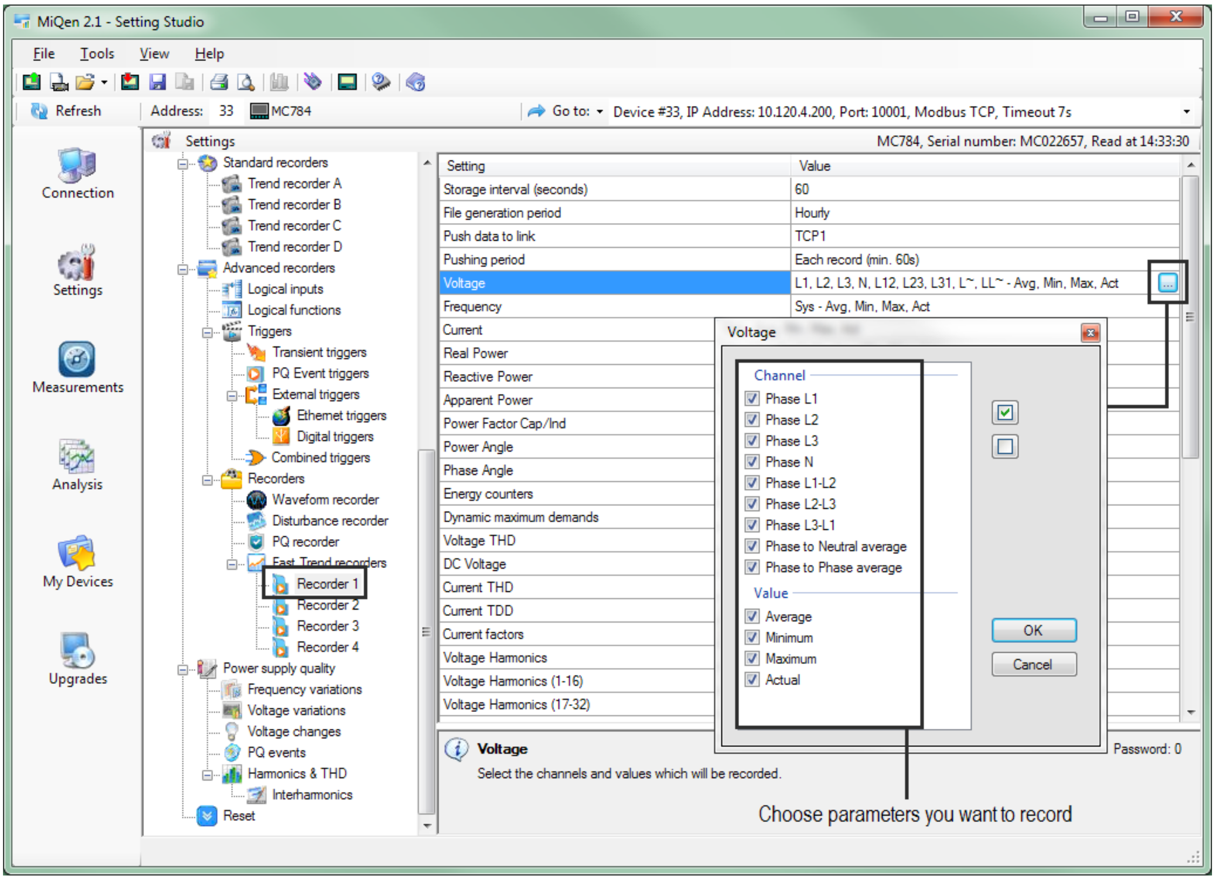
- Measurements:
  Define parameters you want to record.



Voltage	L1, L2, L3, N, L12, L23, L31, L~, LL~ - Avg, Min, Max, Act
Frequency	Sys - Avg, Min, Max, Act
Current	Tot, L1, L2, L3, N - Avg, Min, Max, Act
Real Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Reactive Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Apparent Power	Tot, L1, L2, L3 - Avg, Min, Max, Act
Power Factor Cap/Ind	-
Power Angle	-
Phase Angle	-
Energy counters	-
Dynamic maximum demands	-
Voltage THD	L1, L2, L3, L12, L23, L31 - Avg, Min, Max, Act
DC Voltage	-
Current THD	L1, L2, L3 - Avg, Min, Max, Act
Current TDD	L1, L2, L3 - Avg, Min, Max, Act
Current factors	-
Voltage Harmonics	-
Voltage Harmonics (1-16)	-
Voltage Harmonics (17-32)	-
Voltage Harmonics (33-48)	-
Voltage Harmonics (49-63)	-
Current Harmonics	-
Current Harmonics (1-16)	-
Current Harmonics (17-32)	-
Current Harmonics (33-48)	-
Current Harmonics (49-63)	-
Voltage Interharmonics	-
Voltage Interharmonics (1-10)	-
Signalling voltage	-
Voltage unbalances	-
Flickers Pi	-
Flickers Pst	-
Flickers Plt	-
Voltage Underdeviation	-
Voltage Overdeviation	-
Analogue inputs	-
Digital inputs	-
Digital inputs - Module A	-
Digital inputs - Module B	-

Example:

- Voltage



Device #33, IP Address: 10.120.4.200, Port: 10001, Modbus TCP, Timeout 7s

MC784, Serial number: MC022657, Read at 14:33:30

Setting	Value
Storage interval (seconds)	60
File generation period	Hourly
Push data to link	TCP1
Pushing period	Each record (min. 60s)
Voltage	L1, L2, L3, N, L12, L23, L31, L~, LL~ - Avg, Min, Max, Act
Frequency	Sys - Avg, Min, Max, Act
Current	
Real Power	
Reactive Power	
Apparent Power	
Power Factor Cap/Ind	
Power Angle	
Phase Angle	
Energy counters	
Dynamic maximum demands	
Voltage THD	
DC Voltage	
Current THD	
Current TDD	
Current factors	
Voltage Harmonics	
Voltage Harmonics (1-16)	
Voltage Harmonics (17-32)	

Voltage

Channel
☑ Phase L1
☑ Phase L2
☑ Phase L3
☑ Phase N
☑ Phase L1-L2
☑ Phase L2-L3
☑ Phase L3-L1
☑ Phase to Neutral average
☑ Phase to Phase average

Value
☑ Average
☑ Minimum
☑ Maximum
☑ Actual

Voltage
Select the channels and values which will be recorded.

Choose parameters you want to record

Same principal applies to other three recorders.

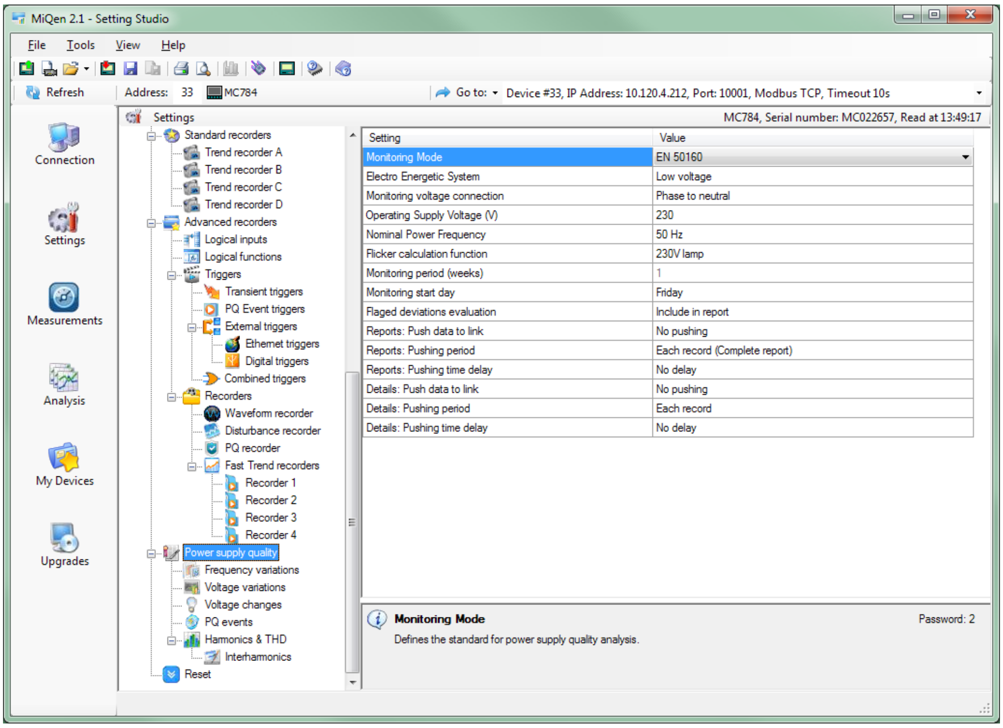
Conformity of voltage with EN 50160 standard

The EN 50160 standard deals with voltage characteristics of electricity supplied by public distribution systems. It specifies the limits or values of voltage characteristics in normal operation within public low or middle voltage system network. Fallowing this definition the measuring instrument is adapted for monitoring voltage characteristics of a distribution systems according to EN 50160 standard. Together with setting and monitoring software MiQen voltage characteristics can be monitored and weekly reports about power quality are issued. Based on requirements stated in the standard, default parameters are set in the device according to which supervision of all required characteristics is performed. Parameters can also be changed in detailed settings for individual characteristics.

CAUTION

Factory default settings for PQ characteristics are in compliance with standard EN 50160. By changing individual parameters conformity of weekly reports with this standard is no longer valid.

Parameters of PQ characteristics are settable only by means of MiQen setting software.



Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

MC784, Serial number: MC022657, Read at 13:49:17

Setting	Value
Monitoring Mode	EN 50160
Electro Energetic System	Low voltage
Monitoring voltage connection	Phase to neutral
Operating Supply Voltage (V)	230
Nominal Power Frequency	50 Hz
Flicker calculation function	230V lamp
Monitoring period (weeks)	1
Monitoring start day	Friday
Flaged deviations evaluation	Include in report
Reports: Push data to link	No pushing
Reports: Pushing period	Each record (Complete report)
Reports: Pushing time delay	No delay
Details: Push data to link	No pushing
Details: Pushing period	Each record
Details: Pushing time delay	No delay

Monitoring Mode

Password: 2

Defines the standard for power supply quality analysis.

General PQ settings

General PQ settings are basic parameters that influence other settings.

Monitoring mode

Monitoring mode can be set to:

- EN 50160: Monitoring according to EN 50160 enabled. Weekly reports are issued according to set parameters
- No monitoring: Weekly reports for network compliance with the standard are disabled

Electro energetic system

Requirements for PQ monitoring differ regarding type of a monitored public distribution system. Therefore it is essential to choose proper type. This setting influences some of the predefined limit lines according to relevant standard EN 50160.

Measuring instrument can monitor PQ within following systems:

- Low Voltage grid connected system
- Medium Voltage grid connected system
- Low Voltage islanded system
- Medium Voltage islanded system

⚠ **PLEASE NOTE**

Choosing one of listed distribution systems automatically sets PQ characteristics according to requirements in EN 50160 for that particular system.

Monitoring voltage connection

When using 4u (3 phase 4 wire) connection mode, there is an option to choose between Phase to neutral or Phase to phase Monitoring voltage. Both are supported.
When using 3u (3 phase 3 wire) connection mode, Phase to phase Monitoring voltage is set automatically.

⚠ **PLEASE NOTE**

When using 3u connection mode or Phase to phase monitoring at 4u connection, Nominal supply voltage has to be set accordingly to your phase to phase nominal network voltage.

Nominal supply voltage

Set a voltage level of a monitored system. This value is used as a reference for calculation of power quality indices and is usually equal to nominal network voltage (also marked as U_{din} in various standards). Factory default value is EU standard low voltage value 230 V.

Nominal power frequency

Nominal frequency of monitored supply voltage is selected. Factory default value is EU standard frequency 50Hz. It is also possible to choose 60 Hz.

Flicker calculation function

Low voltage level for residential lamps can be either 230V or 110V. Function for detection of flicker differs regarding this voltage. Since actual low voltage level can be different as secondary voltage of used VT (nominal measuring voltage) this setting must be set to a voltage level, which is used to supply residential lamps.

Monitoring period (weeks)

Monitoring period predefines period for issuing PQ reports. When Monitoring Mode is set to EN 50160, monitoring is performed continuously.
This setting defines how often should reports be issued.

Monitoring start day

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

After Monitoring period and Monitoring start day are defined, PQ reports will be continuously issued at the end of each monitoring period. All reports and associated anomalies within monitored period are stored in devices internal memory and can be analyzed by means of MiQen software.

Flagged events setting

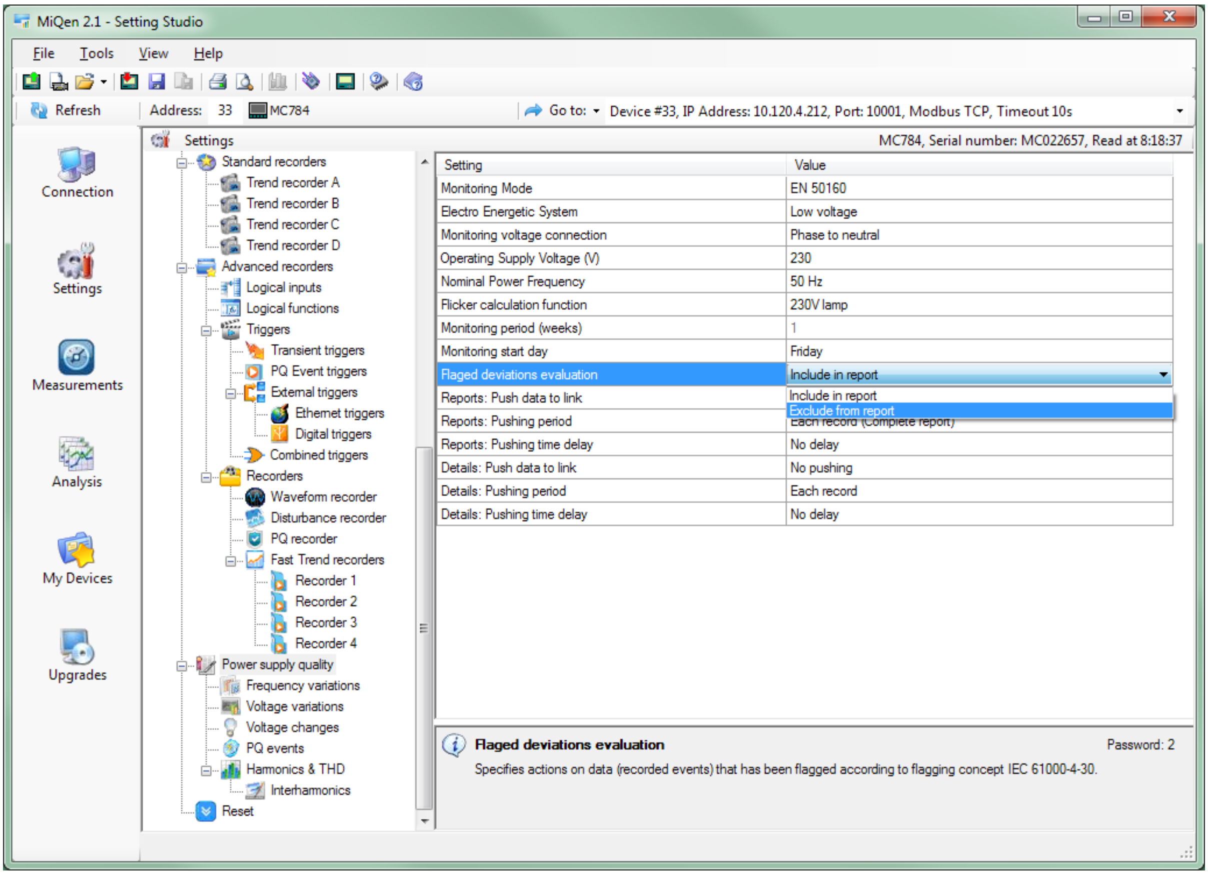
Flagged evens setting specifies actions on data (recorded events) that has been flagged (marked) according to flagging concept IEC 61000-4-30.

Flagged data are power quality records, which has been influenced by one or more voltage events (interruptions, dips, swells).

The purpose of flagging data is to mark recorded parameters when certain disturbances might influenced measurements and caused corrupted data. For example, voltage dip can also trigger occurrence of flicker, inter-harmonics... In this case all parameters which were recorded at a time of voltage events are marked (flagged). In later evaluation those flagged records can be omitted from final report by choosing appropriate setting.

PLEASE NOTE

Regardless of this setting, readings will be always stored in recorder and available for analysis. Flagging only influences PQ reports as a whole.



Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

MC784, Serial number: MC022657, Read at 8:18:37

Setting	Value
Monitoring Mode	EN 50160
Electro Energetic System	Low voltage
Monitoring voltage connection	Phase to neutral
Operating Supply Voltage (V)	230
Nominal Power Frequency	50 Hz
Flicker calculation function	230V lamp
Monitoring period (weeks)	1
Monitoring start day	Friday
Flaged deviations evaluation	Include in report Include in report Exclude from report
Reports: Push data to link	
Reports: Pushing period	Each record (Complete report)
Reports: Pushing time delay	No delay
Details: Push data to link	No pushing
Details: Pushing period	Each record
Details: Pushing time delay	No delay

Flaged deviations evaluation

Password: 2

Specifies actions on data (recorded events) that has been flagged according to flagging concept IEC 61000-4-30.

Flagged data can be included or excluded from a PQ report

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 cannot be sent immediately due to restrictions in network.

For more information about PUSH please see chapter *Settings – Communication*.

EN 50160 parameters settings

Power Quality indices as defined by EN 50160

Phenomena	PQ Parameters
Frequency variations	Frequency distortion
Voltage variations	Voltage fluctuation
	Voltage unbalance
Voltage changes	Rapid voltage changes
	Flicker
Voltage events	Voltage dips
	Voltage interruptions
	Voltage swells
Harmonics & THD	THD
	Harmonics
	Inter-harmonics
	Signaling voltage

Standard EN 50160 describes in details PQ parameters and corresponding limit lines for monitoring whereas distribution system voltage operates in accordance with mentioned standard.

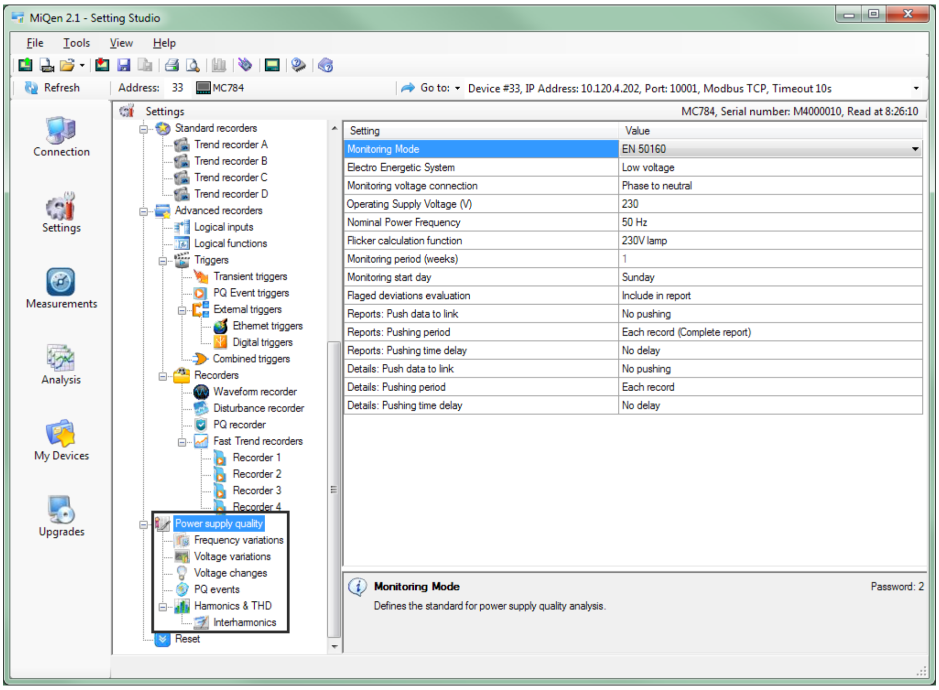
Settings of limit lines and required percentage of appropriate indices resembles requirements of standard EN 50160.

When monitoring according to this standard is required there is no need to make changes to PQ parameters settings.

More detailed description of certain parameter monitoring procedures is in a chapter *Measurements*.

There are some PQ parameters which are interesting for monitoring but are not required to be part of PQ reports. These settings do not have standardized limit values and can be set according to distribution network requirements.

- Short term flicker (limit Pst = 1)
- Interharmonics (10 values of user defined frequencies)



MC784, Serial number: M4000010, Read at 8:26:10

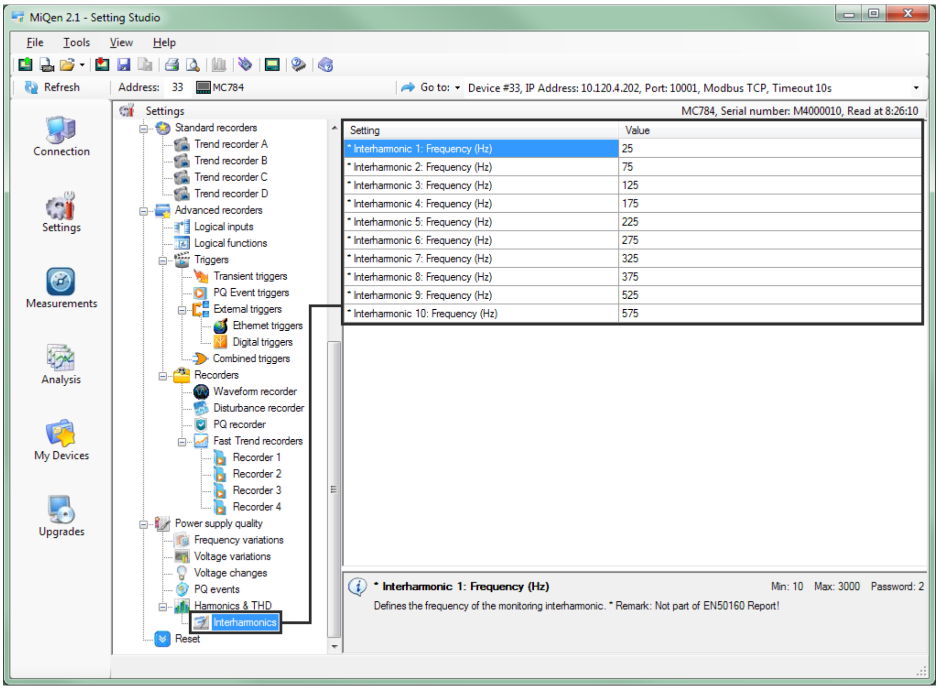
Setting	Value
Monitoring Mode	EN 50160
Electro Energetic System	Low voltage
Monitoring voltage connection	Phase to neutral
Operating Supply Voltage (V)	230
Nominal Power Frequency	50 Hz
Flicker calculation function	230V lamp
Monitoring period (weeks)	1
Monitoring start day	Sunday
Flaged deviations evaluation	Include in report
Reports: Push data to link	No pushing
Reports: Pushing period	Each record (Complete report)
Reports: Pushing time delay	No delay
Details: Push data to link	No pushing
Details: Pushing period	Each record
Details: Pushing time delay	No delay

Monitoring Mode Password: 2

Defines the standard for power supply quality analysis.

Settings for power quality parameters are set with setting and monitoring software MiQen

MiQen HELP description clearly marks PQ parameters, which are not required as a part of EN 50160 PQ report. Below figure shows settings for interharmonic values:



MC784, Serial number: M4000010, Read at 8:26:10

Setting	Value
* Interharmonic 1: Frequency (Hz)	25
* Interharmonic 2: Frequency (Hz)	75
* Interharmonic 3: Frequency (Hz)	125
* Interharmonic 4: Frequency (Hz)	175
* Interharmonic 5: Frequency (Hz)	225
* Interharmonic 6: Frequency (Hz)	275
* Interharmonic 7: Frequency (Hz)	325
* Interharmonic 8: Frequency (Hz)	375
* Interharmonic 9: Frequency (Hz)	525
* Interharmonic 10: Frequency (Hz)	575

*** Interharmonic 1: Frequency (Hz)** Min: 10 Max: 3000 Password: 2

Defines the frequency of the monitoring interharmonic. * Remark: Not part of EN50160 Report!

Settings for 10 user defined interharmonic frequencies

Reset

During normal operation of a Power Quality Analyzer iMC784A different counter s values need to be reset from time to time.

Reset energy counter

All or individual energy meters (counters) are reset.

Reset energy counter Cost

All or individual energy costs are reset.

Reset 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 Last period MD

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.

Synchronize MD

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.

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

Alarm relay [1/2/3/4] Off

When using MiQen, each alarm output can be reset separately. On device (manually) only all alarm outputs together can be reset.

Reset Min/Max values

All Min/Max values are reset.

Reset alarm statistic

Clears the alarm statistic. It can be made by MiQen software under Alarm settings. This setting is only for resetting online alarms statistics displayed in MiQen software.

Reset captured Energy values

Reset 24 hour Load Profile

Reset Energy Profile Daily Values

Reset Energy Profile Monthly Values

Reset Waveform Generation

Reset Disturbance Generation

Reset Fast Trend 1 File Generation

Reset Fast Trend 2 File Generation

Reset Fast Trend 3 File Generation

Reset Fast Trend 4 File Generation

Reset Waveform Level Trg Generation

Reset Disturbance Level Trg Generation

LCD navigation

iMC784A Graphic pixel display

Main menu	
Measurements Settings Resets Info Installation	
14.2.2021	16:53:36

→

Reset
Min/Max values Energy counters MD values Last period MD Synchronize MD Reset alarm output
⇦ Main menu

Main menu > Resets > Min/Max values >Yes/No

Main menu > Resets > Energy counters > All cost counters / All energy counters / Energy counter (E1 / E2 / E3 / E4) / Cost counter (E1 / E2 / E3 / E4)

Main menu > Resets > MD values > Yes/No

Main menu > Resets > Last period MD > Yes/No

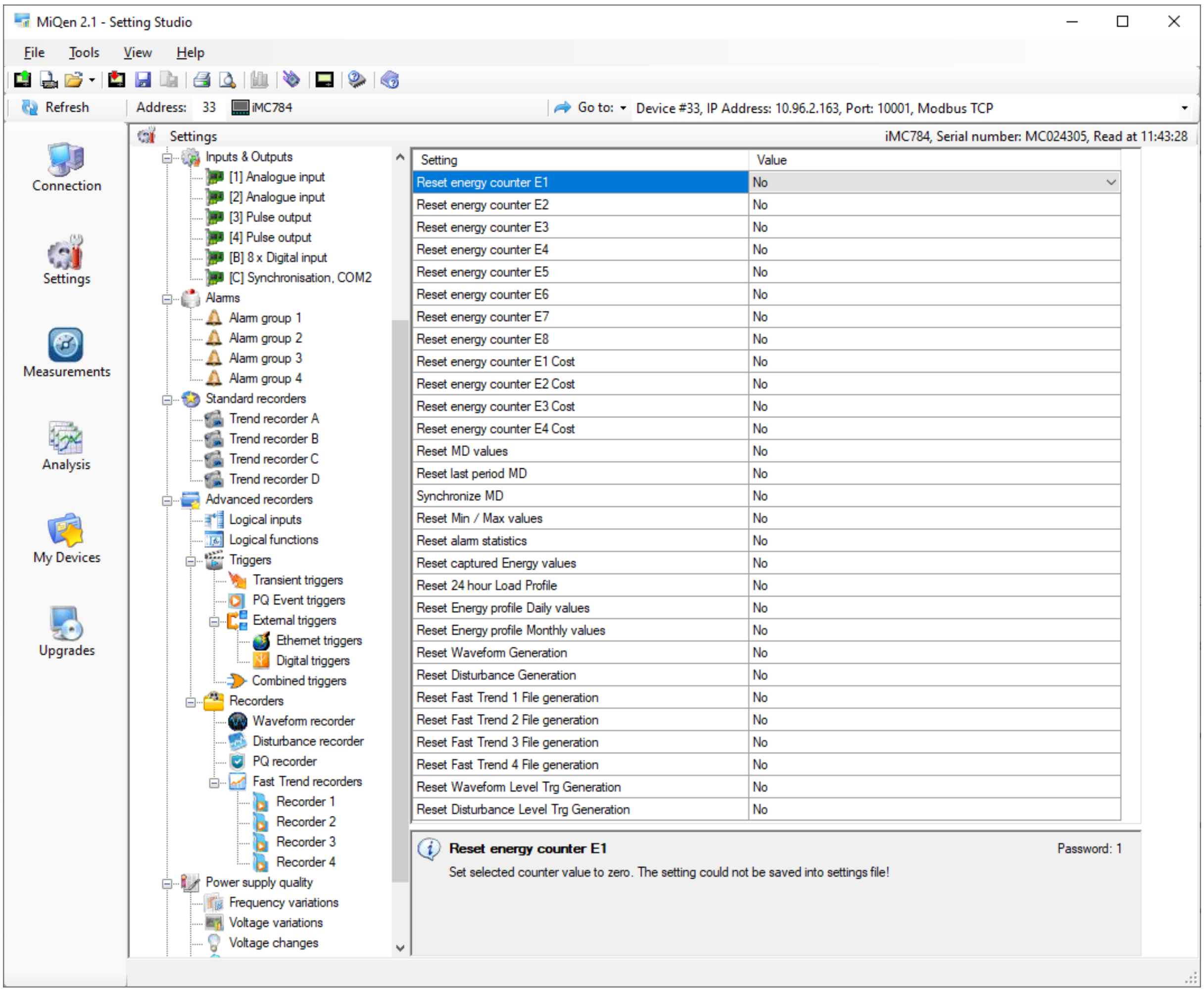
Main menu > Resets > Synchronize MD > Yes/No

Main menu > Resets > Reset alarm output > Yes/No

iMC784A color TFT LCD display

Reset commands for Power Quality Analyzer iMC784A can only be set in MiQen software. There are no options for Reset on device TFT LCD display.

Resets - MiQen SW



Setting	Value
Reset energy counter E1	No
Reset energy counter E2	No
Reset energy counter E3	No
Reset energy counter E4	No
Reset energy counter E5	No
Reset energy counter E6	No
Reset energy counter E7	No
Reset energy counter E8	No
Reset energy counter E1 Cost	No
Reset energy counter E2 Cost	No
Reset energy counter E3 Cost	No
Reset energy counter E4 Cost	No
Reset MD values	No
Reset last period MD	No
Synchronize MD	No
Reset Min / Max values	No
Reset alarm statistics	No
Reset captured Energy values	No
Reset 24 hour Load Profile	No
Reset Energy profile Daily values	No
Reset Energy profile Monthly values	No
Reset Waveform Generation	No
Reset Disturbance Generation	No
Reset Fast Trend 1 File generation	No
Reset Fast Trend 2 File generation	No
Reset Fast Trend 3 File generation	No
Reset Fast Trend 4 File generation	No
Reset Waveform Level Trg Generation	No
Reset Disturbance Level Trg Generation	No

Reset energy counter E1 Password: 1

Set selected counter value to zero. The setting could not be saved into settings file!

Measurements

Power Quality Analyzer iMC784A performs measurements with a constant sampling frequency of 31 kHz. Measurement methods differ for normal operation quantities, where values are averaged and aggregated according to aggregation requirements of the IEC 61000-4-30 standard (Class A). This also holds for voltage events where half-period values are evaluated in accordance with the same standard.

Online measurements

Online measurements are available by using the device display or remotely:

- With the MiQen setting and analysis software
- With devices WEB server

Readings are continuously available on the display with refresh time dependent on the setup average interval whereas the reading rate of monitored values with MiQen is fixed, refreshing approximately every second.

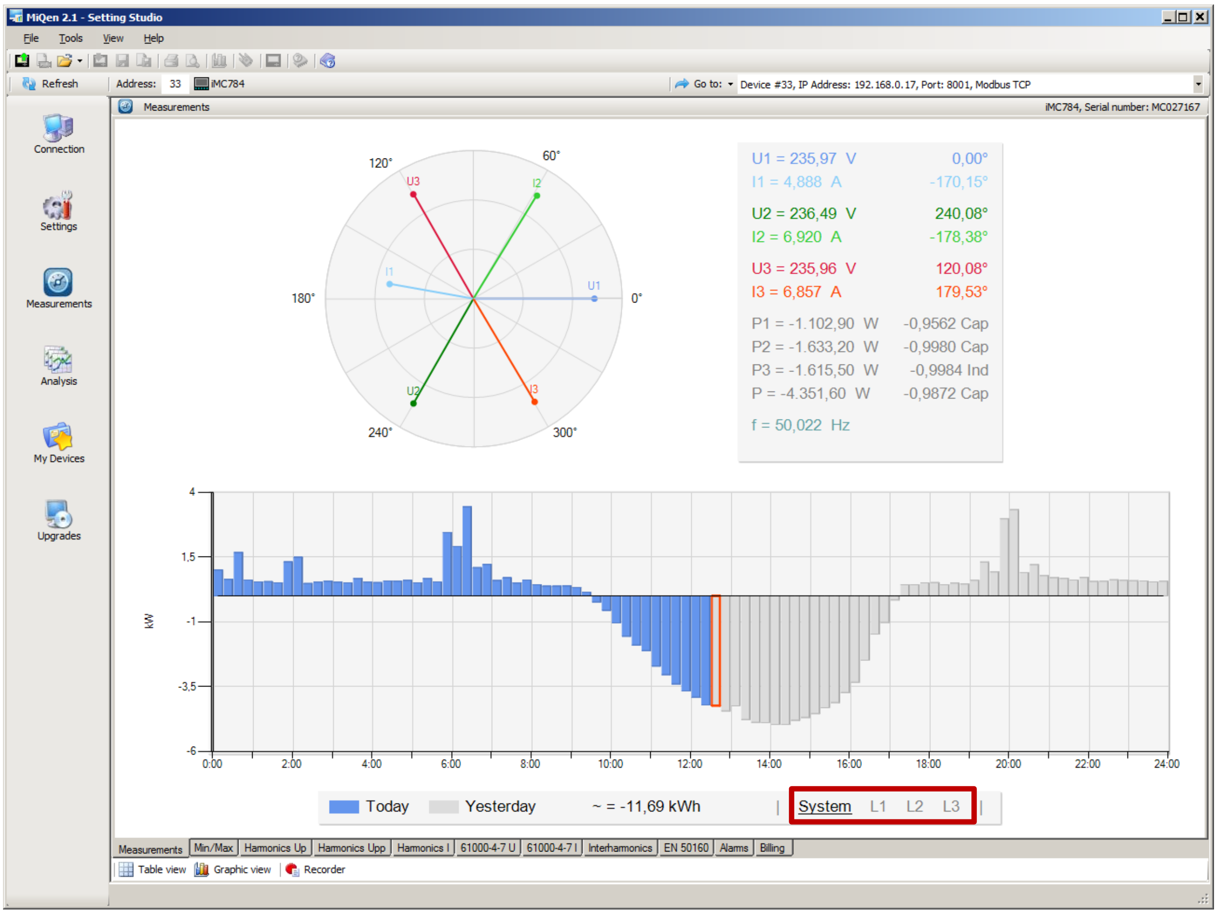
For better overview over numerous readings, the readings are divided into several groups, which contain basic measurements, min. and max. values, alarms, harmonics, interharmonics, billing measurements and PQ parameters.

Each group can represent data in visually favored graphical form or in detailed tabelaric form. The latter allows freezing readings and/or copying data into various report generation software tools.

Daily energy consumption profile

In the graphical form, the measurements of total energy and daily consumption profile of energy of all three phases are represented. The daily energy consumption profile measures a 15-minute average of the active power.

Press the System symbol to observe the measurements of total energy. Press the L1, L2, or L3 symbols to observe the consumption profile of energy of the first, second, or third phase (see picture below, the symbols are surrounded by red).



Device #33, IP Address: 192.168.0.17, Port: 8001, Modbus TCP

iMC784, Serial number: MC027167

U1 = 235,97 V 0,00°
I1 = 4,888 A -170,15°

U2 = 236,49 V 240,08°
I2 = 6,920 A -178,38°

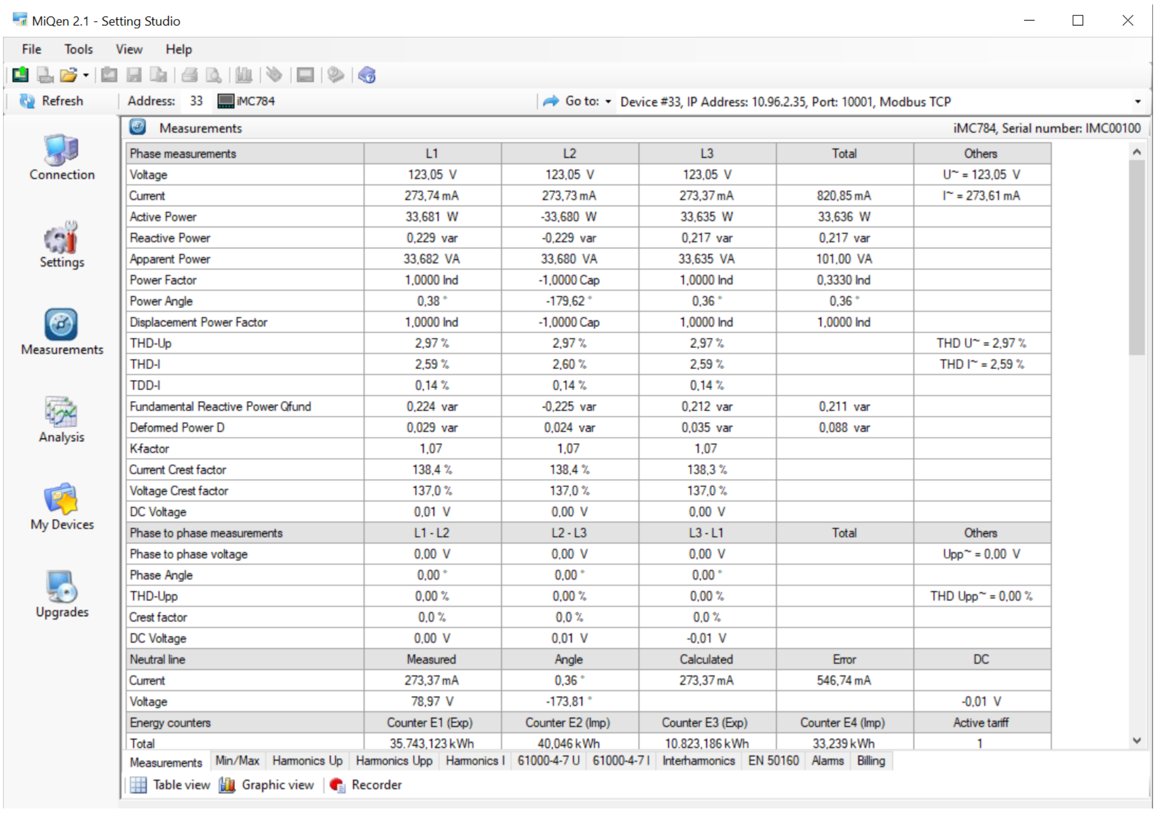
U3 = 235,96 V 120,08°
I3 = 6,857 A 179,53°

P1 = -1.102,90 W -0,9562 Cap
P2 = -1.633,20 W -0,9980 Cap
P3 = -1.615,50 W -0,9984 Ind
P = -4.351,60 W -0,9872 Cap

f = 50,022 Hz

~ = -11,69 kWh

Example: Online measurements in graphical form - phasor diagram and daily total active power consumption histogram



Device #33, IP Address: 10.96.2.35, Port: 10001, Modbus TCP

iMC784, Serial number: IMC00100

Phase measurements	L1	L2	L3	Total	Others
Voltage	123,05 V	123,05 V	123,05 V		U~ = 123,05 V
Current	273,74 mA	273,73 mA	273,37 mA	820,85 mA	I~ = 273,61 mA
Active Power	33,681 W	-33,680 W	33,635 W	33,636 W	
Reactive Power	0,229 var	-0,229 var	0,217 var	0,217 var	
Apparent Power	33,682 VA	33,680 VA	33,635 VA	101,00 VA	
Power Factor	1,0000 Ind	-1,0000 Cap	1,0000 Ind	0,3330 Ind	
Power Angle	0,38 °	-179,62 °	0,36 °	0,36 °	
Displacement Power Factor	1,0000 Ind	-1,0000 Cap	1,0000 Ind	1,0000 Ind	
THD-Up	2,97 %	2,97 %	2,97 %		THD U~ = 2,97 %
THD-I	2,59 %	2,60 %	2,59 %		THD I~ = 2,59 %
TDD-I	0,14 %	0,14 %	0,14 %		
Fundamental Reactive Power Qfund	0,224 var	-0,225 var	0,212 var	0,211 var	
Deformed Power D	0,029 var	0,024 var	0,035 var	0,088 var	
K-factor	1,07	1,07	1,07		
Current Crest factor	138,4 %	138,4 %	138,3 %		
Voltage Crest factor	137,0 %	137,0 %	137,0 %		
DC Voltage	0,01 V	0,00 V	0,00 V		
Phase to phase measurements	**L1 - L2**	**L2 - L3**	**L3 - L1**	**Total**	**Others**
Phase to phase voltage	0,00 V	0,00 V	0,00 V		Upp~ = 0,00 V
Phase Angle	0,00 °	0,00 °	0,00 °		
THD-Upp	0,00 %	0,00 %	0,00 %		THD Upp~ = 0,00 %
Crest factor	0,0 %	0,0 %	0,0 %		
DC Voltage	0,00 V	0,01 V	-0,01 V		
Neutral line	**Measured**	**Angle**	**Calculated**	**Error**	**DC**
Current	273,37 mA	0,36 °	273,37 mA	546,74 mA	
Voltage	78,97 V	-173,81 °			-0,01 V
Energy counters	**Counter E1 (Exp)**	**Counter E2 (Imp)**	**Counter E3 (Exp)**	**Counter E4 (Imp)**	**Active tariff**
Total	35.743,123 kWh	40,046 kWh	10.823,186 kWh	33,239 kWh	1

Example: Online measurements in tabelaric form

Monthly energy consumption profile

The monthly energy consumption profile measures a daily average of the active power for the last 32 days.

PLEASE NOTE

The measured values of the current day are stored even if the meter is switched off or not powered. If the power is returned on the same day, the energy measurements will continue. When the outage lasts for several days, the meter does not record the energy values for these days.

The capture of the energy values could be changed manually by changing the date (on the meter screen or through MODBUS communication).

PLEASE NOTE

When changing the date for a few days forward, the values for intermediate days are deleted. When changing the date back, the values do not change, only the data for the current day is deleted.

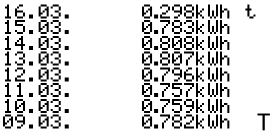
The phase values of the daily energy consumption profile can be stored in a range +/- 5242870 10^{exp} Wh. The exponent (exp) of zero belongs to the value of the phase power 218,453 kW (949 A at 230 V).

Display of monthly energy consumption profile (available only on option with graphical LCD display)

Main menu ⇨ Measurements ⇨ Day Energy⇨ D1 .. D8

Possibility to select a specific group of 8 consecutive days (D1 – current day) or a combined display of the values of these groups (review).

Example of consecutive days

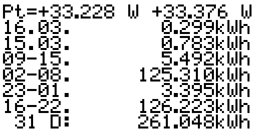


```
16.03.     0.298kWh  t
15.03.     0.783kWh
14.03.     0.808kWh
13.03.     0.807kWh
12.03.     0.796kWh
11.03.     0.757kWh
10.03.     0.759kWh
09.03.     0.782kWh
```

The date is represented as DD.MM.

Symbols in the upper right corner: t - total three-phase energy, 1 – the energy of the first phase, 2 – the energy of the second phase, 3 – the energy of the third phase. Change the phase with the right/left button. Choose the group of days with the up/down button. Click OK to freeze the value. Click OK the second time to go back to the menu.

Example of review



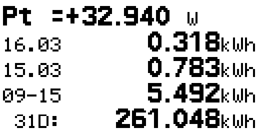
```
Pt=+33.228 W +33.376 W
16.03.         0.299kWh
15.03.         0.783kWh
09-15.         5.492kWh
02-08.       125.310kWh
23-01.         3.395kWh
16-22.       126.223kWh
 31 D:       261.048kWh
```

Row display values:

- The active power (W) the filtered active power (W) with thermal function PtD,
- the energy of the current day (kWh),
- the energy of the previous day (kWh),
- the energy of the first, second, third, and fourth 7-days period (kWh),
- the energy value of the last 31 days (current day not included, kWh).

Most important measurements are quickly available in the measurements of current values.

Main menu ⇨ Measurements ⇨ Current values ⇨Day Energy



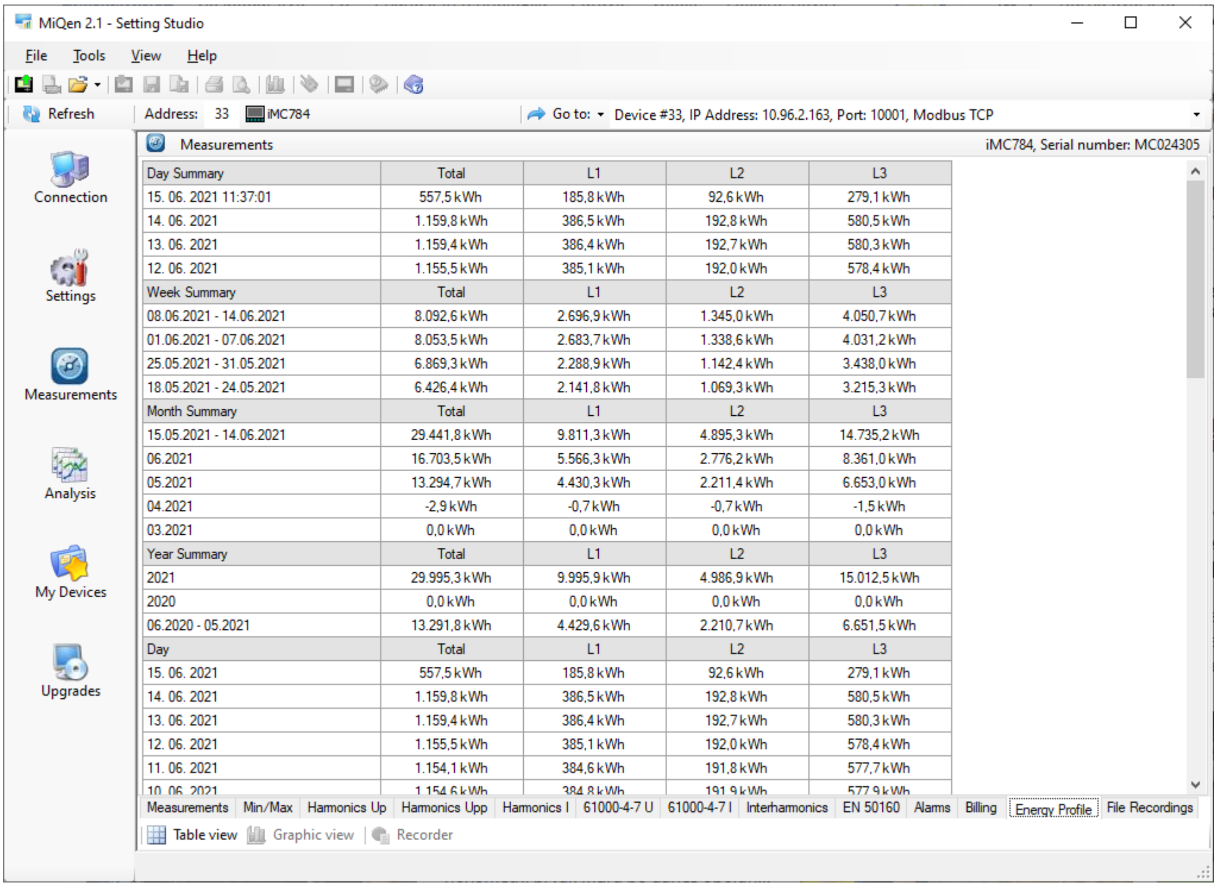
```
Pt  =+32.940 W
16.03       0.318kWh
15.03       0.783kWh
09-15       5.492kWh
 31D:     261.048kWh
```

Row display values:

- The active power (W) of selected phase,
- the energy of the current day (kWh),
- the energy of the previous day (kWh),
- the energy of the last week (current day not included, kWh),
- the energy value of the last 31 days (current day not included, kWh).

Monthly energy consumption profile – MiQen software

Monthly consumption profile of total active energy and active energy of all three phases are represented in the Energy Profile tab.



Address: 33 iMC784

Go to: Device #33, IP Address: 10.96.2.163, Port: 10001, Modbus TCP

iMC784, Serial number: MC024305

Day Summary	Total	L1	L2	L3
15. 06. 2021 11:37:01	557,5 kWh	185,8 kWh	92,6 kWh	279,1 kWh
14. 06. 2021	1.159,8 kWh	386,5 kWh	192,8 kWh	580,5 kWh
13. 06. 2021	1.159,4 kWh	386,4 kWh	192,7 kWh	580,3 kWh
12. 06. 2021	1.155,5 kWh	385,1 kWh	192,0 kWh	578,4 kWh
Week Summary	Total	L1	L2	L3
08.06.2021 - 14.06.2021	8.092,6 kWh	2.696,9 kWh	1.345,0 kWh	4.050,7 kWh
01.06.2021 - 07.06.2021	8.053,5 kWh	2.683,7 kWh	1.338,6 kWh	4.031,2 kWh
25.05.2021 - 31.05.2021	6.869,3 kWh	2.288,9 kWh	1.142,4 kWh	3.438,0 kWh
18.05.2021 - 24.05.2021	6.426,4 kWh	2.141,8 kWh	1.069,3 kWh	3.215,3 kWh
Month Summary	Total	L1	L2	L3
15.05.2021 - 14.06.2021	29.441,8 kWh	9.811,3 kWh	4.895,3 kWh	14.735,2 kWh
06.2021	16.703,5 kWh	5.566,3 kWh	2.776,2 kWh	8.361,0 kWh
05.2021	13.294,7 kWh	4.430,3 kWh	2.211,4 kWh	6.653,0 kWh
04.2021	-2,9 kWh	-0,7 kWh	-0,7 kWh	-1,5 kWh
03.2021	0,0 kWh	0,0 kWh	0,0 kWh	0,0 kWh
Year Summary	Total	L1	L2	L3
2021	29.995,3 kWh	9.995,9 kWh	4.986,9 kWh	15.012,5 kWh
2020	0,0 kWh	0,0 kWh	0,0 kWh	0,0 kWh
06.2020 - 05.2021	13.291,8 kWh	4.429,6 kWh	2.210,7 kWh	6.651,5 kWh
Day	Total	L1	L2	L3
15. 06. 2021	557,5 kWh	185,8 kWh	92,6 kWh	279,1 kWh
14. 06. 2021	1.159,8 kWh	386,5 kWh	192,8 kWh	580,5 kWh
13. 06. 2021	1.159,4 kWh	386,4 kWh	192,7 kWh	580,3 kWh
12. 06. 2021	1.155,5 kWh	385,1 kWh	192,0 kWh	578,4 kWh
11. 06. 2021	1.154,1 kWh	384,6 kWh	191,8 kWh	577,7 kWh
10. 06. 2021	1.154,6 kWh	384,8 kWh	191,9 kWh	577,9 kWh

Yearly energy consumption profile

The yearly energy consumption profile measures a monthly average of the active power for the last 24 months.

PLEASE NOTE

The measure values of the current month are stored even if the meter is switched off or not powered.

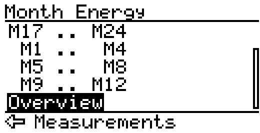
The capture of the energy values could be changed manually by changing the date (on the meter screen or through MODBUS communication).

PLEASE NOTE

When changing the date for a few months forward, the values for intermediate months are deleted. When changing the date back, the values do not change, only the data for the current month is deleted.

Display of yearly energy consumption profile (available only on option with graphical LCD display)

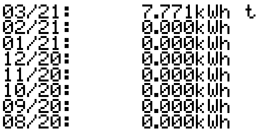
Main menu ⇨ Measurements ⇨ Monthly Energy⇨ M1 .. M4



```
Month Energy
 M17 .. M24
  M1 ..  M4
  M5 ..  M8
  M9 .. M12
 Overview
⇦ Measurements
```

Possibility to select a specific group of 8 consecutive months (M1 – current month), specific group of 4 consecutive months by comparing the previous year, or a combined display of the values of these groups (review).

Example of consecutive months

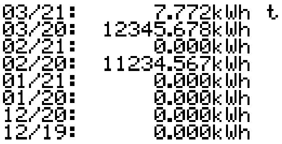


```
03/21:     7.771kWh t
02/21:     0.000kWh
01/21:     0.000kWh
12/20:     0.000kWh
11/20:     0.000kWh
10/20:     0.000kWh
09/20:     0.000kWh
08/20:     0.000kWh
```

The date is represented as MM/LL.

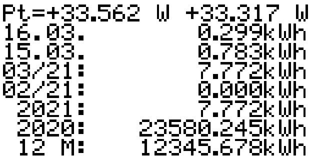
Symbols in the upper right corner: t - total three-phase energy, 1 – the energy of the first phase, 2 – the energy of the second phase, 3 – the energy of the third phase. Change the phase with the right/left button. Choose the group of months with the up/down button. Click OK to freeze the value. Click OK the second time to go back to the menu.

Example of consecutive months by comparing the previous year



```
03/21:      7.772kWh t
03/20:  12345.678kWh
02/21:      0.000kWh
02/20:  11234.567kWh
01/21:      0.000kWh
01/20:      0.000kWh
12/20:      0.000kWh
12/19:      0.000kWh
```

Example of review



```
Pt=+33.562 W +33.317 W
16.03.         0.299kWh
15.03.         0.783kWh
03/21:         7.772kWh
02/21:         0.000kWh
 2021:         7.772kWh
 2020:     23580.245kWh
 12 M:     12345.678kWh
```

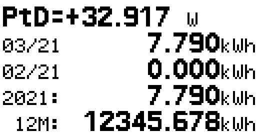
Row display values:

- The active power (W) the filtered active power (W) with thermal function PtD,
- the energy of the current day (kWh),
- the energy of the previous day (kWh),
- the energy of the current month (kWh),
- the energy of the previous month (kWh),
- the energy of the current year (kWh),

- the energy of the previous year (kWh),
- the energy of the previous 12 months (current month not included, kWh).

Most important measurements are quickly available in the measurements of current values.

Main menu ⇨ Measurements ⇨ Current values ⇨Monthly Energy



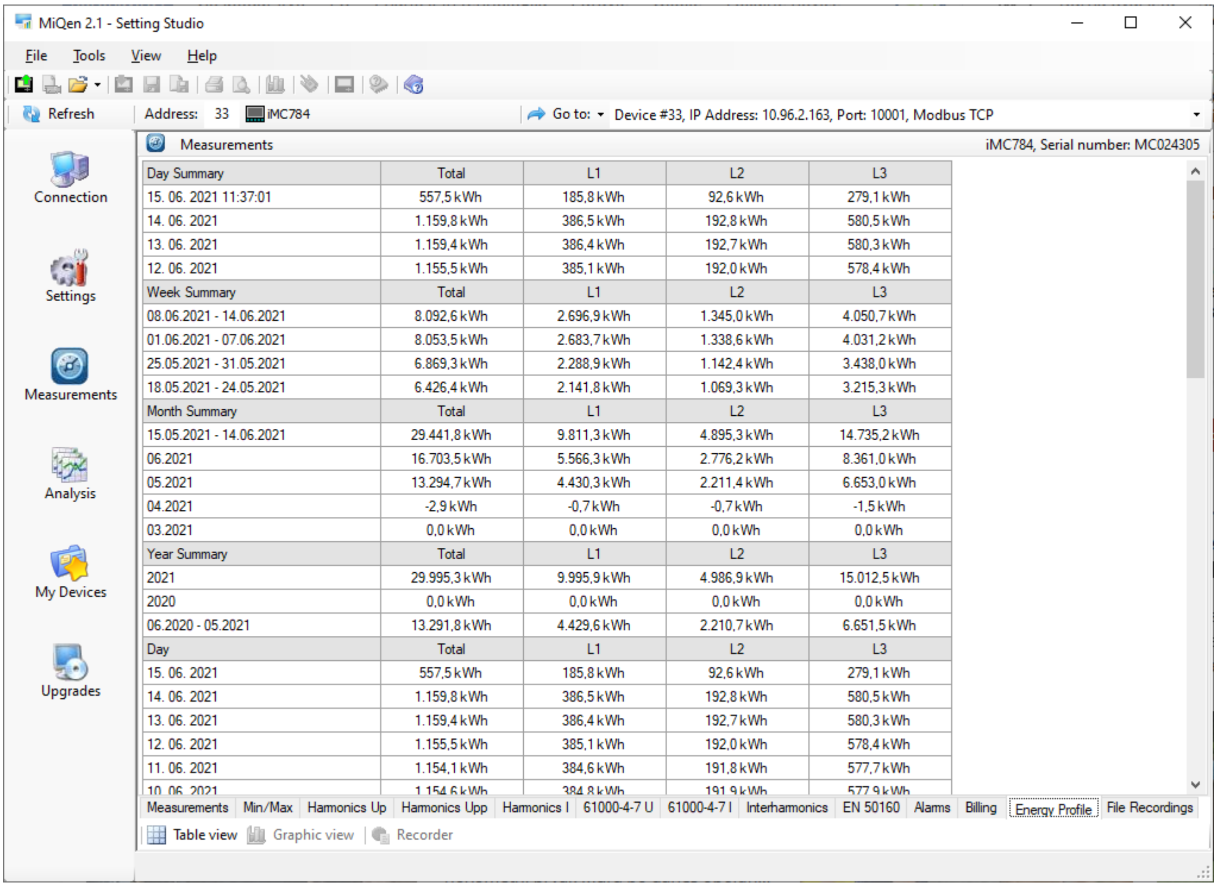
```
PtD=+32.917 W
03/21        7.790kWh
02/21        0.000kWh
2021:        7.790kWh
 12M:   12345.678kWh
```

Row display values:

- The filtered active power (W) with thermal function,
- the energy of the current month (kWh),
- the energy of the previous month (kWh),
- the energy of the current year (kWh),
- the energy of the previous 12 months (current month not included, kWh).

Yearly energy consumption profile – MiQen software

Yearly consumption profile of total active energy and active energy of all three phases are represented in the Energy Profile tab.



Address: 33 iMC784

Go to: Device #33, IP Address: 10.96.2.163, Port: 10001, Modbus TCP

Measurements — iMC784, Serial number: MC024305

Day Summary	Total	L1	L2	L3
15. 06. 2021 11:37:01	557,5 kWh	185,8 kWh	92,6 kWh	279,1 kWh
14. 06. 2021	1.159,8 kWh	386,5 kWh	192,8 kWh	580,5 kWh
13. 06. 2021	1.159,4 kWh	386,4 kWh	192,7 kWh	580,3 kWh
12. 06. 2021	1.155,5 kWh	385,1 kWh	192,0 kWh	578,4 kWh
Week Summary	Total	L1	L2	L3
08.06.2021 - 14.06.2021	8.092,6 kWh	2.696,9 kWh	1.345,0 kWh	4.050,7 kWh
01.06.2021 - 07.06.2021	8.053,5 kWh	2.683,7 kWh	1.338,6 kWh	4.031,2 kWh
25.05.2021 - 31.05.2021	6.869,3 kWh	2.288,9 kWh	1.142,4 kWh	3.438,0 kWh
18.05.2021 - 24.05.2021	6.426,4 kWh	2.141,8 kWh	1.069,3 kWh	3.215,3 kWh
Month Summary	Total	L1	L2	L3
15.05.2021 - 14.06.2021	29.441,8 kWh	9.811,3 kWh	4.895,3 kWh	14.735,2 kWh
06.2021	16.703,5 kWh	5.566,3 kWh	2.776,2 kWh	8.361,0 kWh
05.2021	13.294,7 kWh	4.430,3 kWh	2.211,4 kWh	6.653,0 kWh
04.2021	-2,9 kWh	-0,7 kWh	-0,7 kWh	-1,5 kWh
03.2021	0,0 kWh	0,0 kWh	0,0 kWh	0,0 kWh
Year Summary	Total	L1	L2	L3
2021	29.995,3 kWh	9.995,9 kWh	4.986,9 kWh	15.012,5 kWh
2020	0,0 kWh	0,0 kWh	0,0 kWh	0,0 kWh
06.2020 - 05.2021	13.291,8 kWh	4.429,6 kWh	2.210,7 kWh	6.651,5 kWh
Day	Total	L1	L2	L3
15. 06. 2021	557,5 kWh	185,8 kWh	92,6 kWh	279,1 kWh
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12. 06. 2021	1.155,5 kWh	385,1 kWh	192,0 kWh	578,4 kWh
11. 06. 2021	1.154,1 kWh	384,6 kWh	191,8 kWh	577,7 kWh
10. 06. 2021	1.154,6 kWh	384,8 kWh	191,9 kWh	577,9 kWh

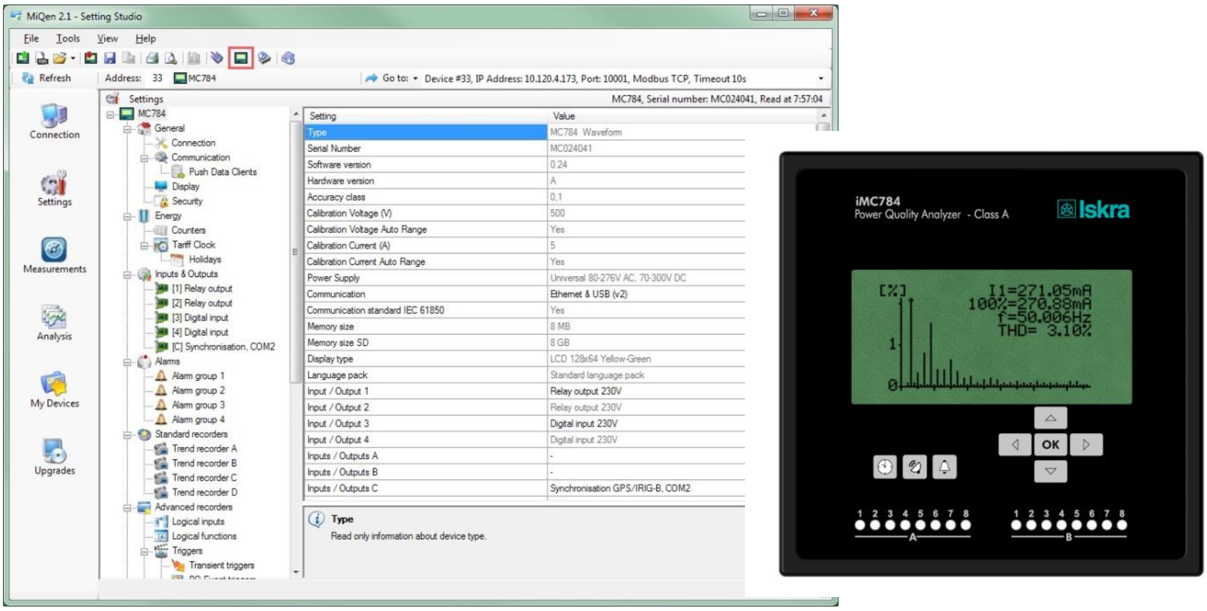
WEB server

Power Quality Analyzer iMC784A supports WEB server for a fast and easy monitoring of devices' settings and online measurements. WEB server can be accessed by entering devices' IP number into your browsers' address bar. IP number can be obtained in communication settings on devices' display. WEB server can be accessed only when your computer is in the same local network as a device. Otherwise secure VPN tunnel has to be implemented to access devices' network.

Web management settings page

Interactive instrument

Additional communication features of the device allow interactive handling with a dislocated device as if it were operated directly through the on-board keyboard and display. This feature can also prove to be very useful for presentations or product training purposes.



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.173, Port: 10001, Modbus TCP, Timeout 10s

MC784, Serial number: MC024041, Read at 7:57:04

Setting	Value
Type	MC784 Waveform
Serial Number	MC024041
Software version	0.24
Hardware version	A
Accuracy class	0,1
Calibration Voltage (V)	500
Calibration Voltage Auto Range	Yes
Calibration Current (A)	5
Calibration Current Auto Range	Yes
Power Supply	Universal 80-276V AC, 70-300V DC
Communication	Ethernet & USB (v2)
Communication standard IEC 61850	Yes
Memory size	8 MB
Memory size SD	8 GB
Display type	LCD 128x64 Yellow-Green
Language pack	Standard language pack
Input / Output 1	Relay output 230V
Input / Output 2	Relay output 230V
Input / Output 3	Digital input 230V
Input / Output 4	Digital input 230V
Inputs / Outputs A	-
Inputs / Outputs B	-
Inputs / Outputs C	Synchronisation GPS/IRIG-B, COM2

Type
Read only information about device type.

Supported measurements

Selection of supported measurements of individual instrument types is changed within the connection settings. All supported measurements can be read via communication (through MiQen) or displayed on the Power Quality Analyzer iMC784A display (depending on hardware).

Available connections

Different electric connections are described in more detail in chapter Electrical connection.
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

PLEASE NOTE

Measurements support depends on connection mode the device type. Calculated measurements (for example voltages U1 and U2 when 3-phase, 4-wire connection with a balanced load is used) are only informative.

Selection of available quantities

Available online measuring quantities and their appearance can vary according to the setup type of power network and other settings such as; average interval, maximum demand mode and reactive power calculation method. A complete list of available online measuring quantities is shown in the table below.

PLEASE NOTE

Measurements support depends on connection mode as well as the Power Quality Analyzer iMC784A type (built-in options). Calculated measurements (for example voltages U_1 and U_2 when 3-phase, 4-wire connection with a balanced load is used) are only informative.

⚠ PLEASE NOTE

For 3b and 3u connection mode, only phase to phase voltages are measured. The factor $\sqrt{3}$ is then applied to calculate the nominal phase voltage. For 4u connection mode the same measurements are supported as for 1b.

Meas. type	Measurement	3-phase 4-wire	3-phase 3-wire	1-phase	comments
Phase measurements	Voltage				
	$U_{\text{1-3\_TRMS}}$	☑		☑1ph	
	$U_{\text{AVG\_TRMS}}$	☑		☑	
	$U_{\text{unbalance\_neg}}$	☑📖	☑📖		
	$U_{\text{unbalance\_zero}}$	☑📖	☑📖		
	$U_{\text{1-3\_DC}}$	☑		☑1ph	DC component of phase voltages
	$U_{\text{0\_Zero\_sequance}}$	☑	☑		Zero sequence voltage
	$U_{\text{1\_Positive\_sequence}}$	☑	☑		Positive sequence voltage
	$U_{\text{2\_Negative\_sequence}}$	☑	☑		Negative sequence voltage
	Current				
	$I_{\text{1-3\_TRMS}}$	☑	☑	☑1ph	
	$I_{\text{TOT\_TRMS}}$	☑	☑	☑	
	$I_{\text{AVG\_TRMS}}$	☑	☑	☑	
	$I_{\text{unbalance}}$	☑	☑		
	$I_{\text{unbalance\_zero}}$	☑	☑		
	$I_{\text{0\_Zero\_sequance}}$	☑	☑		Zero sequence current
	$I_{\text{1\_Positive\_sequence}}$	☑	☑		Positive sequence current
	$I_{\text{2\_Negative\_sequence}}$	☑	☑		Negative sequence current
	Power				
	$P_{\text{1-3}}$	☑		☑1ph	
	P_{TOT}	☑	☑	☑	
	$Q_{\text{1-3}}$	☑📖		☑1ph📖	Reactive power can be calculated as a squared difference between S and P or as sample delayed
	Q_{TOT}	☑	☑	☑	
	$Qb_{\text{1-3}}$	☑		☑1ph	Budeanu reactive power Phase
	Qb_{TOT}	☑	☑	☑	Budeanu reactive power Total
	$S_{\text{1-3}}$	☑		☑1ph	
	S_{TOT}	☑	☑	☑	
	$D_{\text{1-3}}$	☑		☑1ph	Deformed power Phase
	D_{TOT}	☑	☑	☑	Deformed power Total
	$PF_{\text{1-3}}$	☑		☑1ph	
	PF_{TOT}	☑	☑		
	$dPF_{\text{1-3}}$	☑		☑	Displacement Power Factor Phase
	$dPF_{\text{TOT\_}}$	☑	☑	☑1ph	Displacement Power Factor Total
	$\varphi_{\text{1-3}}$	☑		☑1ph	
	Harmonic analysis				
	THD-$U_{\text{1-3}}$	☑		☑1ph	
	THD-$I_{\text{1-3}}$	☑	☑	☑1ph	
	TDD-$I_{\text{1-3}}$	☑	☑	☑1ph	
	$U_{\text{1-3\_harmonic\_1-63\_\%}}$	☑📖		☑1ph📖	% of TRMS or % of base
	$U_{\text{1-3\_harmonic\_1-63\_ABS}}$	☑		☑1ph	
	$U_{\text{1-3\_harmonic\_1-63\_}\varphi}$	☑		☑1ph	
	$U_{\text{1-3\_inter-harmonic\_\%}}$	☑📖		☑1ph📖	Monitoring up to 10 different fixed frequencies
	$U_{\text{1-3\_inter-harmonic\_ABS}}$	☑		☑1ph	
	$U_{\text{1-3\_inter-harmonic\_1-63\_\%}}$	☑📖		☑1ph📖	% of TRMS or % of base
	$U_{\text{1-3\_inter-harmonic\_1-63\_ABS}}$	☑		☑1ph	
	$U_{\text{1-3\_signaling\_\%}}$	☑📖		☑1ph📖	Monitoring of signaling (ripple) voltage of set frequency. % of TRMS or % of base
	$U_{\text{1-3\_signaling\_ABS}}$	☑		☑1ph	
	$I_{\text{1-3\_harmonic\_1-63\_\%}}$	☑📖	☑📖	☑1ph📖	% of TRMS or % of base
	$I_{\text{1-3\_harmonic\_1-63\_ABS}}$	☑	☑	☑1ph	
	$I_{\text{1-3\_harmonic\_1-63\_}\varphi}$	☑	☑	☑1ph	
	$I_{\text{1-3\_inter-harmonic\_\%}}$	☑📖	☑	☑1ph📖	Monitoring up to 10 different fixed frequencies

	$I_{\text{1-3\_inter-harmonic\_ABS}}$	☑	☑	☑1ph	
	$I_{\text{1-3\_inter-harmonic\_1-63\_\%}}$	☑📖	☑	☑1ph📖	% of TRMS or % of base
	$I_{\text{1-3\_inter-harmonic\_1-63\_ABS}}$	☑	☑	☑1ph	
	$I_{\text{1-3\_signaling\_\%}}$	☑📖		☑1ph📖	Monitoring of signaling (ripple) current of set frequency. % of TRMS or % of base
	$I_{\text{1-3\_signaling\_ABS}}$	☑		☑1ph	
	Flickers				
	Pi_{1-3}	☑		☑1ph	Instantaneous flicker sensation measured with 150 samples / sec (original sampling is 1200 samples / sec)
	Pst_{1-3}	☑		☑1ph	10 min statistical evaluation (128 classes of CPF)
	Plt_{1-3}	☑		☑1ph	Derived from 12 Pst acc. to EN 61000-4-15

Meas. type	**Measurement**	**3-phase 4-wire**	**3-phase 3-wire**	**1-phase**	**comments**
	Miscellaneous				
	K-factor$_{1-3}$	☑	☑	☑1ph	
	Current Crest factor I_{1-3}	☑	☑	☑1ph	
	Voltage Crest factor U_{1-3}	☑		☑1ph	
Phase to phase measurements	Voltage				
	$Upp_{\text{1-3\_TRMS}}$	☑	☑		
	$Upp_{\text{AVG\_TRMS}}$	☑	☑		
	THD-Upp_{1-3}	☑	☑		
	φ_{x-y}	☑			Phase-to-phase angle
	$Upp_{\text{1-3\_harmonic\_1-63\_\%}}$	☑📖	☑📖		% of TRMS or % of base
	$Upp_{\text{1-3\_harmonic\_1-63\_ABS}}$	☑	☑		
	$Upp_{\text{1-3\_harmonic\_1-63\_}\varphi}$	☑	☑		
	$Upp_{\text{1-3\_interharmonic\_1-63\_\%}}$	☑	☑	☑1ph	% of TRMS or % of base
	$Upp_{\text{1-3\_interharmonic\_1-63\_ABS}}$	☑	☑	☑1ph	
	$U_{\text{underdeviation}}$	☑	☑	☑1ph	$U_{\text{under.}}$ and $U_{\text{over.}}$ are calculated for phase or phase-to-phase voltages regarding connection mode.
	$U_{\text{overdeviation}}$	☑	☑	☑1ph	
	Voltage Crest factor Upp_{1-3}	☑	☑	☑1ph	
	Flickers				
	Pi_pp_{1-3}		☑		Phase-to-phase flickers.
	Pst_pp_{1-3}		☑		
	Plt_pp_{1-3}		☑		
Metering	Energy	☑	☑	☑	
	Counter E_{1-8}	☑	☑	☑	Each counter can be dedicated to any of four quadrants (P-Q, import-export, L-C). Total energy is a sum of one counter for all tariffs. Tariffs can be fixed, date/time dependent or tariff input dependent
	E_$_{\text{TOT\_1-8}}$	☑	☑	☑	
	Active tariff	☑	☑	☑	
	Billing	☑	☑	☑	
Auxiliary Channel measurements	Aux. line				
	$U_{\text{NEUTRAL-EARTH}}$	☑		☑	Aux. voltage is dedicated for neutral-earth meas. only
	$I_{\text{NEUTRAL\_meas}}$	☑		☑	Measured neutral current with 4th current input
	$I_{\text{NEUTRAL\_calc}}$	☑	☑	☑	Calculated neutral current
	$I_{\text{NEUTRAL\_err}}$	☑		☑	Error neutral current (difference between measured and calculated)
Maximum demand measurements	Maximum demand				
	MD_I_{1-3}	☑	☑	☑1ph	
	MD_P_{import}	☑	☑	☑	
	MD_P_{export}	☑	☑	☑	
	MD_Q_{ind}	☑	☑	☑	
	MD_Q_{cap}	☑	☑	☑	
	MD_S	☑	☑	☑	
Min and max measurements	Min and max				
	$U_{\text{1-3\_TRMS\_MIN}}$	☑		☑1ph	
	$U_{\text{1-3\_TRMS\_MAX}}$	☑		☑1ph	
	$U_{\text{0\_Zero\_sequance\_ MIN}}$	☑	☑		Max/Min Zero sequence voltage

$U_{0\_Zero\_sequance\_MAX}$	☑	☑		
$U_{1\_Positive\_sequence\_MIN}$	☑	☑		Max/Min Positive sequence voltage
$U_{1\_Positive\_sequence\_MAX}$	☑	☑		
$U_{2\_Negative\_sequence\_MIN}$	☑	☑		Max/Min Negative sequence voltage
$U_{2\_Negative\_sequence\_MAX}$	☑	☑		
$Upp_{1-3\_TRMS\_MIN}$	☑	☑	☑	
$Upp_{1-3\_TRMS\_MAX}$	☑	☑	☑	
$I_{1-3\_TRMS\_MIN}$	☑	☑	☑1ph	
$I_{1-3\_TRMS\_MAX}$	☑	☑	☑1ph	
$I_{NEUTRAL\_meas\_TRMS\_MIN}$	☑	☑	☑	
$I_{NEUTRAL\_meas\_TRMS\_MAX}$	☑	☑	☑	

Meas. type	**Measurement**	**3-phase 4-wire**	**3-phase 3-wire**	**1-phase**	**comments**
	$I_{0\_Zero\_sequance\_MIN}$	☑	☑		Max/Min Zero sequence current
	$I_{0\_Zero\_sequance\_MAX}$	☑	☑		
	$I_{1\_Positive\_sequence\_MIN}$	☑	☑		Max/Min Positive sequence current
	$I_{1\_Positive\_sequence\_MAX}$	☑	☑		
	$I_{2\_Negative\_sequence\_MIN}$	☑	☑		Max/Min Negative sequence current
	$I_{2\_Negative\_sequence\_MAX}$	☑	☑		
Min and max measurements	P_{1-3_MIN}	☑		☑1ph	
	P_{1-3_MAX}	☑		☑1ph	
	P_{TOT_MIN}	☑	☑	☑1ph	
	P_{TOT_MAX}	☑	☑	☑1ph	
	Qb_{TOT_MIN}	☑	☑		Max/Min Budeanu reactive power Total
	Qb_{TOT_MAX}	☑	☑		
	Qb_{1-3_MIN}	☑	☑		Max/Min Budeanu reactive power Phase
	Qb_{1-3_MAX}	☑	☑		
	S_{1-3_MIN}	☑		☑1ph	
	S_{1-3_MAX}	☑		☑1ph	
	S_{TOT_MIN}	☑	☑	☑1ph	
	S_{TOT_MAX}	☑	☑	☑1ph	
	D_{TOT_MIN}	☑	☑		Max/Min Deformed power Total
	D_{TOT_MAX}	☑	☑		
	D_{1-3_MIN}	☑	☑		Max/Min Deformed power Phase
	D_{1-3_MAX}	☑	☑		
	dPF_{TOT_MIN}	☑	☑		Max/Min Displacement Power Factor Total
	dPF_{TOT_MAX}	☑	☑		
	dPF_{1-3_MIN}	☑	☑		Max/Min Displacement Power Factor Phase
	dPF_{1-3_MAX}	☑	☑		
	$freq_{MIN}$	☑	☑	☑	
	$freq_{MAX}$	☑	☑	☑	
Other measurements	Miscellaneous				
	Internal temp.	☑	☑	☑	
	Date, Time	☑	☑	☑	
	Last Sync. time	☑📖	☑📖	☑📖	UTC
	GPS Time	☑📖	☑📖	☑📖	If GPS receiver is connected to dedicated RTC time synchronization input
	GPS Longitude	☑📖	☑📖	☑📖	
	GPS Latitude	☑📖	☑📖	☑📖	
	GPS Altitude	☑📖	☑📖	☑📖	

Explanation of basic concepts

Average interval MP

Due to readability of measurements from communication or LCD (where available), an Average interval (MP) is calculated with regard to the measured signal frequency. The Average interval (see chapter Measurements – Min/Max values) defines refresh rate of displayed measurements based on a sampling factor.

Sample frequency

Power Quality Analyzer iMC784A measures all primary quantities with a constant sampling rate of 31,25 kHz (625 sample/per at 50 Hz).

Average interval

Operation of Power Quality Analyzer iMC784A depends on several Average intervals, which should all be well understood and set to a proper value.

Average interval for measurements and display

Due to readability of measurements from LCD and communication, an Average interval can be selected from a range of predefined values (from 0.1s to 5 s). The Average interval (see chapter Measurements – Min/Max values) defines refresh rates of displayed measurements.
Alarms response time is influenced by general average interval if their response time setting is set to “Normal response”. If it is set to “Fast response” alarms depend on a single period measurement.
This average interval has no influence on PQ measurements.

Average interval for min/max values

Min/max values often require special averaging period, which enables or disables detection of short measuring spikes. With this setting it is possible to set averaging from 1 period to 256 periods.

Average (storage) interval for recorders

This storage interval defines a period for writing data into internal memory. It can be set from 1 min to 60 min. At the end of every interval different types of measured data can be stored into the recorder (see General purpose recorder settings).

Average (aggregation) interval for PQ parameters

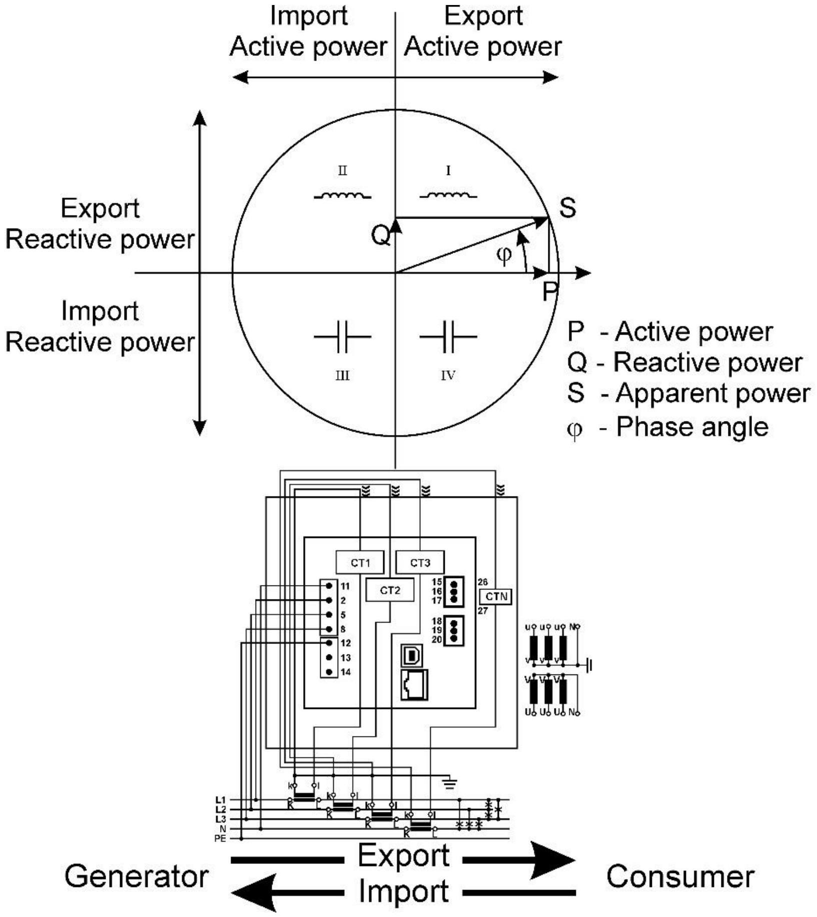
Standard IEC61000-4-30 defines different aggregation intervals and procedures for aggregation of measured PQ parameters.
For each PQ parameter it is possible to set a required aggregation interval. Standard aggregation intervals are:

- 10 periods (12 for 60 Hz system) - for calculations only
- 150 periods (180 for 60 Hz system) - for calculations only
- 3 sec
- 10 sec
- 10 min (also basic time synchronization tick interval)
- 2 h

It is also possible to set other aggregation intervals according to requirements. Additional aggregation intervals are 30 sec, 1 min, 15 min and 1 h.

Power and energy flow

Figures below show the flow of active power, reactive power and energy for 4u connection.
Display of energy flow direction can be adjusted according to connection and operation requirements by changing the Energy flow direction settings.



Explanation of energy flow direction

Calculation and display of measurements

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

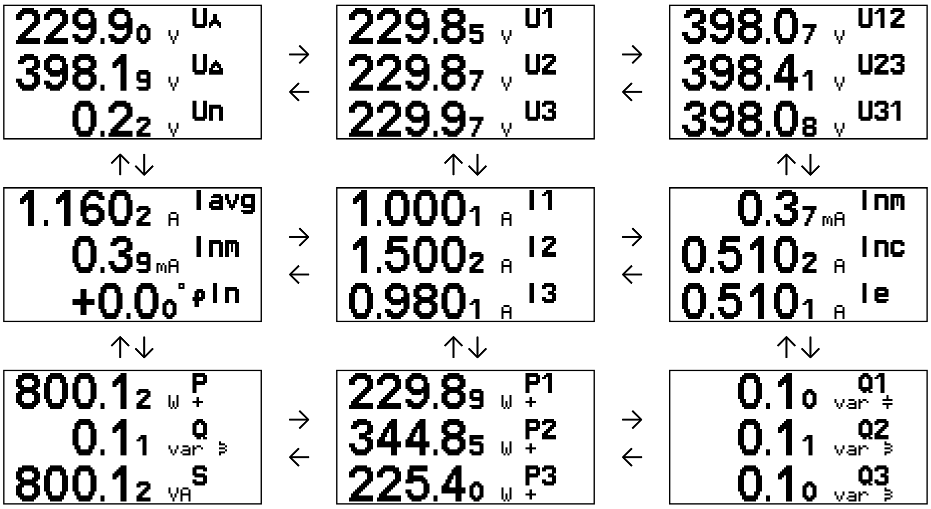
PLEASE NOTE

Calculation and display of measurements depend on the connection used. For more detailed information please see chapter Selection of available quantities.

Keyboard and LCD display presentation

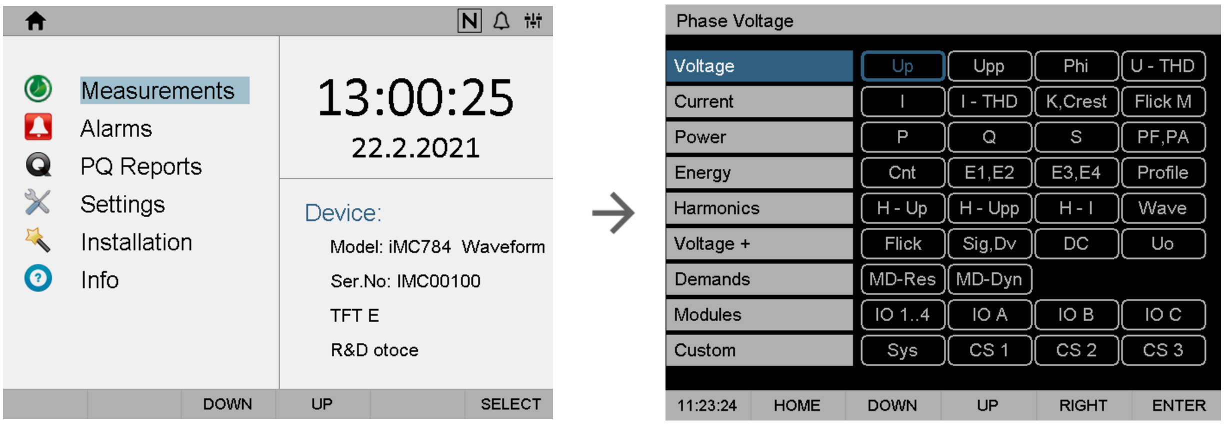
For entering and exiting the measurements display menu, the OK key is used. Measurements are combined in to logical groups named by main measured parameter such as (Voltage, Current…). Within selected group is possible to maneuver with the help of left and right button, between the groups is possible to maneuver with the help of up and down button.

Below is an example for 4u connection mode:



Keyboard and TFT LCD display presentation

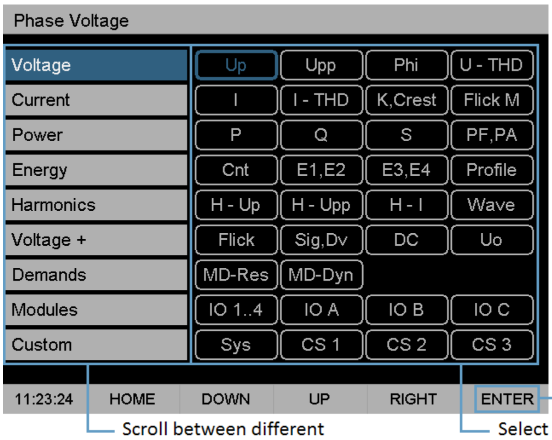
For entering the Measurements menu, use DOWN and UP buttons go to Measurements and use SELECT to enter.



13:00:25
22.2.2021

Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce

Measurements are divided in to different groups. Use DOWN, UP and RIGHT button to select desired measurements and ENTER to enter:



Phase Voltage

Voltage	Up	Upp	Phi	U - THD
Current	I	I - THD	K,Crest	Flick M
Power	P	Q	S	PF,PA
Energy	Cnt	E1,E2	E3,E4	Profile
Harmonics	H - Up	H - Upp	H - I	Wave
Voltage +	Flick	Sig,Dv	DC	Uo
Demands	MD-Res	MD-Dyn		
Modules	IO 1..4	IO A	IO B	IO C
Custom	Sys	CS 1	CS 2	CS 3

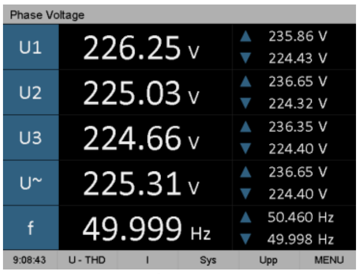
Enter selected measurement using ENTER

Scroll between different measurement groups using UP/DOWN button

Select specific measurement using RIGHT button

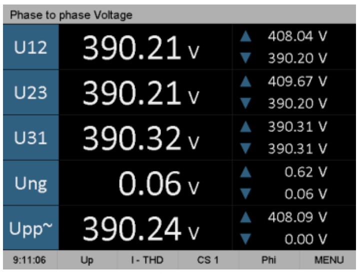
When group of selected measurements is displayed, other, neighbor measurements can be entered directly by pressing button below the measurements description.
To exit measurements display click MENU button.

Below are few examples for 4u connection mode:



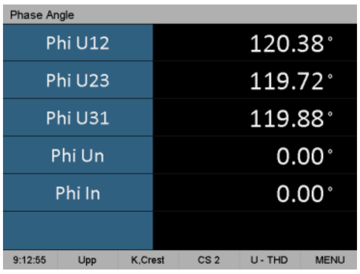
Phase Voltage

U1	226.25 V	▲ 235.86 V ▼ 224.43 V
U2	225.03 V	▲ 236.65 V ▼ 224.32 V
U3	224.66 V	▲ 236.35 V ▼ 224.40 V
U~	225.31 V	▲ 236.65 V ▼ 224.40 V
f	49.999 Hz	▲ 50.460 Hz ▼ 49.998 Hz



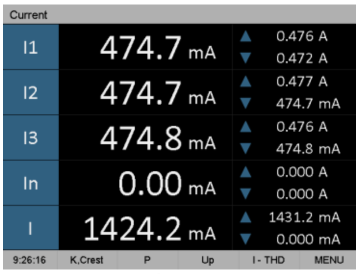
Phase to phase Voltage

U12	390.21 V	▲ 408.04 V ▼ 390.20 V
U23	390.21 V	▲ 409.67 V ▼ 390.20 V
U31	390.32 V	▲ 390.31 V ▼ 390.31 V
Ung	0.06 V	▲ 0.62 V ▼ 0.06 V
Upp~	390.24 V	▲ 408.09 V ▼ 0.00 V



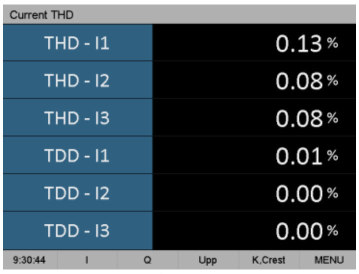
Phase Angle

Phi U12	120.38°
Phi U23	119.72°
Phi U31	119.88°
Phi Un	0.00°
Phi In	0.00°



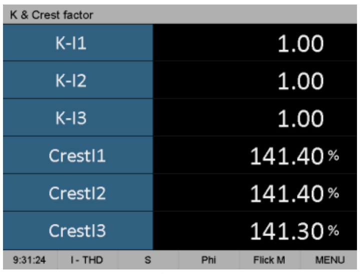
Current

I1	474.7 mA	▲ 0.476 A ▼ 0.472 A
I2	474.7 mA	▲ 0.477 A ▼ 474.7 mA
I3	474.8 mA	▲ 0.476 A ▼ 474.8 mA
In	0.00 mA	▲ 0.000 A ▼ 0.000 A
I	1424.2 mA	▲ 1431.2 mA ▼ 0.000 mA



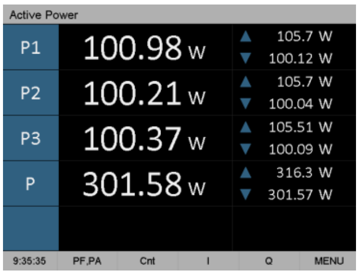
Current THD

THD - I1	0.13 %
THD - I2	0.08 %
THD - I3	0.08 %
TDD - I1	0.01 %
TDD - I2	0.00 %
TDD - I3	0.00 %



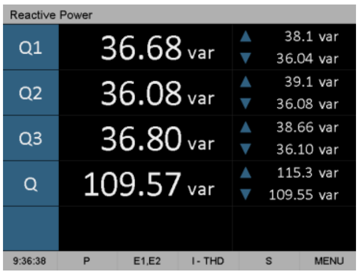
K & Crest factor

K-I1	1.00
K-I2	1.00
K-I3	1.00
CrestI1	141.40 %
CrestI2	141.40 %
CrestI3	141.30 %



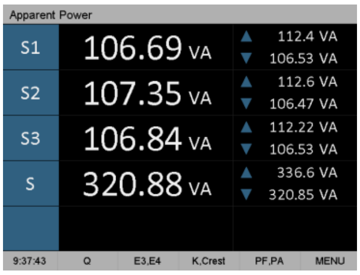
Active Power

P1	100.98 W	▲ 105.7 W ▼ 100.12 W
P2	100.21 W	▲ 105.7 W ▼ 100.04 W
P3	100.37 W	▲ 105.51 W ▼ 100.09 W
P	301.58 W	▲ 316.3 W ▼ 301.57 W



Reactive Power

Q1	36.68 var	▲ 38.1 var ▼ 36.04 var
Q2	36.08 var	▲ 39.1 var ▼ 36.08 var
Q3	36.80 var	▲ 38.66 var ▼ 36.10 var
Q	109.57 var	▲ 115.3 var ▼ 109.55 var



Apparent Power

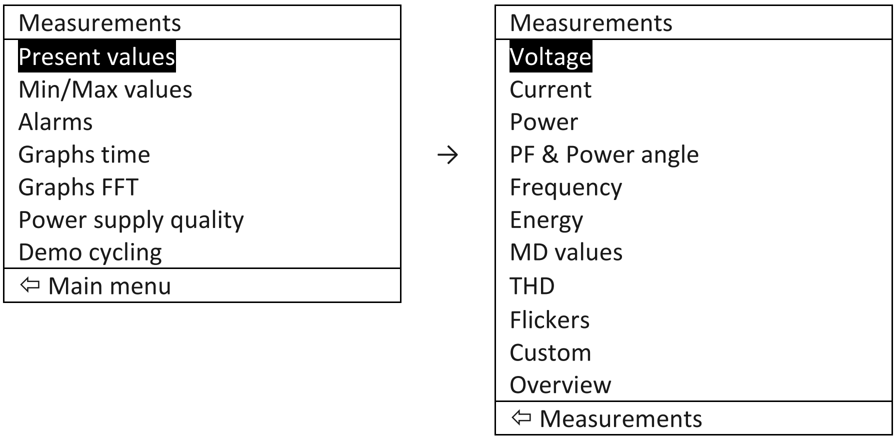
S1	106.69 VA	▲ 112.4 VA ▼ 106.53 VA
S2	107.35 VA	▲ 112.6 VA ▼ 106.47 VA
S3	106.84 VA	▲ 112.22 VA ▼ 106.53 VA
S	320.88 VA	▲ 336.6 VA ▼ 320.85 VA

Measurements menu organization

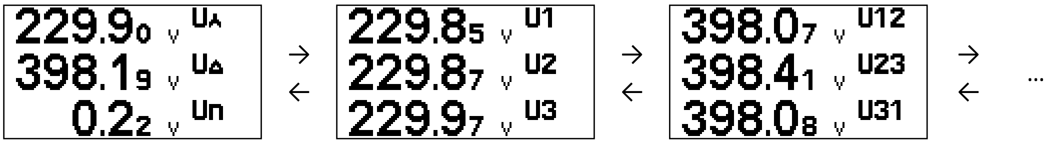
Because of different built in display technologies also organization of data presentation on devices is different thou both models show the same measurement parameters.

Measurements menu iMC784A Graphic pixel display

Measurement menu on LCD display is organized in two levels. In the first level, set of measured data is selected such as present values, Min/Max values, Alarms… when entered, selected measurements are shown.
Because of display limitation maximum three values are shown at the time (exceptions are Overview display and Custom display 4).



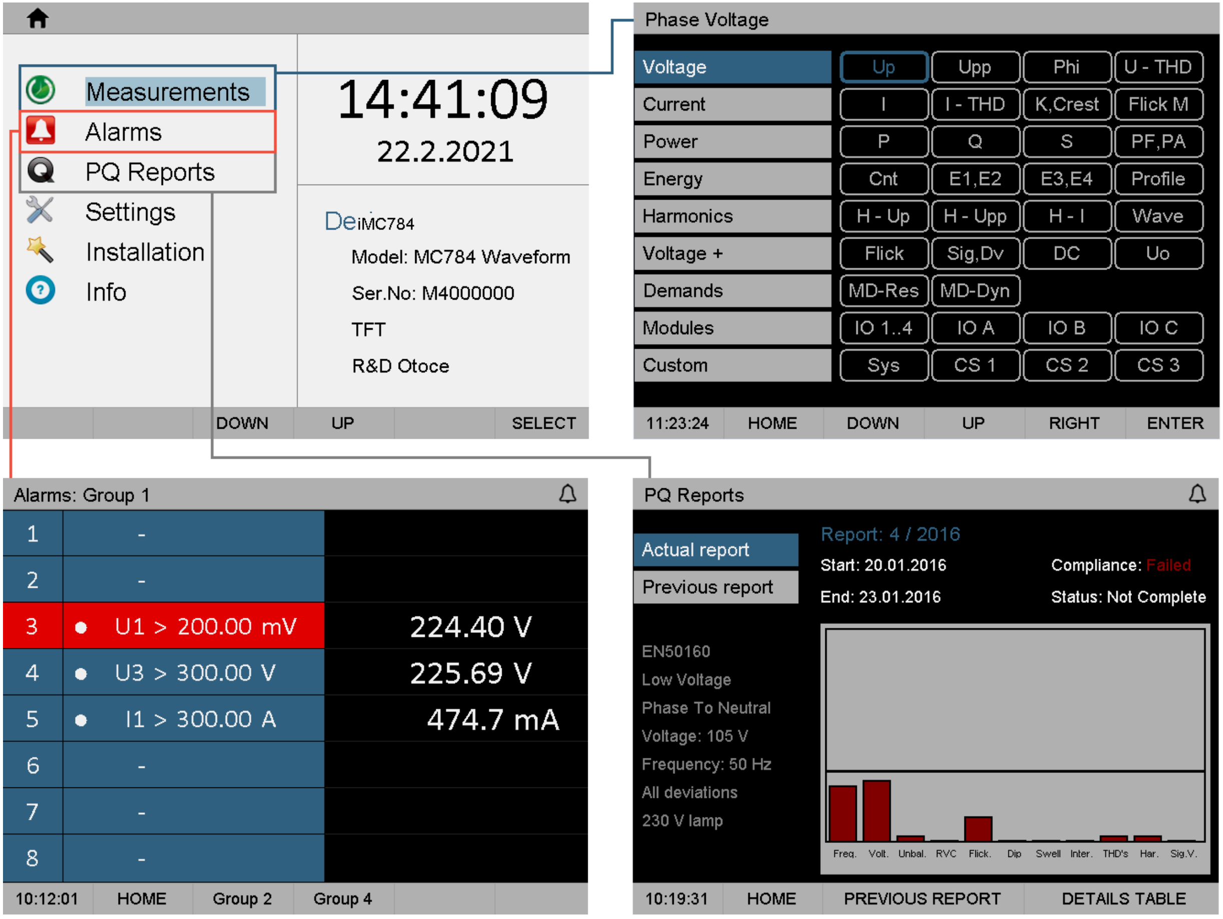
Below is example for Present values > Voltage for 4u connection.



Measurements menu iMC784A color TFT LCD dispaly

On TFT LCD display all measurements options are shown at once in measurement menu. Enter selected measurement using Enter button. Basic differences between LCD and TFT LCD display:

- Alarms and Power Quality information can be accessed directly from the Main menu. More is described later in the following chapters.



14:41:09
22.2.2021
DeiMC784
Model: MC784 Waveform
Ser.No: M4000000
TFT
R&D Otoce

Phase Voltage

Voltage	Up	Upp	Phi	U - THD
Current	I	I - THD	K,Crest	Flick M
Power	P	Q	S	PF,PA
Energy	Cnt	E1,E2	E3,E4	Profile
Harmonics	H - Up	H - Upp	H - I	Wave
Voltage +	Flick	Sig,Dv	DC	Uo
Demands	MD-Res	MD-Dyn		
Modules	IO 1..4	IO A	IO B	IO C
Custom	Sys	CS 1	CS 2	CS 3

Alarms: Group 1

1	-	
2	-	
3	● U1 > 200.00 mV	224.40 V
4	● U3 > 300.00 V	225.69 V
5	● I1 > 300.00 A	474.7 mA
6	-	
7	-	
8	-	

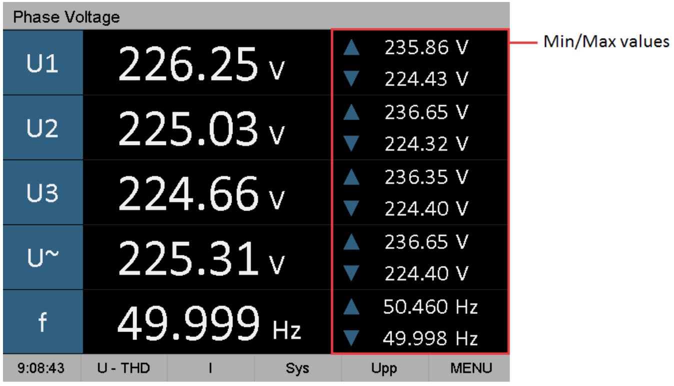
PQ Reports

Actual report
Previous report

Report: 4 / 2016
Start: 20.01.2016
End: 23.01.2016
Compliance: Failed
Status: Not Complete

EN50160
Low Voltage
Phase To Neutral
Voltage: 105 V
Frequency: 50 Hz
All deviations
230 V lamp

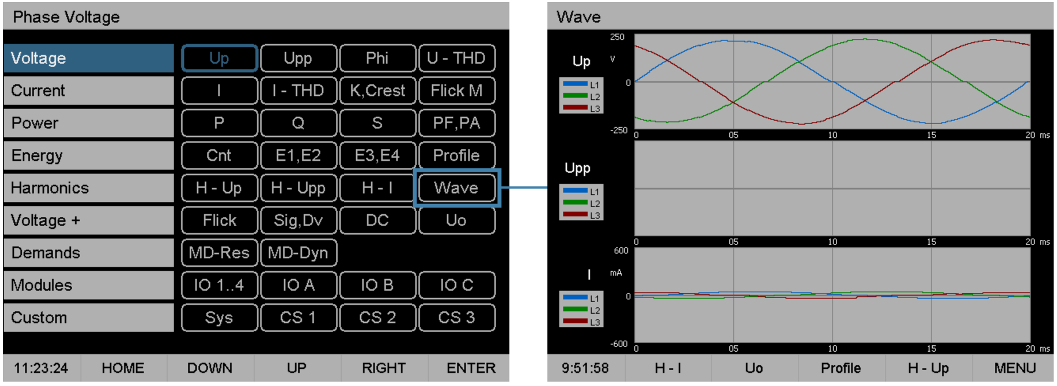
- Min/Max values (where calculated) are presented on the same displays as Present values.



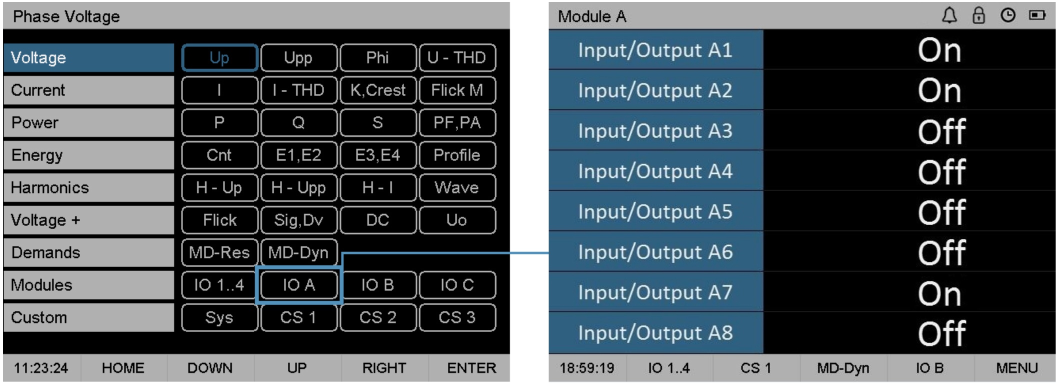
Phase Voltage

U1	226.25 V	▲ 235.86 V ▼ 224.43 V
U2	225.03 V	▲ 236.65 V ▼ 224.32 V
U3	224.66 V	▲ 236.35 V ▼ 224.40 V
U~	225.31 V	▲ 236.65 V ▼ 224.40 V
f	49.999 Hz	▲ 50.460 Hz ▼ 49.998 Hz

- Graphical displays are shown in the group Harmonics

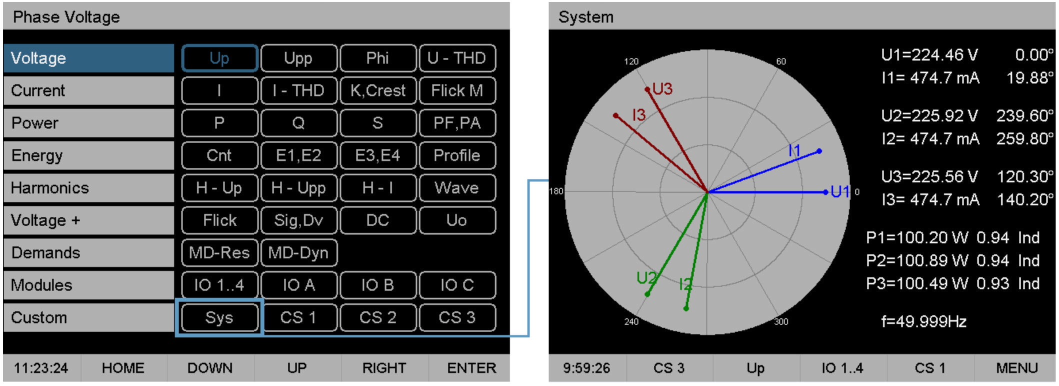


- In group Modules there are added information about the current state of the built in modules



Input/Output A1	On
Input/Output A2	On
Input/Output A3	Off
Input/Output A4	Off
Input/Output A5	Off
Input/Output A6	Off
Input/Output A7	On
Input/Output A8	Off

- On the System display in the group Custom, phasor diagram is shown



U1=224.46 V 0.00°
I1= 474.7 mA 19.88°

U2=225.92 V 239.60°
I2= 474.7 mA 259.80°

U3=225.56 V 120.30°
I3= 474.7 mA 140.20°

P1=100.20 W 0.94 Ind
P2=100.89 W 0.94 Ind
P3=100.49 W 0.93 Ind

f=49.999Hz

Present values

PLEASE NOTE

Display of present values depends on connection mode. Therefore display organization slightly differs from one connection mode to another.

Present values on LCD and TFT LCD display

Organization of measurements on TFT LCD display is, a bit different than on LCD, thou basic concept remains the same.

Because of physical limitation, LCD display on iMC784A shows maximum of 3 measured parameters at the time (with some exceptions). TFT LCD on iMC784A on the other hand have much more possibilities, therefore some data are combined in order to give the user more complex overview over the measured parameter at once.

PLEASE NOTE

Display of present values depends on connection mode. Therefore display organization slightly differs from one connection mode to another.

Voltage

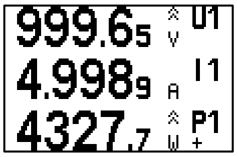
Voltage related measurements are listed below:

- Real effective (TRMS) value of all phase voltages (U_1, U_2, U_3), phase-to-phase voltages (U_{12}, U_{23}, U_{31}) and neutral to earth voltage (U_n).
- Average phase voltage (U⅄) and average phase-to-phase voltage (U△)
- Negative and zero sequence unbalance ratio (U_u, U_0)
- Phase and phase-to-phase voltage angles (φ_{12}, φ_{23}, φ_{31})
- Signaling phase and phase-to-phase voltages (Us_{12}, Us_{23}, Us_{31})
- DC component of phase and phase-to-phase voltages including neutral line ($=U_1$, $=U_2$, $=U_3$, $=U_{12}$, $=U_{23}$, $=U_{31}$)

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

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

All voltage measurements are available through communication as well as on standard or customized displays. The device gives out a warning if input signal is too large. In this case when signal representation is not correct the indicator ︽ is shown above the parameter unit (see example from Custom screen set to show U_1, I_1 and P_1 below):



999.65 ︽ V U1

4.9989 A I1

4327.7 ︽ W P1 +

Current

Power Quality Analyzer iMC784A measures:

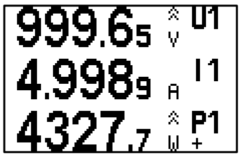
- real effective (TRMS) value of phase currents and neutral measured current (I_{nm}), connected to current inputs
- Neutral calculated current (I_{nc}), Neutral error current ($I_e = |I_{nm} - I_{nc}|$),
- Phase angle between Neutral voltage and Neutral Current (φ_{In}), Average current (I_a) and a sum of all phase currents (I_t)
- Crest factor of phase currents (CRI1-3)

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

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

Active, reactive and apparent power

Active power is calculated from instantaneous phase voltages and currents. All measurements are seen on communication or are displayed on LCD. For more detailed information about calculation see chapter APPENDIX C: EQUATIONS.
There are two different methods of calculating reactive power. See chapter Reactive power & energy calculation.
Power Quality Analyzer iMC784A issues a warning if input signal is too large. In this case signal representation is not correct. Indicator ⇑ is shown above the parameter unit:



Power factor and power angle

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

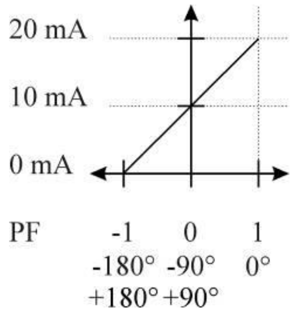
dPF or displacement power factor represents TRUE displacement power factor, which is based on fundamental active and apparent power without influence of harmonic components. It represents the angle between first (base) voltage harmonic and first (base) current harmonic for each individual phase.

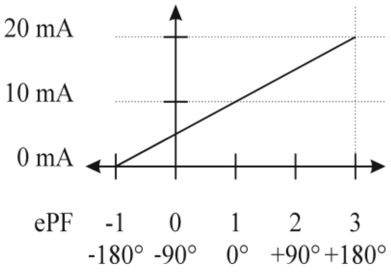
For correct display of PF via analogue output and application of the alarm, ePF (extended power factor) is applied. It illustrates power factor with one value as described in the table below. For a display on LCD both of them have equal display function: between −1 and −1 with the icon for inductive or capacitive load.

Presentation of extended PF (ePF)

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:





Frequency

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

Power Quality Analyzer iMC784A always synchronizes to a phase voltage *U1*. If signal on that phase is too low it (re)synchronizes to the next phase. If all phase voltages are low (e.g. short circuit) device synchronizes to phase currents. If there is no signal present on any voltage or current channels, the device shows a frequency of 0 Hz. Additionally, the frequency with 10−second averaging interval is displayed.

Energy counters

Three different variants of displaying Energy counters are available:

- by individual counter,
- by tariffs for each counter separately and
- energy cost by counter

At a display of measured counter by tariffs, the sum in the upper line depends on the tariffs set in the instrument. There are two different methods of calculating reactive energy. See chapter Reactive power & energy calculation. Additional information, how to set and define a counter quantity is explained in chapter Settings – Energy.

MD values

MD (Maximum Demand) values and time stamp of occurrence are shown for:

- Three phase currents
- Active powers (import and export)
- Reactive power (ind. and cap.)
- Apparent power

Dynamic demands are continuously calculated according to set time constants and other parameters.
Reset demands are max. values of Dynamic demands since last reset.

Harmonic distortion

Power Quality Analyzer iMC784A calculates different harmonic distortion parameters:

- THD is calculated for phase currents, phase voltages and phase−to−phase voltages and is expressed as percent of high harmonic components regarding to fundamental harmonic

Power Quality Analyzer iMC784A uses a measuring technique of real effective (RMS) value that calculates exact measurements with the presence of high harmonics up to 63rd harmonic. Please see Settings – Real time synchronization source – Harmonic calculation for more information on harmonic calculation.

Harmonic distortion parameters

Power Quality Analyzer iMC784A calculates different harmonic distortion parameters:

- THD is calculated for phase currents, phase voltages and phase−to−phase voltages and is expressed as percent of high harmonic components regarding to fundamental harmonic
- TDD is calculated for phase currents
- K-factor is calculated for phase currents

Power Quality Analyzer iMC784A uses the measuring technique of real effective (RMS) value that assures exact measurements with the presence of high harmonics up to 63rd harmonic. Please see Settings – Real time synchronization source – Harmonic calculation for more information on harmonic calculation.

Flickers evaluation

Flickers are one of most important PQ parameters directly (through light flickering) influencing human feeling.
Flickers are measured in statistically evaluated according to relevant standard IEC 61000-4-15.
For basic flicker measurements on all three voltage phases 1200 readings per second are used. Instantaneous flicker sensation decimates this sampling rate 8 times (150 instantaneous flicker calculations per second) and uses approximately 3s averaging time.
With further statistical evaluation short term and long term flickers are calculated.

Pi$_{1-3}$ represents instantaneous flicker and is averaged and refreshed every 3 sec. *Pi* is averaged from 500 instantaneous flicker calculations.

Pim$_{1-3}$ represents max. value of instantaneous flicker *Pi* within 3 sec flicker averaging interval and is refreshed every 3 sec. This value is displayed only on display. It is not available on communication.

Pst$_{1-3}$ represents 10 min statistical evaluation of instantaneous flicker and is refresh every round 10 minutes (x:00, x:10, x:20…)

Plt$_{1-3}$ represents 2 h statistical evaluation of short-time flicker *Pst* and is refreshed every even 2 hours (0:00, 2:00, 4:00…)

Until the flicker value is calculated the symbol − is displayed.

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.

Customized screens

On Power Quality Analyzer **iMC784A** with LCD display, four different customized screens can be set. First three screens shows three different user defined parameters whereas the fourth screen displays five different parameters as a combination of the three parameters of the first screen and the first two parameters of the second screen.

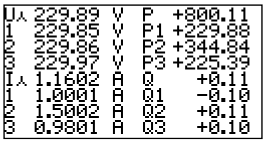
On Power Quality Analyzer **iMC784A** with TFT LCD display, three different customized screens can be set. For each screen, eight different parameters can be set.

PLEASE NOTE

When, due to mode of connection, an unsupported measurement is selected for the customized screen an undefined value is displayed.

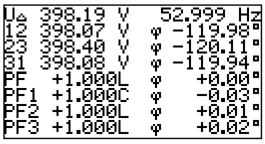
Example: iMC784A on 4u connection:

Main menu ⇒ Measurements ⇒ Present values ⇒ Overview OK / ⇒



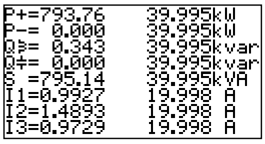
```
U⅄ 229.89 V  P  +800.11
1  229.85 V  P1 +229.88
2  229.86 V  P2 +344.84
3  229.97 V  P3 +225.39
I⅄ 1.1602 A  Q     +0.11
1  1.0001 A  Q1    -0.10
2  1.5002 A  Q2    +0.11
3  0.9801 A  Q3    +0.10
```

→ ←



```
U△ 398.19 V   52.999 Hz
12 398.07 V  φ -119.98°
23 398.40 V  φ -120.11°
31 398.08 V  φ -119.94°
PF   +1.000L φ    +0.00°
PF1 +1.000C  φ    -0.03°
PF2 +1.000L  φ    +0.01°
PF3 +1.000L  φ    +0.02°
```

→ ←



```
P+=793.76    39.995kW
P-= 0.000    39.995kW
Q⋟= 0.343    39.995kvar
Q÷= 0.000    39.995kvar
S =795.14    39.995kVA
I1=0.9927    19.998 A
I2=1.4893    19.998 A
I3=0.9729    19.998 A
```

Min/Max values

All Min/Max values are displayed similar as Present values.

PLEASE NOTE

On Power Quality Analyzer iMC784A Min/Max values are displayed on the same screen as Present values.

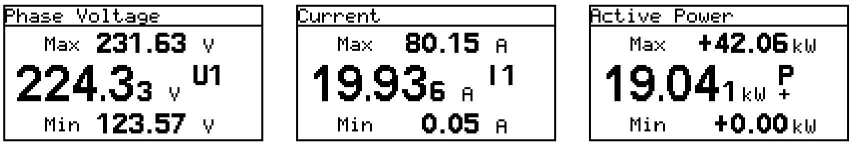
Average interval for min/max values

Min/max values often require special averaging period, which enables or disables detection of short measuring spikes. With this setting is possible to set averaging from 1 period to 256 periods.

Display of min/max values on iMC784A with LCD display

Present values are displayed with larger font in the middle of the screen, while minimal and maximal values are displayed in smaller font above and below the present values.

Example of Min/Max screens:



Phase Voltage
Max 231.63 V
224.33 V U1
Min 123.57 V

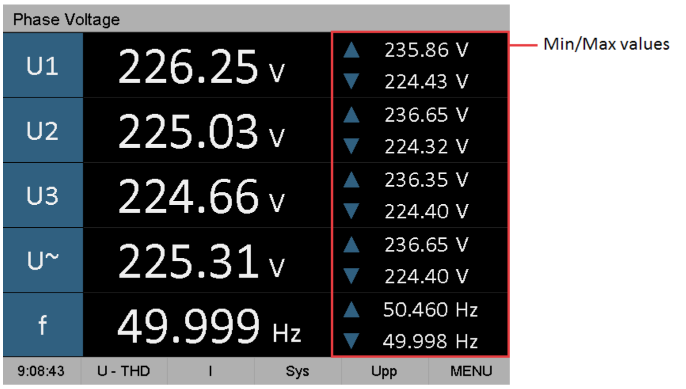
Current
Max 80.15 A
19.936 A I1
Min 0.05 A

Active Power
Max +42.06 kW
19.041 kW P +
Min +0.00 kW

Display of min/max values on iMC784A with TFT LCD display

Present values are displayed with larger font in the middle column, while minimal and maximal values are displayed in smaller font in the right column, indicated with arrows (down for minimal, up for maximal).

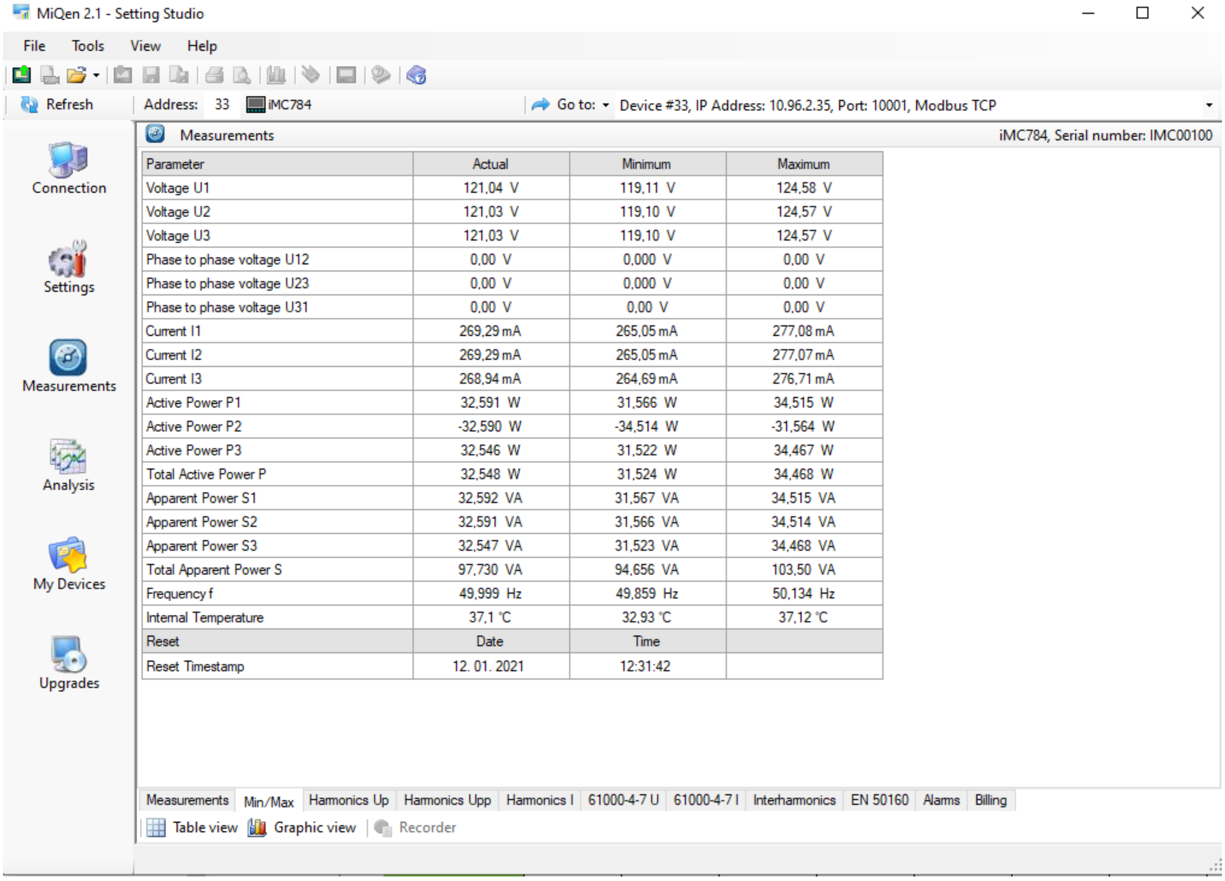
Example of Min/Max values on Power Quality Analyzer iMC784A:



Phase Voltage

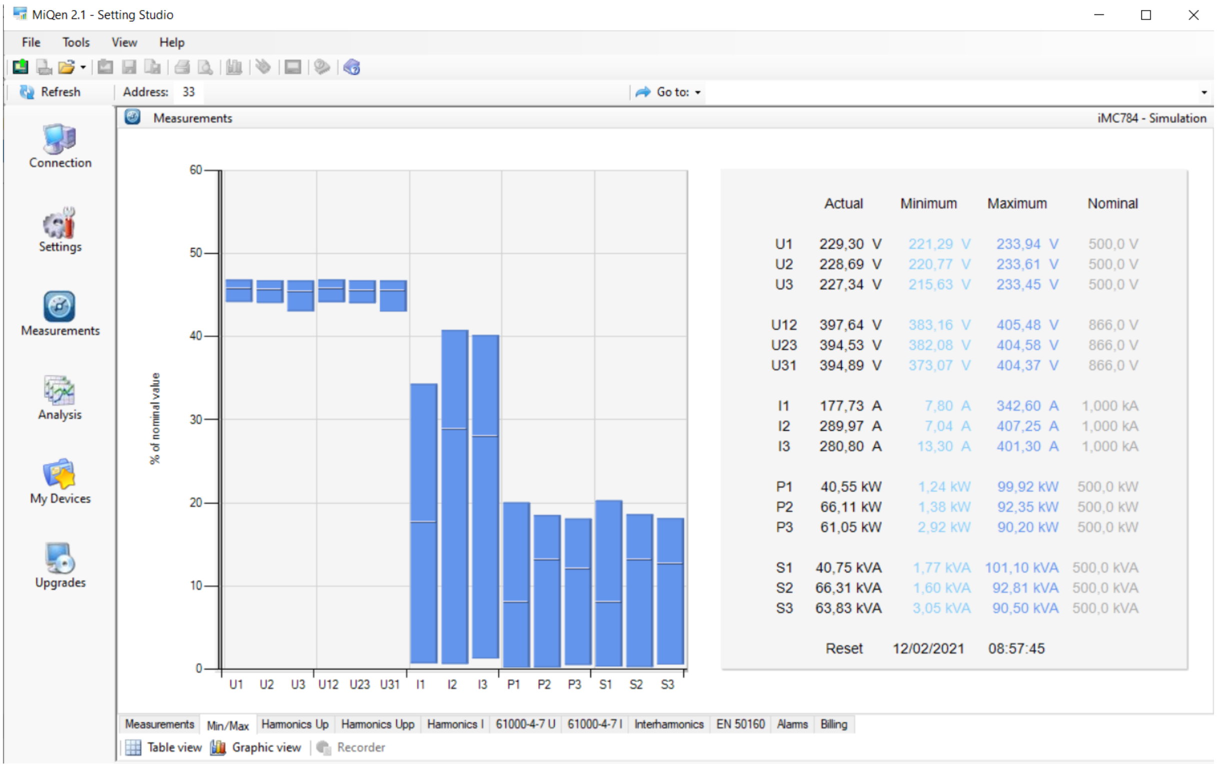
U1	226.25 V	▲ 235.86 V ▼ 224.43 V
U2	225.03 V	▲ 236.65 V ▼ 224.32 V
U3	224.66 V	▲ 236.35 V ▼ 224.40 V
U~	225.31 V	▲ 236.65 V ▼ 224.40 V
f	49.999 Hz	▲ 50.460 Hz ▼ 49.998 Hz

Display of min/max values – MiQen software



Parameter	Actual	Minimum	Maximum
Voltage U1	121,04 V	119,11 V	124,58 V
Voltage U2	121,03 V	119,10 V	124,57 V
Voltage U3	121,03 V	119,10 V	124,57 V
Phase to phase voltage U12	0,00 V	0,000 V	0,00 V
Phase to phase voltage U23	0,00 V	0,000 V	0,00 V
Phase to phase voltage U31	0,00 V	0,00 V	0,00 V
Current I1	269,29 mA	265,05 mA	277,08 mA
Current I2	269,29 mA	265,05 mA	277,07 mA
Current I3	268,94 mA	264,69 mA	276,71 mA
Active Power P1	32,591 W	31,566 W	34,515 W
Active Power P2	-32,590 W	-34,514 W	-31,564 W
Active Power P3	32,546 W	31,522 W	34,467 W
Total Active Power P	32,548 W	31,524 W	34,468 W
Apparent Power S1	32,592 VA	31,567 VA	34,515 VA
Apparent Power S2	32,591 VA	31,566 VA	34,514 VA
Apparent Power S3	32,547 VA	31,523 VA	34,468 VA
Total Apparent Power S	97,730 VA	94,656 VA	103,50 VA
Frequency f	49,999 Hz	49,859 Hz	50,134 Hz
Internal Temperature	37,1 °C	32,93 °C	37,12 °C
Reset	Date	Time	
Reset Timestamp	12. 01. 2021	12:31:42	

Presentation of min/max values – Table view



	Actual	Minimum	Maximum	Nominal
U1	229,30 V	221,29 V	233,94 V	500,0 V
U2	228,69 V	220,77 V	233,61 V	500,0 V
U3	227,34 V	215,63 V	233,45 V	500,0 V
U12	397,64 V	383,16 V	405,48 V	866,0 V
U23	394,53 V	382,08 V	404,58 V	866,0 V
U31	394,89 V	373,07 V	404,37 V	866,0 V
I1	177,73 A	7,80 A	342,60 A	1,000 kA
I2	289,97 A	7,04 A	407,25 A	1,000 kA
I3	280,80 A	13,30 A	401,30 A	1,000 kA
P1	40,55 kW	1,24 kW	99,92 kW	500,0 kW
P2	66,11 kW	1,38 kW	92,35 kW	500,0 kW
P3	61,05 kW	2,92 kW	90,20 kW	500,0 kW
S1	40,75 kVA	1,77 kVA	101,10 kVA	500,0 kVA
S2	66,31 kVA	1,60 kVA	92,81 kVA	500,0 kVA
S3	63,83 kVA	3,05 kVA	90,50 kVA	500,0 kVA
	Reset	12/02/2021	08:57:45	

Presentation of min/max values – Graphic view

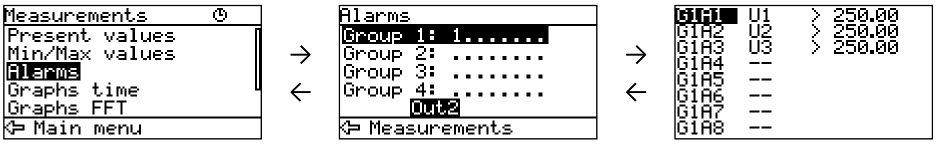
In graphical presentation of min/max values relative values are depicted. Base value for relative representation is defined in general settings/Connection mode/used voltage, current range.
For phase voltages and for phase-to-phase voltages the same value is used.

Alarms

Alarms are an important feature for notifying exceeded user predefined values. Not only for visualization and recording certain events with the exact time stamp. Alarms can be connected to digital/alarm outputs to trigger different processes (switch closures, line breaking, motors start or stop...).
It is also very convenient to monitor the alarms history. This is enabled on display and even better on communication by using the MiQen setting and analysis software.
Alarm menu on display enables surveying the state of ongoing and past alarms.

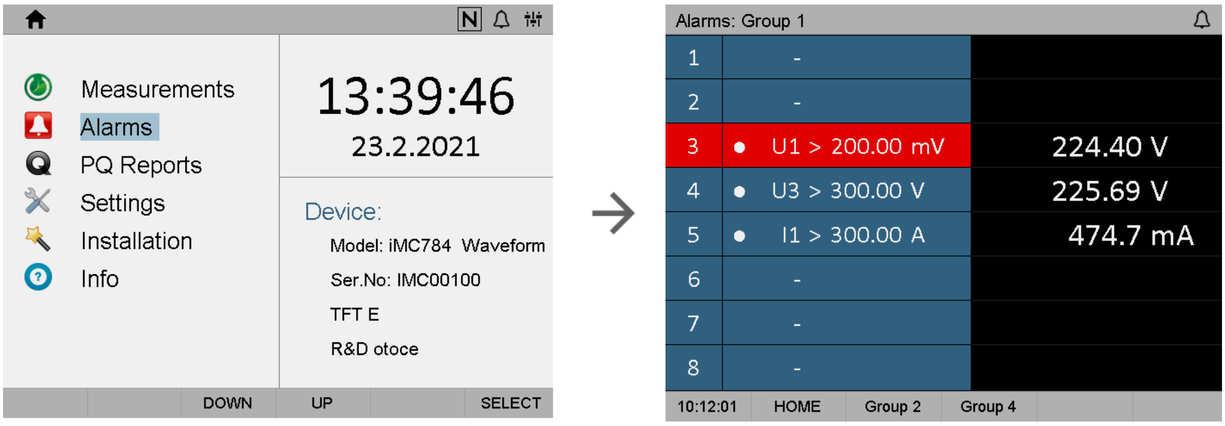
iMC784A Graphic pixel display

In the alarm menu, groups of alarms with states of individual alarms are displayed. Also connected alarm outputs are displayed in the bottom line. If displayed alarm output is highlighted it means it is active (relay closed). For each active alarm a number of alarms is written in a certain group at a certain place: Group 1: 1■ ■ ■45■ ■ ■8. Dot stands for alarm not active.
In example below there was 1 alarm, which happened under condition defined in Group1/Alarm1 (middle picture). Condition for that alarm was *U1 > 250.00 V* (right picture). Alarm activated Relay output 2 (middle picture, highlighted Out2).



G1A1 U1 > 250.00
G1A2 U2 > 250.00
G1A3 U3 > 250.00
G1A4 --
G1A5 --
G1A6 --
G1A7 --
G1A8 --

iMC784A color TFT LCD display

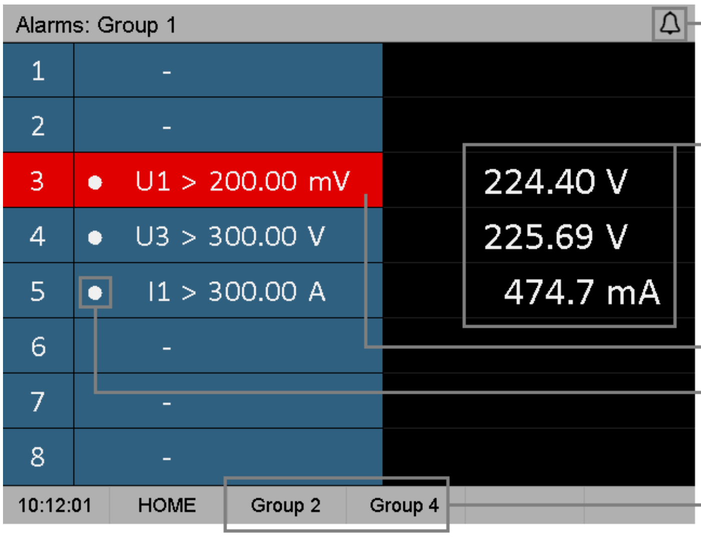


Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce

1	-	
2	-	
3	● U1 > 200.00 mV	224.40 V
4	● U3 > 300.00 V	225.69 V
5	● I1 > 300.00 A	474.7 mA
6	-	
7	-	
8	-	

Alarm menu can be accessed directly from Main menu. In the alarm menu, groups of alarms with states of individual alarms are displayed. If displayed alarm output is highlighted (red) it means it is active. Switch between alarm groups with left/right button.

Example:



Alarms: Group 1

1	-	
2	-	
3	● U1 > 200.00 mV	224.40 V
4	● U3 > 300.00 V	225.69 V
5	● I1 > 300.00 A	474.7 mA
6	-	
7	-	
8	-	

Alarms present

Present value

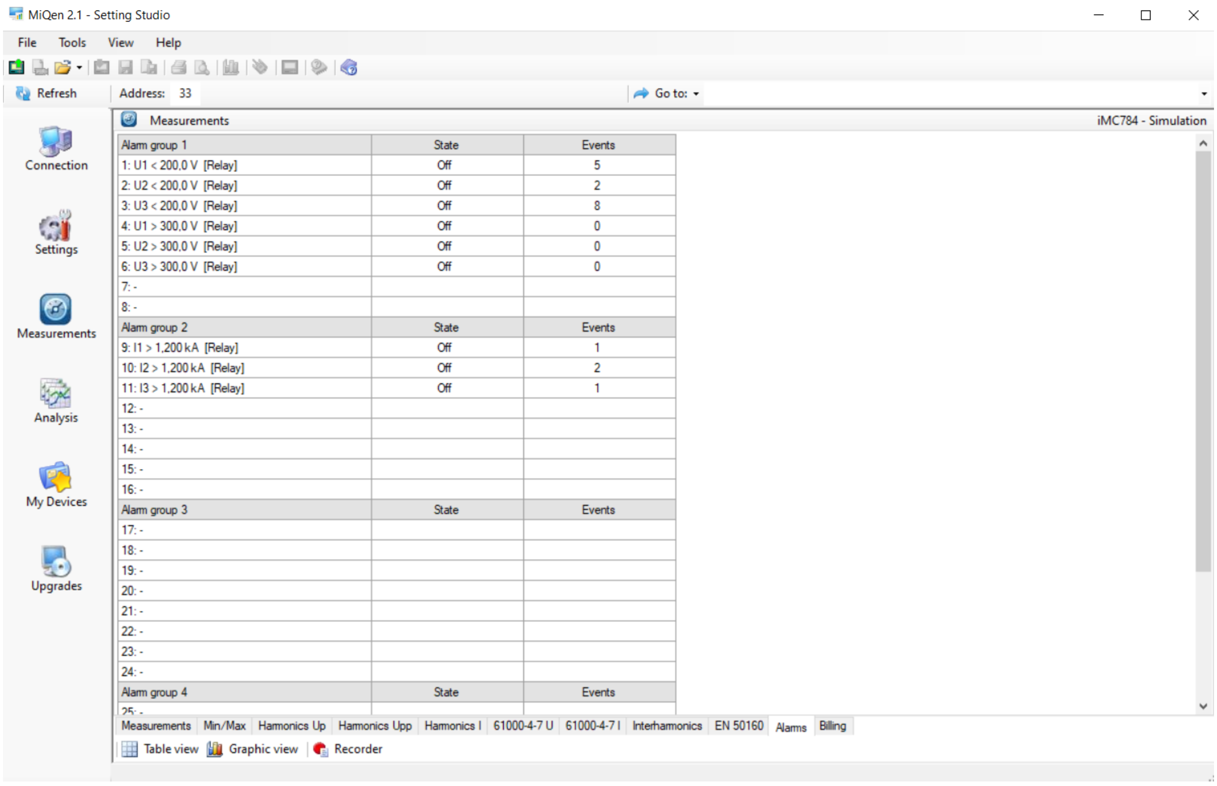
Highlighted in red – indicates that alarm is active

When monitoring certain quantity it is possible to monitor its actual value or its max. demand - Thermal demand value. This white dot indicates that Thermal demand is selected.

Switch between Groups

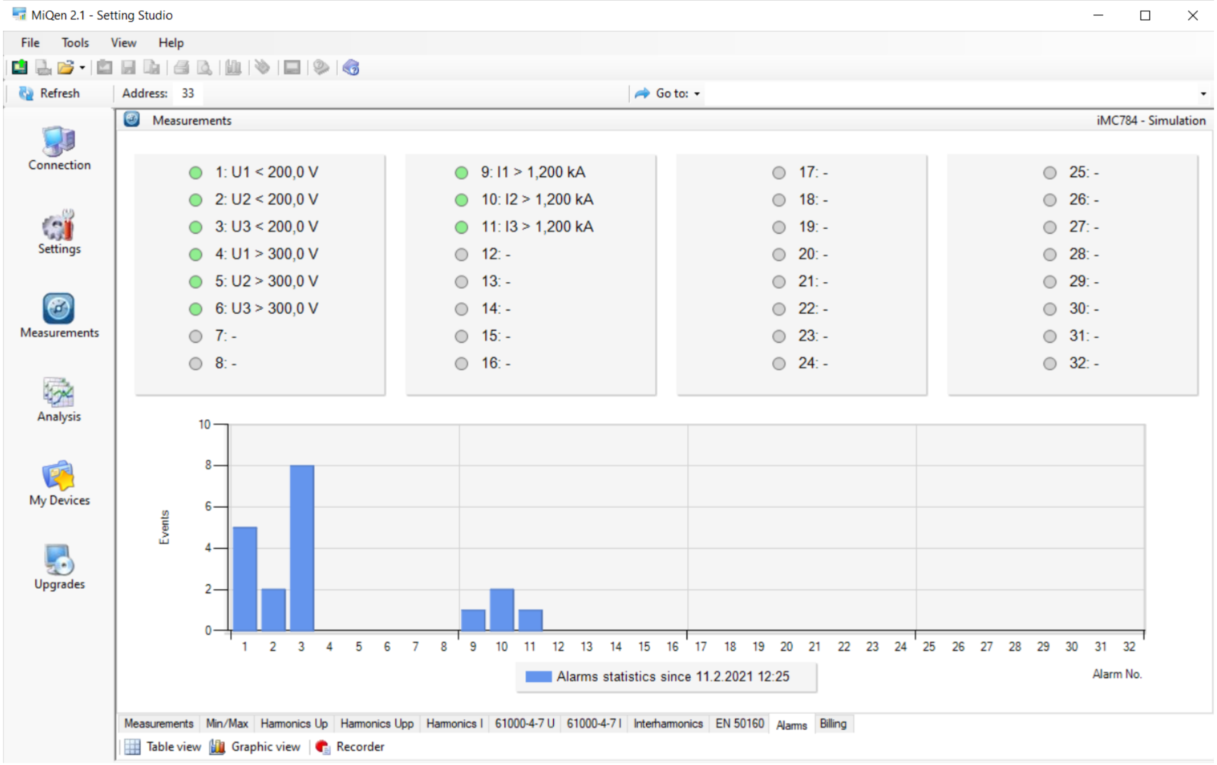
Survey of alarms

In a detailed survey alarms are collected in groups. A number of a group and alarm is stated in the first column, a measurement designation in the second, and a condition for alarm in the third one. An active alarm is also marked.



Alarm group 1	State	Events
1: U1 < 200,0 V [Relay]	Off	5
2: U2 < 200,0 V [Relay]	Off	2
3: U3 < 200,0 V [Relay]	Off	8
4: U1 > 300,0 V [Relay]	Off	0
5: U2 > 300,0 V [Relay]	Off	0
6: U3 > 300,0 V [Relay]	Off	0
7: -		
8: -		
Alarm group 2	**State**	**Events**
9: I1 > 1,200 kA [Relay]	Off	1
10: I2 > 1,200 kA [Relay]	Off	2
11: I3 > 1,200 kA [Relay]	Off	1
12: -		
13: -		
14: -		
15: -		
16: -		
Alarm group 3	**State**	**Events**
17: -		
18: -		
19: -		
20: -		
21: -		
22: -		
23: -		
24: -		
Alarm group 4	**State**	**Events**
25:		

Presentation of alarms – Table view



● 1: U1 < 200,0 V
● 2: U2 < 200,0 V
● 3: U3 < 200,0 V
● 4: U1 > 300,0 V
● 5: U2 > 300,0 V
● 6: U3 > 300,0 V
○ 7: -
○ 8: -

● 9: I1 > 1,200 kA
● 10: I2 > 1,200 kA
● 11: I3 > 1,200 kA
○ 12: -
○ 13: -
○ 14: -
○ 15: -
○ 16: -

○ 17: -
○ 18: -
○ 19: -
○ 20: -
○ 21: -
○ 22: -
○ 23: -
○ 24: -

○ 25: -
○ 26: -
○ 27: -
○ 28: -
○ 29: -
○ 30: -
○ 31: -
○ 32: -

Presentation of alarms – Graphic view

In MiQen software all alarms are presented in tabelaric and graphical form as shown in figures above. For each alarm the following information is shown:

- Group association
- Group Alarm conditions
- Momentary alarm state
- Number of alarm events since last reset

Billing

Energy billing is an additional function for notifying the calculation of the difference of the energy in the previous month or this month.

The value of the energy at the beginning of the previous month, the actual month, and the current value of energy can be observed. The values displayed start to be measured at the beginning of the month. The value of the previous month and the actual month are overwritten when the new month starts or in a case that the date is changed manually. The value of the previous month is erased.

PLEASE NOTE

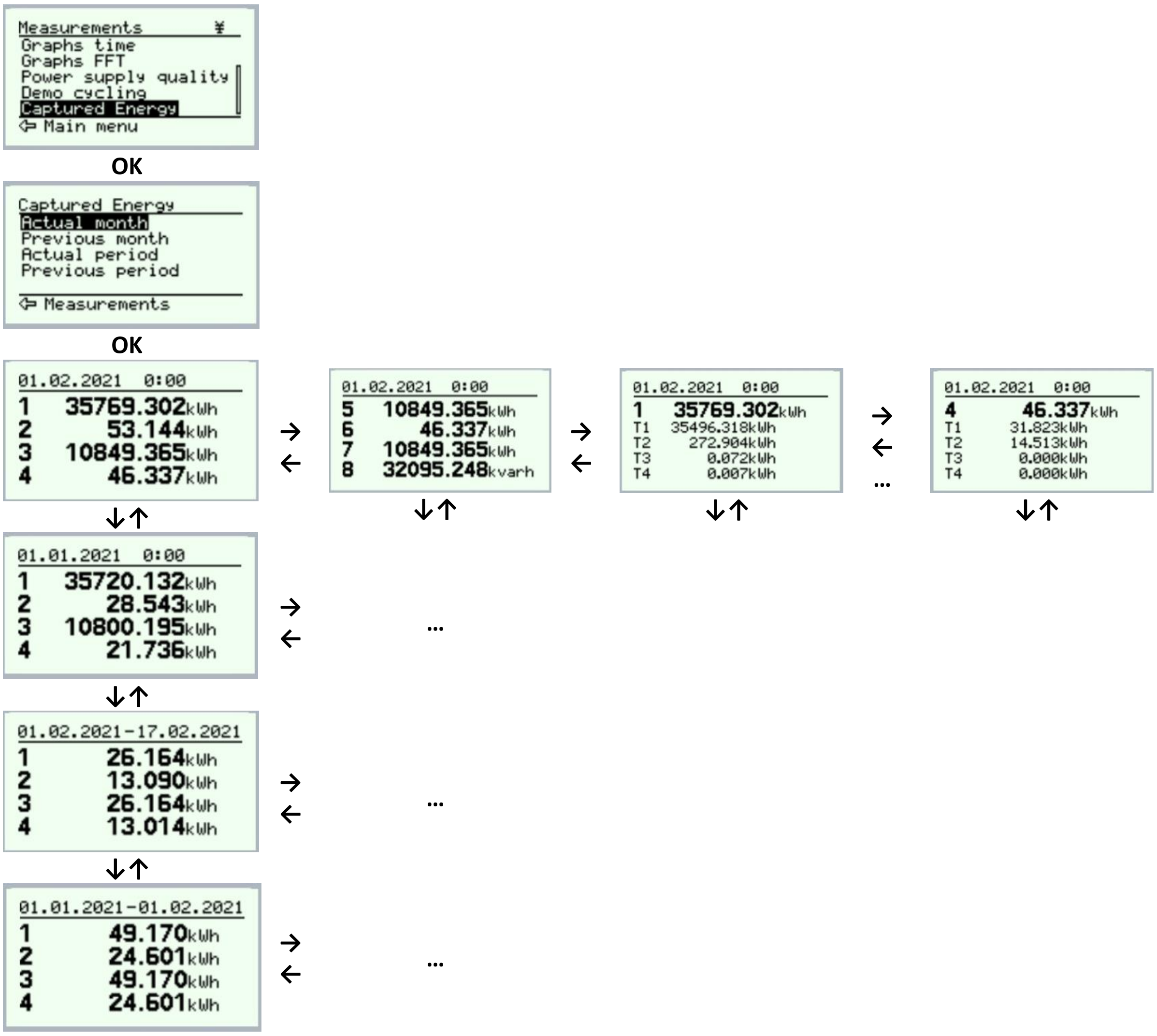
The actual month value is recorded exactly when a new month is detected. If the meter is turned off, it is on the date it is plugged in.

The difference of the energy in the previous month is calculated as the difference between the value of the energy at the beginning of the previous month and the actual month. The difference of the energy in this month is calculated as the difference between the current value of energy and the value of the energy at the beginning of the actual month.

It is also very convenient to monitor the billing. This is enabled on display and even better on measurements by using the MiQen setting and analysis software.

Display of billing values on iMC784A (available only on option with graphical LCD display)

To enter the Captured energy sub-menu press the OK button. To observe different energy values (actual month, previous month, actual period, and previous period) use up/down buttons. Moving between different values of selected month/period use left/right buttons. Press an OK button twice to return to the previous menu.



```
01.02.2021  0:00
1   35769.302kWh
2      53.144kWh
3   10849.365kWh
4      46.337kWh
```

```
01.02.2021  0:00
5   10849.365kWh
6      46.337kWh
7   10849.365kWh
8   32095.248kvarh
```

```
01.02.2021  0:00
1   35769.302kWh
T1  35496.318kWh
T2    272.904kWh
T3      0.072kWh
T4      0.007kWh
```

```
01.02.2021  0:00
4      46.337kWh
T1     31.823kWh
T2     14.513kWh
T3      0.000kWh
T4      0.000kWh
```

```
01.01.2021  0:00
1   35720.132kWh
2      28.543kWh
3   10800.195kWh
4      21.736kWh
```

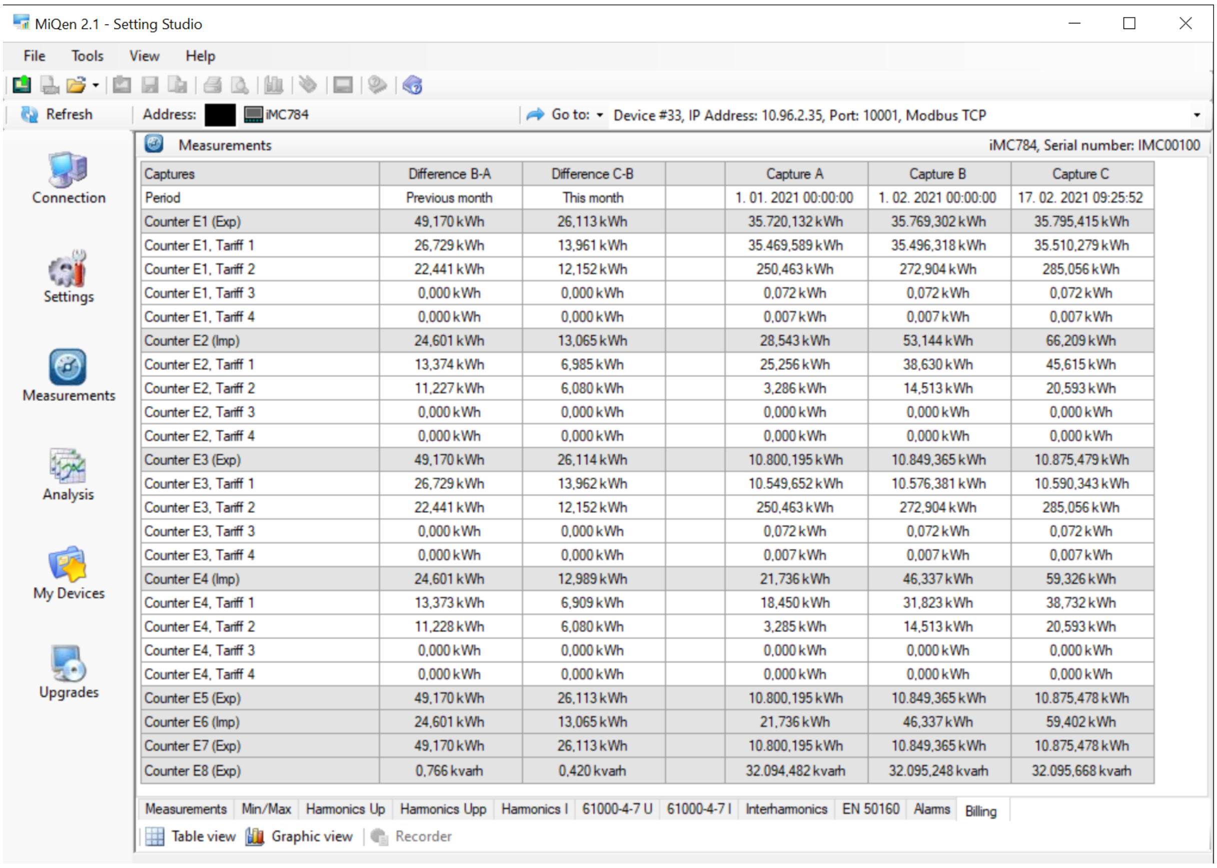
```
01.02.2021-17.02.2021
1      26.164kWh
2      13.090kWh
3      26.164kWh
4      13.014kWh
```

```
01.01.2021-01.02.2021
1      49.170kWh
2      24.601kWh
3      49.170kWh
4      24.601kWh
```

Display of billing – MiQen software

In a detailed survey, energy values are collected in columns. The difference of energy is stated in the first and second columns (Difference B-A, Difference C-B). A measurement designation in the third, fourth and fifth columns (Capture A, Capture B, and Capture C).

The value of the energy of the beginning of the previous month is represented in Column A. The value of the energy at the beginning of the actual month is represented in Column B. The current value of energy is represented in Column C.



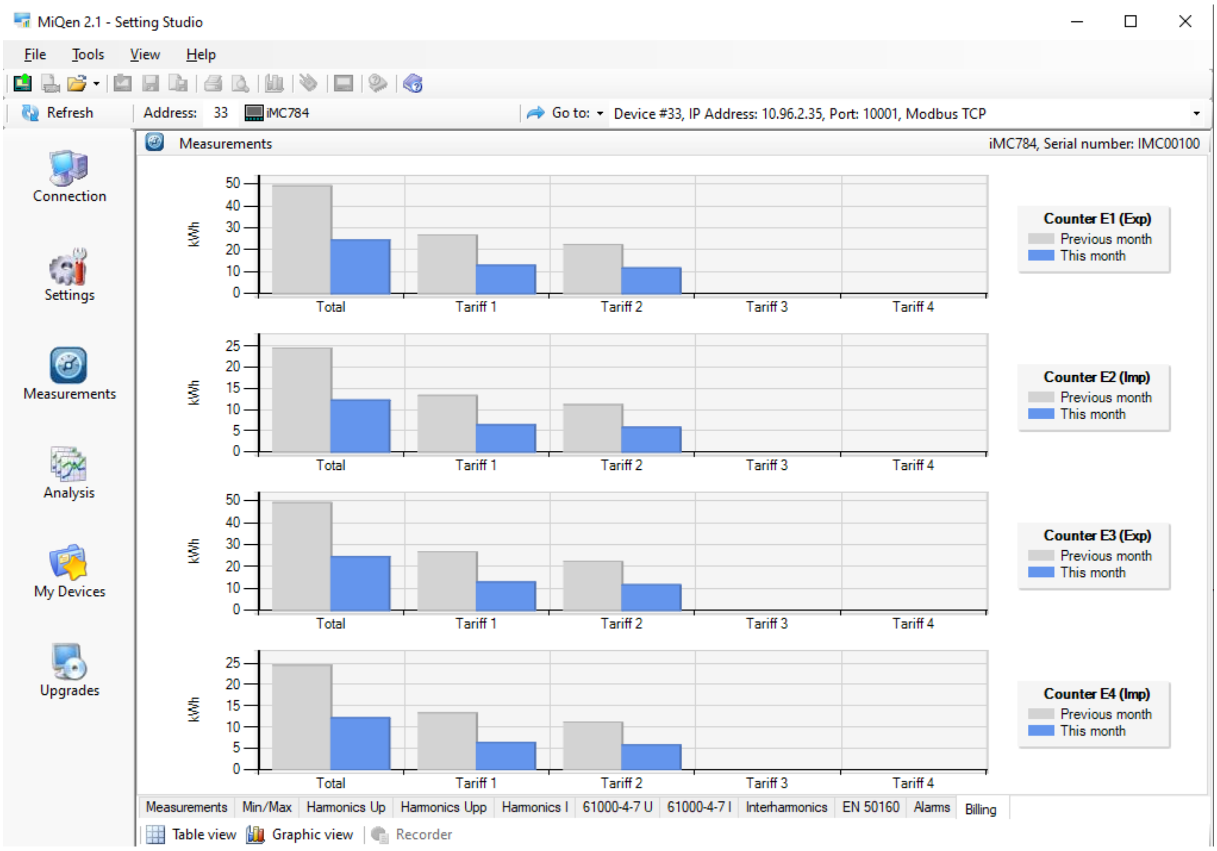
Address: [redacted] iMC784

Go to: Device #33, IP Address: 10.96.2.35, Port: 10001, Modbus TCP

Measurements — iMC784, Serial number: IMC00100

Captures	Difference B-A	Difference C-B		Capture A	Capture B	Capture C
Period	Previous month	This month		1. 01. 2021 00:00:00	1. 02. 2021 00:00:00	17. 02. 2021 09:25:52
Counter E1 (Exp)	49,170 kWh	26,113 kWh		35.720,132 kWh	35.769,302 kWh	35.795,415 kWh
Counter E1, Tariff 1	26,729 kWh	13,961 kWh		35.469,589 kWh	35.496,318 kWh	35.510,279 kWh
Counter E1, Tariff 2	22,441 kWh	12,152 kWh		250,463 kWh	272,904 kWh	285,056 kWh
Counter E1, Tariff 3	0,000 kWh	0,000 kWh		0,072 kWh	0,072 kWh	0,072 kWh
Counter E1, Tariff 4	0,000 kWh	0,000 kWh		0,007 kWh	0,007 kWh	0,007 kWh
Counter E2 (Imp)	24,601 kWh	13,065 kWh		28,543 kWh	53,144 kWh	66,209 kWh
Counter E2, Tariff 1	13,374 kWh	6,985 kWh		25,256 kWh	38,630 kWh	45,615 kWh
Counter E2, Tariff 2	11,227 kWh	6,080 kWh		3,286 kWh	14,513 kWh	20,593 kWh
Counter E2, Tariff 3	0,000 kWh	0,000 kWh		0,000 kWh	0,000 kWh	0,000 kWh
Counter E2, Tariff 4	0,000 kWh	0,000 kWh		0,000 kWh	0,000 kWh	0,000 kWh
Counter E3 (Exp)	49,170 kWh	26,114 kWh		10.800,195 kWh	10.849,365 kWh	10.875,479 kWh
Counter E3, Tariff 1	26,729 kWh	13,962 kWh		10.549,652 kWh	10.576,381 kWh	10.590,343 kWh
Counter E3, Tariff 2	22,441 kWh	12,152 kWh		250,463 kWh	272,904 kWh	285,056 kWh
Counter E3, Tariff 3	0,000 kWh	0,000 kWh		0,072 kWh	0,072 kWh	0,072 kWh
Counter E3, Tariff 4	0,000 kWh	0,000 kWh		0,007 kWh	0,007 kWh	0,007 kWh
Counter E4 (Imp)	24,601 kWh	12,989 kWh		21,736 kWh	46,337 kWh	59,326 kWh
Counter E4, Tariff 1	13,373 kWh	6,909 kWh		18,450 kWh	31,823 kWh	38,732 kWh
Counter E4, Tariff 2	11,228 kWh	6,080 kWh		3,285 kWh	14,513 kWh	20,593 kWh
Counter E4, Tariff 3	0,000 kWh	0,000 kWh		0,000 kWh	0,000 kWh	0,000 kWh
Counter E4, Tariff 4	0,000 kWh	0,000 kWh		0,000 kWh	0,000 kWh	0,000 kWh
Counter E5 (Exp)	49,170 kWh	26,113 kWh		10.800,195 kWh	10.849,365 kWh	10.875,478 kWh
Counter E6 (Imp)	24,601 kWh	13,065 kWh		21,736 kWh	46,337 kWh	59,402 kWh
Counter E7 (Exp)	49,170 kWh	26,113 kWh		10.800,195 kWh	10.849,365 kWh	10.875,478 kWh
Counter E8 (Exp)	0,766 kvarh	0,420 kvarh		32.094,482 kvarh	32.095,248 kvarh	32.095,668 kvarh

Presentation of billing – Table view



Address: 33 iMC784

Go to: Device #33, IP Address: 10.96.2.35, Port: 10001, Modbus TCP

Measurements — iMC784, Serial number: IMC00100

Presentation of billing – Graphic view

Demo cycling

Regarding the period that is defined in settings, measurement screen cycling is started until any key is pressed.

PLEASE NOTE

Power Quality Analyzer iMC784A color TFT LCD display
currently doesn’t support this feature.

Harmonic analysis

Harmonic analysis is an important part of PQ monitoring. Frequency converters, inverters, electronic motor drives, LED, halogen and other modern lamps. All listed above may cause harmonic distortion of supply voltage and can influence other sensitive equipment to malfunction or even damage.

In particular vulnerable are distribution level compensation devices whose capacitor banks act like a drain for higher harmonics and amplify their influence. Higher harmonic currents flowing through capacitors can cause overheating and by that shortening their lifetime or even explosions.

Monitoring harmonic distortion is therefore important not only to prevent malfunction of household equipment and to prolong operation of motors but also to prevent serious damage to distribution equipment and to people working close to compensation devices.

Due to importance of harmonic analysis, a special standard IEC 61000-4-7 defines methods for measurement and calculation of harmonic parameters.

Power Quality Analyzer iMC784A measures harmonics up to 63rd and evaluates the following harmonic parameters:

- Phase Voltage/Current harmonic signals and THD U_{P-N}
- Phase-to-phase Voltage/Current harmonic signals and THD U_{P-P}
- THD $U_{P-N,}$ THD $U_{P-P,}$ THD I_{P-N} and THD I_{P-P}
- TDD total demand distortion for phase currents
- CREST factor for proper dimensioning of connected equipment
- K factor for proper dimensioning of power transformers
- Inter-harmonics (10 user defined inter-harmonic values)
- Signaling voltage (monitoring ripple control signal)

PLEASE NOTE

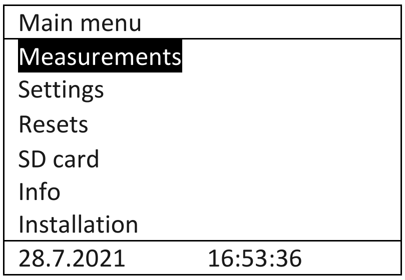
Some of the above listed measurements are only available on communication.

All of the listed harmonic parameters can be monitored online, stored in internal memory and compared against alarm condition threshold limit.

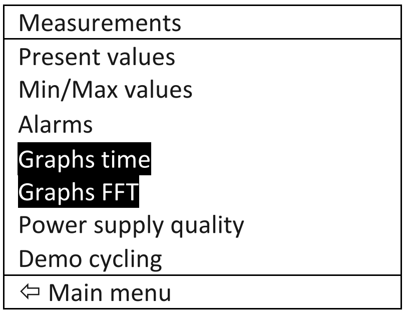
The latter is in combination with alarm relay output suitable for notification and/or automatic disconnection of compensation devices, when too much harmonics could threaten capacitors.

Display of harmonic parameters

iMC784A Graphic pixel display

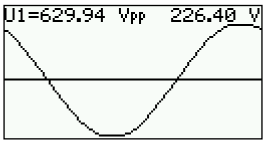


→

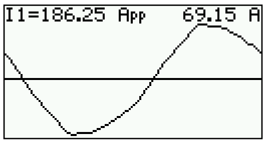


Harmonic parameters can be displayed on the device LCD in graphical form and as a table form in MiQen software:

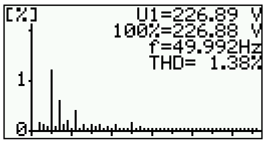
LCD graphical presentation:



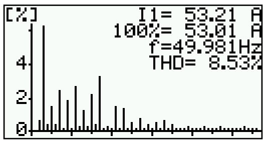
Display of a Phase Voltage in time space diagram. Displayed are also peak value of monitored phase voltage and its RMS value. Similar display is also for phase-to-phase voltages.



Display of a Current in time space diagram. Displayed are also peak value of monitored current and its RMS value

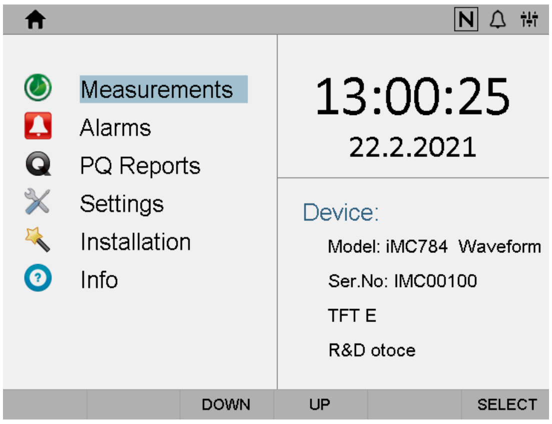


Display of a Phase Voltage in frequency space diagram. Displayed are also RMS value, unit value (100%), system frequency and THD value. Similar display is also for phase-to-phase voltages.



Display of a Current in frequency space diagram. Displayed are also RMS value, unit value (100%), system frequency and THD value.

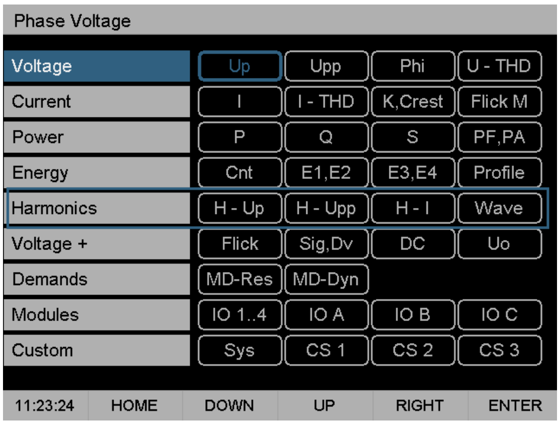
iMC784A color TFT LCD display



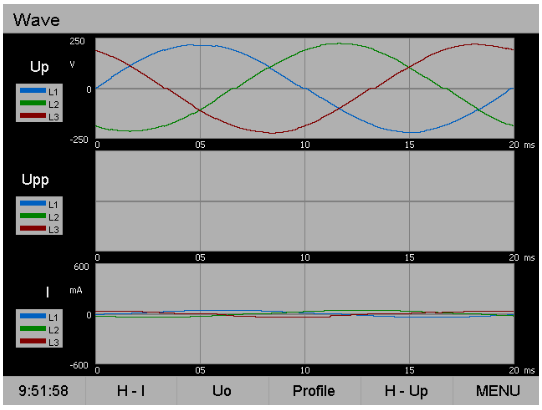
13:00:25
22.2.2021

Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce

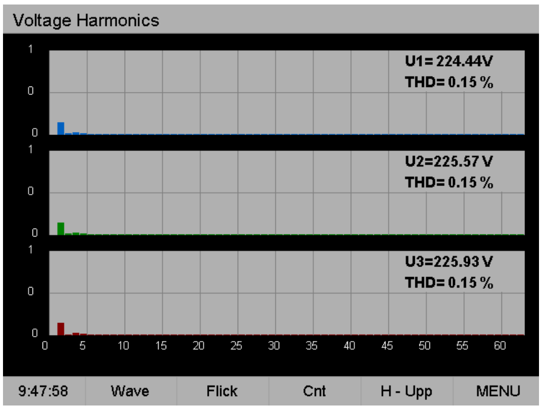
→


Phase Voltage
Voltage Up Upp Phi U - THD
Current I I - THD K,Crest Flick M
Power P Q S PF,PA
Energy Cnt E1,E2 E3,E4 Profile
Harmonics H - Up H - Upp H - I Wave
Voltage + Flick Sig,Dv DC Uo
Demands MD-Res MD-Dyn
Modules IO 1..4 IO A IO B IO C
Custom Sys CS 1 CS 2 CS 3
11:23:24 HOME DOWN UP RIGHT ENTER

Harmonic parameters can be displayed on the device TFT LCD display in graphical form and as a table form in MiQen software:

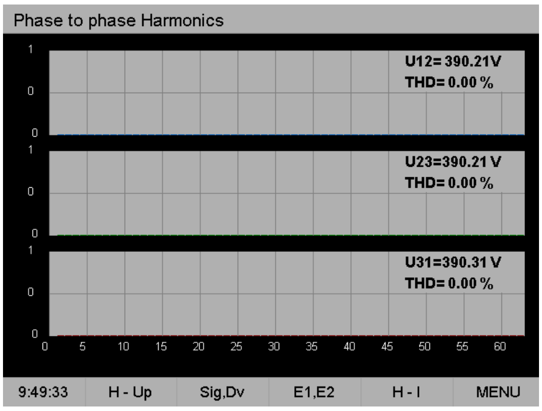


Display of a Phase Voltage, Phase to Phase Voltage and Current in time space diagram.



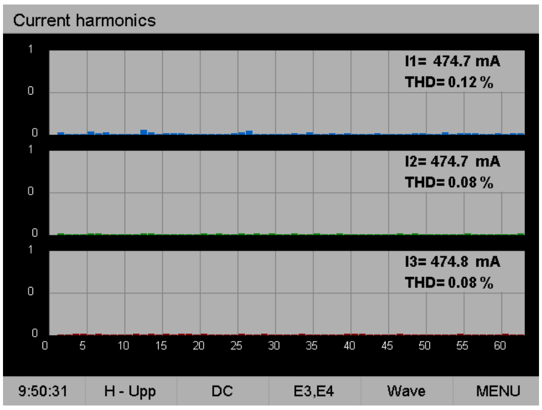
U1=224.44V
THD=0.15 %
U2=225.57 V
THD=0.15 %
U3=225.93 V
THD=0.15 %

Display of a Phase Voltage in frequency space diagram. Displayed are also RMS value and THD value.



U12=390.21V
THD=0.00 %
U23=390.21 V
THD=0.00 %
U31=390.31 V
THD=0.00 %

Display of a Phase to Phase Voltage in frequency space diagram. Displayed are also RMS value and THD value.



I1= 474.7 mA
THD=0.12 %
I2= 474.7 mA
THD=0.08 %
I3= 474.8 mA
THD=0.08 %

Display of a Current in frequency space diagram. Displayed are also RMS value and THD value.

More information about harmonic parameters, especially individual harmonic values, can be obtained when the device is connected through communication by using the MiQen software.

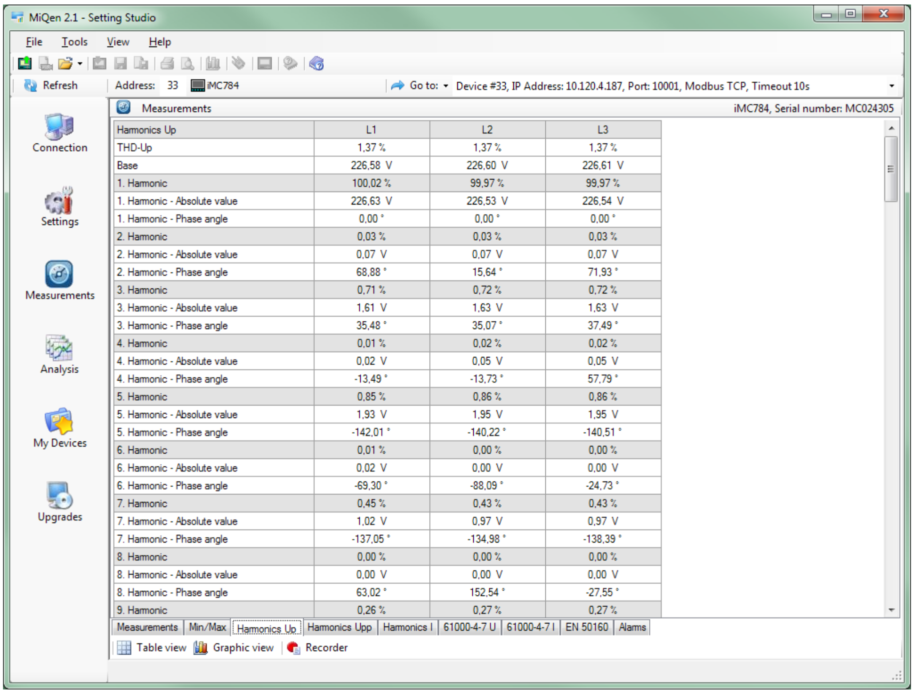
Representation of individual harmonics in consists of:

- Absolute value
- Relative value
- Phase angle between base and observed harmonic

PLEASE NOTE

Relative value can be calculated as a percentage of the base unit or as a percentage of the RMS value. Setting of this relative factor is available under General settings (see Harmonic calculation setting).

Harmonic analysis – MiQen



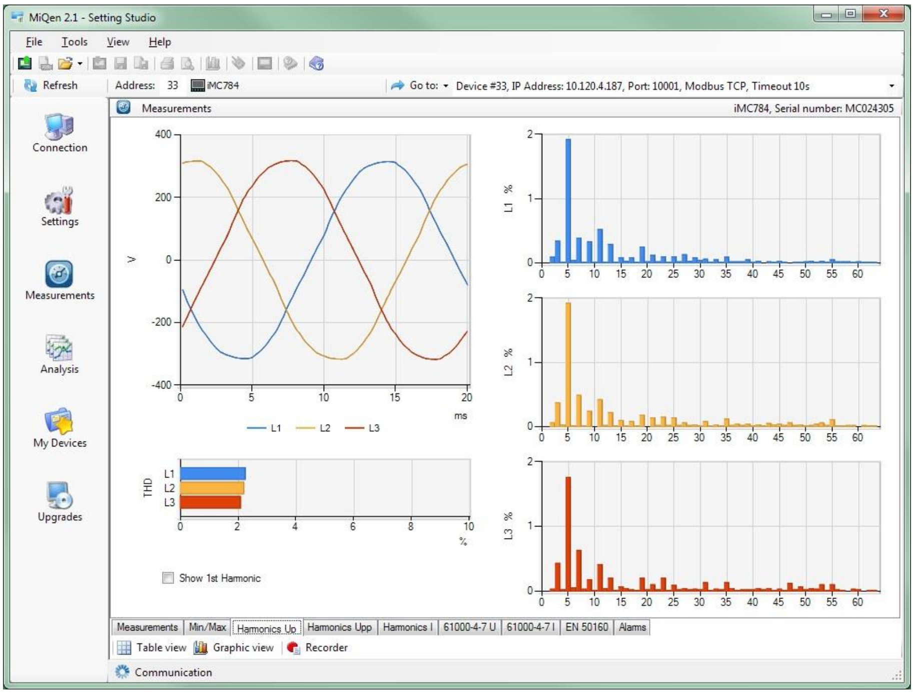
Address: 33 iMC784

Go to: Device #33, IP Address: 10.120.4.187, Port: 10001, Modbus TCP, Timeout 10s

Measurements — iMC784, Serial number: MC024305

Harmonics Up	L1	L2	L3
THD-Up	1,37 %	1,37 %	1,37 %
Base	226,58 V	226,60 V	226,61 V
1. Harmonic	100,02 %	99,97 %	99,97 %
1. Harmonic - Absolute value	226,63 V	226,53 V	226,54 V
1. Harmonic - Phase angle	0,00 °	0,00 °	0,00 °
2. Harmonic	0,03 %	0,03 %	0,03 %
2. Harmonic - Absolute value	0,07 V	0,07 V	0,07 V
2. Harmonic - Phase angle	68,88 °	15,64 °	71,93 °
3. Harmonic	0,71 %	0,72 %	0,72 %
3. Harmonic - Absolute value	1,61 V	1,63 V	1,63 V
3. Harmonic - Phase angle	35,48 °	35,07 °	37,49 °
4. Harmonic	0,01 %	0,02 %	0,02 %
4. Harmonic - Absolute value	0,02 V	0,05 V	0,05 V
4. Harmonic - Phase angle	-13,49 °	-13,73 °	57,79 °
5. Harmonic	0,85 %	0,86 %	0,86 %
5. Harmonic - Absolute value	1,93 V	1,95 V	1,95 V
5. Harmonic - Phase angle	-142,01 °	-140,22 °	-140,51 °
6. Harmonic	0,01 %	0,00 %	0,00 %
6. Harmonic - Absolute value	0,02 V	0,00 V	0,00 V
6. Harmonic - Phase angle	-69,30 °	-88,09 °	-24,73 °
7. Harmonic	0,45 %	0,43 %	0,43 %
7. Harmonic - Absolute value	1,02 V	0,97 V	0,97 V
7. Harmonic - Phase angle	-137,05 °	-134,98 °	-138,39 °
8. Harmonic	0,00 %	0,00 %	0,00 %
8. Harmonic - Absolute value	0,00 V	0,00 V	0,00 V
8. Harmonic - Phase angle	63,02 °	152,54 °	-27,55 °
9. Harmonic	0,26 %	0,27 %	0,27 %

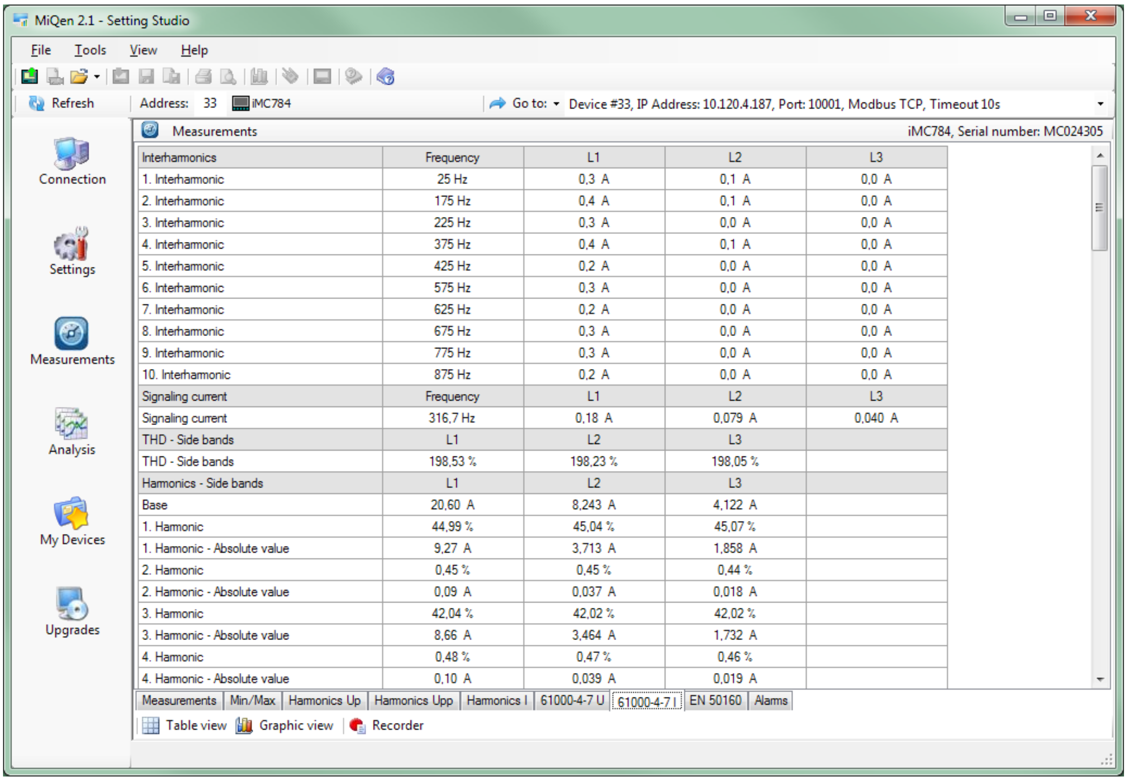
Presentation of phase voltage harmonic components – Table view



Presentation of phase voltage harmonic components – Graphic view

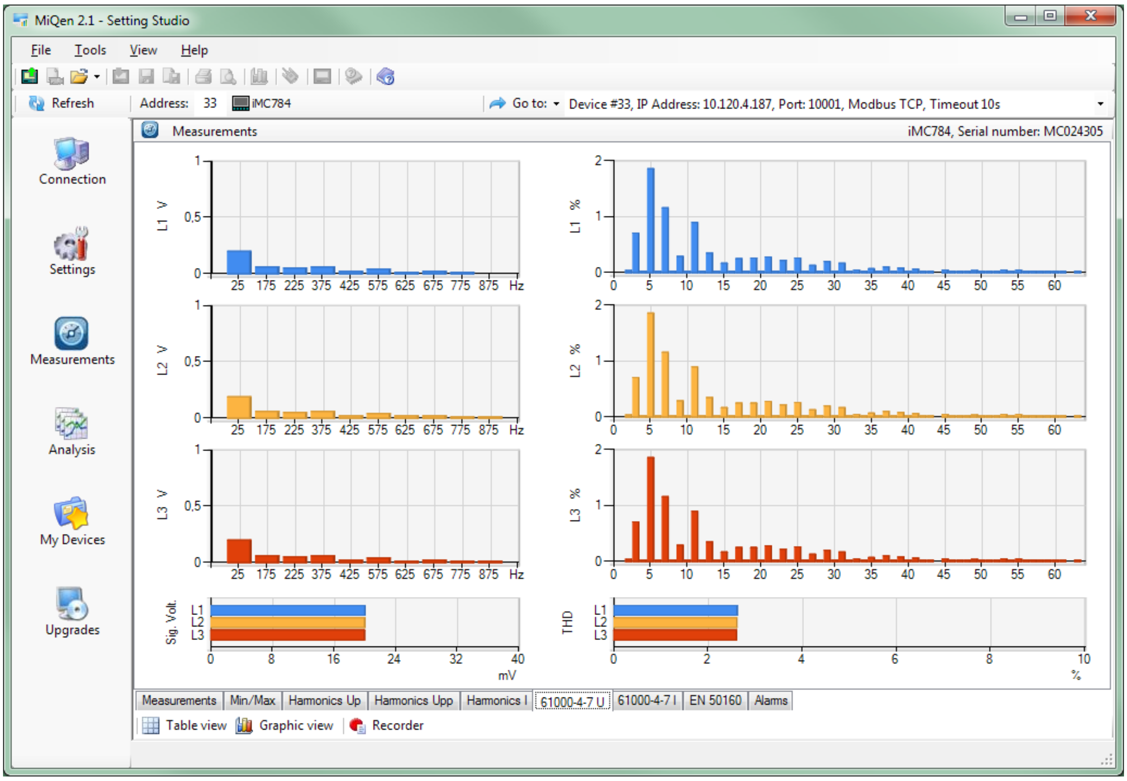
PLEASE NOTE

According to the IEC 61000-4-7 standard that defines methods for calculation of harmonic parameters; harmonic values and inter-harmonic values do not represent signal magnitude at the exact harmonic frequency but weighted sum of cantered (harmonic) values and its sidebands. More information on this can be found in the mentioned standard.



Interharmonics	Frequency	L1	L2	L3
1. Interharmonic	25 Hz	0,3 A	0,1 A	0,0 A
2. Interharmonic	175 Hz	0,4 A	0,1 A	0,0 A
3. Interharmonic	225 Hz	0,3 A	0,0 A	0,0 A
4. Interharmonic	375 Hz	0,4 A	0,1 A	0,0 A
5. Interharmonic	425 Hz	0,2 A	0,0 A	0,0 A
6. Interharmonic	575 Hz	0,3 A	0,0 A	0,0 A
7. Interharmonic	625 Hz	0,2 A	0,0 A	0,0 A
8. Interharmonic	675 Hz	0,3 A	0,0 A	0,0 A
9. Interharmonic	775 Hz	0,3 A	0,0 A	0,0 A
10. Interharmonic	875 Hz	0,2 A	0,0 A	0,0 A
Signaling current	Frequency	L1	L2	L3
Signaling current	316,7 Hz	0,18 A	0,079 A	0,040 A
THD - Side bands	L1	L2	L3	
THD - Side bands	198,53 %	198,23 %	198,05 %	
Harmonics - Side bands	L1	L2	L3	
Base	20,60 A	8,243 A	4,122 A	
1. Harmonic	44,99 %	45,04 %	45,07 %	
1. Harmonic - Absolute value	9,27 A	3,713 A	1,858 A	
2. Harmonic	0,45 %	0,45 %	0,44 %	
2. Harmonic - Absolute value	0,09 A	0,037 A	0,018 A	
3. Harmonic	42,04 %	42,02 %	42,02 %	
3. Harmonic - Absolute value	8,66 A	3,464 A	1,732 A	
4. Harmonic	0,48 %	0,47 %	0,46 %	
4. Harmonic - Absolute value	0,10 A	0,039 A	0,019 A	

Presentation of 10 phase voltage inter-harmonic components – Table view



Presentation of phase voltage inter-harmonic component – Graphic view

PQ Analysis

PQ analysis is a core functionality of the Power Quality Analyzer iMC784A. PQ (Power Quality) is a very common and well understood expression. However it is not exactly in accordance with its actual meaning.

PQ analysis actually deals with Quality of Supply Voltage. Supply Voltage is a quantity for quality of which utility companies are responsible. It influences the behavior of connected apparatus and devices.

Current and power on the other hand are the consequence of different loads and hence the responsibility of consumers. With proper filtering load influence can be restricted within consumer internal network or at most within single feeder while poor supply voltage quality influences a much wider area.

Therefore indices of supply voltage (alias PQ) are limited to anomalies connected only to supply voltage:

Power Quality indices as defined by EN 50160

Phenomena	PQ Parameters
Frequency variations	Frequency distortion
Voltage variations	Voltage fluctuation Voltage unbalance
Voltage changes	Rapid voltage changes Flicker
Voltage events	Voltage dips Voltage interruptions Voltage swells
Harmonics & THD	THD Harmonics Inter-harmonics Signaling voltage

For evaluation of voltage quality the device can store main characteristics in the internal memory. The reports are made on the basis of stored data. Data of the last 300 weeks and up to 170,000 variations of the measured quantities from the standard values are stored in the report, which enables detection of anomalies in the network.

MiQen software offers a complete survey of reports with a detailed survey of individual measured quantities and anomalies. A survey of compliance of individual measured quantities in previous and actual monitored periods is possible.

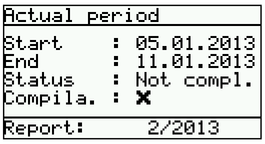
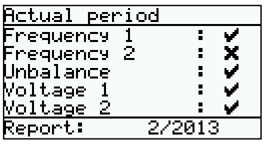
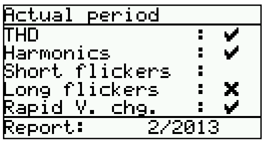
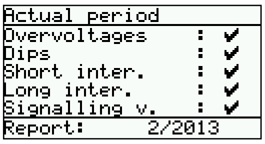
Online monitoring

When all PQ parameters are set and analysis is enabled (information about settings for PQ analysis can be found in a chapter *Conformity of PQ according to EN 50160*) PQ starts with defined date and starts issuing weekly reports (if monitoring period setting is set to one week).

MiQen software enables monitoring state of actual period and of previous monitoring period. Both periods can be overviewed on the device display just as well.

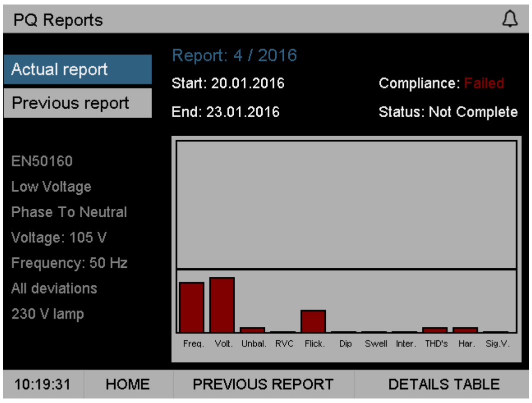
iMC784A Graphic pixel display

Example of a PQ report for an actual period is generated on device display. More detailed information about PQ is available through communication.

 Actual period Start : 05.01.2013 End : 11.01.2013 Status : Not compl. Compila. : ✗ Report: 2/2013	Basic information about actual monitoring period. The period here is not completed and currently not in compliance with EN 50160.
 Actual period Frequency 1 : ✓ Frequency 2 : ✗ Unbalance : ✓ Voltage 1 : ✓ Voltage 2 : ✓ Report: 2/2013	Display of current status of PQ parameters. Some (Frequency 2) are currently not in compliance with EN 50160.
 Actual period THD : ✓ Harmonics : ✓ Short flickers : Long flickers : ✗ Rapid V. chg. : ✓ Report: 2/2013	Display of current status of PQ parameters. Some (Long flickers) are currently not in compliance with EN 50160.
 Actual period Overvoltages : ✓ Dips : ✓ Short inter. : ✓ Long inter. : ✓ Signalling v. : ✓ Report: 2/2013	Display of current status of PQ parameters. All are in compliance with EN 50160.

iMC784A color TFT LCD display

Example of a PQ report for an actual period is generated on device display. More detailed information about PQ is available through communication.



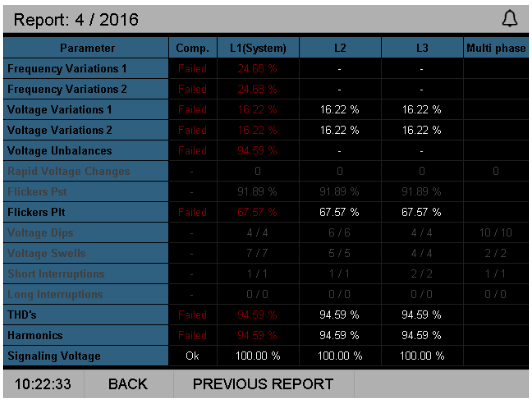
PQ Reports

Actual report
Previous report

Report: 4 / 2016
Start: 20.01.2016 Compliance: Failed
End: 23.01.2016 Status: Not Complete

EN50160
Low Voltage
Phase To Neutral
Voltage: 105 V
Frequency: 50 Hz
All deviations
230 V lamp

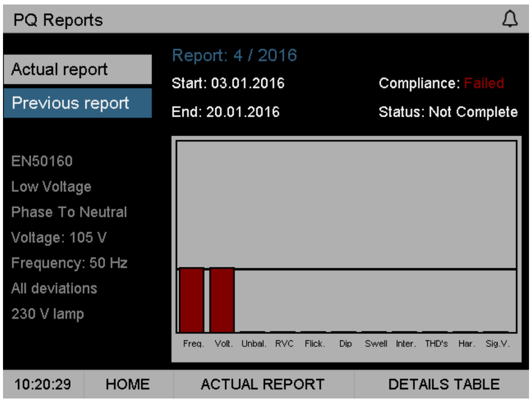
Basic information about actual monitoring period. The period here is not completed and currently not in compliance with EN 50160



Report: 4 / 2016

Parameter	Comp.	L1(System)	L2	L3	Multi phase
Frequency Variations 1	Failed	24.68 %	-	-	
Frequency Variations 2	Failed	24.68 %	-	-	
Voltage Variations 1	Failed	16.22 %	16.22 %	16.22 %	
Voltage Variations 2	Failed	16.22 %	16.22 %	16.22 %	
Voltage Unbalances	Failed	94.59 %	-	-	
Rapid Voltage Changes	-	0	0	0	0
Flickers Pst	-	91.89 %	91.89 %	91.89 %	
Flickers Plt	Failed	67.57 %	67.57 %	67.57 %	
Voltage Dips	-	4 / 4	6 / 6	4 / 4	10 / 10
Voltage Swells	-	7 / 7	5 / 5	4 / 4	2 / 2
Short Interruptions	-	1 / 1	1 / 1	2 / 2	1 / 1
Long Interruptions	-	0 / 0	0 / 0	0 / 0	0 / 0
THD's	Failed	94.59 %	94.59 %	94.59 %	
Harmonics	Failed	94.59 %	94.59 %	94.59 %	
Signaling Voltage	Ok	100.00 %	100.00 %	100.00 %	

Display of current status of PQ parameters for actual monitoring period. Some are currently not in compliance with EN 50160



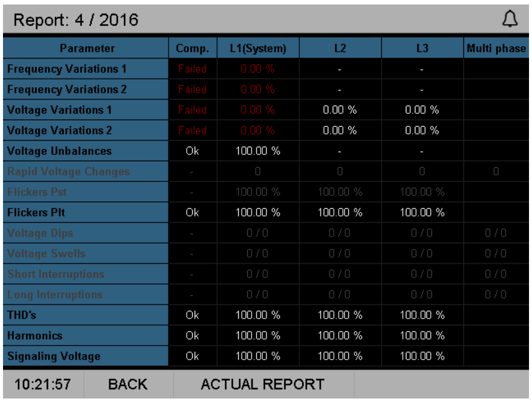
PQ Reports

Actual report
Previous report

Report: 4 / 2016
Start: 03.01.2016 Compliance: Failed
End: 20.01.2016 Status: Not Complete

EN50160
Low Voltage
Phase To Neutral
Voltage: 105 V
Frequency: 50 Hz
All deviations
230 V lamp

Basic information about previous monitoring period. The period here is not completed and currently not in compliance with EN 50160

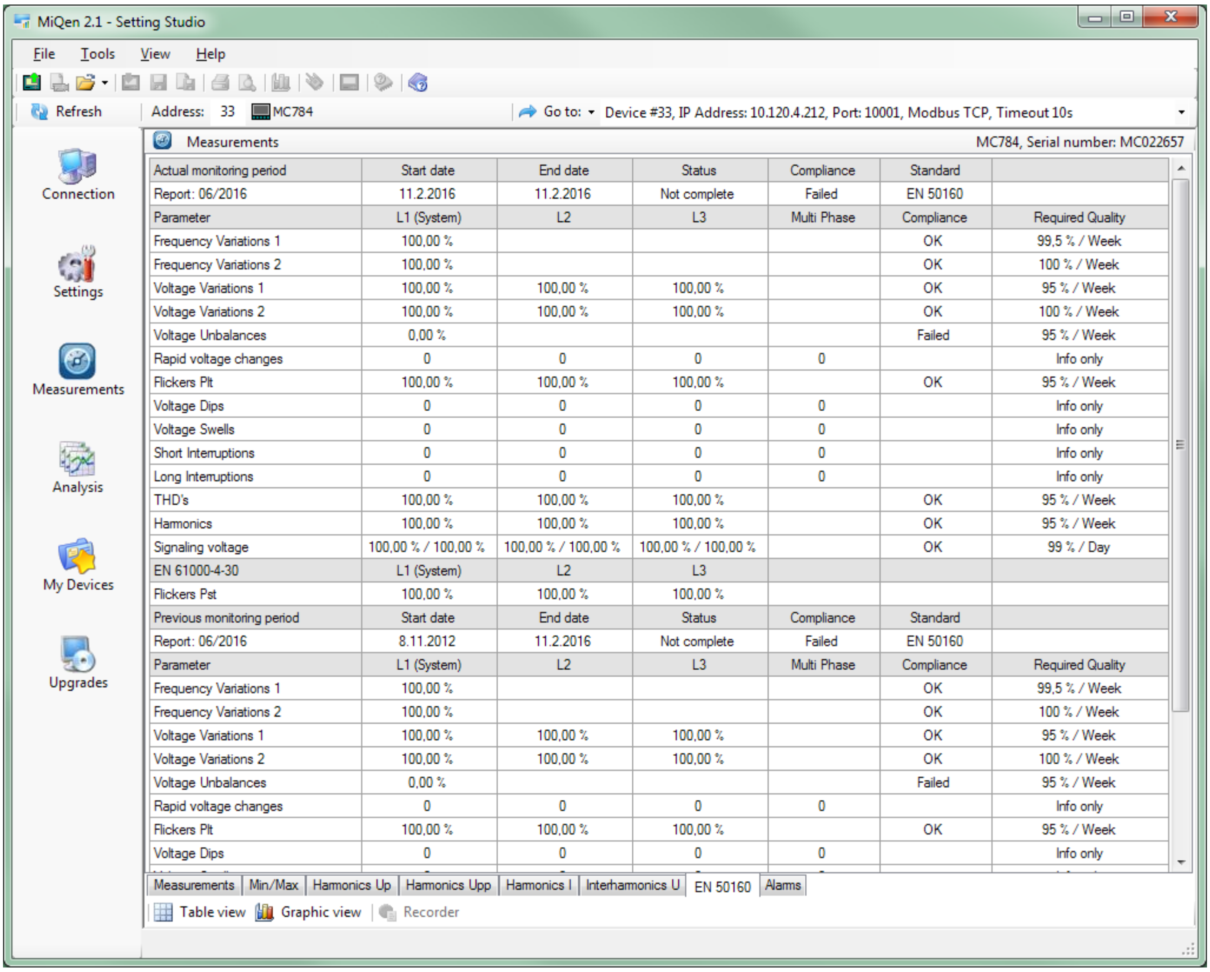


Report: 4 / 2016

Parameter	Comp.	L1(System)	L2	L3	Multi phase
Frequency Variations 1	Failed	0.00 %	-	-	
Frequency Variations 2	Failed	0.00 %	-	-	
Voltage Variations 1	Failed	0.00 %	0.00 %	0.00 %	
Voltage Variations 2	Failed	0.00 %	0.00 %	0.00 %	
Voltage Unbalances	Ok	100.00 %	-	-	
Rapid Voltage Changes	-	0	0	0	0
Flickers Pst	-	100.00 %	100.00 %	100.00 %	
Flickers Plt	Ok	100.00 %	100.00 %	100.00 %	
Voltage Dips	-	0 / 0	0 / 0	0 / 0	0 / 0
Voltage Swells	-	0 / 0	0 / 0	0 / 0	0 / 0
Short Interruptions	-	0 / 0	0 / 0	0 / 0	0 / 0
Long Interruptions	-	0 / 0	0 / 0	0 / 0	0 / 0
THD's	Ok	100.00 %	100.00 %	100.00 %	
Harmonics	Ok	100.00 %	100.00 %	100.00 %	
Signaling Voltage	Ok	100.00 %	100.00 %	100.00 %	

Display of current status of PQ parameters for previous monitoring period. Some are currently not in compliance with EN 50160

Online monitoring of PQ parameters and reports overviewing is easier with MiQen software.



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

Measurements — MC784, Serial number: MC022657

Actual monitoring period	Start date	End date	Status	Compliance	Standard	
Report: 06/2016	11.2.2016	11.2.2016	Not complete	Failed	EN 50160	
Parameter	L1 (System)	L2	L3	Multi Phase	Compliance	Required Quality
Frequency Variations 1	100,00 %				OK	99,5 % / Week
Frequency Variations 2	100,00 %				OK	100 % / Week
Voltage Variations 1	100,00 %	100,00 %	100,00 %		OK	95 % / Week
Voltage Variations 2	100,00 %	100,00 %	100,00 %		OK	100 % / Week
Voltage Unbalances	0,00 %				Failed	95 % / Week
Rapid voltage changes	0	0	0	0		Info only
Flickers Plt	100,00 %	100,00 %	100,00 %		OK	95 % / Week
Voltage Dips	0	0	0	0		Info only
Voltage Swells	0	0	0	0		Info only
Short Interruptions	0	0	0	0		Info only
Long Interruptions	0	0	0	0		Info only
THD's	100,00 %	100,00 %	100,00 %		OK	95 % / Week
Harmonics	100,00 %	100,00 %	100,00 %		OK	95 % / Week
Signaling voltage	100,00 % / 100,00 %	100,00 % / 100,00 %	100,00 % / 100,00 %		OK	99 % / Day
EN 61000-4-30	L1 (System)	L2	L3			
Flickers Pst	100,00 %	100,00 %	100,00 %			
Previous monitoring period	Start date	End date	Status	Compliance	Standard	
Report: 06/2016	8.11.2012	11.2.2016	Not complete	Failed	EN 50160	
Parameter	L1 (System)	L2	L3	Multi Phase	Compliance	Required Quality
Frequency Variations 1	100,00 %				OK	99,5 % / Week
Frequency Variations 2	100,00 %				OK	100 % / Week
Voltage Variations 1	100,00 %	100,00 %	100,00 %		OK	95 % / Week
Voltage Variations 2	100,00 %	100,00 %	100,00 %		OK	100 % / Week
Voltage Unbalances	0,00 %				Failed	95 % / Week
Rapid voltage changes	0	0	0	0		Info only
Flickers Plt	100,00 %	100,00 %	100,00 %		OK	95 % / Week
Voltage Dips	0	0	0	0		Info only

Presentation of PQ parameters and overall compliance status for actual and previous monitoring period – Table view

For all parameters, the following basic information is shown:

Actual quality

Actual quality is for some parameters expressed as a percentage of time, when parameters were inside limit lines and for others (events) it is expressed as a number of events within the monitored period.

Actual quality is for some parameters measured in all three phases and for some only in a single phase (e.g. frequency). Events can also occur as Multi-Phase events (more about multiphase events is described in following chapters)

Events are evaluated on a yearly basis according to EN 50160. Actual quality information is therefore combined of two numbers (x / y) as shown in the figure above, where:

- X … number of events in monitored period
- Y … total number of events in current year

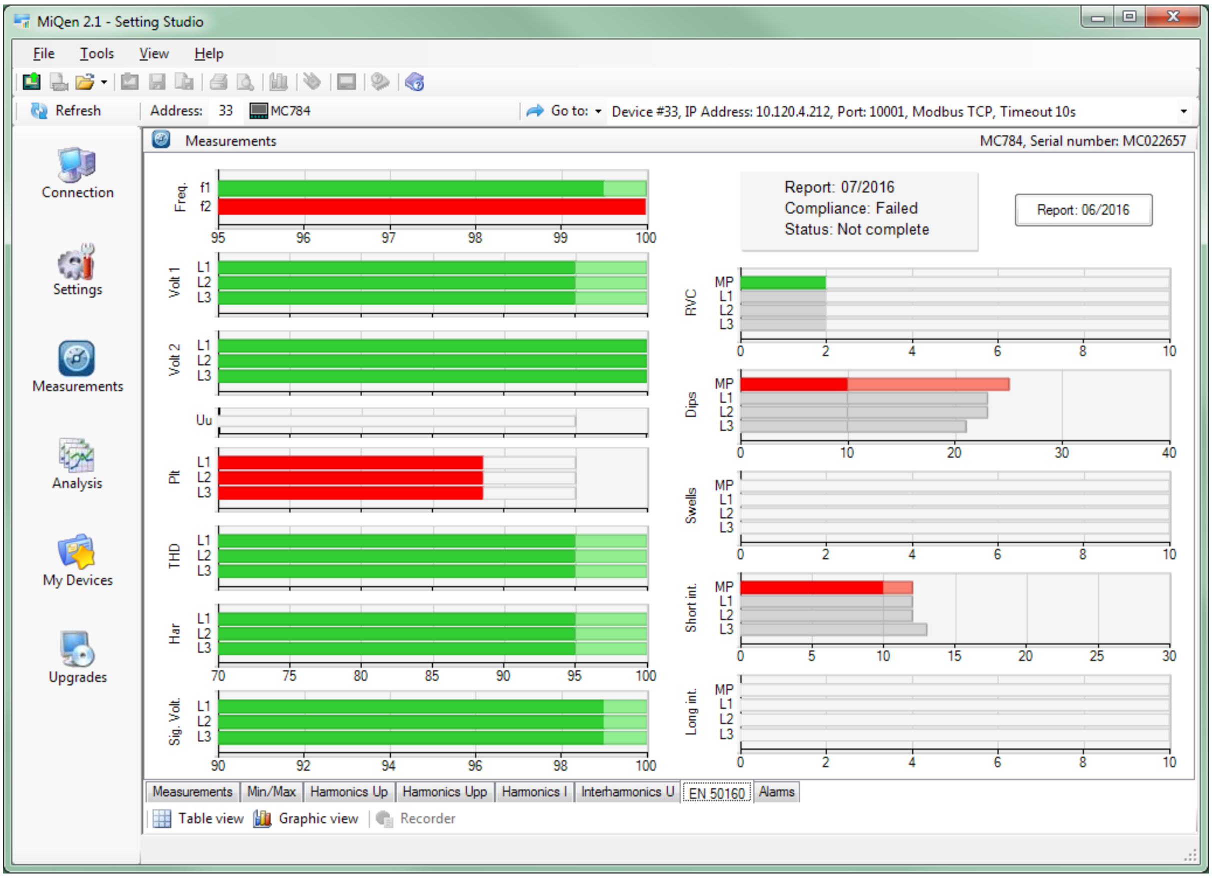
Required quality

Required quality is a limit for compliance with standard EN 50160 and is directly compared with actual quality. The comparison result is the actual status of compliance.

More information about the required quality limits can be found in standard EN 50160.

⚠ PLEASE NOTE

To make the complete quality report the aux. power supply for Power Quality Analyzer iMC784A 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.



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

MC784, Serial number: MC022657

Report: 07/2016
Compliance: Failed
Status: Not complete

Graphical presentation of PQ parameters and overall compliance are available only for actual monitoring period:

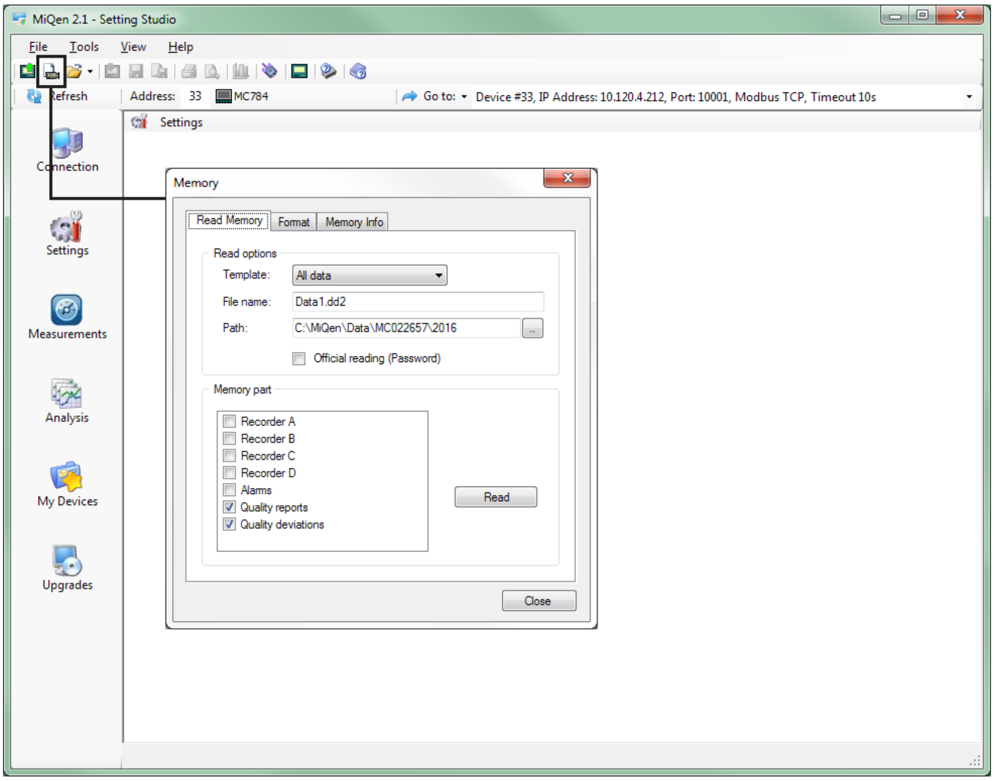
- Darker green color marks required quality
- Light green color marks actual quality
- Red color marks incompliance with standard EN 50160
- Grey color at events marks number of events
- MP at events marks Multi phase events

PQ records

Even more detailed description about PQ can be obtained by accessing PQ reports with details about anomalies in internal memory.

Structure and operation of internal memory and instructions on how to access data in internal memory is described in chapters *Device management and Internal memory*).

After memory has been read information about downloaded data is shown.



Address: 33 MC784

Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

Template: All data

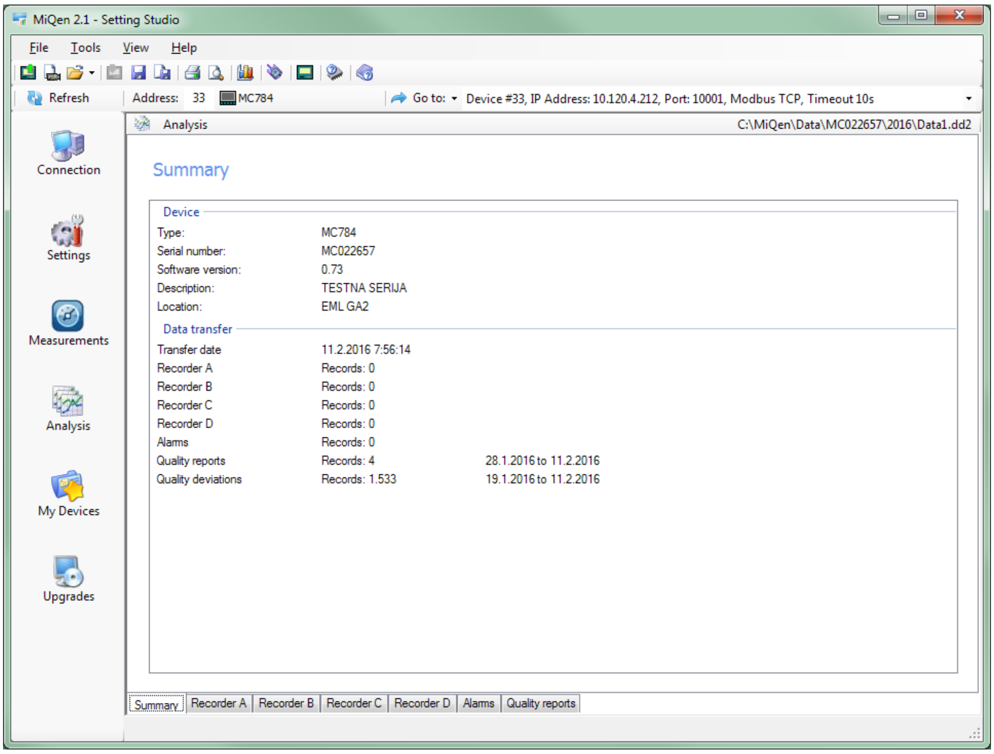
File name: Data1.dd2

Path: C:\MiQen\Data\MC022657\2016

☐ Official reading (Password)

☐ Recorder A
☐ Recorder B
☐ Recorder C
☐ Recorder D
☐ Alarms
☑ Quality reports
☑ Quality deviations

Read Power Quality memory



Address: 33 MC784

Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

C:\MiQen\Data\MC022657\2016\Data1.dd2

Summary

Device

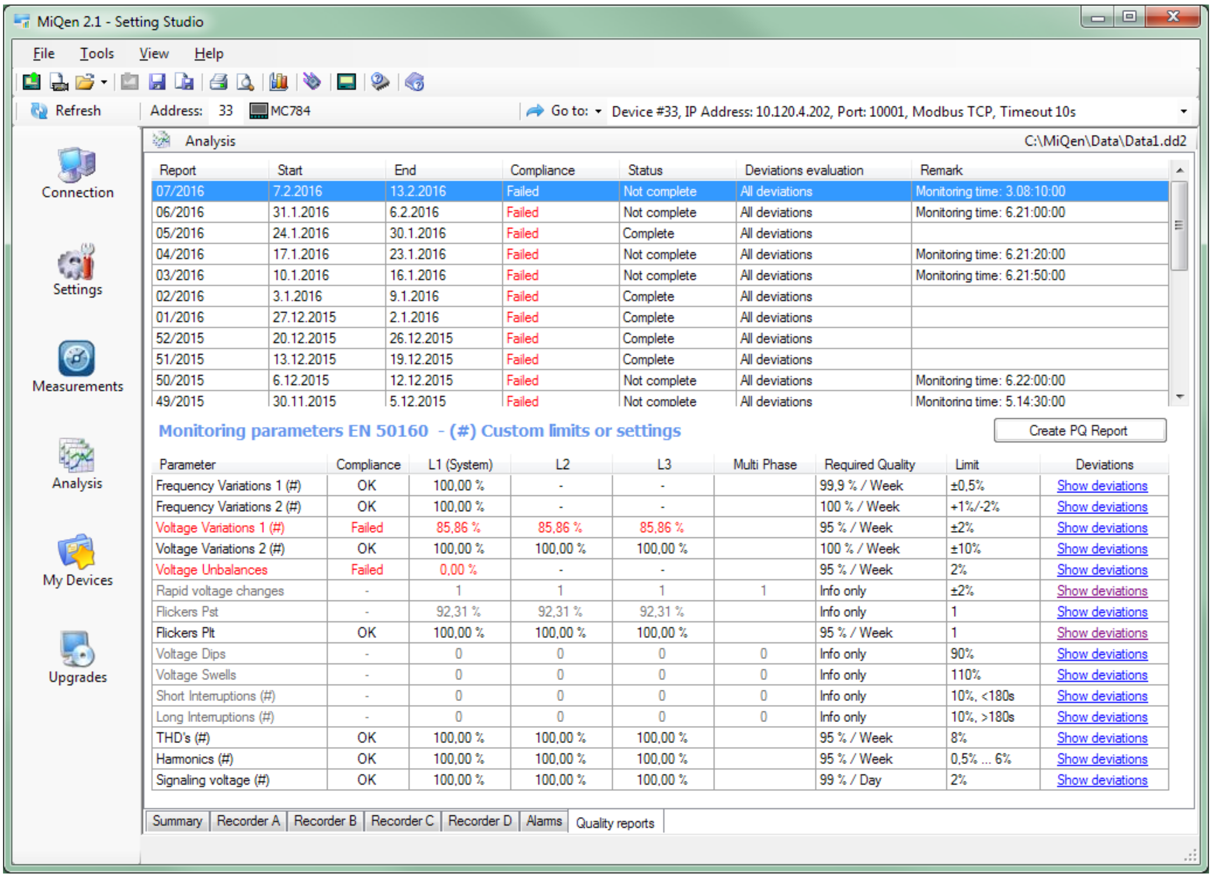
Type:	MC784	
Serial number:	MC022657	
Software version:	0.73	
Description:	TESTNA SERIJA	
Location:	EML GA2	

Data transfer

Transfer date	11.2.2016 7:56:14	
Recorder A	Records: 0	
Recorder B	Records: 0	
Recorder C	Records: 0	
Recorder D	Records: 0	
Alarms	Records: 0	
Quality reports	Records: 4	28.1.2016 to 11.2.2016
Quality deviations	Records: 1.533	19.1.2016 to 11.2.2016

Information about downloaded data with tabs for different memory partitions

All information about PQ is stored in the Quality reports tab.



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.202, Port: 10001, Modbus TCP, Timeout 10s

Analysis C:\MiQen\Data\Data1.dd2

Report	Start	End	Compliance	Status	Deviations evaluation	Remark
07/2016	7.2.2016	13.2.2016	Failed	Not complete	All deviations	Monitoring time: 3.08:10:00
06/2016	31.1.2016	6.2.2016	Failed	Not complete	All deviations	Monitoring time: 6.21:00:00
05/2016	24.1.2016	30.1.2016	Failed	Complete	All deviations	
04/2016	17.1.2016	23.1.2016	Failed	Not complete	All deviations	Monitoring time: 6.21:20:00
03/2016	10.1.2016	16.1.2016	Failed	Not complete	All deviations	Monitoring time: 6.21:50:00
02/2016	3.1.2016	9.1.2016	Failed	Complete	All deviations	
01/2016	27.12.2015	2.1.2016	Failed	Complete	All deviations	
52/2015	20.12.2015	26.12.2015	Failed	Complete	All deviations	
51/2015	13.12.2015	19.12.2015	Failed	Complete	All deviations	
50/2015	6.12.2015	12.12.2015	Failed	Not complete	All deviations	Monitoring time: 6.22:00:00
49/2015	30.11.2015	5.12.2015	Failed	Not complete	All deviations	Monitoring time: 5.14:30:00

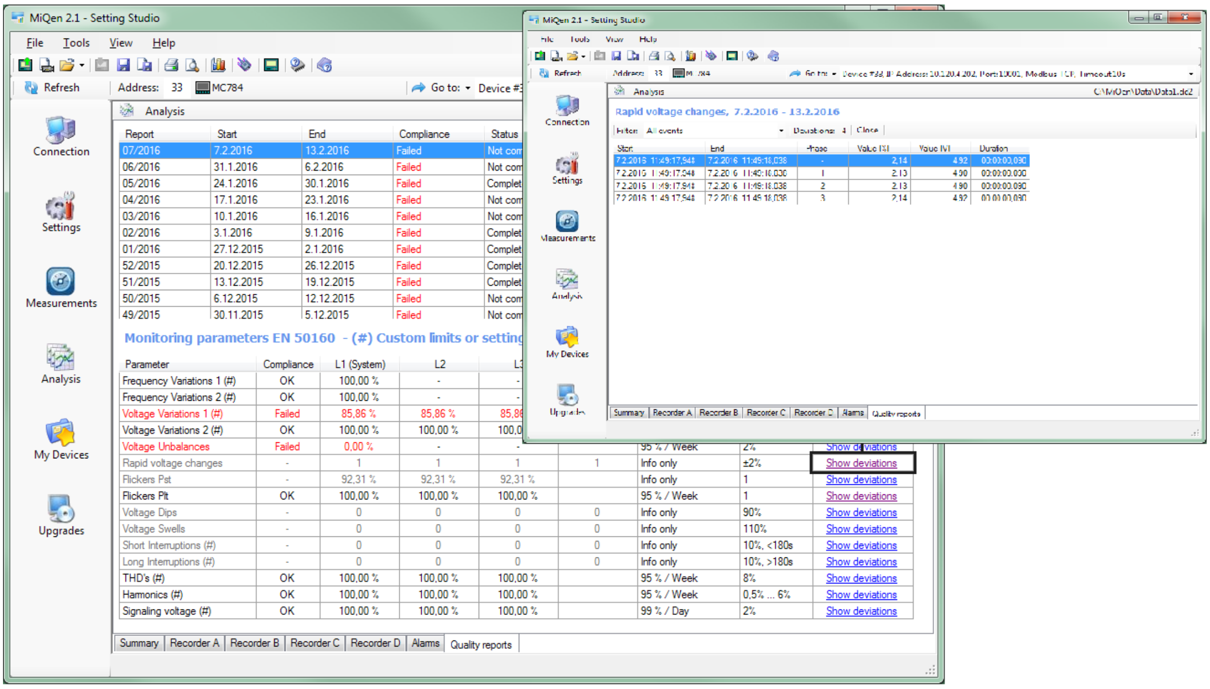
Monitoring parameters EN 50160 - (#) Custom limits or settings

Parameter	Compliance	L1 (System)	L2	L3	Multi Phase	Required Quality	Limit	Deviations
Frequency Variations 1 (#)	OK	100,00 %	-	-		99,9 % / Week	±0,5%	Show deviations
Frequency Variations 2 (#)	OK	100,00 %	-	-		100 % / Week	+1%/-2%	Show deviations
Voltage Variations 1 (#)	Failed	85,86 %	85,86 %	85,86 %		95 % / Week	±2%	Show deviations
Voltage Variations 2 (#)	OK	100,00 %	100,00 %	100,00 %		100 % / Week	±10%	Show deviations
Voltage Unbalances	Failed	0,00 %	-	-		95 % / Week	2%	Show deviations
Rapid voltage changes	-	1	1	1	1	Info only	±2%	Show deviations
Flickers Pst	-	92,31 %	92,31 %	92,31 %		Info only	1	Show deviations
Flickers Plt	OK	100,00 %	100,00 %	100,00 %		95 % / Week	1	Show deviations
Voltage Dips	-	0	0	0	0	Info only	90%	Show deviations
Voltage Swells	-	0	0	0	0	Info only	110%	Show deviations
Short Interruptions (#)	-	0	0	0	0	Info only	10%, <180s	Show deviations
Long Interruptions (#)	-	0	0	0	0	Info only	10%, >180s	Show deviations
THD's (#)	OK	100,00 %	100,00 %	100,00 %		95 % / Week	8%	Show deviations
Harmonics (#)	OK	100,00 %	100,00 %	100,00 %		95 % / Week	0,5% ... 6%	Show deviations
Signaling voltage (#)	OK	100,00 %	100,00 %	100,00 %		99 % / Day	2%	Show deviations

Main window of recorded PQ reports

The main window is divided into two parts. Upper part holds information about recorded periodic PQ reports and lower part about each of the upper reports.

For each of the monitored parameters it is possible to display an anomaly report. This represents a complete list of accurately time stamped measurements that were outside PQ limit lines.



Rapid voltage changes, 7.2.2016 - 13.2.2016

Filter: All events Deviations: 4 Close

Start	End	Phase	Value [%]	Value [V]	Duration
7.2.2016 11:49:17,948	7.2.2016 11:49:18,038	-	2,14	4,92	00:00:00,090
7.2.2016 11:49:17,948	7.2.2016 11:49:18,038	1	2,13	4,90	00:00:00,090
7.2.2016 11:49:17,948	7.2.2016 11:49:18,038	2	2,13	4,90	00:00:00,090
7.2.2016 11:49:17,948	7.2.2016 11:49:18,038	3	2,14	4,92	00:00:00,090

By clicking on "Show details" for each PQ parameter MiQen displays time-stamped measurements (events), which were outside limit lines

Flagged data evaluation

Flagged data represent data (recorded events) that has been flagged (marked) according to the flagging concept IEC 61000-4-30.

Flagged data are power quality records, which have been influenced by one or more voltage events (interruptions, dips, swells).

The purpose of flagging data is to mark recorded parameters when certain disturbances might influence measurements and cause corrupted data. For example, voltage dip can also trigger the occurrence of flicker, inter-harmonics ... In this case all parameters which were recorded at a time of voltage events are marked (flagged).

A PQ report will omit or include flagged data according to appropriate settings (please see chapter *Settings – Conformity of voltage with EN 50160 standard – Flagged events setting*).

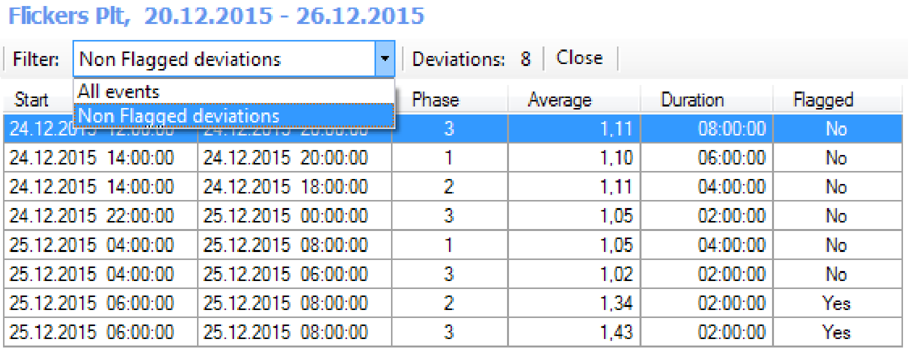
⚠ PLEASE NOTE

Regardless of this setting, readings will always be stored in recorder and available for analysis. Flagging only influences PQ reports as a whole.

In evaluation of PQ parameter details it is possible to show:

- All events
- Non-flagged events

As depicted in the figure below.



Flickers Plt, 20.12.2015 - 26.12.2015

Filter: Non Flagged deviations | Deviations: 8 | Close

Start		Phase	Average	Duration	Flagged
24.12.20		3	1,11	08:00:00	No
24.12.2015 14:00:00	24.12.2015 20:00:00	1	1,10	06:00:00	No
24.12.2015 14:00:00	24.12.2015 18:00:00	2	1,11	04:00:00	No
24.12.2015 22:00:00	25.12.2015 00:00:00	3	1,05	02:00:00	No
25.12.2015 04:00:00	25.12.2015 08:00:00	1	1,05	04:00:00	No
25.12.2015 04:00:00	25.12.2015 06:00:00	3	1,02	02:00:00	No
25.12.2015 06:00:00	25.12.2015 08:00:00	2	1,34	02:00:00	Yes
25.12.2015 06:00:00	25.12.2015 08:00:00	3	1,43	02:00:00	Yes

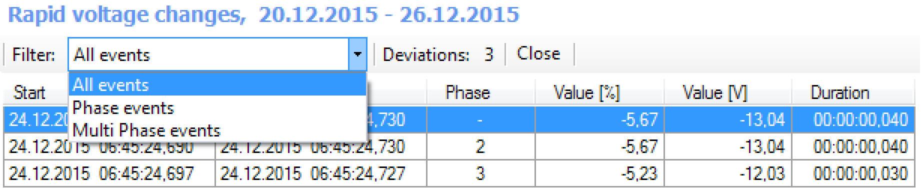
Display of all or non-flagged events

Multiphase events

According to the EN 50160 standard events (interruptions, dips, swells) should be multiphase aggregated.

Multiphase aggregation is a method where events, which occur in all phases at a same time, are substituted with a single multiphase event since they were most likely triggered by a single anomaly in a network.

However, to eliminate possibility of information loss all events should be recorded. Therefore during a multiphase anomaly four events are recorded. Three events for each phase and an additional multiphase event.



Rapid voltage changes, 20.12.2015 - 26.12.2015

Filter: All events | Deviations: 3 | Close

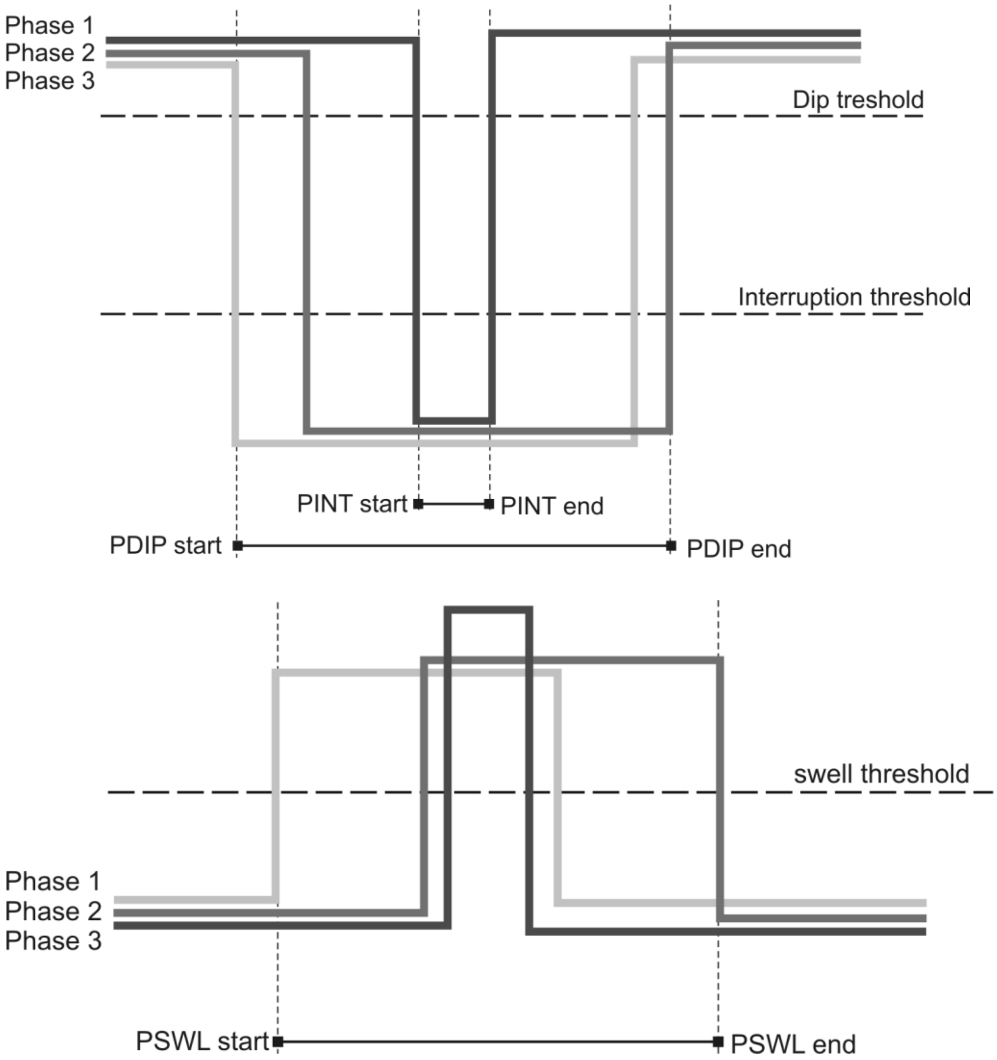
Start		Phase	Value [%]	Value [V]	Duration
24.12.20	,730	-	-5,67	-13,04	00:00:00,040
24.12.2015 06:45:24,690	24.12.2015 06:45:24,730	2	-5,67	-13,04	00:00:00,040
24.12.2015 06:45:24,697	24.12.2015 06:45:24,727	3	-5,23	-12,03	00:00:00,030

“Phase” column in a list of events marks multiphase event with “-“. In this example one event accrued on second phase, one on third phase and one is a multiphase event.

Definition for multiphase dip and swell is:

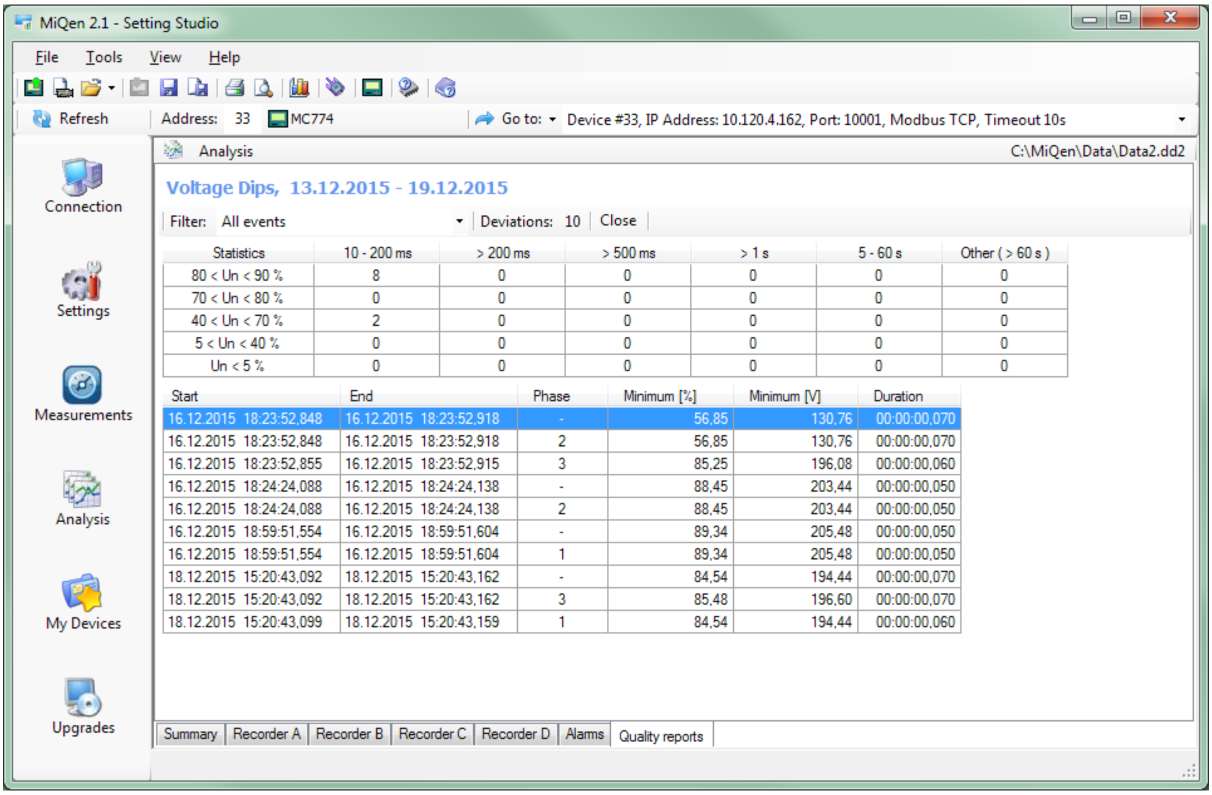
“Multiphase event starts when voltage on one or more phases crosses threshold line for event detection and ends when voltage on all phases is restored to normal value”

Definition for multiphase interruption is:
"Multiphase interruption starts when voltage on all three phases crosses threshold line for interruption detection and ends when voltage on at least one phase is restored to normal value"



Graphical presentation of multiphase (PDIP, PINT, PSWL) event detection

Voltage event details are displayed in two ways. First as a list of all events with all details and second in a table according to UNIPEDE DISDIP specifications.



Device #33, IP Address: 10.120.4.162, Port: 10001, Modbus TCP, Timeout 10s

C:\MiQen\Data\Data2.dd2

Voltage Dips, 13.12.2015 - 19.12.2015

Filter: All events Deviations: 10 Close

Statistics	10 - 200 ms	> 200 ms	> 500 ms	> 1 s	5 - 60 s	Other (> 60 s)
80 < Un < 90 %	8	0	0	0	0	0
70 < Un < 80 %	0	0	0	0	0	0
40 < Un < 70 %	2	0	0	0	0	0
5 < Un < 40 %	0	0	0	0	0	0
Un < 5 %	0	0	0	0	0	0

Start	End	Phase	Minimum [%]	Minimum [V]	Duration
16.12.2015 18:23:52,848	16.12.2015 18:23:52,918	-	56,85	130,76	00:00:00,070
16.12.2015 18:23:52,848	16.12.2015 18:23:52,918	2	56,85	130,76	00:00:00,070
16.12.2015 18:23:52,855	16.12.2015 18:23:52,915	3	85,25	196,08	00:00:00,060
16.12.2015 18:24:24,088	16.12.2015 18:24:24,138	-	88,45	203,44	00:00:00,050
16.12.2015 18:24:24,088	16.12.2015 18:24:24,138	2	88,45	203,44	00:00:00,050
16.12.2015 18:59:51,554	16.12.2015 18:59:51,604	-	89,34	205,48	00:00:00,050
16.12.2015 18:59:51,554	16.12.2015 18:59:51,604	1	89,34	205,48	00:00:00,050
18.12.2015 15:20:43,092	18.12.2015 15:20:43,162	-	84,54	194,44	00:00:00,070
18.12.2015 15:20:43,092	18.12.2015 15:20:43,162	3	85,48	196,60	00:00:00,070
18.12.2015 15:20:43,099	18.12.2015 15:20:43,159	1	84,54	194,44	00:00:00,060

Presentation of Dips and Interruptions in a list (only four events) and in a statistics table

LCD navigation

iMC784A Graphic pixel display

Main menu
Measurements
Settings
Resets
SD card
Info
Installation
28.7.2021 16:53:36

→

Measurements
Present values
Min/Max values
Alarms
Graphs time
Graphs FFT
Power supply quality
Demo cycling
⇦ Main menu

Main menu > Measurements > Present values > Voltage / Current / Power / PF & Power angle / Frequency / Energy / MD values / THD / Flickers / Custom / Overview / Analog input

Main menu > Measurements > Min/Max values > Phase Voltage / Phase-Phase Voltage / Current / Active Power / Apparent Power / Frequency / Date&Time of Reset

Main menu > Measurements > Alarms > Group 1 / Group 2 / Group 3 / Group 4

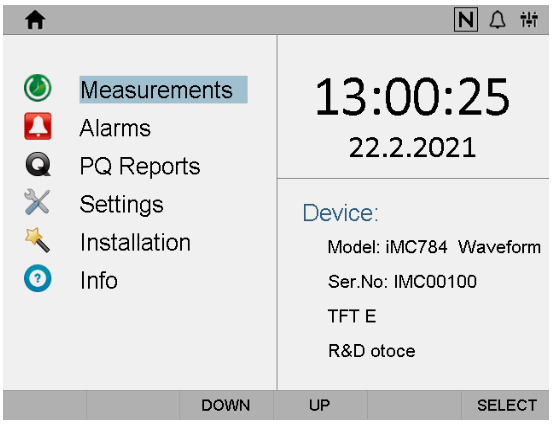
Main menu > Measurements > Graphs time > Phase Voltage / Phase-Phase Voltage / Current

Main menu > Measurements > Graphs FFT > Phase Voltage / Phase-Phase Voltage / Current

Main menu > Measurements > Power supply quality > Actual period / Previous period

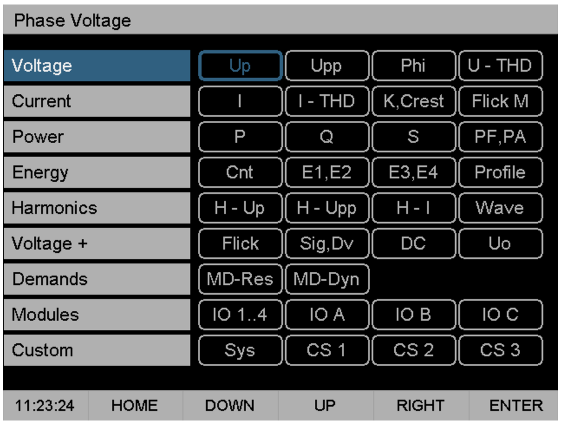
Main menu > Measurements > Demo cycling

iMC784A color TFT LCD display



13:00:25
22.2.2021

Device:
Model: iMC784 Waveform
Ser.No: IMC00100
TFT E
R&D otoce



Main menu > Measurements:

- Voltage
- Current
- Power
- Energy
- Harmonics
- Voltage +
- Demands
- Modules
- Custom

PQDIF and COMTRADE files on iMC784A – concept description

Power Quality Analyzer iMC784A stores recorded data in standardized PQDIF and COMTRADE file formats. This concept was introduced for compatibility purposes with 3rd party software, which enable data viewing and analyzing by means of simple file importing.

The PQDIF acronym stands for Power Quality Data Interchange Format, and represents a binary file format according to the IEEE Std. 1159.3-2003. The primary purpose for introducing this standard was to exchange voltage, current, power, and energy measurements between software applications. The COMTRADE acronym stands for Common Format for Transient Data Exchange, and represents a file format specified in IEEE Std. C37.111. This file format was defined for storing oscillography and status data related to transient power system disturbances.

For viewing records of both types we recommend the PQDiffractor Viewer which can be freely downloaded from http://www.electrotek.com/pqdiffractor/ or any of the software supporting these formats.

Power Quality Analyzer iMC784A instrument has a list of advanced recorders (which are described in chapter *Settings –Advanced recorders*). These recorders are listed below together with their file storage options:

Recorder Type	Supported file record format
Waveform recorder	PQDIF and COMTRADE
Disturbance recorder	PQDIF and COMTRADE
PQ recorder	PQDIF
4 Fast Trend Recorders	PQDIF

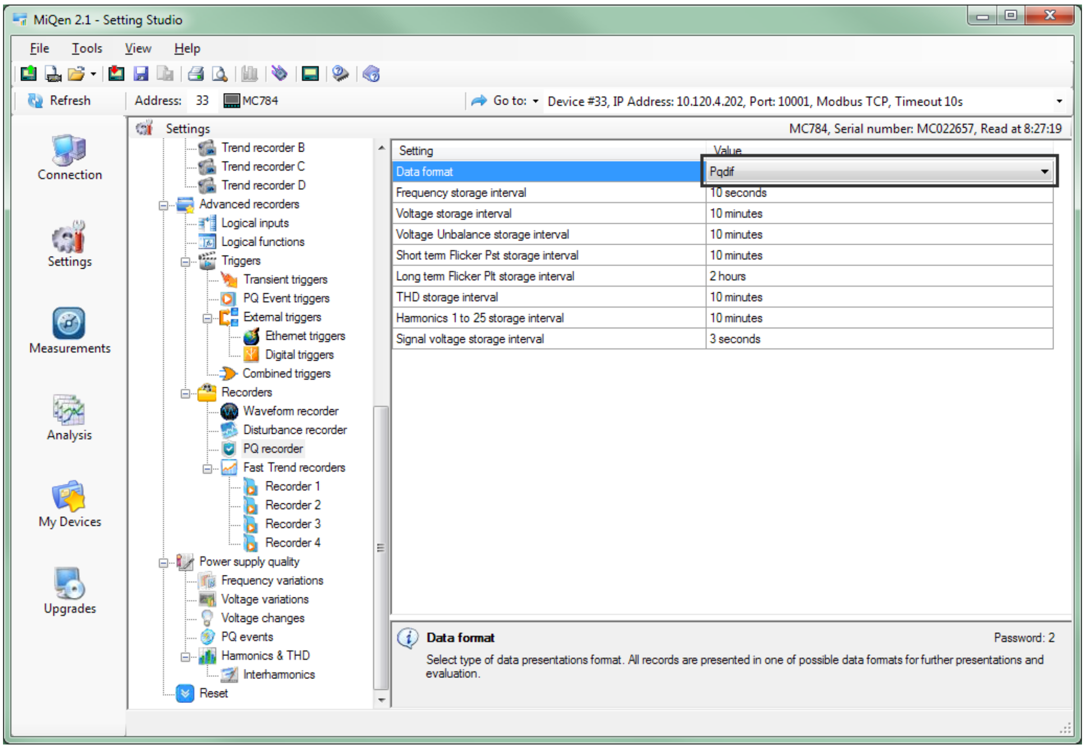
Apart from selecting which one of the available file formats data will be stored-in, some other file record related parameters must also be specified when setting up the a recorder. These parameters are recording resolution, recorded parameters, pretrigger/posttrigger time (for Waveform and Disturbance recorders only) and file generation period (for fast trend periodic recorder).

Working with PQDIF and COMTRADE files on the device

All created recorder files can be accessed through FTP. This is normally done through the MiQEN setting & Analysis software within the My Devices section of the SW. Another way is to directly connect to Power Quality Analyzer iMC784A using one of the standard FTP clients. To see how data in the internal device recorder is structured please see Appendix F.

Accessing PQDIF files

Under every one of the advanced recorders a desired file format can be chosen by the user. For the PQ advanced recorder this selection is shown below:



Device #33, IP Address: 10.120.4.202, Port: 10001, Modbus TCP, Timeout 10s

MC784, Serial number: MC022657, Read at 8:27:19

Setting	Value
Data format	Pqdif
Frequency storage interval	10 seconds
Voltage storage interval	10 minutes
Voltage Unbalance storage interval	10 minutes
Short term Flicker Pst storage interval	10 minutes
Long term Flicker Plt storage interval	2 hours
THD storage interval	10 minutes
Harmonics 1 to 25 storage interval	10 minutes
Signal voltage storage interval	3 seconds

Data format Password: 2

Select type of data presentations format. All records are presented in one of possible data formats for futher presentations and evaluation.

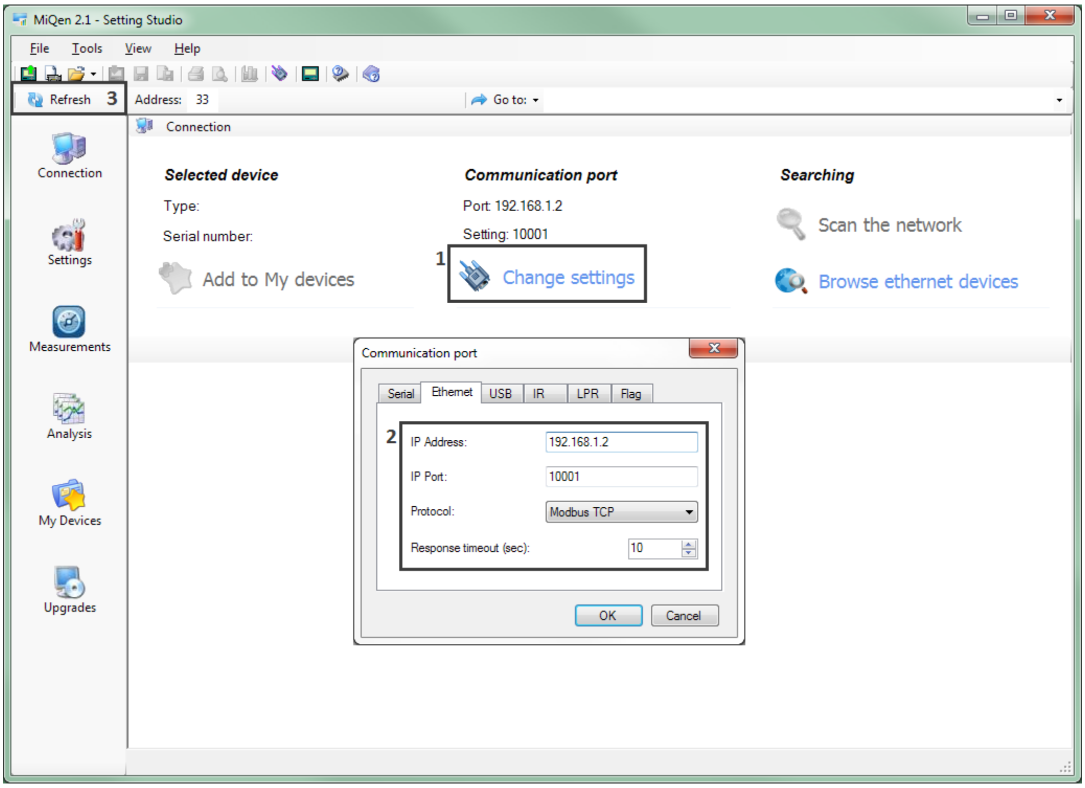
MiQen –Select type of data presentations format PQdif

Procedure of accessing PQDIF files:

In order to access PQDIF files which are stored on the device the device first needs to be added to My devices. To do this the device from which you require recorded data should first be selected from the list of available devices or by directly entering its' communication settings:

MiQen – Choosing a device from a list

By clicking on Add to My devices we can add the chosen instrument into My devices:



Selected device

Type:

Serial number:

Communication port

Port: 192.168.1.2

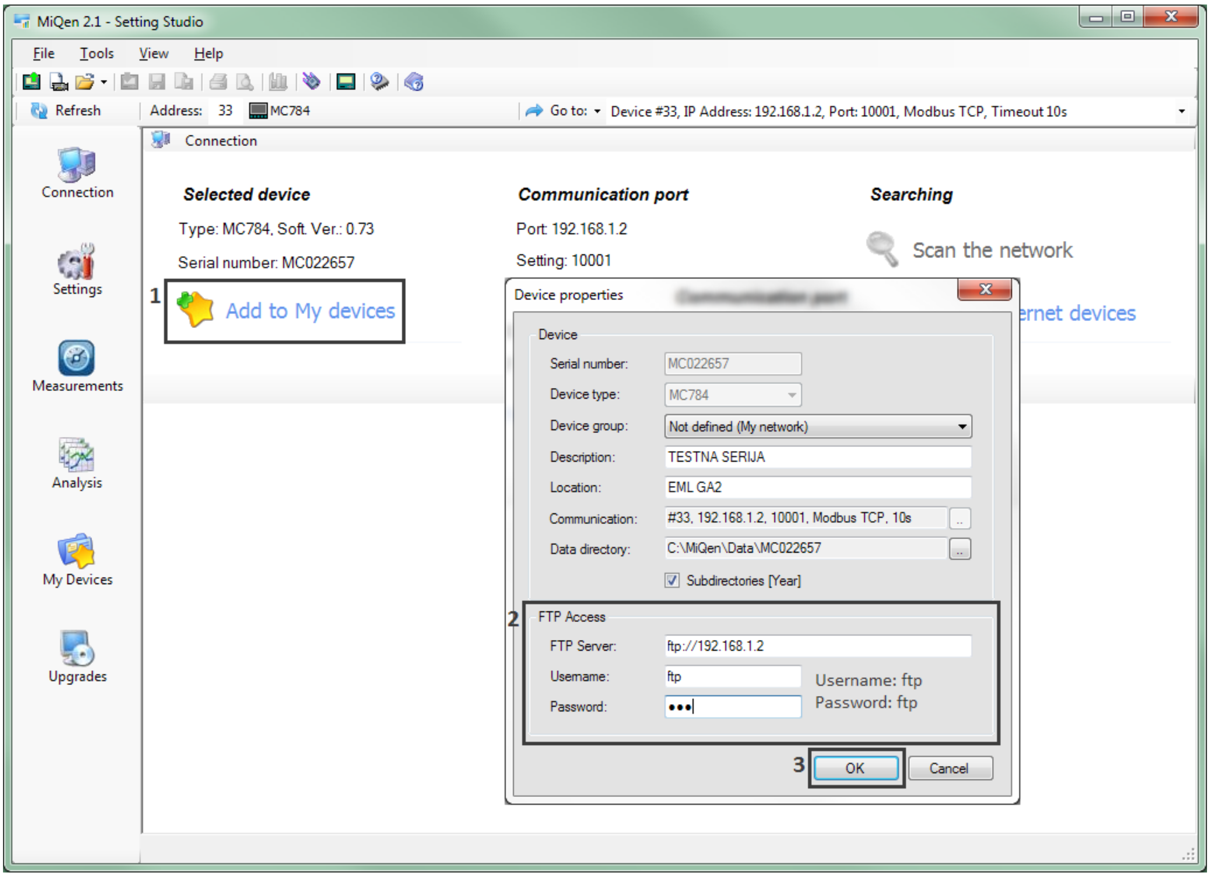
Setting: 10001

IP Address: 192.168.1.2

IP Port: 10001

Protocol: Modbus TCP

Response timeout (sec): 10



Address: 33 MC784

Go to: Device #33, IP Address: 192.168.1.2, Port: 10001, Modbus TCP, Timeout 10s

Connection

Selected device

Type: MC784, Soft. Ver.: 0.73

Serial number: MC022657

Communication port

Port: 192.168.1.2

Setting: 10001

Searching

Device properties

Device

Serial number: MC022657

Device type: MC784

Device group: Not defined (My network)

Description: TESTNA SERIJA

Location: EML GA2

Communication: #33, 192.168.1.2, 10001, Modbus TCP, 10s

Data directory: C:\MiQen\Data\MC022657

☑ Subdirectories [Year]

FTP Access

FTP Server: ftp://192.168.1.2

Username: ftp

Password: •••

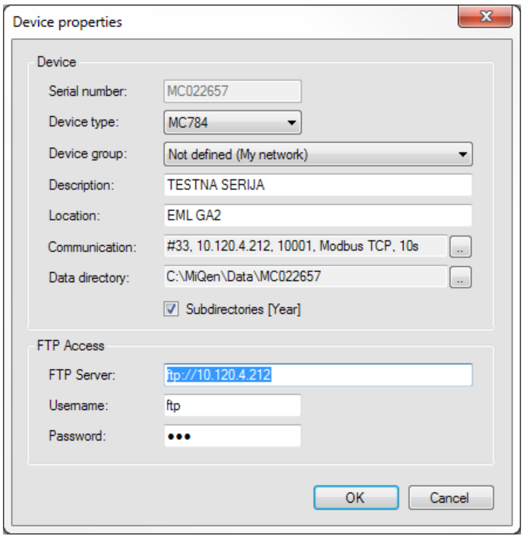
Username: ftp

Password: ftp

MiQen – Add the device to My devices

A dialog box appears where the user chooses basic parameters such as PQDIF file storage location and FTP credentials:

The default read-only access username and password are:
Username: ftp
Password: ftp



Device properties

Device

Serial number: MC022657

Device type: MC784

Device group: Not defined (My network)

Description: TESTNA SERIJA

Location: EML GA2

Communication: #33, 10.120.4.212, 10001, Modbus TCP, 10s

Data directory: C:\MiQen\Data\MC022657

☑ Subdirectories [Year]

FTP Access

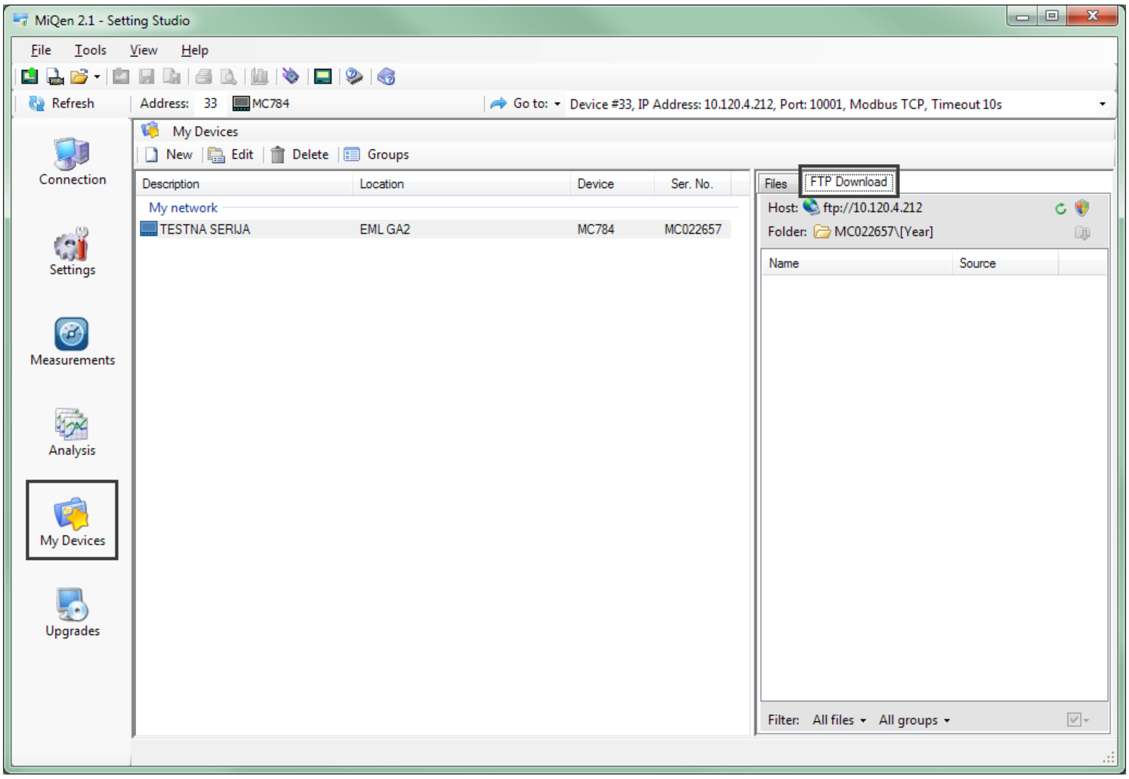
FTP Server: ftp://10.120.4.212

Username: ftp

Password: •••

MiQen – Entering device properties within My devices

After this click, My devices tab located in the bottom left and the FTP Download tab at upper right:



Address: 33 MC784

Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

Description	Location	Device	Ser. No.
My network			
TESTNA SERIJA	EML GA2	MC784	MC022657

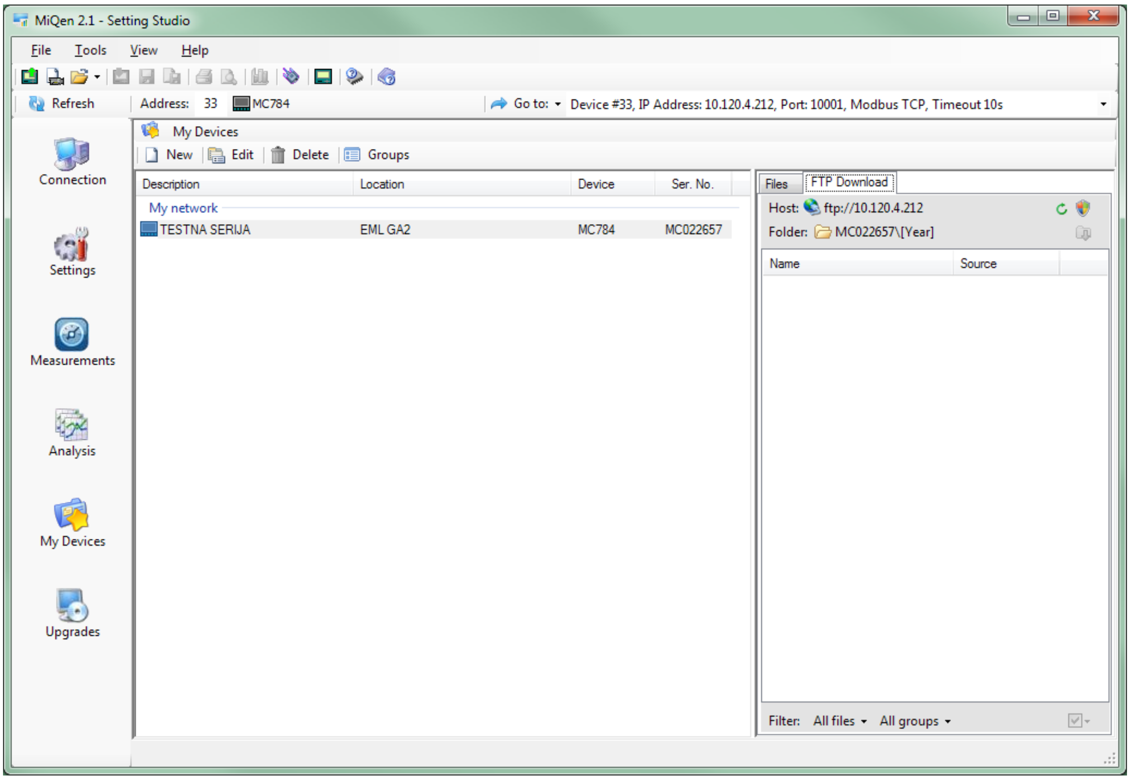
Host: ftp://10.120.4.212

Folder: MC022657\[Year]

Name	Source

MiQen: Accessing data through My devices

To refresh a list of files the upper right corner refresh ↻ button should be pressed:



Address: 33 MC784

Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

Description	Location	Device	Ser. No.
My network			
TESTNA SERIJA	EML GA2	MC784	MC022657

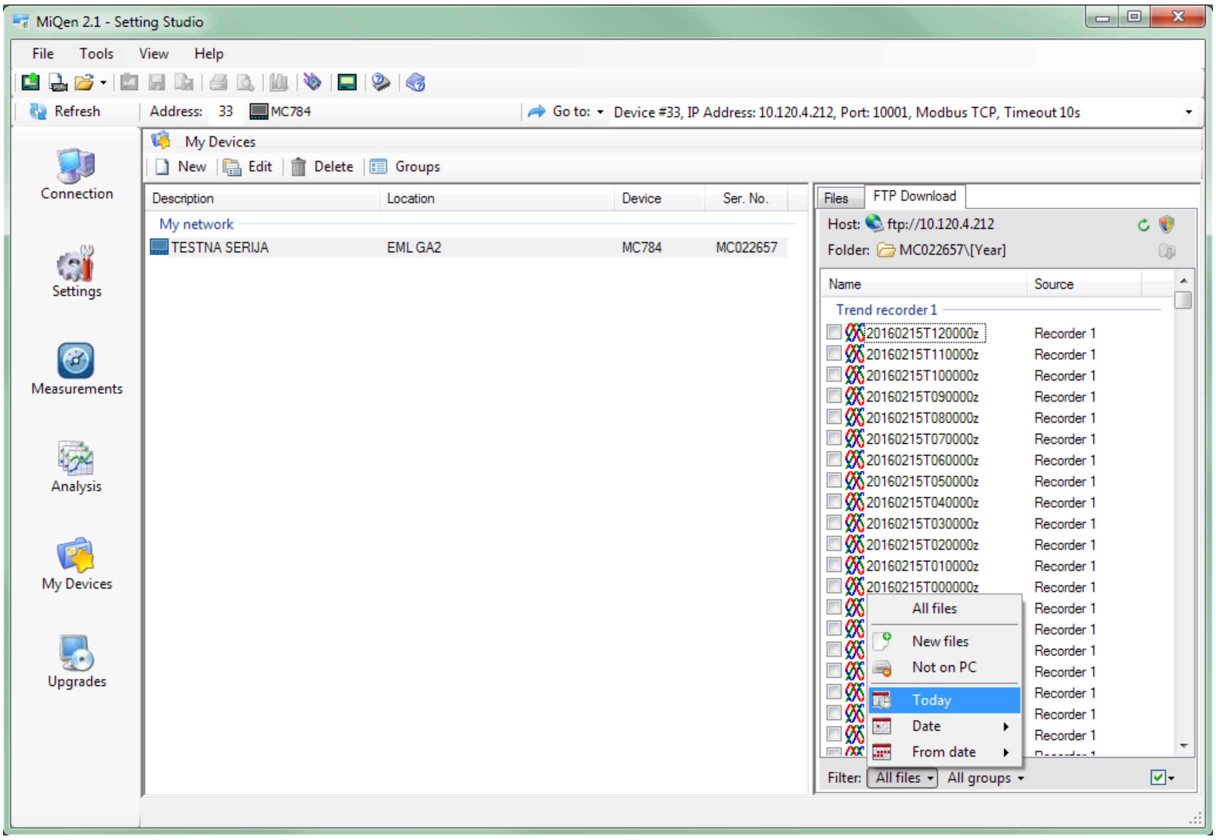
Host: ftp://10.120.4.212

Folder: MC022657\[Year]

Name	Source

MiQen - Displaying recorded PQDIF files via FTP

Next, the required files for download are chosen by filtering them or marking the desired ones:



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

Description	Location	Device	Ser. No.
My network			
TESTNA SERIJA	EML GA2	MC784	MC022657

Host: ftp://10.120.4.212

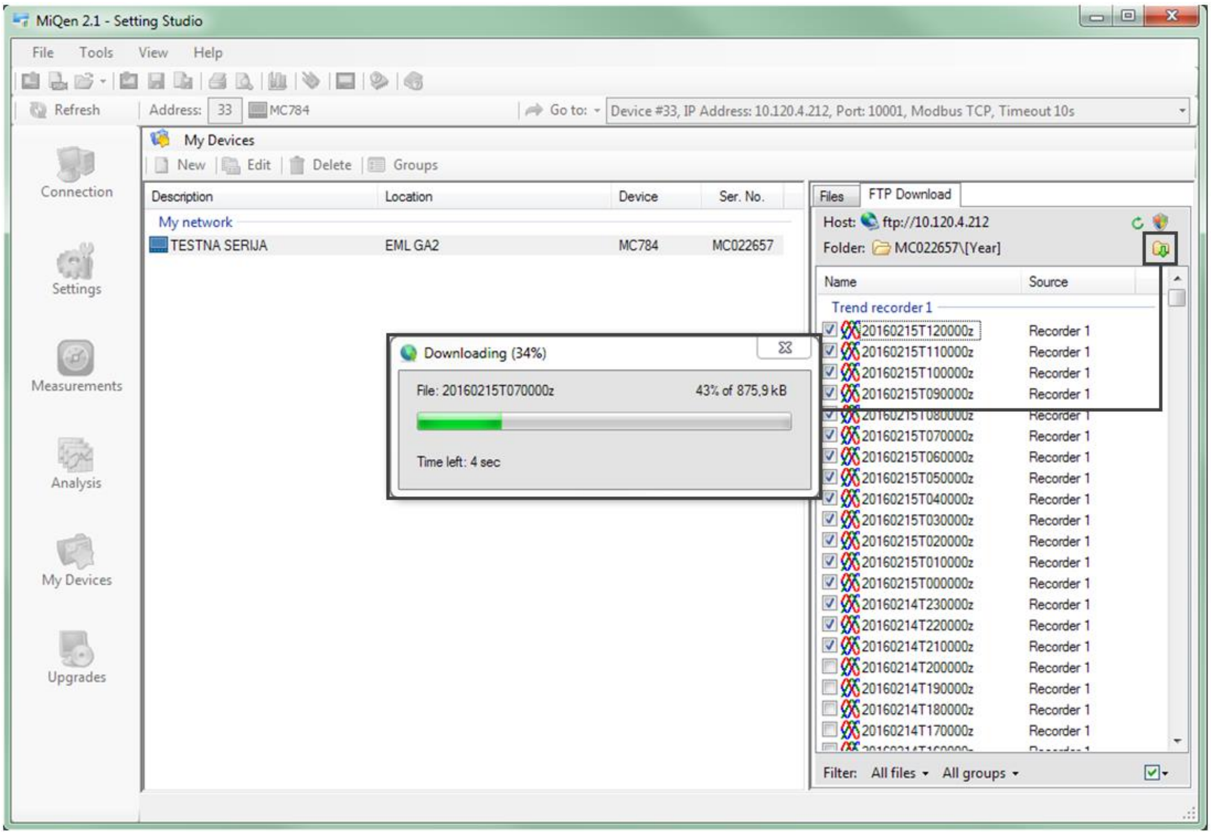
Folder: MC022657\[Year]

Name	Source
Trend recorder 1	
☐ 20160215T120000z	Recorder 1
☐ 20160215T110000z	Recorder 1
☐ 20160215T100000z	Recorder 1
☐ 20160215T090000z	Recorder 1
☐ 20160215T080000z	Recorder 1
☐ 20160215T070000z	Recorder 1
☐ 20160215T060000z	Recorder 1
☐ 20160215T050000z	Recorder 1
☐ 20160215T040000z	Recorder 1
☐ 20160215T030000z	Recorder 1
☐ 20160215T020000z	Recorder 1
☐ 20160215T010000z	Recorder 1
☐ 20160215T000000z	Recorder 1

Filter: All files

MiQen – Selection of files for download

To download the selected files click on Download selected:



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

Description	Location	Device	Ser. No.
My network			
TESTNA SERIJA	EML GA2	MC784	MC022657

Downloading (34%)

File: 20160215T070000z 43% of 875,9 kB

Time left: 4 sec

Host: ftp://10.120.4.212

Folder: MC022657\[Year]

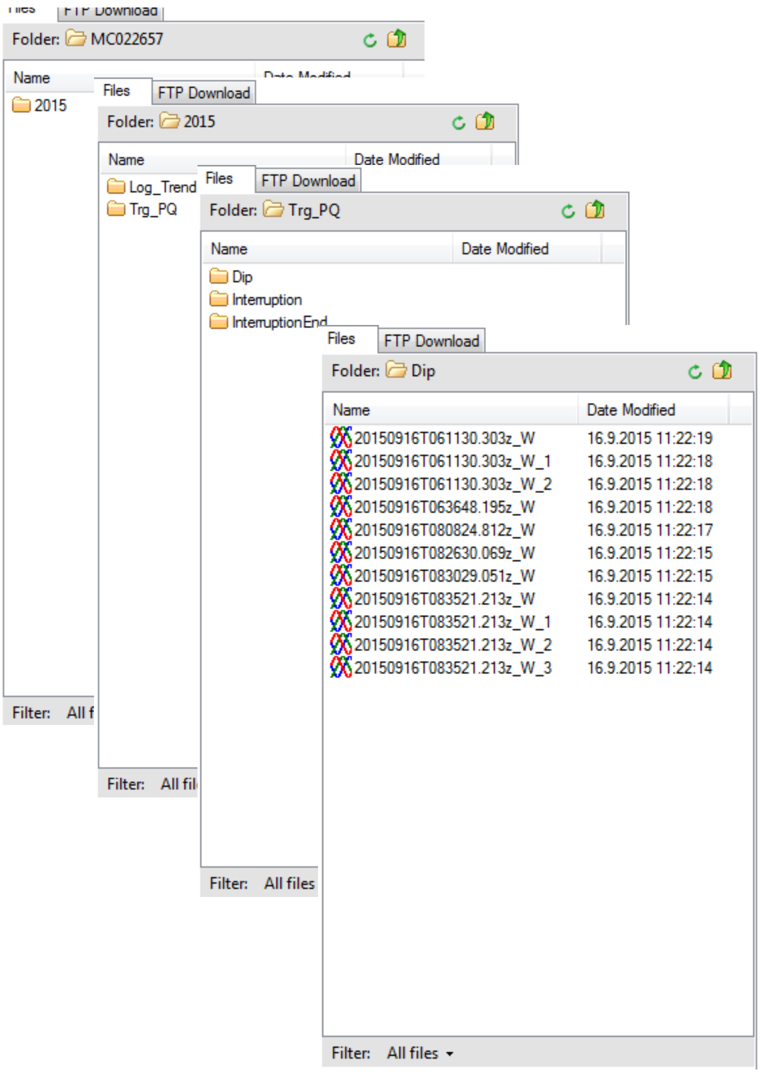
Name	Source
Trend recorder 1	
☑ 20160215T120000z	Recorder 1
☑ 20160215T110000z	Recorder 1
☑ 20160215T100000z	Recorder 1
☑ 20160215T090000z	Recorder 1
☑ 20160215T080000z	Recorder 1
☑ 20160215T070000z	Recorder 1
☑ 20160215T060000z	Recorder 1
☑ 20160215T050000z	Recorder 1
☑ 20160215T040000z	Recorder 1
☑ 20160215T030000z	Recorder 1
☑ 20160215T020000z	Recorder 1
☑ 20160215T010000z	Recorder 1
☑ 20160215T000000z	Recorder 1
☑ 20160214T230000z	Recorder 1
☑ 20160214T220000z	Recorder 1
☑ 20160214T210000z	Recorder 1
☐ 20160214T200000z	Recorder 1
☐ 20160214T190000z	Recorder 1
☐ 20160214T180000z	Recorder 1
☐ 20160214T170000z	Recorder 1

Filter: All files

MiQen – Downloading selected files

Files are saved in the previously defined folder. This folder can be found under the tab named ''files''. If you double click the files tab, you can directly open saved files with PQDiffractor, or any other PQDIF file reader that was previously installed for viewing PQDIF files (look in section PQDiffractor below). For the whole file structure and terminology please see APPENDIX F.

PQDIF files are then arranged in folders according to event type as shown below:



Folder: MC022657
- 2015

Folder: 2015
- Log_Trend
- Trg_PQ

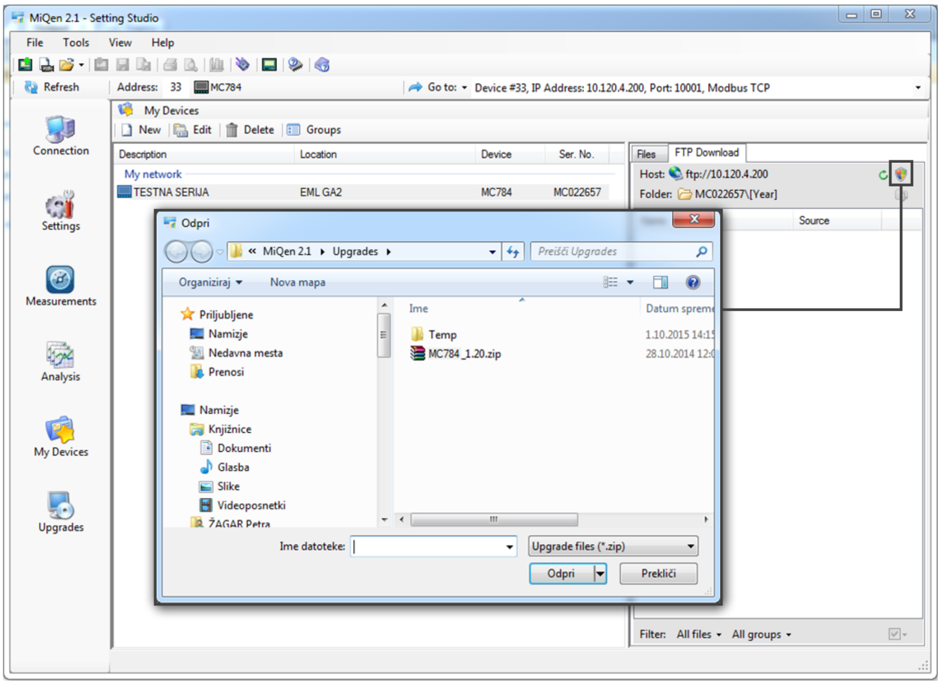
Folder: Trg_PQ
- Dip
- Interruption
- InterruptionEnd

Folder: Dip

Name	Date Modified
20150916T061130.303z_W	16.9.2015 11:22:19
20150916T061130.303z_W_1	16.9.2015 11:22:18
20150916T061130.303z_W_2	16.9.2015 11:22:18
20150916T063648.195z_W	16.9.2015 11:22:18
20150916T080824.812z_W	16.9.2015 11:22:17
20150916T082630.069z_W	16.9.2015 11:22:15
20150916T083029.051z_W	16.9.2015 11:22:15
20150916T083521.213z_W	16.9.2015 11:22:14
20150916T083521.213z_W_1	16.9.2015 11:22:14
20150916T083521.213z_W_2	16.9.2015 11:22:14
20150916T083521.213z_W_3	16.9.2015 11:22:14

MiQen - Organization of saved files

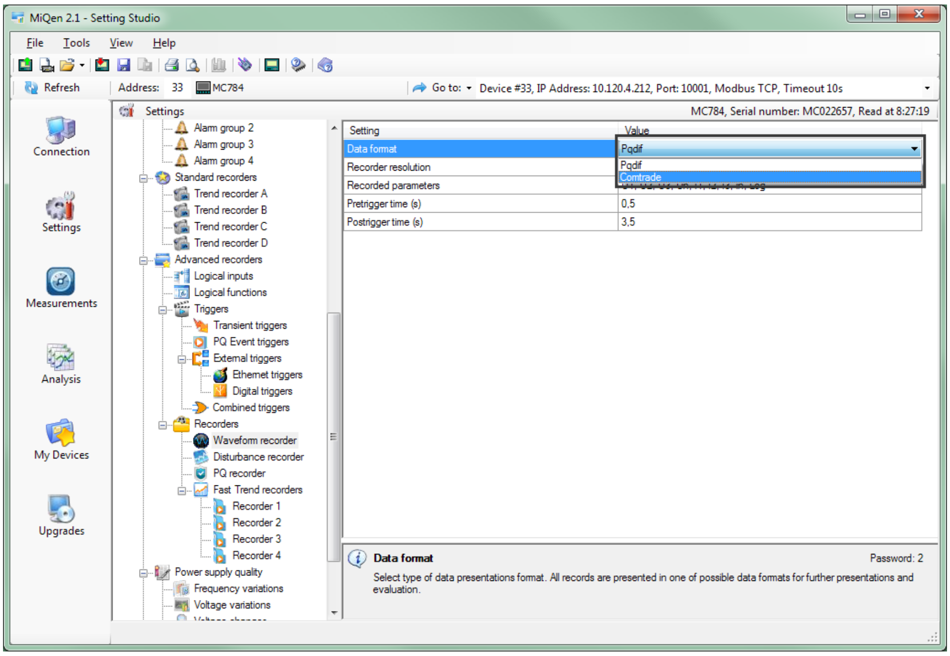
A FW upgrade process for the Power Quality Analyzer iMC784A which is currently open by clicking the icon shown in the figure below:



MiQen - Upgrade

Accessing COMTRADE files

When using Waveform or Disturbance advanced recorder the COMTRADE can be chosen:



Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

MC784, Serial number: MC022657, Read at 8:27:19

Setting	Value
Data format	Pqdif
Recorder resolution	
Recorded parameters	
Pretrigger time (s)	0,5
Postrigger time (s)	3,5

Data format Password: 2

Select type of data presentations format. All records are presented in one of possible data formats for further presentations and evaluation.

MiQen – Select COMTRADE file type for data presentations

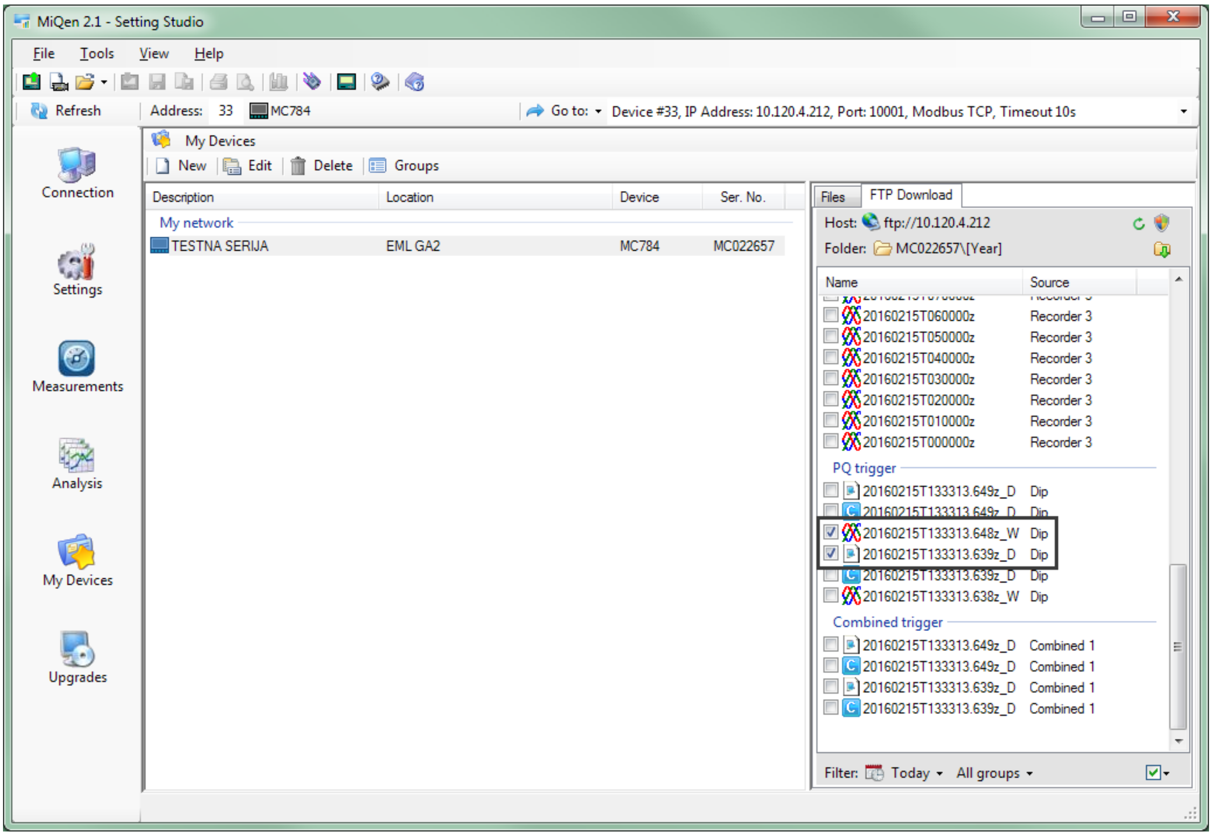
The procedure for accessing these files is the same as for accessing PQDIF files (see Chapter Accessing PQDIF files).

Under the file tab two files (.cfg and .dat file) need to be selected for storing one record in PQDIF format. Both files need to be downloaded in order to access all the data, which can then be opened as one COMTRADE document in a program such as PQDiffractor (Available free of charge for download).

The following icons denote these two file types:

.CFG FILE icon: C

.DAT FILE icon:



Address: 33 MC784

Go to: Device #33, IP Address: 10.120.4.212, Port: 10001, Modbus TCP, Timeout 10s

My Devices

Description	Location	Device	Ser. No.
My network			
TESTNA SERIJA	EML GA2	MC784	MC022657

Host: ftp://10.120.4.212

Folder: MC022657\[Year]

Name	Source
☐ 20160215T060000z	Recorder 3
☐ 20160215T050000z	Recorder 3
☐ 20160215T040000z	Recorder 3
☐ 20160215T030000z	Recorder 3
☐ 20160215T020000z	Recorder 3
☐ 20160215T010000z	Recorder 3
☐ 20160215T000000z	Recorder 3
PQ trigger	
☐ 20160215T133313.649z_D	Dip
☐ C 20160215T133313.649z_D	Dip
☑ 20160215T133313.648z_W	Dip
☑ 20160215T133313.639z_D	Dip
☐ C 20160215T133313.639z_D	Dip
☐ 20160215T133313.638z_W	Dip
Combined trigger	
☐ 20160215T133313.649z_D	Combined 1
☐ C 20160215T133313.649z_D	Combined 1
☐ 20160215T133313.639z_D	Combined 1
☐ C 20160215T133313.639z_D	Combined 1

Filter: Today All groups

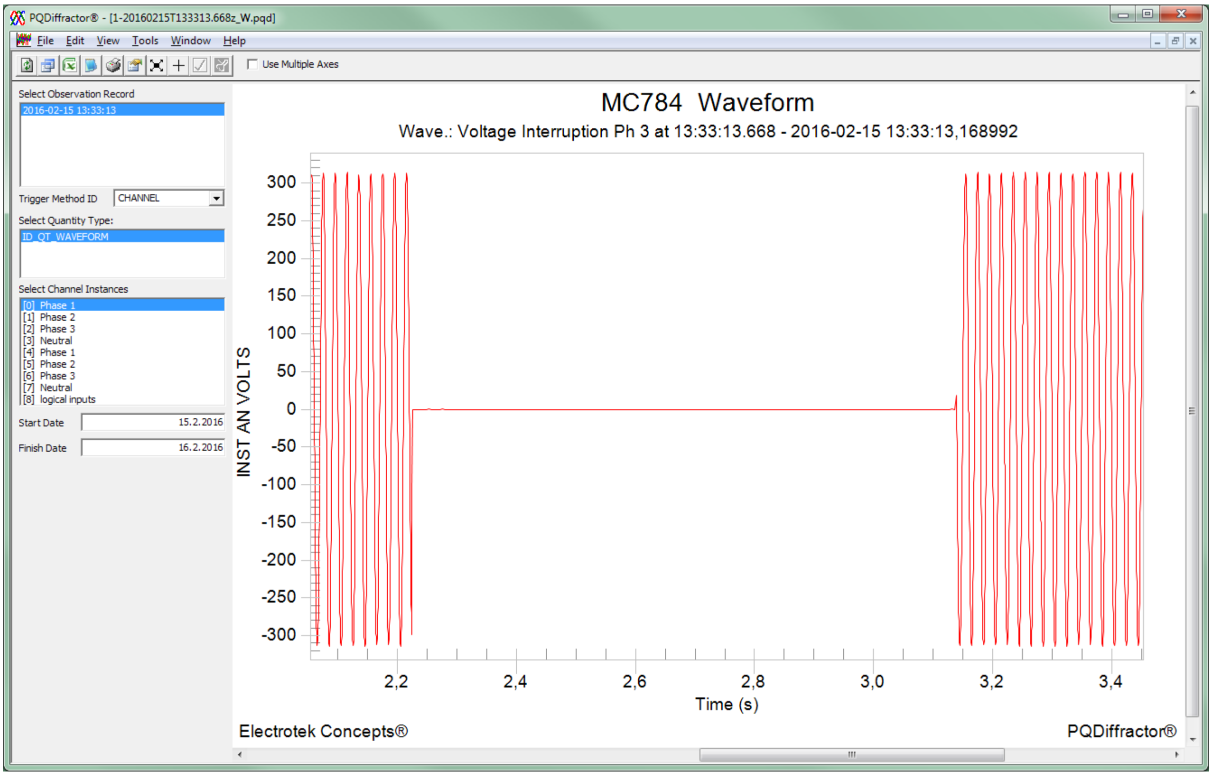
MiQen – Selecting COMTRADE files for download

Under the files tab you can find .cfg files. By clicking on the file you can also open the .dat file that was saved in the background.

PQDiffractor - PQDIF and COMTRADE file viewer

To open PQDIF and COMTRADE files we recommend installing PQDiffractor or some other program to read these files.

An example of a PQDIFF file opened in the PQDiffractor program is seen in the image below where a voltage interruption PQ event can be seen:



Select Observation Record: 2016-02-15 13:33:13

Trigger Method ID: CHANNEL

Select Quantity Type: ID_QT_WAVEFORM

Select Channel Instances:
- [0] Phase 1
- [1] Phase 2
- [2] Phase 3
- [3] Neutral
- [4] Phase 1
- [5] Phase 2
- [6] Phase 3
- [7] Neutral
- [8] logical inputs

Start Date: 15.2.2016

Finish Date: 16.2.2016

MiQen – Displaying a PQDIFF file in PQDifractor (voltage interruption action)

TECHNICAL DATA

In following chapter all technical data regarding operation of Power Quality Analyzer iMC784A is presented.

Accuracy

Accuracy is presented as percentage of reading of the measured value except when it is stated as an absolute value. All values required for PQ analysis, which should be measured according to IEC61000-4-30 correspond to Class A accuracy. The following table states accuracies as well as measuring ranges of all measured values:

Measured values	Measuring Range (Direct connection)	Accuracy class	
		Standard	Class
Active power	1.8 – 18 kW (In = 5 A)	IEC61557-12	0.2
	0 – 1.8 kW (In = 1 A)	IEC61557-12	0.5
Reactive power	0 – 18 kvar	IEC61557-12	1(0.5)
Apparent power	0 – 18 kVA	IEC61557-12	0.2
Active energy	9 digit	IEC61557-22	0.2S
Reactive energy	9 digit	IEC62053-24	0.5s
Apparent energy	9 digit	IEC61557-12	0.2

Rms current
(I_1, I_2, I_3, Iavg)
(I_{n_meas})
(I_{n_calc})
	0,001 to 12.5 Arms
	In = 1 A or 5A
	In = 1 A or 5A(1)
	In = 1 A or 5A
		IEC61557-12	
			0.1
			0.2
			0.5

Rms phase voltage (U_1, U_2, U_3, U_{n-g}, U_{avg})	U_{meas}:10 - 600 V_{L-N} U_{din} = 120/230V	IEC61557-12 IEC61000-4-30	0.1 Class A
Rms phase-to-phase voltage (U_{12}, U_{23}, U_{31}, U_{avg})	18 - 1000 V_{L-L}	IEC61557-12 IEC61000-4-30	0.1 Class A
Voltage negative sequence unbalance (2) (u_2)	10 - 600 V_{L-N}	IEC61557-12 IEC61000-4-30	0.2 Class A
Voltage zero sequence unbalance (2) (u_0)	10 - 600 V_{L-N}	IEC61557-12 IEC61000-4-30	0.2 Class A
Voltage flicker (Pst, Plt)	0.2 Pst – 10 Pst	IEC61000-4-15 IEC61000-4-30	Class F1 (2) Class A
Frequency – actual (f)	50 / 60Hz	IEC61557-12 IEC61000-4-30	0.02 Class A
Frequency - (10 s average) (f_{10s})	50 / 60 Hz	IEC61557-12 IEC61000-4-30	0.02 Class A
Nominal frequency range	16…400 Hz	IEC61557-12	0.02

(1) Accurate measurements of neutral current (I_{n_meas}) at lower frequencies (16Hz – 30Hz) are possible up to 6Arms

(2) Voltage unbalance is measured as amplitude and phase unbalance U_{nb}

Measured values	Measuring Range (Direct connection)	Accuracy class	
		Standard	Class
Power factor (PF_A)	−1(C)…0…+1(L)	IEC61557-12	0.5
Voltage swells (U_{swl})	100 – 120 % U_{din}	IEC61557-12 IEC61000-4-30	0.2, ±1 cyc Class A
Volatge dips (U_{dip})	5 – 100 % U_{din}	IEC61557-12 IEC61000-4-30	0.2, ±1 cyc Class A
Voltage interruptions (U_{int})	0 – 5 % U_{din}	IEC61557-12 IEC61000-4-30	±1 cyc Class A
THDU[3]	10 – 200% of IEC61000-4-2 Class 3 Up to 4kHz	IEC61557-12 IEC61000-4-7 IEC61000-4-30	0.3 Class I Class A
Voltage harmonics (U_{h_l-n}, U_{h_l-l})	10 – 200% of IEC61000-4-2 Class 3 Up to 4kHz (63rd)	IEC61557-12 IEC61000-4-7 IEC61000-4-30	0.15 Class I Class A
Voltage interharmonics (U_{Ih})	10 – 200% of IEC61000-4-2 Class 3	IEC61000-4-7 IEC61000-4-30	Class I Class A
THDI[4]	Up to 4kHz	IEC61557-12	0.3
Current harmonics (I_h)	Up to 4kHz (63rd)	IEC61557-12	0.5
Signaling voltage (U_{msv})	Up to 3kHz	IEC61000-4-30	Class A
Real time clock (RTC)	synchronized unsynchronized	IEC61000-4-30	Class A < ±1 sec/day

[3] Test specifications for flickermeter according to standard IEC61000-4-15:2010

[4] When measuring THD, user can set how it is calculated (as a % of fundamental or as a % from RMS value)

Measurement inputs

Frequency:

Nominal frequency range	50, 60 Hz
Measuring frequency range	16 – 400 Hz

Voltage measurements:

Number of channels	4 (1)
Min. voltage for sync.	1 V_{rms}
Nominal value (U_N)	500 V_{LN} , 866 V_{LL}
Max. measured value (cont.)	600 V_{LN} ; 1000 V_{LL}
Max. allowed value	1.2 × U_N permanently
	2 × U_N ; 10 s
Consumption	< U^2 / 4.2 MΩ per phase
Input impedance	4.2 MΩ per phase

(1) 4th channel is used for measuring $U_{\text{EARTH-NEUTRAL}}$

Current measurements:

Number of channels	4
Nominal value (I_{NOM})	1 A, 5 A
Max. measured value (I_1-I_3 only)	12.5 A sin.
Max. allowed value (thermal)	15 A cont.
	≤ 300 A; 1s
Consumption	< I^2 × 0.01 Ω per phase

Sampling and resolution:

Transient sampling	32 µs (625 Samples per Cycle)
ADC resolution	24 bit 8-ch simultaneous inputs
Reading refresh rate	100 ms – 5 s (User defined)

System:

Voltage inputs can be connected either directly to low-voltage network or via a VT to higher voltage network. Current inputs can be connected either directly to low-voltage network or shall be connected to network via a corresponding CT (with standard 1 A or 5 A outputs).

Connection

Power Quality Analyzer iMC784A is equipped with terminals for voltage/current inputs, power supply, communications and I/O modules. Power Quality Analyzer iMC784A current input cables shall be attached as through-hole connection without screwing.

⚠ **PLEASE NOTE**

Stranded wire must be used with insulated end sleeve to assure firm connection.

Terminals	Max. conductor cross-sections DIN / ANSI housing
Voltage inputs (4)	≤ 2.5 mm², AWG 24-12 single wire
Current inputs (3)	≤ Ø 6 mm one conductor with insulation
Current inputs – neutral (1)	≤ Ø 5 mm one conductor with insulation
Supply (2)	≤ 2.5 mm², AWG 24-12 single wire
I/O (31)	≤ 2.5 mm², AWG 24-12 single wire

Connection table

Function			Terminals	Comment
Measuring input	AC current	IL1	1/3	⚠ CAT III 600V
		IL2	4/6	
		IL3	7/9	
		ILN	26/27	
	AC voltage	UL1	2	⚠ CAT III 600V
		UL2	5	
		UL3	8	
		UN	11	
Inputs / outputs	I/O module 1/2	+ / ~	15	I/O function depends on type of I/O module
		– / ~ (common)	16	
		+ / ~	17	
	I/O module 3/4	+ / ~	18	
		– / ~ (common)	19	
		+ / ~	20	
	I/O module A	– / ~ (common)	30	
		+ / ~	31 - 38	
	I/O module B	– / ~ (common)	40	
		+ / ~	41 - 48	
	I/O module C	⊙ BNC input	BNC	IRIG-B modulated (1kHz) time sync. signal
		1 pps	53	TTL level 1 pps time sync. Signal or IRIG-B digital
		RS485	54, 55	A – 54, B – 55
		MODEM/RS232	56-59	Rx – 56, GND – 57, Tx – 58, +5V - 59
Auxiliary power supply		+ / ~ (L)	13	⚠ CAT III 300V
		– / ~ (N)	14	
		⏚	12	⚠ GROUND terminal must always be connected!
Communication		USB	Type B	USB 2.0 type B
		ETHERNET	RJ-45	10/100 BASE-TX Ethernet

Communication

Power Quality Analyzer iiMC784A is equipped with standard communication port COM1 and auxiliary communication port COM2. This allows two different users to access data from a device simultaneously and by using TCP/IP communication, data can be accessed worldwide.

The device is equipped with the following configuration:

Configuration(1)	COM1	COM2(2)
	Ethernet & USB	RS232/485

(1) Galvanic separation between Eth. and USB is 1 kV_{ACRMS}. USB can be used as service port.

(2) COM2 is NOT available if GPS time synchronization is used

Power Quality Analyzer iMC784A communication configuration

Standard communication protocols MODBUS RTU, MODBUS TCP and DNP3 L1 are supported with IEC61850 Ed.2 optionally (see appendix G).

Input/Output modules

Power Quality Analyzer iMC784A is equipped with two main I/O slots, two auxiliary I/O slots and special time-synchronization module. The following I/O modules are available:

Module type	Number of modules per slot	
	Main slot	Aux slot
Analogue output (AO)	2	/
Analogue input (AI)	2	/
Pulse output (PO)	2	/
Pulse input (PI)	2	/
Tariff input (TI)	2	/
Relay output (RO)	2	8
Digital input (DI)	2	8
Bistable alarm output (BO)	1	/
Watchdog / Relay output	WO / RO	/

List of available I/O modules

Analogue input (AI):

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, wind speed …)

DC current input:

Nominal input range	–20 … 0 … 20 mA (±20%)
input resistance	20 Ω
accuracy	0.5 % of range
temperature drift	0.01 % / °C
conversion resolution	16 bit (sigma-delta)
Analogue input mode	internally referenced Single-ended

DC voltage input:

Nominal input range	–10 … 0 … 10 V (±20%)
input resistance	100 kΩ
accuracy	0.5 % of range
temperature drift	0.01 % / °C
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*

Analogue output (AO):

Output range	0 … 20 mA
Accuracy	0.5 % of range
Max. burden	150 Ω
Linearization	Linear, Quadratic
No. of break points	5
Output value limits	± 120 % of nominal output
Response time (measurement and analogue output)	depends on set general average interval (0.1 s … 5 s)
Residual ripple	< 1 % p.p.

Outputs may be either short or open-circuited. They are electrically insulated from each other and from all other circuits. Output range values can be altered subsequently (zoom scale) using the setting software, but a supplementary error results.

Digital input (DI)

Purpose	Tariff input, Pulse input, General purpose digital input
Max. current	8 mA (48 V), <0.6 mA (110, 230 V)
SET voltage	40 ... 120 % of rated voltage
RESET voltage	0 ... 10 % of rated voltage
Tariff input	Main slot only
Rated voltage	(5 … 48), 110, 230 ± 20 % $V_{AC/DC}$
Frequency range	45 … 65 Hz
Pulse input	Main slot only
Rated voltage	5 – 48 V_{DC}
Min. pulse width	0.5 ms
Min. pulse period	2 ms
Digital input	(5 … 48), 110, 230 ± 20 % $V_{AC/DC}$
Min. signal width	20 ms
Min. pause width	40 ms

Bistable alarm output (BO)

Type	Relay switch
Purpose	Alarm output, General purpose digital output
Rated voltage	230 $V_{AC/DC}$ ± 20 % max
Max. switching current	1000 mA (main slot)
	100 mA (aux. slot, DO only)
Contact resistance	≤ 100 mΩ (100 mA, 24 V)
Impulse	Max. 4000 imp/hour
	Min. length 100 ms

Status (watchdog) output (WO)

Type	Relay switch
Normal operation	Relay in ON position
Failure detection delay	≈ 1.5 s
Rated voltage	230 $V_{AC/DC}$ ±20% max
Max. switching current	1000 mA
Contact resistance	≤ 100 mΩ (100 mA, 24 V)

Pulse output (PO)

Type	Optocoupler open collector switch
Purpose	Pulse output
Rated voltage	40 $V_{AC/DC}$
Max. switching current	30 mA (R_{ONmax} = 8 Ω)
Pulse length	programmable (2 … 999 ms)

Time synchronization input

Digital input	GPS or IRIG-B TTL
1pps voltage level	TTL level (+5 V)
Time code telegram	RS232 (GPS) DC level shift (IRIG-B)
AM analogue input	IRIGB-B AM modulated
Carrier frequency	1 kHz
Input impedance	600 Ohms
Amplitude	2.5 V_{P-Pmin}, 8 V_{P-Pmax}
Modulated ratio	3:1 – 6:1

Safety

Protection	protection class II
⚠ ⧈	Functional earth terminal must be connected to earth potential! Voltage inputs via high impedance Double insulation for I/O ports and COM ports
Pollution degree	2
Installation category	CAT III ; 600 V
Measuring inputs	CAT IV ; 300 V Acc. to EN 61010-1
Test voltages	UAUX↔I/O, COM1: 3510 VACrms UAUX↔U, I inputs: 3510 VACrms U, I inputs↔I/O, COM1: 3510 VACrms HV I/O ↔ I/O, COM1: 3510 VACrms U inputs↔I inputs: 3510 VACrms

Time synchronization input

Digital input	GPS or IRIG-B TTL
1pps voltage level	TTL level (+5 V)
Time code telegram	RS232 (GPS) DC level shift (IRIG-B)
AM analogue input	IRIGB-B AM modulated
Carrier frequency	1 kHz
Input impedance	600 Ohms
Amplitude	2.5 V_{P-Pmin}, 8 V_{P-Pmax}
Modulated ratio	3:1 – 6:1

Auxiliary Power Supply

Measurement category	CAT III 300V
Nominal voltage AC	100 … 240 V; -20%...+15%
Nominal frequency	40 … 65 Hz
Nominal voltage DC	100 … 250 V; ± 20%
Consumption (typical)	< 8 VA
Consumption (max. all I/O)	< 12 VA (iMC784A) < 13 VA (iMC784A)
Power-on transient current	< 20 A ; 1 ms

Mechanical

Dimensions	144 × 144 × 100 mm
Mounting	Panel mounting 144 × 144 mm
Required mounting hole	138 × 138 mm
Enclosure material	PC / ABS
Flammability	Acc. to UL 94 V-0
Weight	550 g
Enclosure material	PC / ABS Acc. to UL 94 V-0

Ambient conditions

Ambient temperature	K55 temperature class
	Acc. to EN61557-12
	-10 … 55 °C
Storage temperature	-40 … +70 °C
Average annual humidity	≤ 90% r.h. (no condensation)
Pollution degree	2
Enclosure protection	IP 40 (front plate) IP 20 (rear side)
Installation altitude	≤ 2000 m

Real time clock

A built-in real time clock is also without external synchronization very stable when Power Quality Analyzer iMC784A is connected to auxiliary power supply. For handling shorter power interruptions without influence on RTC, device uses high capacity capacitor. It ensures auxiliary supply (for internal RTC only) for more than two days of operation.

Type	Low power embedded RTC
RTC stability	< 1 sec / day

Operating conditions

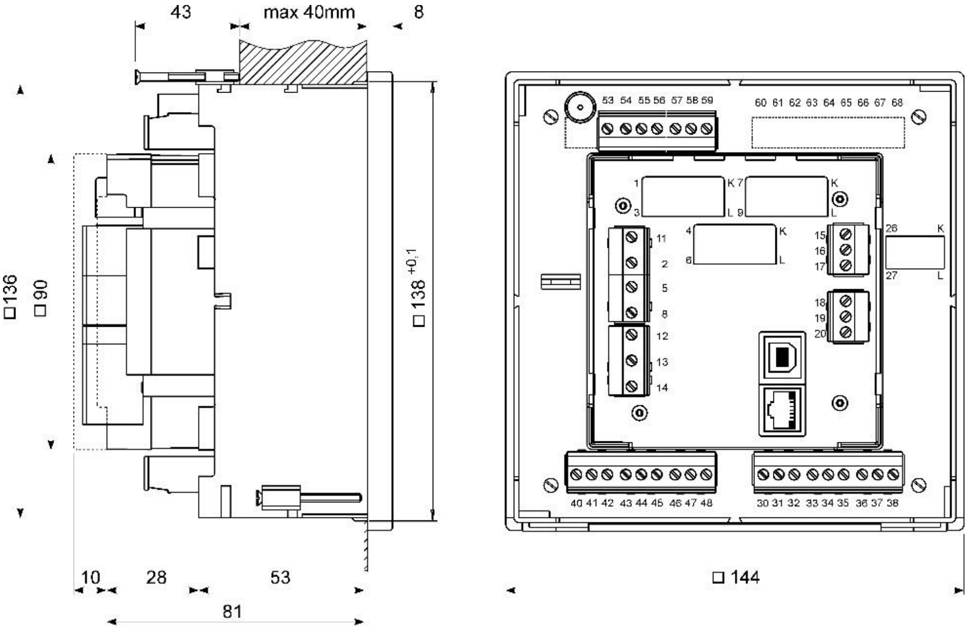
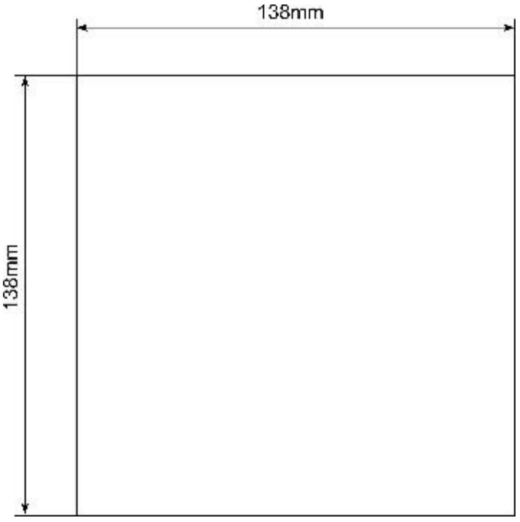
Operating conditions which have been tested for proper operation of Power Quality Analyzer iMC784A within specified accuracy are in accordance with requirements in standards IEC 61557-12, IEC 61326-1, IEC 61000-4-30 and IEC 61000-4-7

Ambient conditions	Ambient temperature	K55 temperature class Acc. to EN 61557-12 -10 … 55 °C
	Storage temperature range	-40 … +70 °C
	Ambient humidity	≤ 75% r.h. (no condensation)
	Max. storage and transport humidity	≤ 90% r.h. (no condensation)
	Voltage and Current max. temperature influence limit	± 20 ppm / K (10 V … 600 V; 0,05 A … 10 A) (T_{amb} : -30 °C … +70 °C)
Influence of Auxiliary Supply	Voltage and Current max. aux. supply change influence limit (IEC 61557-12)	< ± 0,02 % (Supply voltage magnitude and frequency in a specified range)
	Common mode input voltage rejection (IEC 61557-12)	< ± 0,08 % (common mode voltage at 500 V)
Influence of 2014/30/EU	External A.C. field IEC 61326-1	< ±0,02 % Performance criteria A
	Electrostatic discharges IEC 61326-1	(IEC 61000-4-2) Performance criteria B
	Electromagnetic RF fields IEC 61326-1	(IEC 61000-4-3) Limit 1 %; < ±0,4 % (a) Performance criteria A
	Conducted disturbances IEC 61326-1	(IEC 61000-4-6) Limit 1 %; < ±0,4 % (a) Performance criteria A

(a) Test performed my measuring active energy with pulse output. Error (0.4%) is due to short measuring time

Dimensions

Dimensional drawing (All dimensions are in mm)

Construction	Appearance	
Dimensions	 43 max 40mm 8 □136 □90 □138 +0,1 10 28 53 81 □144 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 1 3 K 7 L 9 K L 4 6 K L 11 2 5 8 12 13 14 15 16 17 18 19 20 26 K 27 L 40 41 42 43 44 45 46 47 48 30 31 32 33 34 35 36 37 38	
Panel cut-out		
Enclosure		
	Dimensions	144 × 144 ×100 mm
	Mounting	Panel mounting 144×144 mm
	Required mounting hole	138 × 138 mm
	Enclosure material	PC/ABS
	Flammability	Acc. to UL 94 V-0
	Weight	550 g
	Enclosure material	PC/ABS

APPENDICES

APPENDIX A: MODBUS 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 Power Quality Analyzer iMC784A. The response is the same type as the request.

Modbus

Modbus protocol enables operation of device on Modbus networks. For Power Quality Analyzer iMC784A 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.
In this document main modbus registers are listed. For complete, latest, Modbus table please visit ISKRA web site.
The memory reference for input and holding registers is 30000 and 40000 respectively.

PLEASE NOTE

For the latest and complete MODBUS table please visit ISKRA web page.

Register table for the actual measurements

Parameter	MODBUS		
	Register		Type
	Start	End	
Actual time	30101	30104	T_Time
Frequency	30105	30106	T5
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
Voltage neutral to ground Uno$_{\sim}$	30485	30486	T5
Voltage Zero sequence U0	35201	35202	T5
Voltage Positive sequence U1	35203	35204	T5
Voltage Negative sequence U2	35205	35206	T5
Current I_1	30126	30127	T5
Current I_2	30128	30129	T5
Current I_3	30130	30131	T5
Neutral Current Inc (calculated)	30132	30133	T5
Neutral Current Inm (measured)	30134	30135	T5
Average Current	30136	30137	T5
Total Current I	30138	30139	T5
Current Zero sequence I0	35207	35208	T5
Current Positive sequence I1	35209	35210	T5
Current Negative sequence I2	35211	35212	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 Q1	30150	30151	T6
Reactive Power Q2	30152	30153	T6
Reactive Power Q3	30154	30155	T6
Total Reactive Power Q	30148	30149	T6
Fundamental reactive power Total (Qbt)	35221	35222	T6
Fundamental reactive power Phase L1 (Qb1)	35223	35224	T6
Fundamental reactive power Phase L2 (Qb2)	35225	35226	T6
Fundamental reactive power Phase L3 (Qb3)	35227	35228	T6
Apparent Power S1	30158	30159	T5
Apparent Power S2	30160	30161	T5
Apparent Power S3	30162	30163	T5
Total Apparent Power S	30156	30157	T5
Deformed power Total (Dt)	35229	35230	T6
Deformed power Phase L1 (D1)	35231	35232	T6
Deformed power Phase L2 (D2)	35233	35234	T6
Deformed power Phase L3 (D3)	35235	35236	T6

Register table for the actual measurements

Parameter	MODBUS		
	Register		Type
	Start	End	
Power Factor PF1	30166	30167	T7
Power Factor PF2	30168	30169	T7
Power Factor PF3	30170	30171	T7
Total Power Factor PF	30164	30165	T7
Displacement Power Factor Total (dPFt)	35213	35214	T7
Displacement Power Factor Phase 1 (dPF1)	35215	35216	T7
Displacement Power Factor Phase 2 (dPF2)	35217	35218	T7
Displacement Power Factor Phase 3 (dPF3)	35219	35220	T7
Power Angle U1−I1	30173		T17
Power Angle U2−I2	30174		T17
Power Angle U3−I3	30175		T17
Angle between In and Un	30488		T17
Power Angle atan2(Pt, Qt)	30172		T17
Angle U1−U2	30115		T17
Angle U2−U3	30116		T17
Angle U3−U1	30117		T17
Angle Un−U1	30487		T17
Voltage unbalance Uu	30176		T16
Voltage unb. zero sequence Uo	30177		T16
U1 Signal voltage Abs	30592	30593	T5
U2 Signal voltage Abs	30594	30595	T5
U2 Signal voltage Abs	30596	30597	T5
THD I1	30188		T16
THD I2	30189		T16
THD I3	30190		T16
THD U1	30182		T16
THD U2	30183		T16
THD U3	30184		T16
THD U12	30185		T16
THD U23	30186		T16
THD U31	30187		T16
Internal Temperature	30181		T2
DC Voltage U1	30471	30472	T6
DC Voltage U2	30473	30474	T6
DC Voltage U3	30475	30476	T6
DC Voltage U12	30477	30478	T6
DC Voltage U23	30479	30480	T6
DC Voltage U31	30481	30482	T6
DC Voltage Un	30483	30484	T6
TDD I1	30491		T16
TDD I2	30492		T16
TDD I3	30493		T16
K factor I1	30494		T16
K factor I2	30495		T16
K factor I3	30496		T16
CREST factor I1	30497		T1
CREST factor I2	30498		T1
CREST factor I3	30499		T1

Register table for the actual measurements

Parameter	MODBUS		
	Register		Type
	Start	End	
CREST factor U1	30568		T1
CREST factor U2	30569		T1
CREST factor U3	30570		T1
CREST factor U12	30571		T1
CREST factor U23	30572		T1
CREST factor U31	30573		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 I1	30518	30519	T5
MD Current I2	30524	30525	T5
MD Current I3	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 – C	30516	30517	T6
MD Apparent Power S	30508	30509	T5
MD Current I1	30502	30503	T5
MD Current I2	30504	30505	T5
MD Current I3	30506	30507	T5

Register table for the actual measurements

Parameter	MODBUS		
	Register		Type
	Start	End	
Energy			
Energy Counter 1 Exponent	30401		T2
Energy Counter 2 Exponent	30402		T2
Energy Counter 3 Exponent	30403		T2
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
Counter E1 Tariff 1	30414	30415	T3
Counter E2 Tariff 1	30416	30417	T3
Counter E3 Tariff 1	30418	30419	T3
Counter E4 Tariff 1	30420	30421	T3
Counter E1 Tariff 2	30422	30423	T3
Counter E2 Tariff 2	30424	30425	T3
Counter E3 Tariff 2	30426	30427	T3
Counter E4 Tariff 2	30428	30429	T3
Counter E1 Tariff 3	30430	30431	T3
Counter E2 Tariff 3	30432	30433	T3
Counter E3 Tariff 3	30434	30435	T3
Counter E4 Tariff 3	30436	30437	T3
Counter E1 Tariff 4	30438	30439	T3
Counter E2 Tariff 4	30440	30441	T3
Counter E3 Tariff 4	30442	30443	T3
Counter E4 Tariff 4	30444	30445	T3
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

Actual counter is calculated:

Cnt.× 10^{exponent}

Register table for the actual measurements

Parameter	MODBUS		
	Register		Type
	Start	End	
Flickers			
Flicker Pst1	30580		T17
Flicker Pst2	30581		T17
Flicker Pst3	30582		T17
Flicker Plt1	30583		T17
Flicker Plt2	30584		T17
Flicker Plt3	30585		T17
Flicker Pf5 - L1	30586	30587	T5
Flicker Pf5 - L2	30588	30589	T5
Flicker Pf5 - L3	30590	30591	T5
Phase voltage harmonic data			
U1 Harmonic Data			
Base for % calculation	31001	31002	T5
U1 1 Harmonic Abs %	31003		T16
U1 1 Harmonic Phase Angle	31004		T17
U1 Harmonics from 2 to 62			
U1 63 Harmonic Abs %	31127		T16
U1 63 Harmonic Phase Angle	31128		T17
U2 Harmonic Data			
Base for % calculation	31129	31130	T5
U2 1 Harmonic Abs %	31131		T16
U2 1 Harmonic Phase Angle	31132		T17
U2 Harmonics from 2 to 62			
U2 63 Harmonic Abs %	31255		T16
U2 63 Harmonic Phase Angle	31256		T17
U3 Harmonic Data			
Base for % calculation	31257	31258	T5
U3 2 Harmonic Abs %	31259		T16
U3 2 Harmonic Phase Angle	31260		T17
U3 Harmonics from 3rd to 30th			
U3 63 Harmonic Abs %	31383		T16
U3 63 Harmonic Phase Angle	31384		T17

Register table for the actual measurements

Parameter	MODBUS Register Start	 End	 Type
Line voltage harmonic data			
U12 Harmonic Data			
Base for % calculation	31385	31386	T5
U12 1 Harmonic Abs %	31387		T16
U12 1 Harmonic Phase Angle	31388		T17
U12 Harmonics from 2 to 62			
U12 63 Harmonic Abs %	31511		T16
U12 63 Harmonic Phase Angle	31512		T17
U23 Harmonic Data			
Base for % calculation	31513	31514	T5
U23 1 Harmonic Abs %	31515		T16
U23 1 Harmonic Phase Angle	31516		T17
U23 Harmonics from 2 to 62			
U23 63 Harmonic Abs %	31639		T16
U23 63 Harmonic Phase Angle	31640		T17
U31 Harmonic Data			
Base for % calculation	31641	31642	T5
U31 2 Harmonic Abs %	31643		T16
U31 2 Harmonic Phase Angle	31644		T17
U31 Harmonics from 3rd to 30th			
U31 63 Harmonic Abs %	31767		T16
U31 63 Harmonic Phase Angle	31768		T17

Register table for the actual measurements

Parameter	MODBUS Register Start	 End	 Type
Phase current harmonic data			
I1 Harmonic Data			
Base for % calculation	31769	31770	T5
I1 1 Harmonic Abs %	31771		T16
I1 1 Harmonic Phase Angle	31772		T17
I1 Harmonics from 2 to 62			
I1 63 Harmonic Abs %	31895		T16
I1 63 Harmonic Phase Angle	31896		T17
I2 Harmonic Data			
Base for % calculation	31897	31898	T5
I2 1 Harmonic Abs %	31899		T16
I2 1 Harmonic Phase Angle	31900		T17
I2 Harmonics from 2 to 62			
I2 63 Harmonic Abs %	32023		T16
I2 63 Harmonic Phase Angle	32024		T17
I3 Harmonic Data			
Base for % calculation	32025	32026	T5
I3 2 Harmonic Abs %	32027		T16
I3 2 Harmonic Phase Angle	32028		T17
I3 Harmonics from 3rd to 30th			
I3 63 Harmonic Abs %	32151		T16
I3 63 Harmonic Phase Angle	32152		T17

Register table for the actual measurements

Parameter	MODBUS		
	Register		Type
	Start	End	
Phase voltage interharmonic data			
U1 Interharmonic Data			
Base for % calculation	32153	32154	T5
1. Interharmonic Abs %	32155		T16
2. Interharmonic Abs %	32156		T16
3. - 10 Interharmonic	32157	32164	T16
63 Interharmonic Abs %	36405	36466	T16
U2 Interharmonic Data			
Base for % calculation	32471	32472	T5
1. Interharmonic Abs %	32173		T16
2. Interharmonic Abs %	32174		T16
3. - 10 Interharmonic	32175	32182	T16
63 Interharmonic Abs %	36471	36532	T16
U3 Interharmonic Data			
Base for % calculation	32189	32190	T5
1. Interharmonic Abs %	32191		T16
2. Interharmonic Abs %	32192		T16
3. - 10 Interharmonic	32193	32200	T16
63 Interharmonic Abs %	36537	36598	T16
Phase to phase voltage interharmonic data			
U12 Interharmonic Data			
Base for % calculation	32417	32418	T5
1. Interharmonic Abs %	32419		T16
2. Interharmonic Abs %	32420		T16
3. - 10 Interharmonic	32421	32428	T16
63 Interharmonic Abs %	36603	36664	T16
U23 Interharmonic Data			
Base for % calculation	32435	32436	T5
1. Interharmonic Abs %	32437		T16
2. Interharmonic Abs %	32438		T16
3. - 10 Interharmonic	32439	32446	T16
63 Interharmonic Abs %	36669	36730	T16
U31 Interharmonic Data			
Base for % calculation	32453	32454	T5
1. Interharmonic Abs %	32455		T16
2. Interharmonic Abs %	32456		T16
3. - 10 Interharmonic	32457	32464	T16
63 Interharmonic Abs %	36735	36796	T16

All other MODBUS registers are a subject to change. For the latest MODBUS register definitions go to ISKRA web page http://www.ISKRA.eu or contact ISKRA support.

Register table for the basic settings

Register	Content	Type	Ind	Values / Dependencies	Min	Max	Pass. Level
40143	Connection Mode	T1	0	No mode	1	5	2
			1	1b - Single Phase			
			2	3b - 3 phase 3 wire balanced			
			3	4b - 3 phase 4 wire balanced			
			4	3u - 3 phase 3 wire unbalanced			
			5	4u - 3 phase 4 wire unbalanced			
40144	CT Secondary	T4		mA			2
40145	CT Primary	T4		A/10			2
40146	VT Secondary	T4		mV			2
40147	VT Primary	T4		V/10			2
40148	Current input range (%)	T16		10000 for 100%	5,00	200,00	2
40149	Voltage input range (%)	T16		10000 for 100%	2,50	100,00	2
40150	Frequency nominal value	T1		Hz	10	1000	2

Data types decoding

Type	Bit mask	Description
T1		Unsigned Value (16 bit) Example: 12345 = 3039(16)
T2		Signed Value (16 bit) Example: -12345 = CFC7(16)
T3		Signed Long Value (32 bit) Example: 123456789 = 075B CD15(16)
T4	bits # 15…14 bits # 13…00	Short Unsigned float (16 bit) Decade Exponent(Unsigned 2 bit) Binary Unsigned Value (14 bit) Example: 10000*1^{02} = 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)

Data types decoding

Type	Bit mask	Description
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_float	 bits # 31 bits # 31 bits # 31	IEEE 754 Floating-Point Single Precision Value (32bit) Sign Bit (1 bit) Exponent Field (8 bit) Significand (23 bit) Example: 123.45 stored as 123.45000 = 42F6 E666(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)

APPENDIX B: 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 Power Quality Analyzer iMC784A. The response is the same type as the request.

DNP3

DNP3 protocol enables operation of a device on DNP3 networks. For Power Quality Analyzer iMC784A 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.
Power Quality Analyzer iMC784A automatically responses to MODBUS or DNP3 request.

PLEASE NOTE

For the latest and complete DNP3 table please visit ISKRA web page.

DNP 3.0 Device Profile Document	Issue: E Date: 8 Jan 2013
Device Name: Measurement center Vendor Name: ISKRA d.o.o. Models Covered: iMC784A	
Highest DNP Level Supported: For Requests: 1 For Responses: 1	Device Function: ☐ Master ☑ Slave
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the DNP V3.0 Implementation table):	
Maximum Data Link Frame Size (octets): Transmitted: 292 Received: 249 Maximum Data Link Re-tries: ☑ None ☐ Configurable	Maximum Application Fragment Size (octets): Transmitted: 2048 Received: 249 Maximum Application Layer Re-tries: ☑ None ☐ Configurable
Requires Data Link Layer Confirmation: ☑ Never ☐ Always ☐ Sometimes ☐ Configurable	
Requires Application Layer Confirmation: ☑ Never ☐ Always ☐ Sometimes ☐ Configurable	

Timeouts while waiting for:
Data Link Confirm: ☑ **None** ☐ Fixed at _____ ☐ Variable ☐ Configurable
Complete Appl. Fragment: ☑ **None** ☐ Fixed at _____ ☐ Variable ☐ Configurable
Application Confirm: ☑ **None** ☐ Fixed at _____ ☐ Variable ☐ Configurable
Complete Appl. Response: ☑ **None** ☐ Fixed at _____ ☐ Variable ☐ Configurable
Others:

Sends/Executes Control Operations:
WRITE Binary Outputs ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable
SELECT/OPERATE ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable
DIRECT OPERATE ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable
DIRECT OPERATE – NO ACK ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable

Count > 1 ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable
Pulse On ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable
Pulse Off ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable
Latch On ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable
Latch Off ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable

Queue ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable
Clear Queue ☑ **Never** ☐ Always ☐ Sometimes ☐ Configurable

Reports Binary Input Change Events when no specific variation requested: ☑ **Never** ☐ Only non-time-tagged ☐ Configurable	Reports time-tagged Binary Input Change Events when no specific variation requested: ☑ **Never** ☐ Binary Input Change With Relative Time ☐ Configurable
Sends Unsolicited Responses: ☑ **Never** ☐ Configurable ☐ Only certain Objects ☐ Sometimes ☐ ENABLE/DISABLE UNSOLICITED Function codes supported	Sends Static Data in Unsolicited Responses: ☑ **Never** ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted.
Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable ☑ **Default Object: 30** ☑ **Default Variation: 4** **Point-by-point list attached**	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable ☐ 16 Bits ☐ 32 Bits ☑ **Other Value: 20000** **Point-by-point list attached**

Sends Multi-Fragment Responses:
☐ Yes
☑ **No**

Object			Request		Response	
Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
0	242	Device Attributes - software version	1	0	129	00, 17
0	243	Device Attributes – hardware version	1	0	129	00, 17
0	246	Device Attributes – user assigned ID	1	0	129	00, 17
0	248	Device Attributes – serial number	1	0	129	00, 17
0	250	Device Attributes – product name	1	0	129	00, 17
0	252	Device Attributes – manufacture name	1	0	129	00, 17
0	254	Device Attributes – nonspecific all attributes request	1	00, 06		
0	255	Device Attributes – list of attribute variation	1	00, 06	129	00, 5B
Points for object 0						
0	Software version	T_Str3	Data var	242		
0	Hardware version	T_Str2	Data var	243		
0	user assigned ID	T_Str2	Data var	246		
0	serial number	T_Str8	Data var	248		
0	product name	T_Str16	Data var	250		
0	manufacture name	T_Str20	Data var	252		

Object				Request			Response	
Object Number	Variation Number	Description		Function Codes (dec)		Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
10	0	Binary output status		1		00, 01, 06		
10	2	Binary output status		1		00, 01, 06	129	00, 01
Points for object 10								
0	Relay 1	T1		Data	0	1		
1	Relay 2	T1		Data	0	1		
2	Relay 3	T1		Data	0	1		
3	Relay 4	T1		Data	0	1		
4	Slot A - Relay 1	T1		Data	0	1		
5	Slot A - Relay 2	T1		Data	0	1		
6	Slot A - Relay 3	T1		Data	0	1		
7	Slot A - Relay 4	T1		Data	0	1		
8	Slot A - Relay 5	T1		Data	0	1		
9	Slot A - Relay 6	T1		Data	0	1		
10	Slot A - Relay 7	T1		Data	0	1		
11	Slot A - Relay 8	T1		Data	0	1		
12	Slot B - Relay 1	T1		Data	0	1		
13	Slot B - Relay 2	T1		Data	0	1		
14	Slot B - Relay 3	T1		Data	0	1		
15	Slot B - Relay 4	T1		Data	0	1		
16	Slot B - Relay 5	T1		Data	0	1		
17	Slot B - Relay 6	T1		Data	0	1		
18	Slot B - Relay 7	T1		Data	0	1		
19	Slot B - Relay 8	T1		Data	0	1		

Object			Request		Response	
Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
30	0	16-Bit Analog Input without flag	1	00, 01, 06		
30	2	16-Bit Analog Input with flag	1	00, 01, 06	129	00, 01
30	4	16-Bit Analog Input without flag	1	00, 01, 06	129	00, 01

Points for object 30							
0	U1	T16		Data	-Un	+Un	
1	U2	T16		Data	-Un	+Un	
2	U3	T16		Data	-Un	+Un	
3	Uavg (phase to neutral)	T16		Data	-Un	+Un	
4	U12	T16		Data	-Un	+Un	
5	U23	T16		Data	-Un	+Un	
6	U31	T16		Data	-Un	+Un	
7	Uavg (phase to phase)	T16		Data	-Un	+Un	
8	I1	T16		Data	-In	+In	
9	I2	T16		Data	-In	+In	
10	I3	T16		Data	-In	+In	
11	I total	T16		Data	-In	+In	
12	I neutral (calculated)	T16		Data	-In	+In	
13	I neutral (measured)	T16		Data	-In	+In	
14	Iavg	T16		Data	-In	+In	
15	Active Power Phase L1 (P1)	T17		Data	-Pn	+Pn	
16	Active Power Phase L2 (P2)	T17		Data	-Pn	+Pn	
17	Active Power Phase L3 (P3)	T17		Data	-Pn	+Pn	
18	Active Power Total (Pt)	T17		Data	-Pt	+Pt	
19	Reactive Power Phase L1 (Q1)	T17		Data	-Pn	+Pn	
20	Reactive Power Phase L2 (Q2)	T17		Data	-Pn	+Pn	
21	Reactive Power Phase L3 (Q3)	T17		Data	-Pn	+Pn	
22	Reactive Power Total (Qt)	T17		Data	-Pt	+Pt	
23	Apparent Power Phase L1 (S1)	T16		Data	-Pn	+Pn	
24	Apparent Power Phase L2 (S2)	T16		Data	-Pn	+Pn	
25	Apparent Power Phase L3 (S3)	T16		Data	-Pn	+Pn	
26	Apparent Power Total (St)	T16		Data	-Pt	+Pt	
27	Power Factor Phase 1 (PF1)	T17		Data	-1	1	
28	Power Factor Phase 2 (PF2)	T17		Data	-1	1	
29	Power Factor Phase 3 (PF3)	T17		Data	-1	1	
Points for object 30 cont.							
30	Power Factor Total (PFt)	T17		Data	-1	1	
31	CAP/IND P. F. Phase 1 (PF1)	T17		Data	-1 CAP	+1	300% for -1 IND
32	CAP/IND P. F. Phase 2 (PF2)	T17		Data	-1 CAP	+1	300% for -1 IND
33	CAP/IND P. F. Phase 3 (PF3)	T17		Data	-1 CAP	+1	300% for -1 IND
34	CAP/IND P. F. Total (PFt)	T17		Data	-1 CAP	+1	300% for -1 IND
35	j1 (angle between U1 and I1)	T17		Data	-100°	+100°	
36	j2 (angle between U2 and I2)	T17		Data	-100°	+100°	
37	j3 (angle between U3 and I3)	T17		Data	-100°	+100°	
38	Power Angle Total (atan2(Pt,Qt))	T17		Data	-100°	+100°	
39	j 12 (angle between U1 and U2)	T17		Data	-100°	+100°	
40	j 23 (angle between U2 and U3)	T17		Data	-100°	+100°	
41	j 31 (angle between U3 and U1)	T17		Data	-100°	+100°	
42	Frequency	T17		Data	Fn-10Hz	Fn+10Hz	
43	U unbalance	T16		Data	-100%	100%	
44	I1 THD%	T16		Data	-100%	100%	

45	I2 THD%	T16		Data	-100%	100%	
46	I3 THD%	T16		Data	-100%	100%	
47	U1 THD%	T16		Data	-100%	100%	
48	U2 THD%	T16		Data	-100%	100%	
49	U3 THD%	T16		Data	-100%	100%	
50	U12 THD%	T16		Data	-100%	100%	
51	U23 THD%	T16		Data	-100%	100%	
52	U31 THD%	T16		Data	-100%	100%	
MAX DEMAND SINCE LAST RESET							
53	Active Power Total (Pt) - (positive)	T16		Data	-Pt	+Pt	
54	Active Power Total (Pt) - (negative)	T16		Data	-Pt	+Pt	
55	Reactive Power Total (Qt) - L	T16		Data	-Pt	+Pt	
56	Reactive Power Total (Qt) - C	T16		Data	-Pt	+Pt	
57	Apparent Power Total (St)	T16		Data	-Pt	+Pt	
58	I1	T16		Data	-In	+In	
59	I2	T16		Data	-In	+In	
60	I3	T16		Data	-In	+In	
DYNAMIC DEMAND VALUES							
61	Active Power Total (Pt) - (positive)	T16		Data	-Pt	+Pt	
62	Active Power Total (Pt) - (negative)	T16		Data	-Pt	+Pt	
63	Reactive Power Total (Qt) - L	T16		Data	-Pt	+Pt	
64	Reactive Power Total (Qt) - C	T16		Data	-Pt	+Pt	
65	Apparent Power Total (St)	T16		Data	-Pt	+Pt	
66	I1	T16		Data	-In	+In	
67	I2	T16		Data	-In	+In	
68	I3	T16		Data	-In	+In	
ENERGY							
	Energy Counter 1	T17		Data			(32-bit value) MOD 20000
	Energy Counter 2	T17		Data			(32-bit value) MOD 20000
	Energy Counter 3	T17		Data			(32-bit value) MOD 20000
	Energy Counter 4	T17		Data			(32-bit value) MOD 20000
	Energy Counter 1 Cost	T17		Data			(32-bit value) MOD 20000
	Energy Counter 2 Cost	T17		Data			(32-bit value) MOD 20000
	Energy Counter 3 Cost	T17		Data			(32-bit value) MOD 20000
	Energy Counter 4 Cost	T17		Data			(32-bit value) MOD 20000
	Total Energy Counter Cost	T17		Data			(32-bit value) MOD 20000
	Aktiv Tariff	T1		Data			
	Internal Temperature	T17		Data	-100°	+100°	

<table>
<tr><td colspan="4">Object</td><td colspan="3">Request</td><td colspan="2">Response</td></tr>
<tr><td>Object</td><td>Variation</td><td colspan="2" rowspan="2">Description</td><td colspan="2">Function</td><td>Qualifier</td><td>Function</td><td>Qualifier</td></tr>
<tr><td>Number</td><td>Number</td><td colspan="2">Codes (dec)</td><td>Codes (hex)</td><td>Codes (dec)</td><td>Codes (hex)</td></tr>
<tr><td>40</td><td>0</td><td colspan="2">16-bit Analog output status</td><td colspan="2">1</td><td>00, 01, 06</td><td></td><td></td></tr>
<tr><td>40</td><td>2</td><td colspan="2">16-bit Analog output status</td><td colspan="2">1</td><td>00, 01, 06</td><td>129</td><td>00, 01</td></tr>
<tr><td colspan="9">Points for object 40</td></tr>
<tr><td>0</td><td>Analog output 1</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>1</td><td>Analog output 2</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>2</td><td>Analog output 3</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>3</td><td>Analog output 4</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>4</td><td>Slot A - Analog output 1</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>5</td><td>Slot A - Analog output 2</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>6</td><td>Slot A - Analog output 3</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>7</td><td>Slot A - Analog output 4</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>8</td><td>Slot B - Analog output 1</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>9</td><td>Slot B - Analog output 2</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>10</td><td>Slot B - Analog output 3</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
<tr><td>11</td><td>Slot B - Analog output 4</td><td>T1</td><td></td><td>Data</td><td>0</td><td></td><td colspan="2"></td></tr>
</table>

<table>
<tr><td colspan="4">Object</td><td colspan="3">Request</td><td colspan="2">Response</td></tr>
<tr><td>Object</td><td>Variation</td><td colspan="2" rowspan="2">Description</td><td colspan="2">Function</td><td>Qualifier</td><td>Function</td><td>Qualifier</td></tr>
<tr><td>Number</td><td>Number</td><td colspan="2">Codes (dec)</td><td>Codes (hex)</td><td>Codes (dec)</td><td>Codes (hex)</td></tr>
<tr><td>50</td><td>0</td><td colspan="2">Time and Date – absolute time</td><td colspan="2">2</td><td>7</td><td></td><td></td></tr>
<tr><td>50</td><td>1</td><td colspan="2">Time and Date – absolute time</td><td colspan="2">2</td><td>7</td><td>129</td><td>7</td></tr>
<tr><td colspan="9">Points for object 40</td></tr>
<tr><td>0</td><td>Time and Date</td><td>T_Time</td><td></td><td>Data</td><td></td><td></td><td colspan="2"></td></tr>
</table>

Object			Request		Response	
Object	Variation	Description	Function	Qualifier	Function	Qualifier
Number	Number		Codes (dec)	Codes (hex)	Codes (dec)	Codes (hex)
60	1	CLASS 0 DATA	1	6		
60	2	CLASS 1 DATA	1,22*	6		
60	3	CLASS 2 DATA	1,22*	6		
60	4	CLASS 3 DATA	1,22*	6		

*only object 30

APPENDIX C: Equations

Definitions of symbols

No	Symbol	Definition
1	MP	Average interval
2	Uf	Phase voltage (U1, U2 or U3)
3	Uff	Phase-to-phase voltage (U12, U23 or U31)
4	N	Total number of samples in a period
5	n	Sample number (0 ≤ n ≤ N)
6	x, y	Phase number (1, 2 or 3)
7	in	Current sample n
8	ufn	Phase voltage sample n
9	ufFn	Phase-to-phase voltage sample n
10	φ_f	Power angle between current and phase voltage f (φ_1, φ_2 or φ_3)
11	Uu	Voltage unbalance
12	Uc	Agreed supply voltage

Voltage

$U_f = \sqrt{\frac{\sum_{n=1}^{N} u_n^2}{N}}$	**Phase voltage** N – samples in averaging interval (up to 65 Hz)
$U_{xy} = \sqrt{\frac{\sum_{n=1}^{N}(u_{xn} - u_{yn})^2}{N}}$	**Phase-to-phase voltage** u_x, u_y – phase voltages (U_f) N – a number of samples in averaging interval
$U_u = \sqrt{\frac{1 - \sqrt{3 - 6\beta}}{1 + \sqrt{3 - 6\beta}}} \times 100\%$ $\beta = \frac{U_{12fund}^4 + U_{23fund}^4 + U_{31fund}^4}{(U_{12fund}^2 + U_{23fund}^2 + U_{31fund}^2)^2}$	**Voltage unbalance** U_{fund} – first harmonic of phase-to-phase voltage
$\mathbf{U_{POS}} = \frac{\mathbf{1}}{\mathbf{3}} \lvert \mathbf{U_{L1,fund}} + \mathbf{U_{L2,fund}^{120°}} + \mathbf{U_{L3,fund}^{240°}} \rvert$	**Positive voltage sequence** U_{fund} – first harmonic of phase voltage
$\mathbf{U_{NEG}} = \frac{\mathbf{1}}{\mathbf{3}} \lvert \mathbf{U_{L1,fund}} + \mathbf{U_{L2,fund}^{120°}} + \mathbf{U_{L3,fund}^{240°}} \rvert$	**Negative voltage sequence** U_{fund} – first harmonic of phase voltage
$\mathbf{U_{ZERO}} = \frac{\mathbf{1}}{\mathbf{3}} \lvert \mathbf{U_{L1,fund}} + \mathbf{U_{L2,fund}} + \mathbf{U_{L3,fund}} \rvert$	**Zero voltage sequence** U_{fund} – first harmonic of phase voltage

Current

$I_{TRMS} = \sqrt{\frac{\sum_{n=1}^{N} i_n^2}{N}}$	**Phase current** N – samples in averaging interval (up to 65 Hz)
$I_n = \sqrt{\frac{\sum_{n=1}^{N}(i_{1n} + i_{2n} + i_{3n})^2}{N}}$	**Neutral current** i – n sample of phase current (1, 2 or 3) N – samples in averaging interval (up to 65 Hz)

Power

$P_f = \frac{1}{N}\sum_{n=1}^{N}(u_{fn}\times i_{fn})$	**Active power by phases** N – a number of periods n – index of sample in a period f – phase designation
$P_t = P_1 + P_2 + P_3$	**Total active power** t – total power 1, 2, 3 – phase designation
$\mathrm{Sign}Q_f(\varphi)$ $\varphi \in [0° - 180°] \rightarrow \mathrm{Sign}Q_f(\varphi) = +1$ $\varphi \in [180° - 360°] \rightarrow \mathrm{Sign}Q_f(\varphi) = -1$	**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_t – apparent power by phases
$Q_f = \mathrm{Sign}Q_f(\varphi) \times \sqrt{S_f^2 - P_f^2}$	**Reactive power by phases** S_f – apparent power by phases P_f – active power by phases
$Q_f = \frac{1}{N}\sum_{n=1}^{N}(u_{f\,n}\times i_{f\,[n+N/4]})$	**Reactive power by phases (displacement method)** N – a number of samples in a period n – sample number (0 ≤ n ≤ N) f – phase designation
$Q_t = Q_1 + Q_2 + Q_3$	**Total reactive power** Q_t – reactive power by phases
$D = \sqrt{S^2 - P^2 - Q_{fund}^2}$	**Distortion power** S – Apparent power P – Acive power Q_{fund} – Fundamental reactive power
$Q_{fund} = \mathrm{Im}\{\mathrm{DFT}[u \times i]\}$	**Fundamental reactive power** Imaginary part of first harmonic part of momentary voltage and current product
$\varphi_s = \mathrm{arctan2}\ (P_t, Q_t)$ $\varphi_s = [-180°, 179{,}99°]$	**Total power angle** P_t – total active power Q_t – total reactive power
$PF = \frac{\lvert P\rvert}{S}$	**Distortion power factor** P – active power S –apparent power

$\mathrm{dPF} = \frac{\mathrm{P_1}}{\mathrm{S_1}}$	**Displacement power factor** P_1 – Fundamental active power S_1 – Fundamental apparent power

THD, TDD

$\mathrm{I_fTHD(\%)} = \frac{\sqrt{\sum_{n=2}^{63} I_n^2}}{I_1} \times 100$	**Current THD** I_1 – value of first harmonic n – number of harmonic
$\mathrm{I_fTDD(\%)} = \frac{\sqrt{\sum_{n=2}^{63} I_n^2}}{I_L} \times 100$	**Current TDD** I_L – value of max. load current (fixed, user defined value) n – number of harmonic
$\mathrm{U_fTHD(\%)} = \frac{\sqrt{\sum_{n=2}^{63} U_{fn}^2}}{U_{f1}} \times 100$	**Phase voltage THD** U_1 – value of first harmonic n – number of harmonic
$\mathrm{U_{ff}THD(\%)} = \frac{\sqrt{\sum_{n=2}^{63} U_{ffn}^2}}{U_{ff1}} \times 100$	**Phase-to-phase voltage THD** U_1 – value of first harmonic n – number of harmonic

Current factors

$\mathrm{CFI(\%)} = \frac{I_{PEAK}}{I_{RMS}} \times 100$	**CREST factor** I_{RMS} – RMS value of phase current I_{PEAK} – Peak value of current within cycle
$K_i = \frac{\sum_{n=1}^{63} (I_n \times n)^2}{\sum_{n=1}^{63} I_n^2}$	**K factor** n – number of harmonic

Flickers

$P_{50S} = (P_{30} + P_{50} + P_{80})/3$ $P_{10S} = (P_{6} + P_{8} + P_{10} + P_{13} + P_{17})/5$ $P_{3S} = (P_{2,2} + P_{3} + P_{4})/3$ $P_{1S} = (P_{1,7} + P_{1} + P_{1,5})/3$ $P_{st} = \sqrt{0{,}0314P_{0,1} + 0{,}0525P_{1S} + 0{,}0657P_{3S} + 0{,}28P_{10S} + 0{,}08P_{50S}}$	**Pst – Short-term flicker intensity** Short-term flicker intensity is measured in 10 minute periods. **Px** – 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)
$P_{1t} = \sqrt[3]{\sum_{i=1}^{12} \frac{P_{sti}^{3}}{12}}$	**Plt – Long-term flicker intensity** Calculated from twelve successive values of short-term flicker intensity in a two-hour period

Energy

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

APPENDIX D: XML Data format

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

There are 5 various types of XML push packages in the iMC784A:

- measurement packages,
- alarm packages,
- PQ event packages,
- PQ report packages and
- Index packages (these are related trigger based events) – *these are only supported in iMC784A*.

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>`

APPENDIX E: JSON Data format

```
{
  "response": {
        "version": "1","service": "http://www.****"},
        "device": {"type":"iMC784A","serial":"MC024305","location":"","description":""},
        "data": [{

                "info":                          {"utc":                          "yyyy-MM-dd
hh.mm.ss","part":"1","interval":"60","format":"trendlog","logid":"1762"},

        "voltage": {"unit": "V",
        "L1": {"val": "0","avg": "0","min": "0","max": "0"},
        "L2": {"val": "0","avg": "0","min": "0","max": "0"},
        "L3": {"val": "0","avg": "0","min": "0","max": "0"},
        "LN": {"val": "0","avg": "0","min": "0","max": "0"},
        "L12": {"val": "0","avg": "0","min": "0","max": "0"},
        "L23": {"val": "0","avg": "0","min": "0","max": "0"},
        "L31": {"val": "0","avg": "0","min": "0","max": "0"},
        "LN_ave": {"val": "0","avg": "0","min": "0","max": "0"},
        "LL_ave": {"val": "0","avg": "0","min": "0","max": "0"}},

        "frequency": {"unit": "Hz",
        "system": {"val": "0","avg": "0","min": "0","max": "0"}},

        "current": {"unit": "A",
        "L1": {"val": "0","avg": "0","min": "0","max": "0"},
        "L2": {"val": "0","avg": "0","min": "0","max": "0"},
        "L3": {"val": "0","avg": "0","min": "0","max": "0"},
        "LN": {"val": "0","avg": "0","min": "0","max": "0"},
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        "reapower": {"unit": "var",
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        "funpower": {"unit": "var",
        "L1": {"val": "0","avg": "0","min": "0","max": "0"},
        "L2": {"val": "0","avg": "0","min": "0","max": "0"},
        "L3": {"val": "0","avg": "0","min": "0","max": "0"},
"total": {"val": "0","avg": "0","min": "0","max": "0"}},

"defpower": {"unit": "var",
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"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"},
"total": {"val": "0","avg": "0","min": "0","max": "0"}},

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"pfactor": {"unit": "* CAP/IND",
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"L2": {"val": "0","avg": "0","min": "0","max": "0"},
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"dpfactor": {"unit": "* CAP/IND",
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"L2": {"val": "0","avg": "0","min": "0","max": "0"},
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"pangle": {"unit": "°",
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"L2": {"val": "0","avg": "0","min": "0","max": "0"},
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"LN": {"val": "0","avg": "0","min": "0","max": "0"},
"total": {"val": "0","avg": "0","min": "0","max": "0"}},

"energy": {
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"E2": {"unit": "* wh/varh/VAh","val": "0"},
"E3": {"unit": "* wh/varh/VAh","val": "0"},
"E4": {"unit": "* wh/varh/VAh","val": "0"},
"E5": {"unit": "* wh/varh/VAh","val": "0"},
"E6": {"unit": "* wh/varh/VAh","val": "0"},
"E7": {"unit": "* wh/varh/VAh","val": "0"},
"E8": {"unit": "* wh/varh/VAh","val": "0"}},

"demands": {
"I1": {"unit": "A","val": "0"},
"I2": {"unit": "A","val": "0"},
"I3": {"unit": "A","val": "0"},
"P_pos": {"unit": "W","val": "0"},
"P_neg": {"unit": "W","val": "0"},
"Q_ind": {"unit": "var","val": "0"},
"Q_cap": {"unit": "var","val": "0"},
"S": {"unit": "VA","val": "0"}},

"thd_v": {"unit": "%",
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"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"},
"L12": {"val": "0","avg": "0","min": "0","max": "0"},
"L23": {"val": "0","avg": "0","min": "0","max": "0"},
"L31": {"val": "0","avg": "0","min": "0","max": "0"}},

"crest_v": {"unit": "%",
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"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"},
"L12": {"val": "0","avg": "0","min": "0","max": "0"},
"L23": {"val": "0","avg": "0","min": "0","max": "0"},
"L31": {"val": "0","avg": "0","min": "0","max": "0"}},

"dc_v": {"unit": "V",
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"L3": {"val": "0","avg": "0","min": "0","max": "0"},
"LN": {"val": "0","avg": "0","min": "0","max": "0"},
"L12": {"val": "0","avg": "0","min": "0","max": "0"},
"L23": {"val": "0","avg": "0","min": "0","max": "0"},
"L31": {"val": "0","avg": "0","min": "0","max": "0"}},

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"0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0",
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"max":["0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0"]},

"L2":{"val":["0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0"],

"max":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0"]},

"L3":{"val":["0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0"],

"max":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0"]},

"L12":{"val":["0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0"],

"max":["0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0"]},

"L23":{"val":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0"],

"max":["0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0"]},

"L31":{"val":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0"],


"max":["0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0"]}},

"interhar_v": {"unit": "V","freq": ["* Hz","* Hz","* Hz","* Hz",
"* Hz","* Hz","* Hz","* Hz","* Hz","* Hz"],

"L1": {"val": ["0","0","0","0","0","0","0","0","0","0"],
"max": ["0","0","0","0","0","0","0","0","0","0"]},

"L2": {"val": ["0","0","0","0","0","0","0","0","0","0"],
"max": ["0","0","0","0","0","0","0","0","0","0"]},

"L3": {"val": ["0","0","0","0","0","0","0","0","0","0"],
"max": ["0","0","0","0","0","0","0","0","0","0"]},

"L12": {"val": ["0","0","0","0","0","0","0","0","0","0"],
"max": ["0","0","0","0","0","0","0","0","0","0"]},

"L23": {"val": ["0","0","0","0","0","0","0","0","0","0"],
"max": ["0","0","0","0","0","0","0","0","0","0"]},

"L31": {"val": ["0","0","0","0","0","0","0","0","0","0"],
"max": ["0","0","0","0","0","0","0","0","0","0"]}},

"sbands_v": {"unit": "V",
"band": ["0.5-3.5","4.5-7.5","8.5-11.5","12.5-15.5","16.5-19.5",
"20.5-23.5","24.5-27.5","28.5-31.5","32.5-35.5","36.5-39.5",
"40.5-43.5","44.5-47.5","48.5-51.5","52.5-55.5","56.5-59.5",
"60.5-63.5"],

"L1":{"val":["0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0"]},

"L2":{"val":["0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0"]},

"L3":{"val":["0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0"]},
"L12":{"val":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0"]},

"L23":{"val":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0"]},

"L31":{"val":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0"]}},

"signal_v": {"unit": "V",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"},
"L12": {"val": "0","avg": "0","min": "0","max": "0"},
"L23": {"val": "0","avg": "0","min": "0","max": "0"},
"L31": {"val": "0","avg": "0","min": "0","max": "0"}},

"underdev_v": {"unit": "%",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},

"overdev_v": {"unit": "%",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},

"thd_c": {"unit": "%",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},

"tdd_c": {"unit": "%",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},

"kfact_c": {"unit": "",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},
"crest_c": {"unit": "%",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},

"harmonic_c": {"unit": "A",
"L1":{"val":["0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0"],

"max":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0"]},

"L2":{"val":["0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0"],

"max":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0"]},

"L3":{"val":["0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0"],

"max":["0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0","0","0","0"]}},

"interhar_c": {"unit": "A","freq": ["* Hz","* Hz","* Hz",
"* Hz","* Hz","* Hz","* Hz","* Hz","* Hz","* Hz"],

"L1": {"val": ["0","0","0","0","0","0","0","0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0"]},
"L2": {"val": ["0","0","0","0","0","0","0","0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0"]},

"L3": {"val": ["0","0","0","0","0","0","0","0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0"]}},

"sbands_c": {"unit": "A",

"band": ["0.5-3.5","4.5-7.5","8.5-11.5","12.5-15.5",
"16.5-19.5","20.5-23.5","24.5-27.5","28.5-31.5",
"32.5-35.5","36.5-39.5","40.5-43.5","44.5-47.5",
"48.5-51.5","52.5-55.5","56.5-59.5","60.5-63.5"],

"L1":{"val":["0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0"],"max": ["0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0"]},

"L2":{"val":["0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0"],

"max": ["0","0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0"]},

"L3":{"val":["0","0","0","0","0","0","0","0","0","0",
"0","0","0","0","0","0"],"max": ["0","0","0","0","0",
"0","0","0","0","0","0","0","0","0","0","0"]}},

"signal_c": {"unit": "A",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},

"unbalance": {
"Uu": {"unit": "V","val": "0","avg": "0","min": "0","max": "0"},
"Uo": {"unit": "V","val": "0","avg": "0","min": "0","max": "0"},
"Iu": {"unit": "A","val": "0","avg": "0","min": "0","max": "0"},
"Io": {"unit": "A","val": "0","avg": "0","min": "0","max": "0"}},

"flic_pi": {"unit": "",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},

"flic_pst": {"unit": "",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},

"flic_plt": {"unit": "",
"L1": {"val": "0","avg": "0","min": "0","max": "0"},
"L2": {"val": "0","avg": "0","min": "0","max": "0"},
"L3": {"val": "0","avg": "0","min": "0","max": "0"}},

"aninput": {
"I1": {"unit": "*","val": "0","avg": "0","min": "0","max": "0"},
"I2": {"unit": "*","val": "0","avg": "0","min": "0","max": "0"},
"I3": {"unit": "*","val": "0","avg": "0","min": "0","max": "0"},
"I4": {"unit": "*","val": "0","avg": "0","min": "0","max": "0"},
"T": {"unit": "°C","val": "0","avg": "0","min": "0","max": "0"}},

"diginput": {"unit": "",
"I1": {"val": "0","min": "0","max": "0"},
"I2": {"val": "0","min": "0","max": "0"},
"I3": {"val": "0","min": "0","max": "0"},
"I4": {"val": "0","min": "0","max": "0"}},

"module_a": {"unit": "",
"I1": {"val": "0","min": "0","max": "0"},
"I2": {"val": "0","min": "0","max": "0"},
"I3": {"val": "0","min": "0","max": "0"},
"I4": {"val": "0","min": "0","max": "0"},
"I5": {"val": "0","min": "0","max": "0"},
"I6": {"val": "0","min": "0","max": "0"},
"I7": {"val": "0","min": "0","max": "0"},
"I8": {"val": "0","min": "0","max": "0"}},

"module_b": {"unit": "",
"I1": {"val": "0","min": "0","max": "0"},
"I2": {"val": "0","min": "0","max": "0"},
"I3": {"val": "0","min": "0","max": "0"},
"I4": {"val": "0","min": "0","max": "0"},
"I5": {"val": "0","min": "0","max": "0"},
"I6": {"val": "0","min": "0","max": "0"},
"I7": {"val": "0","min": "0","max": "0"},
"I8": {"val": "0","min": "0","max": "0"}}

}
]
}
```

Example of readings measurement <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 packages:

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

APPENDIX F: PQDIF and COMTRADE recorder data storage organization

All PQDIF and COMTRADE file records which are created on Power Quality Analyzer iMC784A are stored in a predefined folder in a logical hierarchy which is shown in the table below. Apart from this, table below also gives trigger names, trigger IDs, Record group IDs and subgroup IDs which cause these records to be created.

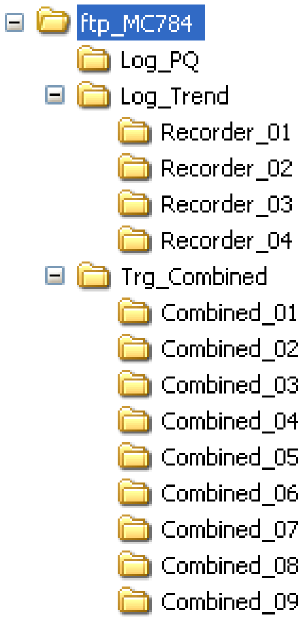
Trigger_Name	Trigger_ID	Record folder	Record Group_ID	Record SubGroup_ID
Trend recorder 1	TrLog_01	\Log_Trend\Recorder_01	TrLog	Rec_01
Trend recorder 2	TrLog_02	\Log_Trend\Recorder_02	TrLog	Rec_02
Trend recorder 3	TrLog_03	\Log_Trend\Recorder_03	TrLog	Rec_03
Trend recorder 4	TrLog_04	\Log_Trend\Recorder_04	TrLog	Rec_04
PQ Recorder	PQLog	\Log_PQ	PQLog	
Transient trigger Current	TrgTrC	\Trg_Transient\Current	TrgTr	Curr
Transient trigger Voltage	TrgTrV	\Trg_Transient\Voltage	TrgTr	Volt
PQ trigger Dip	TrgPqDip	\Trg_PQ\Dip	TrgPq	Dip
PQ trigger Inrush	TrgPqInrush	\Trg_PQ\Inrush	TrgPq	Inrush
PQ trigger Interuption	TrgPqInter	\Trg_PQ\Interruption	TrgPq	Inter
PQ trigger End Interuption	TrgPqInterEnd	\Trg_PQ\InterruptionEnd	TrgPq	InterEnd
PQ trigger RVC	TrgPqRvc	\Trg_PQ\Rvc	TrgPq	Rvc
PQ trigger Swell	TrgPqSwell	\Trg_PQ\Swell	TrgPq	Swell
Digital trigger 1	TrgDig01	\Trg_External\Digital_01	TrgExt	Dig_01
Digital trigger 2	TrgDig02	\Trg_External\Digital_02	TrgExt	Dig_02
Digital trigger 3	TrgDig03	\Trg_External\Digital_03	TrgExt	Dig_03
Digital trigger 4	TrgDig04	\Trg_External\Digital_04	TrgExt	Dig_04
Digital trigger 5	TrgDig05	\Trg_External\Digital_05	TrgExt	Dig_05
Digital trigger 6	TrgDig06	\Trg_External\Digital_06	TrgExt	Dig_06
Digital trigger 7	TrgDig07	\Trg_External\Digital_07	TrgExt	Dig_07
Digital trigger 8	TrgDig08	\Trg_External\Digital_08	TrgExt	Dig_08
Ethernet trigger 1	TrigEth01	\Trg_External\Ethernet_01	TrgExt	Eth_01
Ethernet trigger 2	TrigEth02	\Trg_External\Ethernet_02	TrgExt	Eth_02
Ethernet trigger 3	TrigEth03	\Trg_External\Ethernet_03	TrgExt	Eth_03
Ethernet trigger 4	TrigEth04	\Trg_External\Ethernet_04	TrgExt	Eth_04
Ethernet trigger 5	TrigEth05	\Trg_External\Ethernet_05	TrgExt	Eth_05
Ethernet trigger 6	TrigEth06	\Trg_External\Ethernet_06	TrgExt	Eth_06
Ethernet trigger 7	TrigEth07	\Trg_External\Ethernet_07	TrgExt	Eth_07
Ethernet trigger 8	TrigEth08	\Trg_External\Ethernet_08	TrgExt	Eth_08
Combined trigger 1	TrigCmb01	\Trg_Combined\Combined_01	TrgCmb	Cmb_01
Combined trigger 2	TrigCmb02	\Trg_Combined\Combined_02	TrgCmb	Cmb_02
Combined trigger 3	TrigCmb03	\Trg_Combined\Combined_03	TrgCmb	Cmb_03
Combined trigger 4	TrigCmb04	\Trg_Combined\Combined_04	TrgCmb	Cmb_04
Combined trigger 5	TrigCmb05	\Trg_Combined\Combined_05	TrgCmb	Cmb_05
Combined trigger 6	TrigCmb06	\Trg_Combined\Combined_06	TrgCmb	Cmb_06
Combined trigger 7	TrigCmb07	\Trg_Combined\Combined_07	TrgCmb	Cmb_07
Combined trigger 8	TrigCmb08	\Trg_Combined\Combined_08	TrgCmb	Cmb_08
Combined trigger 9	TrigCmb09	\Trg_Combined\Combined_09	TrgCmb	Cmb_09
Combined trigger 10	TrigCmb10	\Trg_Combined\Combined_10	TrgCmb	Cmb_10
Combined trigger 11	TrigCmb11	\Trg_Combined\Combined_11	TrgCmb	Cmb_11
Combined trigger 12	TrigCmb12	\Trg_Combined\Combined_12	TrgCmb	Cmb_12
Combined trigger 13	TrigCmb13	\Trg_Combined\Combined_13	TrgCmb	Cmb_13
Combined trigger 14	TrigCmb14	\Trg_Combined\Combined_14	TrgCmb	Cmb_14
Combined trigger 15	TrigCmb15	\Trg_Combined\Combined_15	TrgCmb	Cmb_15
Combined trigger 16	TrigCmb16	\Trg_Combined\Combined_16	TrgCmb	Cmb_16

A further explanation to the group and subgroup IDs are stated in the two tables below:

Record Group_ID	Description - Group_Name_En
TrLog	Trend recorder logs
PQLog	PQ recorder logs
TrgTr	Transient trigger events
TrgPq	PQ trigger events
TrgExt	External trigger events
TrgCmb	Combined trigger events

Record SubGroup_ID	Description - Group_Name_En
Rec_N	Recorder N
Curr	Current
Volt	Voltage
Dip	Dip
Inrush	Inrush current
Inter	Interruption
InterEnd	End Interruption
Rvc	RVC
Swell	Swell
Dig_N	Digital N
Eth_N	Ethernet N
Cmb_N	Combined N

All this file records are easily available from the device by means of FTP connection. Depending on FTP account permissions, the user can manipulate the stored data. The default read-only ftp account is user: “ftp”/pass: ”ftp”



- ftp_MC784
  - Log_PQ
  - Log_Trend
    - Recorder_01
    - Recorder_02
    - Recorder_03
    - Recorder_04
  - Trg_Combined
    - Combined_01
    - Combined_02
    - Combined_03
    - Combined_04
    - Combined_05
    - Combined_06
    - Combined_07
    - Combined_08
    - Combined_09

PQDIF AND COMTRADE FILE NAMING CONVENTION

File names are determined according to the ISO standard 8601 standard.
There are a few examples below:

Fast Trend recorders (Recorder 1-4, PQ Recorder)

- these are created periodically with a predefined period
  Date: 26.3.2014
  Time: 00:00:00
  Abbreviations: z = UTC time, T = date - time separator

  Example: 20142603T000000z.pqd

Event recorders

- Here many events can occur within one seconds so milliseconds are used

  Example:20142603T000000.046z.pqd

- If all records cannot be stored in one single file the recorder signature is added at the end of file name:

_T	Transient recorder
_W	Waveform recorder
_D	Disturbance recorder

Example:20142603T000000.046z**_T**.pqd
Example:20142603T000000.046z**_W**.pqd
Example:20142603T000000.046z**_D**.pqd

APPENDIX G: IEC61850 Ed.2 protocol support overview

Overview

This appendix describes the scope of support for the IEC61850 Ed.2 protocol within Power Quality Analyzer iMC784A. It provides the functionality overview as well as all the necessary means on how the configuration can be done.

Basic implementation facts

- The Model Implementation Conformance Statement (MICS) for IEC61850 support is defined in IEC 61850-7-3 and IEC61850-7-4
- IEC61850 support is a SW-enabled optional feature
- Up to 8 preconfigured report datasets
- Up to 4 simultaneous IEC61850 client connections

IEC61850 Ed.2 configuration

For every IEC61850 there should be a related ICD and CID configuration files. The implementation in Power Quality Analyzer iMC784A has the following characteristics:

- Only one single ICD file corresponds to all HW variants of Power Quality Analyzer iMC784A – this file corresponds to all available options within the instrument.
- A predefined CID file is provided with every device with the IEC61850 server feature enabled and is the same as the publicly available ICD file. The file resides in Power Quality Analyzer iMC784A file system in the /61850/ folder so any user can optionally reconfigure the device through standard FTP communication channel if required by making the (re)configuration of the CID file and uploading and overwriting the existing CID file – file location. When reconfiguring the CID file we recommend to stick to the limits defined within this appendix.
- Any XML editor or 3rd party IEC61850 configuration tool can be used for reconfiguring the CID files.

Logical nodes supported in Power Quality Analyzer iMC784A implementation of IEC61850 Ed.2

A general standard support scope overview is given in the table below:

	Logical node	Description
SYSTEM related nodes	LPHD - Physical device information	Physical device. Contains information related to the physical device. Only one instance of this node can be defined.
	LLN0 - Logical node zero	Logical node zero. Contains the data related to the associated IED. Only one instance of this node can be defined.
MEASUREMENT related nodes	MMXU - Measurements	Measurements. Contains per-phase and total current, voltage and power flow for operational purposes.
	AVGMMXU - Metering Statistics Average	Metering statistics. Consists of average, min and max for metered (MMXU) data.
	MAXMMXU - Metering Statistics Maximum	
	MINMMXU - Metering Statistics Minimum	
	MSQI - Sequence and imbalance	Sequence. Consists of sequence values for three/multi-phase power systems via symmetrical components
	MMTR - Metering	Metering. Consists of the integrated values (energy), primarily for billing purposes.
	GGIO - Generic process I/O	Generic process HW I/O module current statuses which include (depending on device HW variant): 4 analog inputs 4 general indication I/Os 8 bit Slot A 8 bit Slot B Current status of 32 SW configurable alarms which are programmed into the device.
	GGIO - Commands	Sending commands into iMC784A: Energy counters reset Min/Max measurements reset (affects statistic) Output relay ON/OFF (Output 1-4, Slot A)
	MHAI - Harmonics	Harmonics. Consists of voltage and current harmonic values as well as THD, K factor, Crest factor.
	RDRE - Disturbance recorder function	Disturbance Recorder Function. Indicates to a client that a new PQDIF or COMTRADE file has been created in one of the device recorders and is available for transfer.

IEC61850 Ed.2 Data Sets in Power Quality Analyzer iMC784A

Datasets are configured using any IEC 61850 configuration tool. One can have up to 8 datasets containing a maximum of 256 data values each. If this limit is exceeded, the resulting CID file will not function. Data sets must be located in LLN0 so that they can contain data from any logical node within that logical device. The ICD file for Power Quality Analyzer iMC784A is preconfigured with eight default datasets and can be reconfigured by the user if required:

Dataset	Description
LPHD	Status dataset
MMXU	Measurements dataset
MSTA	Statistics dataset
MMTR	Metering dataset
GGIO	Inputs and outputs dataset
MHAI	Power quality dataset
MSQI	Sequence dataset
RDRE	Recorded files of all record types

IEC61850 Ed.2 Reports in Power Quality Analyzer iMC784A

Reports can be configured using any IEC 61850 configuration tool. Reports will only be transmitted to the client if that client has enabled the report. Reports must be located in LLN0 so that they can contain any dataset.

Dataset	Buffered/Unbuffered	Description
Device status	Unbuffered	Report containing status dataset (LPHD)
Measurements	Unbuffered	Report containing measurements dataset (MMXU)
Statistics	Unbuffered	Report containing statistics dataset (MSTA)
Energy	Unbuffered	Report containing metering dataset (MMTR)
Inputs and outputs	Unbuffered	Report containing inputs and outputs dataset (GGIO)
Imbalances	Unbuffered	Report containing sequence dataset (MSQI)

Configuring Reporting Triggers

Reporting triggers allow Power Quality Analyzer iMC784A automatically generate and send reports to clients when certain conditions are met. They are configured using any IEC 61850 configuration tool. The most commonly-used triggers are:

Trigger Option	Description	Default setting in iMC784A CID file
dchg (data-change)	Report is triggered when there is a change in value of a member of the data set. This data change must be greater than the deadband value configured in CID file.	Disabled
Integrity period	Report is triggered at regular, periodic intervals.	Enabled (4000 msec)
Quality changed	Report is triggered when quality is changed. Quality is part of every parameter within the CID file.	Disabled
GI (general interrogation)	Report is triggered upon client request.	Enabled
Data update	Only used for frozen counters	Disabled

Model Implementation Conformance Statement

The model implementation conformance statement according to IEC 61850-7-3 and IEC 61850-7-4, is listed below:

Attribute name	**Explanation**	**Attribute Type**	**Modbus Start**	**Modbus End**
LPHD - Physical device information				
PhyNam	Physical device name plate	DPL	20001	20020
			20021	
			20022	
			20025	20028
			20029	20036
PhyHealth	Physical device health	INS		
Proxy	Indicates if this LN is a proxy	SPS		
LLN0 - Logical node zero				
Mod	Mode	INC	20051	
Beh	Behaviour	INS	20052	
Health	Health	INS	20053	
NamPlt	Name plate	LPL	20001	20020
RDRE - Disturbance recorder function				
RcdMade	Recording made	SPS	20101	
		SPS	20102	
FltNum	Fault Number	INS	20111	
MMXU - Measurements				
TotW	Total Active Power (Total P)	MV	21001	21002
TotVAr	Total Reactive Power (Total Q)	MV	21003	21004
TotVA	Total Apparent Power (Total S)	MV	21005	21006
TotPF	Average Power factor (Total PF)	MV	21007	21008

Attribute name	Explanation	Attribute Type	Modbus Start	Modbus End
MMXU - Measurements				
PPV	Phase to phase voltages, including angles	DEL	21011	21012
		DEL	21013	21014
		DEL	21015	21016
		DEL	21017	21018
		DEL	21019	21020
		DEL	21021	21022
PhV	Phase to ground voltages, including angles	WYE	21023	21024
		WYE	21025	21026
		WYE	21027	21028
		WYE	21029	21030
		WYE	21031	21032
A	Phase currents, including power angles	WYE	21033	21034
		WYE	21037	21038
		WYE	21039	21040
		WYE	21041	21042
		WYE	21043	21044
		WYE	21045	21046
		WYE	21049	21050
		WYE	21053	21054
		WYE	21055	21056
VAr	Phase reactive power (Q)	WYE	21057	21058
		WYE	21059	21060
		WYE	21061	21062
VA	Phase apparent power (S)	WYE	21063	21064
		WYE	21065	21066
		WYE	21067	21068
PF	Phase power factor (PF)	WYE	21069	21070
		WYE	21071	21072
		WYE	21073	21074
MMXU - Metering Statistics Average				
AvW	Average real power	MV	21075	21076
AvVAr	Average reactive power	MV	21081	21082
AvVA	Average apparent power	MV	21087	21088
MMXU - Metering Statistics Maximum				
MaxW	Maximum real power	MV	21077	21078
MaxVAr	Maximum reactive power	MV	21083	21084
MaxVA	Maximum apparent power	MV	21089	21090
MMXU - Metering Statistics Minimum				
MinW	Minimum real power	MV	21079	21080
MinVAr	Minimum reactive power	MV	21085	21086
MinVA	Minimum apparent power	MV	21091	21092
MSQI - Sequence and imbalance				
ImbNgV	Imbalance negative sequence voltage	MV	21093	21094
ImbZroV	Imbalance zero sequence voltage	MV	21095	21096
MMTR - Metering				
TotWh	Net Real energy since last reset	BCR	21097	21098
TotVArh	Net Reactive energy since last reset	BCR	21099	21100
TotVAh	Net Apparent energy since last reset	BCR	21101	21102
SupWh	Real energy supply (default supply direction: energy flow towards busbar)	BCR	21103	21104
SupVArh	Reactive energy supply (default supply direction: energy flow towards busbar)	BCR	21105	21106
DmdWh	Real energy demand (default demand direction: energy flow from busbar away)	BCR	21107	21108
DmdVArh	Reactive energy demand (default demand direction: energy flow from busbar away)	BCR	21109	21110

Attribute name	Explanation	Attribute Type	Modbus Start	Modbus End
GGIO - Generic process I/O				
AnIn_1	Analog input 1	MV	21111	21112
AnIn_2	Analog input 2	MV	21113	21114
AnIn_3	Analog input 3	MV	21115	21116
AnIn_4	Analog input 4	MV	21117	21118
Ind_1	General indication (input/output) 1	SPC	21119	
Ind_2	General indication (input/output) 2	SPC	21120	
Ind_3	General indication (input/output) 3	SPC	21121	
Ind_4	General indication (input/output) 4	SPC	21122	
IntIn_A	Integer status - Slot A	INS	21123	21124
IntIn_B	Integer status - Slot B	INS	21125	21126
ISCSO	Integer status - Alarms	INS	21127	21128
GGIO - Commands				
Reset	Energy Counters	SPC	41801	On=1, Off=0
Reset	Min/Max measurements	SPC	41802	On=1, Off=0
Output 1	Relay ON/OFF	SPC	41803	On=1, Off=0
Output 2	Relay ON/OFF	SPC	41804	On=1, Off=0
Output 3	Relay ON/OFF	SPC	41805	On=1, Off=0
Output 4	Relay ON/OFF	SPC	41806	On=1, Off=0
Output A1	Relay ON/OFF	SPC	41807	On=1, Off=0
Output A2	Relay ON/OFF	SPC	41808	On=1, Off=0
Output A3	Relay ON/OFF	SPC	41809	On=1, Off=0
Output A4	Relay ON/OFF	SPC	41810	On=1, Off=0
Output A5	Relay ON/OFF	SPC	41811	On=1, Off=0
Output A6	Relay ON/OFF	SPC	41812	On=1, Off=0
Output A7	Relay ON/OFF	SPC	41813	On=1, Off=0
Output A8	Relay ON/OFF	SPC	41814	On=1, Off=0

Attribute name	Explanation	Attribute Type	Modbus Start	Modbus End
MHAI - Harmonics				
Hz	Basic frequency	MV	21151	21152
HA	Sequence of harmonics current	HWYE	21153	21154
		HWYE	21155	21156
		HWYE	21405	21406
		HWYE	21407	21408
		HWYE	21657	21658
		HWYE	21659	21660
HPhV	Sequence of harmonics phase to ground voltages	HWYE	21909	21910
		HWYE	21911	21912
		HWYE	22161	22162
		HWYE	22163	22164
		HWYE	22413	22414
		HWYE	22415	22416
HPPV	Sequence of harmonics phase to phase voltages	HDEL	22665	22666
		HDEL	22667	22668
		HDEL	22917	22918
		HDEL	22919	22920
		HDEL	23169	23170
		HDEL	23171	23172
HKf	K factor	WYE	23421	23422
		WYE	23423	23424
		WYE	23425	23426
ThdA	Current total harmonic distortion	WYE	23427	23428
		WYE	23429	23430
		WYE	23431	23432
ThdPhV	Phase to ground voltage total harmonic distortion	WYE	23433	23434
		WYE	23435	23436
		WYE	23437	23438
ThdPPV	Phase to phase voltage total harmonic distortion	DEL	23439	23440
		DEL	23441	23442
		DEL	23443	23444
TddA	Current Total Demand Distortion	WYE	23445	23446
		WYE	23447	23448
		WYE	23449	23450
HCfA	Current crest factors	WYE	23451	23452
		WYE	23453	23454
		WYE	23455	23456

Preconfigured datasets	
STATUS	Status dataset
MMXU	Measurements dataset
AVGMMUX	Statistics dataset
MAXMMUX	Statistics dataset
MINMMUX	Statistics dataset
MMTR	Metering dataset
GGIO	Inputs and outputs dataset
MHAI	Power quality dataset
MSQI	Sequence dataset
RDRE	Recorder dataset
Preconfigured reports	
Device status	Contains Status dataset (STATUS)
Measurements	Contains Measurements dataset (MMXU)
Metering Statistics Average	Contains Statistics dataset (AVGMMUX)
Metering Statistics Maximum	Contains Statistics dataset (MAXMMUX)
Metering Statistics Minimum	Contains Statistics dataset (MINMMUX)
Energy	Contains Metering dataset (MMTR)
Inputs and outputs	Contains Inputs and outputs dataset (GGIO)
Imbalances	Contains Sequence dataset(MSQI)

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