DEIF

-power in control

USER'S MANUAL

Multi-instrument, MIQ96-3

- 1- or 3-phase measurements, true RMS
- More than 60 displayed parameters
- Multi-language support
- RS485 serial communication
- Frequency range from 16 Hz to 400 Hz
- Pulse output for kWh and kVArh or limit switches
- Four energy registers
- Configurable display

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Table of contents

1. About this document

This chapter includes general user information about this manual concerning the general purpose, the intended users and the overall contents and structure.

General purpose

This document is the User's Manual for DEIF's multi-instrument, the MIQ96-3. The document mainly includes instructions for installation and use of the instrument and information about basic, daily operation. The general purpose of the manual is to provide the information needed to install the unit correctly and to provide information about the basic functionality of the instrument.

Please make sure that you read this manual before starting to work with the multi-instrument. Failure to do this could result in human injury or damage to the equipment.

Intended users

The manual is mainly intended for the person responsible for the installation and setup of the instrument. On the basis of this document the operator will be able to use the multi-instrument for simple, daily operation.

Contents/overall structure

This document is divided into chapters, and in order to make the structure simple and easy to use, each chapter will begin from the top of a new page.

2. Warnings and legal information

This chapter includes important information about general legal issues relevant in the handling of DEIF products. Furthermore, some overall safety precautions will be introduced and recommended. Finally, the highlighted notes and warnings, which will be used throughout the document, are presented

Legal information and responsibility

DEIF takes no responsibility for installation or operation of the instrument. If there is any doubt about how to install or operate the instrument, the company responsible for the installation or the operation of the instrument must be contacted.

The units are not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

Electrostatic discharge awareness

Sufficient care must be taken to protect the terminals against static discharges during the installation. Once the unit is installed and connected, these precautions are no longer necessary.

Safety issues

Installing the unit implies work with dangerous currents and voltages. Therefore, the installation should only be carried out by authorised personnel who understand the risks involved in the working with live electrical equipment.

Be aware of the hazardous live currents and voltages. Do not touch any AC measurement inputs as this could lead to injury or death.

Definitions

Throughout this document a number of notes and warnings will be presented. To ensure that these are noticed, they will be highlighted in order to separate them from the general text.

Notes

The notes provide general information which will be helpful for the reader to bear in mind.

Warnings

The warnings indicate a potentially dangerous situation which could result in death, personal injury or damaged equipment if certain guidelines are not followed.

3. General product information

Please check the following before switching on the device:

- Nominal voltage
- Supply voltage
- Nominal frequency
- Voltage ratio and phase sequence
- Current transformer ratio and integrity of terminals
- Protection fuse (recommended max. external fuse size is 2 A)
- Integrity of earth terminals (where necessary)

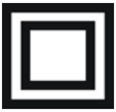
A current transformer secondary should be short-circuited before connecting the meter.

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 the auxiliary supply has been completely disconnected (both poles of any DC supply).

Symbols

The following symbols are used:

	See product documentation.
	Double insulation in compliance with the **SIST EN 61010−1**: 2002 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.

4. Basic description and operation

Description of symbols

Various symbols appear in this User's Manual. According to the position of the symbols, they have different meanings.

Symbols in the subtitles/subchapters indicate accessibility of the functions described. Accessibility of functions is indicated with the following symbols:

The function is accessible via communication (M-Set software).

The function is accessible via the navigation keys on the instrument front.

Glossary

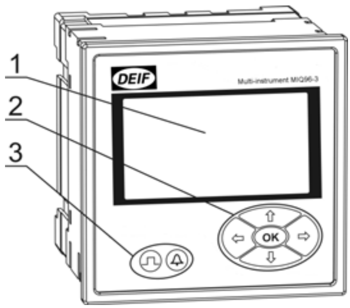
Term	Explanation
RMS	Root mean square value
Modbus	Industrial protocol for data transmission
M-Set	Software for MIQ96-3 instrument
AC	Alternating voltage
PA total	Angle calculated from total active and apparent power
PA1, PA2, PA3	Angle between fundamental phase voltage and phase current
PF	Power factor
THD	Total harmonic distortion
MD	Measurement of average values in time interval
FFT graphs	Graphical display of presence of harmonics
Hand-over place	Connection spot of consumer installation in public network
M_v − sample factor	Defines a number of periods for measuring calculation on the basis of measured frequency
M_p − average interval	Defines frequency of refreshing displayed measurements on the basis of a sample factor
Hysteresis expressed as percentage [%]	Percentage specifies increase or decrease of a measurement from a certain limit after exceeding it
2RO	Relay (alarm)/S0 (pulse) output module

Description of the product

The MIQ96-3 is used for measuring, analysing and monitoring of three-phase or single-phase electrical power networks. Using the latest technologies and numerical methods, high accuracy over a wide measuring range of current and integrated quantities is achieved.

Appearance

1 − graphical LCD
2 − navigation keyboard
3 − LED indicators



Graphical LCD

A graphical LCD with backlight is used for high resolution of displayed measuring quantities and for a display of selected functions when setting the device.

Navigation keyboard

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

LED indicators

LED indicators warn of a certain state of the instrument. A red LED to the left is blinking as pulse output. A red LED to the right is blinking when the condition for the alarm is fulfilled.

Multi-instrument MIQ96-3

The instrument is used for monitoring and measuring of electric quantities of three-phase and single-phase electrical power distribution systems. The meter is provided with 16 programmable alarms, one output module and a communication module, RS485. With the communication, the MIQ96-3 can be set and measurements can be checked. The meter also functions as an energy counter. As an energy counter it can record energy in all four quadrants.

Feature	MIQ96-3
Graphical LCD display	●
Backlight of LCD display	●
LED indicator (pulse/alarm)	●/●
Control keys on front panel (5)	●
Communication interface RS485	●
Two relay outputs (pulse/alarm output)	●/●
Automatic voltage range	●
Automatic current range	●
Universal supply	●

Software functions

	Functions	MIQ96-3
Standard	Setup wizard	●
	Wrong connection warning	●
	Custom screens (3)	●
	Demonstration screen cycling	●
	Programmable refresh time	●
	Modbus protocol	●
	MD calculation (TF, FW, SW)	●/●/●
	Programmable alarms (16)	●

Supported measurements

	Basic measurements	**MIQ96-3**
Phase	Voltage U_1, U_2, U_3 and $U^{\sim}$	●
	Current I_1, I_2, I_3, I_n, I_t and I_a	●
	Active power P_1, P_2, P_3 and P_t	●
	Reactive power Q_1, Q_2, Q_3 and Q_t	●
	Apparent power S_1, S_2, S_3 and S_t	●
	Power factor PF_1, PF_2, PF_3 and $PF^{\sim}$	●
	Power angle φ_1, φ_2, φ_3 and $\varphi^{\sim}$	●
	THD of phase voltage U_{f1}, U_{f2} and U_{f3}	●
	THD of power angle I_1, I_2 and I_3	●
Phase-to-phase	Phase-to-phase voltage U_{12}, U_{23}, U_{31}	●
	Average phase-to-phase voltage U_{ff}	●
	Phase-to-phase angle φ_{12}, φ_{23}, φ_{31}	●
	Voltage unbalance U_u	●
	THD of phase-to-phase voltage	●
Energy	Counter 1	●
	Counter 2	●
	Counter 3	●
	Counter 4	●
	Total	●

	Other measurements	**MIQ96-3**
MD values	Phase current I_1, I_2, I_3	●
	Active power P (positive)	●
	Active power P (negative)	●
	Reactive power Q-L	●
	Reactive power Q-C	●
	Apparent power S	●

	Other measurements	**MIQ96-3**
	Frequency	●
	Internal temperature	●

5. Connection

Introduction

This chapter deals with instructions for connection of the MIQ96-3. Use and connection of the device implies work with dangerous currents and voltages. Therefore, the connection should only be carried out by qualified personnel. DEIF A/S does not take any responsibility regarding the use and connection. If any doubt occurs regarding connection and use in the system the device is intended for, please contact support@deif.com.

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

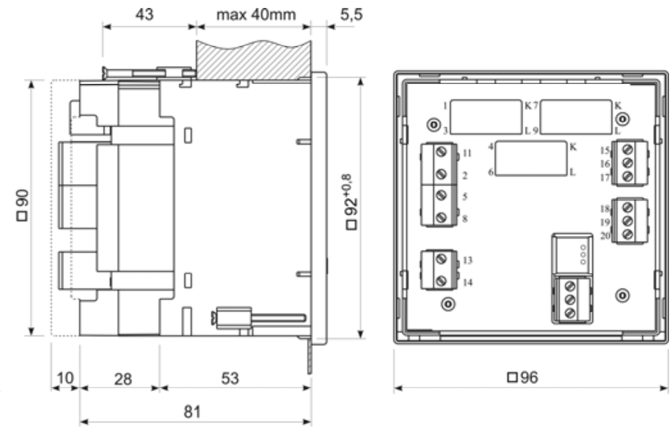
Check protective fuse rating (the recommended maximum rating of the external protective fuse for this equipment is 2 A).

Wrong or incomplete connection of voltage or other terminals may cause interruption of operation or damage to the device.

After connection, settings have to be made via the keys on the instrument front or via the M-Set software (connection mode, current and voltage transformer ratio).

Mounting

Before you insert the device into the panel cut-out, you must remove the four screws. Then insert the device and position the screws correctly. Fix the device to the panel and remove the protection foil from the screen.



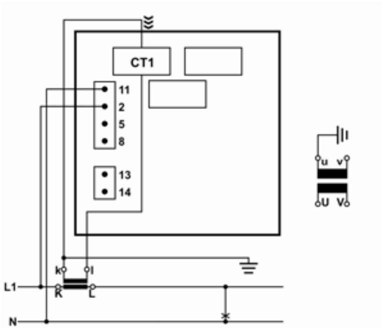
Panel cut-out: DIN 92 x 92 mm + 0.8

Electric connection

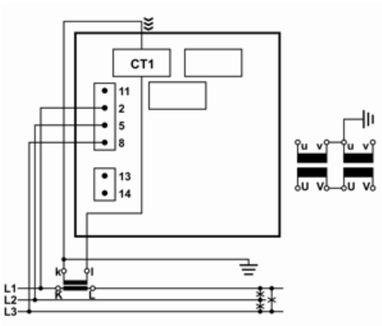
Voltage inputs on the MIQ96-3 can be connected directly to low-voltage networks or via a voltage measuring transformer to high-voltage networks.

Current inputs are led through a hole in the current transformers. Connection to the network is performed via a corresponding current transformer.

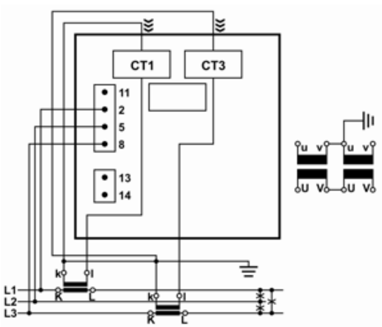
Choose the corresponding connection from the figures below and connect the corresponding voltages and currents. Information on electrical consumption of current and voltage inputs is given in the data sheet, document no. 4921210131.



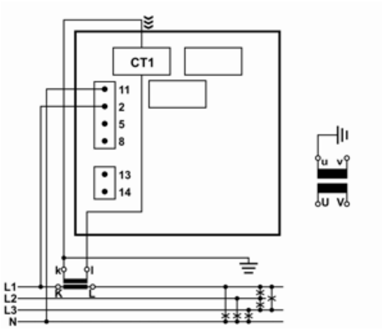
Connection 1b (1W)
Single-phase connection



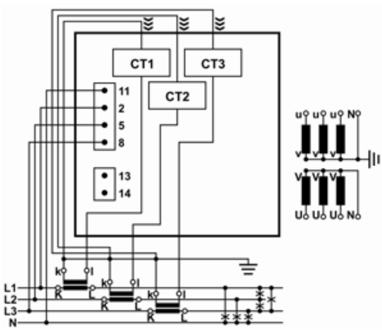
Connection 3b (1W3)
Three-phase three-wire
connection with balanced load



Connection 3u (2W3)
Three-phase three-wire
connection with unbalanced load



Connection 4b (1W4)
Three-phase four-wire
connection with balanced load

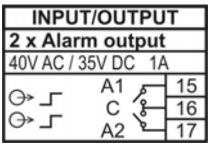


Connection 4u (3W4)
Three-phase four-wire
connection with unbalanced load

Connection of input/output modules

Check the information specified on the label before connecting the MIQ96-3. Wrong connection may cause damage or destruction of the module and/or the device.

Connect the relay contacts as specified on the label. An example of a label is given below.



Relay (alarm and pulse) output with two outputs.

Communication connection

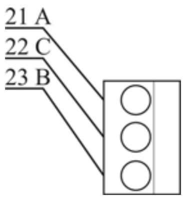
Three terminals are used for RS485 communication.

Connector terminals are marked on the label on the upper side of the instrument. More detailed information on communication is given in Appendix A, Modbus protocol.

RS485

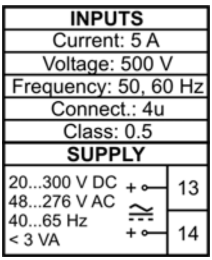
RS485 communication is intended for connection of devices to networks where several instruments with RS485 communication are connected to a common communication interface.

Overview of communication connection

	Connector	Terminals	Posi-tion	Data direction	Descrip-tion
RS485	Connector		21	To/From	A
			22	-	Do not connect!
			23	To/From	B

Connection of power supply

The MIQ96-3 has a universal (AC/DC) power supply.



Connection of universal power supply to terminals 13 and 14.

6. First steps

Introduction

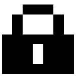
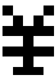
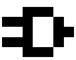
Instructions for work with the MIQ96-3 are given in the following chapters.

After electrical connection, start-up of the MIQ96-3 can be initiated.

Once the unit has been properly connected and switched on in compliance with the safety measures, working with the device does not represent any danger for the user.

Basic concepts

Navigation keys and LCD enable application and basic instrument settings. During the operation some icons may be displayed in the upper part of the LCD. The meaning of the icons is explained in the table below.

Icon	Meaning
	The instrument is locked with a password of the second level (L2). The first level (L1) can be unlocked.
	The instrument can be wrongly connected at 4u (3W4) connection. The energy flow direction is different by phases.
	The device supply is too low.

Example:

Main menu ⇒ Info OK ⇑

```
Info
Locked
Wrong connection
Low supply

Main menu
```

The meaning of the icons is displayed on the LCD in the information menu.

Installation wizard

After installation and electrical connection, basic parameters must be set in order to ensure correct operation. The easiest way to achieve this is to use the installation wizard. When entering the Installation menu, settings will follow one another when the previous one is confirmed. All required parameters must be entered and confirmed. It is possible to exit the menu when all required settings are confirmed, or with interruption (press ⇐ several times) without changes.

All settings that are made using the installation wizard can be changed subsequently by means of the Settings menu or via M-Set by means of communication.

Main menu ⇒ Installation ⇒

The menus follow one after another.

Start menu:
The start screen is displayed on the LCD.

Language:
Set device language.

Connection mode:
Choose connection and define load connection.

Primary voltage:
Set primary voltage if a voltage transformer is used.

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

Primary current:
Set primary current if a current transformer is used.

Secondary current:
Set secondary current.

Common energy exponent:
Define the common energy exponent as recommended in the table below where the counter divider default value is 10. Values of primary voltage and current determine the proper common energy exponent. For detailed information, see the chapter Energy on page 35.

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

* − Counter divider should be at least 100.

Device address:
Set Modbus address for the device. Default address is 33.

Bits per second:
Set communication rate. Default rate is 115200 b/s.

Parity:
Set communication parity. Default value is None.

Stop bit:
Set communication stop bits. Default value is 2.

Display of device info

A menu is divided into several submenus with data and information about the device:

- Welcome screen
- Information
- Meaning of icons

Welcome screen

When entering the Information menu a welcome screen is displayed on the LCD, showing type designation and name, MIQ96-3.

Main menu ⇒ Info OK

Information

Data on a meter are collected in the Information menu. They include a serial number, a software version, a hardware version, date of manufacture and number of operational hours in days, hours and minutes.

Main menu ⇒ Info OK ⇓

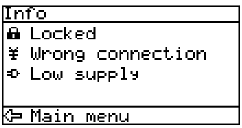
Main menu ⇒ Info OK ⇓ ⇓

Meaning of icons

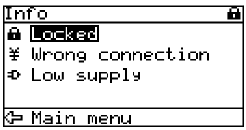
All icons and their meaning are displayed.

Main menu ⇒ Info OK ⇓ ⇓ ⇓

Example of display of icons and their meaning:



⇒ After password activation ⇒



7. Settings

Introduction

Setting of the MIQ96-3 can be made via the front keyboard or with a PC and the M-Set software. Setting is easier using M-Set. Basic and simpler settings are accessible via the navigation keyboard. For a new setting to be activated, a settings file should be transferred to the device via communication (M-Set). Settings made via the navigation keyboard are activated after confirmation (OK).

M-Set software

The M-Set software is a tool for complete monitoring of the measuring instruments. RS485 is used for connection with a PC. A user-friendly interface consists of four segments: device management, instrument settings, real-time measurements and software upgrading.

Device management

Connect the instrument in a communication line. Use the network explorer to set and explore the device network. Communication parameters of all devices and their addresses in the network can be set easily.

Instrument settings

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

Real-time measurements

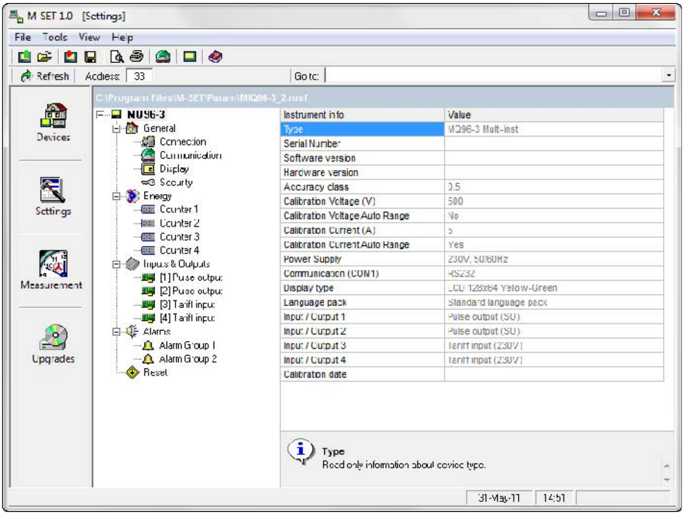
All supported measurements can be seen in real time in a table form.

Software upgrading

Always use the latest version of software, both M-Set and software in the instrument. The programme automatically informs you of available upgrades that can be transferred from the website and used for upgrading.

More information about the M-Set software can be found in the M-Set Help system.

PC M-Set user interface:



You can download M-Set freely from:
www.deif.com/Download_centre.aspx

Setting procedure

Before setting the instrument by means of M-Set, the current settings should be read first. Reading is available either via communication or from a file (stored on a PC local disk). A setting structure that is similar to a file structure in an explorer is displayed in the left part of the M-Set setting window. Available settings of that segment are displayed in the right part by clicking any of the stated parameters.

General settings

General settings are essential for the MIQ96-3. They are divided into four additional sublevels (connection, communication, display and security).

Description and location

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

Average interval

The average interval defines a refresh rate of measurements on the LCD and communication.

Language

Set the language on the LCD. When the language is changed from or to Russian, the characters of the password are changed too. For an overview of character translation, see the chapter Password and language on page 34.

Main menu ⇒ Settings ⇒ General ⇒ Language

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

Temperature unit

Choose a unit for temperature display.

Main menu ⇒ Settings ⇒ General ⇒ Temperature unit

Maximum demand calculation (MD mode)

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

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

Main menu ⇒ Settings ⇒ General ⇒ MD mode/MD time constant

Thermal function

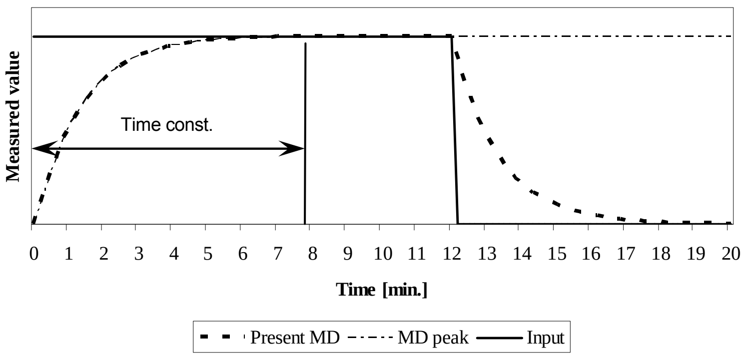
A thermal function ensures exponent thermal characteristic based on simulation of bimetal meters.

Maximum values and time of their occurrence are stored in the device. A time constant (t. c.) can be set from 1 to 255 minutes and is 6 times thermal time constant (t. c. = 6 x thermal time constant).

Example:

Mode: Thermal function
Time constant: 8 min.
Current MD and maximum MD: Reset at 0 min.

Thermal function



Fixed window

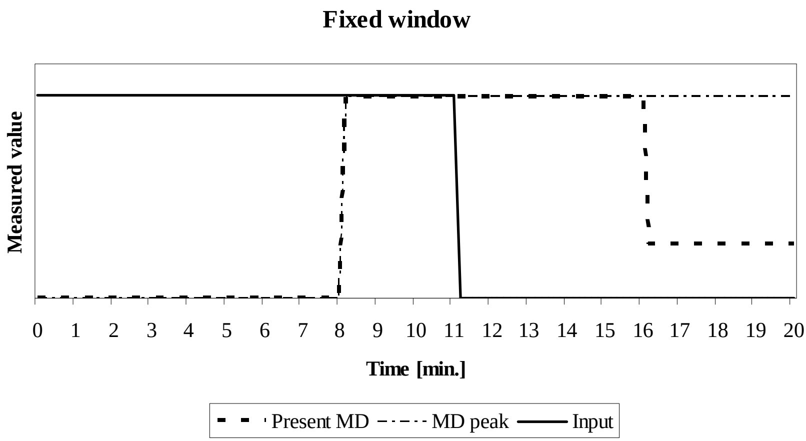
Fixed window is a mode that calculates average value over a fixed time period. This (t. c. – time constant) can be set from 1 to 255 min.

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

A new period also starts after a longer interruption of power supply (more than 1 s).

Example:

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



Sliding windows

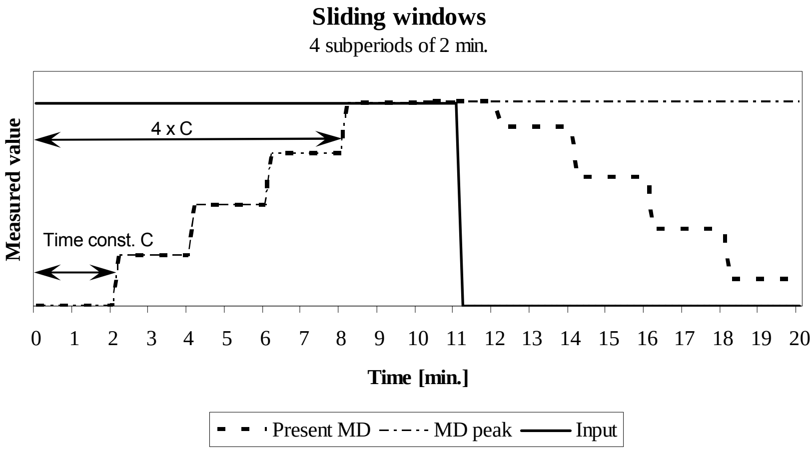
The sliding windows mode enables multiple calculation of average in a period and thus more frequent regeneration of measuring results. The average value over a complete period is displayed. A current MD is updated every subperiod for average of previous subperiods.

A number of subperiods can be set from 2 to 15.
A time period (t. c.) can be set from 1 to 255 minutes.
A new period also starts after a longer interruption of power supply (more than 1 s).

Example:

Mode: Sliding windows
Time constant: 2 min.
No. of subperiods: 4
Current MD and maximum MD: Reset at 0 min.

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



Starting current for PF and PA (mA)

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

Starting current for all powers (mA)

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

Starting voltage for all measurements (V)

Noise is limited with a starting voltage, the level is adjusted so no frequency measurement is possible with disconnected unit.

Reactive power and energy calculation

Connection

Settings of connections must reflect the actual state, otherwise the measurements are not valid.

Connection

When the connection is selected, the load connection and the supported measurements are defined (see the chapter Survey of supported measurements regarding connection mode on page 41).

Main menu ⇒ Settings ⇒ Connection ⇒ Connection mode

Setting of current and voltage ratios

Before setting the current and voltage ratios, it is necessary to be familiar with the conditions under which the device 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) at the last (empty) place or the decimal point.

Settings range	VT primary	VT secondary	CT primary	CT secondary
Max. value	1638.3 kV	13383 V	1638.3 kA	13383 A
Min. value	0.1 V	1 mV	0.1 A	1 mA

Main menu ⇒ Settings ⇒ Connection ⇒ VT primary/VT secondary/CT primary/CT secondary

Used voltage and current range

Setting of the range is connected with all settings of alarms, where 100% represents 500 V and 5 A. In case of subsequent change of the range, alarm settings must also be changed correspondingly.

Nominal frequency

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

Wrong connection warning

Energy flow direction

CT connection

Serial communication

Communication parameters

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

Main menu ⇒ Settings ⇒ Communication ⇒

Display

Display settings

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

Note: The intensity of the backlight can be reduced at low power supply.

Main menu ⇒ Settings ⇒ LCD ⇒ Contrast/Backlight/Backlight time off

Demo cycling period

It defines the time in seconds for each displayed screen of measurements on the LCD.

Main menu ⇒ Settings ⇒ LCD ⇒ Demo cycling period

Settings of customised screens

For easier and faster survey of measurements that are important for the user, three settings of customised screens are available. Each customised screen displays three measurements. When setting the customised screens, the designations are displayed in shorter form, with up to 4 characters. For a survey of all designations, see the chapter Survey of supported measurements regarding connection on page 41.

Example:

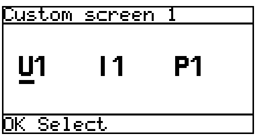
Desired result:

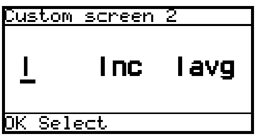
Customised screen 1	Customised screen 2	Customised screen 3
Phase voltage 1	Total current	Power angle (U_1-I_1)
Phase current 1	Neutral current	Frequency
Phase power 1	Average current	THD of current I_1

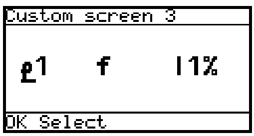
Setting:

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

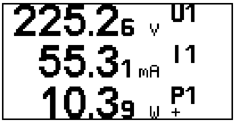
Customised screen 1 Customised screen 2 Customised screen 3

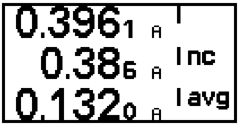


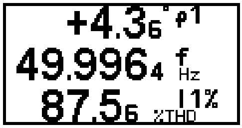




Main menu ⇒ Measurements ⇒ Present values ⇒ Custom OK



⇔


⇔


Security

Setting parameters are divided into four groups regarding security level:

1. At the lowest level (PL0), where a password is not required, the parameters of the LCD can be set: language, contrast and LCD backlight.
2. At the first level (PL1), energy meters and MD can be reset.
3. At the second level (PL2), the access to all data that are protected with the first level (PL1) and setting of all other parameters in the Settings menu are available.
4. 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 the serial number of the meter). The BP password is available in the support department at support@deif.com and is entered instead of the password PL1 or/and PL2. Remember to state the meter serial number when contacting the personnel at DEIF support.

A serial number of the device is stated on the label and under info (see the example below) and is also accessible in the M-Set software.

The meter serial number is accessed in the main menu, via the keyboard.

Example:

Main menu ⇒ Info OK ⇓

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, the others are shown as *.

A password of the first (L1) and the second (L2) level is entered, and time of automatic activation is set.

Main menu ⇒ Settings ⇒ Security ⇒ Password level 1/Password level 2/Password lock time

Password modification

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

Main menu ⇒ Settings ⇒ Security ⇒ Password level 1/Password level 2

Password disabling

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

Main menu ⇒ Settings ⇒ Security ⇒ Password level 1/Password level 2 ⇒ "AAAA" OK

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

Password and language

It is possible to change the language without password input. When the language is changed from or to Russian, character transformation has to be taken into account. See the character transformation table (English or Russian alphabet) below.

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

Energy

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

Common energy exponent

The common energy exponent defines the minimum 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 the setting of a number of impulses for energy of pulse output or alarm output.

Counter divider

The counter divider additionally defines precision of a certain counter according to settings of common energy exponent. This is done to prevent the counter from having an early energy overflow.

An example for 23.331 kWh of consumed active energy:

Divider	Exponent	Resolution	Displayed
1	0	1 x 10^0 = 1 W	23.331 kW
10	0	10 x 10^0 = 10 W	23.33 kW
100	0	100 x 10^0 = 100 W	0.0233 MW
1000	0	1000 x 10^0 = 1 kW	0.023 MW
1	1	1 x 10^1 = 10 W	23.33 kW
1	2	1 x 10^2 = 100 W	0.0233 MW
1	3	1 x 10^3 = 1 kW	0.023 MW
1	4	1 x 10^4 = 10 kW	0.02 MW
10	2	10 x 10^2 = 1 kW	0.023 MW

Outputs

An alarm output and a pulse output can be set via the keyboard. As regards settings of energy and quadrants for a certain meter, only preset selection is possible, while more demanding settings are accessible via communication.

Output

A corresponding energy counter is defined to a pulse output. A number of pulses per energy unit and pulse length.

Main menu ⇒ Settings ⇒ Inputs/Outputs ⇒ I/O 1/2/3/4 ⇒ Setting of pulse output OK

Calculation of recommended pulse parameters

The number of pulses per energy unit should be within certain limits according to the expected power. If this is not the case, the measurement from the pulse output may be incorrect. The settings of the current and voltage transformers may help in the estimation of the expected power.

A parallel RC filter with a time constant of at least 250 μs (R•C ≥ 250 μs) should be used in case of a sensitive pulse counter. The RC filter attenuates relay transient signals.

The principle for pulse setting described below, where e is prefix, complies with SIST EN 62053−31: 2001 standard pulse specifications:

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

Examples:

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

Relay output

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

Main menu ⇒ Settings ⇒ Inputs/Outputs ⇒ V/I 1/2/3/4 ⇒ Setting of alarm output OK

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

Signal shape:

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

This possibility of permanent alarm setting enables remote control via communication.

Alarms

Alarms are used when the set values of the measured quantities are exceeded.

Alarms setting

The MIQ96-3 supports recording and storing of 16 alarms in 2 groups. For each group of alarms, a time constant of maximum values in thermal mode, a delay time and alarm deactivation hysteresis can be defined.

Quantity, value (a current value or an MD – thermal function) and a condition for alarm switch-on are defined for every individual alarm.

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

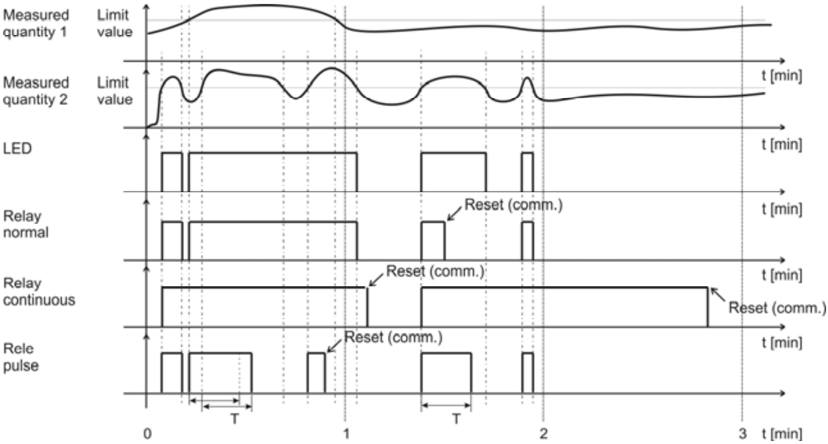
Types of alarms

Visual alarm

When an alarm is switched on, a red LED on the instrument front is blinking (see the figure below).

Alarm output (pulse)

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



Reset operations

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

All or individual energy meters are reset.

Main menu ⇒ Resets ⇒ Energy counters ⇒ All energy counters/ Energy counter E1/E2/E3/E4 OK

Reset maximum MD values

Thermal mode

Current and stored MDs are reset.

Fixed interval/sliding windows

The values in the current time interval, in all subwindows for sliding windows and stored MD are reset. At the same time, synchronisation of time interval to the beginning of the first subwindow is also performed.

Main menu ⇒ Resets ⇒ MD values ⇒

Reset the last MD period

Thermal mode

Current MD value is reset.

Fixed interval/sliding windows

The values in the current time interval and in all subwindows for sliding windows are reset. At the same time, synchronisation of the time interval is also performed.

Main menu ⇒ Resets ⇒ Last period MD ⇒

MD synchronisation

Thermal mode

In this mode, synchronisation does not have any influence.

Fixed interval/sliding windows

Synchronisation sets time in a period or a subperiod for sliding windows to 0 (zero).

Main menu ⇒ Resets ⇒ Synchronise MD ⇒

Reset alarm output

All alarms are reset.

Main menu ⇒ Reset ⇒ Reset alarm output ⇒

8. Measurements

Introduction

In the following chapters, the meter operation is explained in detail.

Available connections

Different electric connections are described in detail in the chapter Electric connection on page 15. 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

Support of measurements depends on connection mode. Calculated measurements are only informative.

Survey of supported measurements regarding connection mode

All measurements with designations can be displayed on customised screens.

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

● = supported ○ = calculated × = not supported

	Basic measurements	Desig-nation	Unit	1b	3b	3u	4b	4u
Phase	Apparent power S_1	S1	VA	●	×	×	●	●
	Apparent power S_2	S2	VA	×	×	×	○	●
	Apparent power S_3	S3	VA	×	×	×	○	●
	Total apparent power S_t	S	VA	●	●	●	○	●
	Power factor PF_1	PF1/ePF1		●	×	×	●	●
	Power factor PF_2	PF2/ePF2		×	×	×	○	●
	Power factor PF_3	PF3/ePF3		×	×	×	○	●
	Total power factor $PF^{\sim}$	PF/ePF		●	●	●	○	●
	Power angle φ_1	φ1	○	●	×	×	●	●
	Power angle φ_2	φ2	○	×	×	×	○	●
	Power angle φ_3	φ3	○	×	×	×	○	●
	Total power angle $\varphi^{\sim}$	φ	○	●	●	●	○	●
	THD of phase voltage U_{f1}	U1%	%THD	●	×	×	●	●
	THD of phase voltage U_{f2}	U2%	%THD	×	×	×	○	●
	THD of phase voltage U_{f3}	U3%	%THD	×	×	×	○	●
	THD of phase current I_1	I1%	%THD	●	●	●	●	●
	THD of phase current I_2	I2%	%THD	×	○	●	○	●
	THD of phase current I_3	I3%	%THD	×	○	●	○	●
Phase-to-phase	Phase-to-phase voltage U_{12}	U12	V	×	●	●	○	●
	Phase-to-phase voltage U_{23}	U23	V	×	●	●	○	●
	Phase-to-phase voltage U_{31}	U31	V	×	●	●	○	●
	Average phase-	UΔ	V	×	●	●	○	●

	Basic measurements	**Desig-nation**	**Unit**	**1b**	**3b**	**3u**	**4b**	**4u**
	to-phase voltage (U_{ff})							
	Phase-to-phase angle φ_{12}	φ12	○	×	×	×	○	●
	Phase-to-phase angle φ_{23}	φ23	○	×	×	×	○	●
	Phase-to-phase angle φ_{31}	φ31	○	×	×	×	○	●
	THD of phase-to-phase voltage $THDU_{12}$	U12%	%THD	×	●	●	○	●
	THD of phase-to-phase voltage $THDU_{23}$	U23%	%THD	×	●	●	○	●
	THD of phase-to-phase voltage $THDU_{31}$	U31%	%THD	×	●	●	○	●
Energy	Counters 1-4	E1, E2, E3, E4	Wh VAh VArh	●	●	●	●	●
Max. values MD	MD current I_1	I1	A	●	●	●	●	●
	MD current I_2	I2	A	×	○	●	○	●
	MD current I_3	I3	A	×	○	●	○	●
	MD active power P (positive)	P+	W	●	●	●	●	●
	MD active power P (negative)	P−	W	●	●	●	●	●
	MD reactive power Q−L	Q	VAr	●	●	●	●	●
	MD reactive power Q−C	Q	VAr	●	●	●	●	●
	MD apparent power S	S	VA	●	●	●	●	●

● = supported ○ = calculated × = not supported

Explanation of basic concepts

Sample factor − M_V

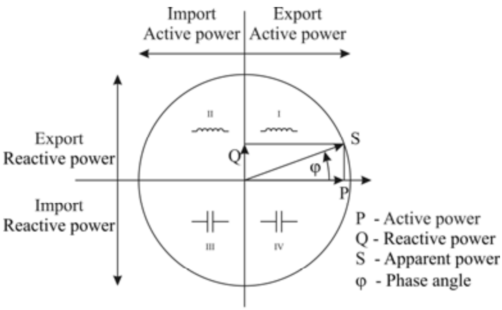
A meter measures all primary quantities with a sample frequency which cannot exceed a certain number of samples in a time period. Based on these limitations (65 Hz•128 samples), a sample factor is calculated. Depending on the frequency of a measured signal, a sample factor (M_V) defines a number of periods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

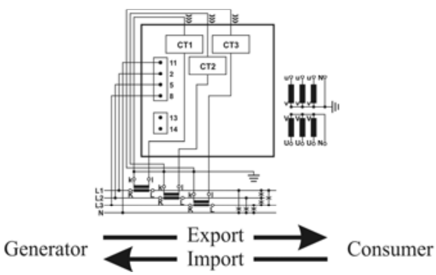
Average interval − M_P

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

Power and energy flow

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





Calculation and display of measurements

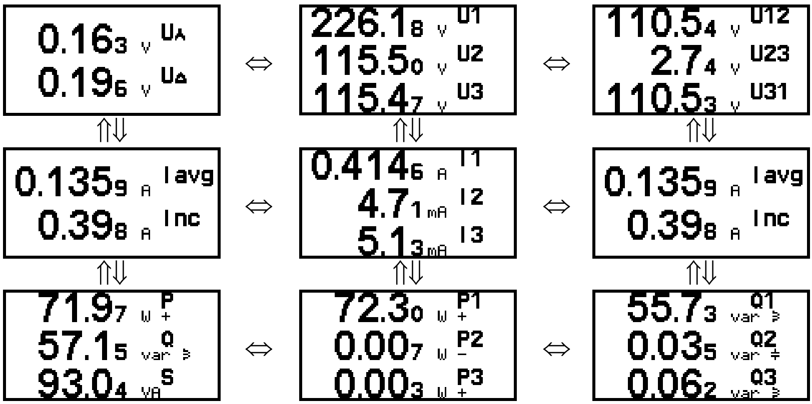
This chapter deals with capture, calculation and display of all supported quantities of measurements. Only the most important equations are described; however, all of them are shown in the chapter Equations on page 62, with additional descriptions and explanations.

Calculation and display of measurements depend on the connection used. For more detailed information, see the chapter Survey of supported measurements regarding connection modes.

The OK key is used to enter and quit the measurement display menu. The arrow keys (left/right/up/down) are used to shift between displays as show in the example below.

Example for MC330 at 4u connection mode:

Main menu ⇒ Measurements ⇒ Present values ⇒ Voltage OK



Present values

Since the support of measurement depends on connection mode, some display groups can be combined into one within the Measurements menu.

Voltage

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

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

All voltage measurements are available via communication, serial and customised displays on the LCD.

Main menu ⇒ Measurements ⇒ Present values ⇒ Voltage OK

Current

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

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

All current measurements are available via communication, serial and customised displays on the LCD.

Main menu ⇒ Measurements ⇒ Present values ⇒ Current OK

Active, reactive and apparent power

Active power is calculated from instantaneous phase voltages and currents. All measurements are seen via communication or are displayed on the LCD. For more detailed information about calculation, see the chapter Equations on page 62.

Main menu ⇒ Measurements ⇒ Present values ⇒ Power OK

Power factor and power angle

Power angle is calculated as quotient of active and apparent power for each phase separately ($\cos\varphi_1$, $\cos\varphi_2$, $\cos\varphi_3$) and total power angle ($\cos\varphi_t$). A coil symbol represents inductive load, and a capacitor symbol represents capacitive load. For correct display of PF via application of the alarm, ePF (extended power factor) is applied. It illustrates the power factor with one value as described in the table below. For a display on LCD, both of them have equal display symbols: between −1 and −1 with the icon for inductive or capacitive load.

Load	C	→		←	L
Angle [°]	-180	-90	0	+90	+180 (179.99)
PF	-1	0	1	0	-1

Main menu ⇒ Measurements ⇒ Present values ⇒ PF and power angle OK

Frequency

Network frequency is calculated from time periods of measured voltage.

Main menu ⇒ Measurements ⇒ Present values ⇒ Frequency OK

Energy

Energy measurements available correspond to the energy flow. Tariffs are manually supported and only on the display.

Main menu ⇒ Measurements ⇒ Present values ⇒ Energy OK

MD values

Display of MD values.

Main menu ⇒ Measurements ⇒ Present values ⇒ MD values OK

THD − total harmonic distortion

THD is calculated for phase currents, phase and phase-to-phase voltages and is expressed as percent of high harmonic components regarding rms value or relative to first harmonic.

The instrument uses the measuring technique of real effective (rms) value that ensures exact measurements with the presence of high harmonics up to 32nd harmonic.

Main menu ⇒ Measurements ⇒ Present values ⇒ THD OK

Customised screens

A display of customised screens depends on the settings. See the chapter Settings of customised screens on page 31.

Overview

It combines several measurements on each display as the following screens are displayed:

Explanation of measurements for the MIQ96-3 at connection mode 4u:

Screen 1:

Current phase measurements			Current phase measurements		
U⅄	Average voltage $U^{\sim}$	V	P	Total active power P_t	W
1	Phase voltage U_1	V	P1	Active power P_1	W
2	Phase voltage U_2	V	P2	Active power P_2	W
3	Phase voltage U_3	V	P3	Active power P_3	W
I⅄	Average current $I^{\sim}$	A	Q	Total reactive power Q_t	VAr
1	Current I_1	A	Q1	Reactive power Q_1	VAr
2	Current I_2	A	Q2	Reactive power Q_2	VAr
3	Current I_3	A	Q3	Reactive power Q_3	VAr

Screen 2:

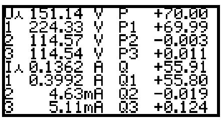
Current phase-to-phase measurements			**Current phase-to-phase measurements**		
UΔ	Average phase-to-phase $U^{\sim}$	V		Frequency f	Hz
12	Phase-to-phase voltage U_{12}	V	φ	Power angle φ_1	○
23	Phase-to-phase voltage U_{23}	V	φ	Power angle φ_2	○
31	Phase-to-phase voltage U_{31}	V	φ	Power angle φ_3	○
PF	Total power factor		φ	Average phase-to-phase angle $\varphi^{\sim}$	○
PF1	Power factor PF_1		φ	Power angle φ_{12}	○
PF2	Power factor PF_2		φ	Power angle φ_{23}	○
PF3	Power factor PF_3		φ	Power angle φ_{31}	○

Screen 3:

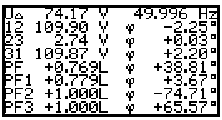
Dynamic MD values			**Maximum MD values**		
P+	MD active power P (positive)	W		MD active power P (positive)	W
P−	MD active power P (negative)	W	φ	MD active power P (negative)	W
Q⇛	MD reactive power Q−L	VAr	φ	MD reactive power Q−L	VAr
Q‡	MD reactive power Q−C	VAr	φ	MD reactive power Q−C	VAr
S	MD apparent power S	VA	φ	MD apparent power S	VA
I1	MD current I1	A	φ	MD current I1	A
I2	MD current I2	A	φ	MD current I2	A
I3	MD current I3	A	φ	MD current I3	A

Example of MIQ96-3 at connection 4u:

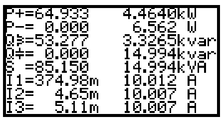
Main menu ⇒ Measurements ⇒ Present values ⇒ Overview OK / ⇒



⇔

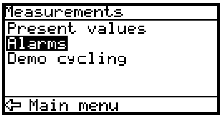


⇔

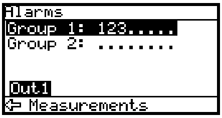


Alarms

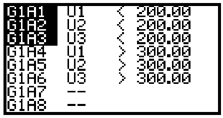
An alarm menu enables surveying of the state of alarms. In the basic alarm menu, groups of alarms with the states of the individual alarms and data on alarm outputs are displayed in the bottom line. For each active alarm, a number is written in a certain group at a certain place: Group 1: 1**…**45**…**8. Dots mean that the alarm is not active.



OK



OK



Survey of alarms

The alarms are collected in groups in a detailed survey. Group number and alarm number are stated in the first column, measurement designation in the second and condition for the alarm in the third column. Active alarms are marked.

Main menu ⇒ Measurements ⇒ Alarms OK / ⇒

Demonstration measurements

Demo cycling

Regarding the period that is defined in the settings, measurement screen cycling is active until any key is pressed.

Main menu ⇒ Measurements ⇒ Demo cycling OK

9. Appendix A: Modbus protocol

Modbus communication protocol

Communication protocols

Modbus protocol is enabled via the RS485 communication port.

Modbus protocol enables operation of the device on Modbus networks. Modbus protocol is a widely supported open interconnection originally designed by Modicon.

The memory reference for input and holding registers is 30000 and 40000 respectively.

At Modbus register 40100 (Modbus table for measurements) you can select register map value “0” or “1”. Value “1” is an MIQ96-2 compatible register map.

Register table for the actual measurements

Parameter	**Type**	**"0"**		**MIQ96-2 comp "1"**	
		Start	**End**	**Start**	**End**
Voltage U_1	T5	30107	30108	30044	30045
Voltage U_2	T5	30109	30110	30046	30047
Voltage U_3	T5	30111	30112	30048	30049
Average phase voltage $U^{\sim}$	T5	30113	30114	30042	30043
Phase-to-phase voltage U_{12}	T5	30118	30119	30081	30082
Phase-to-phase voltage U_{23}	T5	30120	30121	30083	30084
Phase-to-phase voltage U_{31}	T5	30122	30123	30085	30086
Average phase-to-phase voltage $U_{pp\sim}$	T5	30124	30125	30079	30080
Current I_1	T5	30126	30127	30036	30037
Current I_2	T5	30128	30129	30038	30039
Current I_3	T5	30130	30131	30040	30041
Total current I	T5	30138	30139	30034	30035
Neutral current In	T5	30132	30133	30074	30075
Real power P_1	T6	30142	30143	30020	30021
Real power P_2	T6	30144	30145	30022	30023
Real power P_3	T6	30146	30147	30024	30025
Total real power P	T6	30140	30141	30018	30019
Reactive power Q_1	T6	30150	30151	30028	30029
Reactive power Q_2	T6	30152	30153	30030	30031
Reactive power Q_3	T6	30154	30155	30032	30033
Total reactive power Q	T5	30148	30149	30026	30027
Apparent power S_1	T5	30158	30159	30052	30053
Apparent power S_2	T5	30160	30161	30054	30055
Apparent power S_3	T5	30162	30163	30056	30057
Total apparent power S	T7	30156	30157	30050	30051
Power factor PF_1	T7	30166	30167	30060	30061
Power factor PF_2	T7	30168	30169	30062	30063
Power factor PF_3	T7	30170	30171	30064	30065

Parameter	**Type**	**"0"**		**MIQ96-2 comp "1"**	
		Start	**End**	**Start**	**End**
Total power factor PF	T7	30164	30165	30058	30059
Power angle U_1-I_1	T2	30173		30071	
Power angle U_2-I_2	T2	30174		30072	
Power angle U_3-I_3	T2	30175		30073	
Power angle atan2(Pt, Qt)	T2	30172		30070	
Angle U_1-U_2	T2	30115		30076	
Angle U_2-U_3	T2	30116		30077	
Angle U_3-U_1	T2	30117		30078	
Frequency f	T5	30105	30106		
Frequency f (mHz)	T1			30066	
THD I_1	T1	30188		30118	
THD I_2	T1	30189		30119	
THD I_3	T1	30190		30120	
THD U_1	T1	30182		30112	
THD U_2	T1	30183		30113	
THD U_3	T1	30184		30114	
THD U_{12}	T1	30185		30115	
THD U_{23}	T1	30186		30116	
THD U_{31}	T1	30187		30117	
Max. demand since last reset					
MD real power P (positive)	T6	30542	30543		
MD real power P (negative)	T6	30548	30549		
MD reactive power Q-L	T6	30554	30555		
MD reactive power Q-C	T6	30560	30561		
MD apparent power S	T5	30536	30537		
MD current I_1	T5	30518	30519		
MD current I_2	T5	30524	30525		
MD current I_3	T5	30530	30531		
Dynamic demand values					
MD real power P (positive)	T6	30510	30511		
MD real power P (negative)	T6	30512	30513		
MD reactive power Q-L	T6	30514	30515		
MD reactive power Q-C	T6	30516	30517		
MD apparent power S	T5	30508	30509		
MD current I_1	T5	30502	30503		

Parameter	**Type**	**"0"**		**MIQ96-2 comp "1"**	
		Start	**End**	**Start**	**End**
MD current I_2	T5	30504	30505		
MD current I_3	T5	30506	30507		
Energy					
Energy counter 1 exponent	T2	30401		30006	
Energy counter 2 exponent	T2	30402		30007	
Energy counter 3 exponent	T2	30403		30008	
Energy counter 4 exponent	T2	30404		30009	
Counter E1	T3	30406	30407	30010	30011
Counter E2	T3	30408	30409	30012	30013
Counter E3	T3	30410	30411	30014	30015
Counter E4	T3	30412	30413	30016	30017
Active tariff	T1	30405		30133	
Internal temperature	T17	30181		30128	

Register table for the normalised actual measurements

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

Parameter	Modbus		100% value
	Regist.	Type	
Power angle U_2-I_2	30837	T17	100°
Power angle U_3-I_3	30838	T17	100°
Power angle atan2(Pt, Qt)	30839	T17	100°
Angle U_1-U_2	30840	T17	100°
Angle U_2-U_3	30841	T17	100°
Angle U_3-U_1	30842	T17	100°
Frequency	30843	T17	Fn+10 Hz
THD I_1	30845	T16	100%
THD I_2	30846	T16	100%
THD I_3	30847	T16	100%
THD U_1	30848	T16	100%
THD U_2	30849	T16	100%
THD U_3	30850	T16	100%
THD U_{12}	30851	T16	100%
THD U_{23}	30852	T16	100%
THD U_{31}	30853	T16	100%
Max demand since last reset			
MD real power P (positive)	30854	T16	Pt
MD real power P (negative)	30855	T16	Pt
MD reactive power Q-L	30856	T16	Pt
MD reactive power Q-C	30857	T16	Pt
MD apparent power S	30858	T16	Pt
MD current I_1	30859	T16	In
MD current I_2	30860	T16	In
MD current I_3	30861	T16	In
Dynamic demand values			
MD real power P (positive)	30862	T16	Pt
MD real power P (negative)	30863	T16	Pt
MD reactive power Q-L	30864	T16	Pt
MD reactive power Q-C	30865	T16	Pt
MD apparent power S	30866	T16	Pt
MD current I_1	30867	T16	In
MD current I_2	30868	T16	In
MD current I_3	30869	T16	In
Energy			
Energy counter 1	30870	T17	
Energy counter 2	30871	T17	

Parameter	Modbus		100% value
	Regist.	Type	
Energy counter 3	30872	T17	Actual counter value MOD 20000 is returned
Energy counter 4	30873	T17	
Energy counter 1 cost	30874	T17	
Energy counter 2 cost	30875	T17	
Energy counter 3 cost	30876	T17	
Energy counter 4 cost	30877	T17	
Total energy counter cost	30878	T17	
Active tariff	30879	T1	
Internal temperature	30880	T17	100°

100% values calculations for normalised measurements

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

Register	Content
30015	Calibration voltage
30017	Calibration current

Register table for the basic settings

Register	Content	Type	Ind.	Values/ dependencies	Min.	Max.	P 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 CD 15(16)
T4	Bits # 15…14 Bits # 13…00	**Short unsigned float (16 bit)** Decade exponent (unsigned 2 bit) Binary unsigned value (14 bit) Example: 10000*102 = A710(16)
T5	Bits # 31…24 Bits # 23…00	**Unsigned measurement (32 bit)** Decade exponent (signed 8 bit) Binary unsigned value (24 bit) Example: 123456*10-3 = FD01 E240(16)
T6	Bits # 31…24 Bits # 23…00	**Signed measurement (32 bit)** Decade exponent (signed 8 bit) Binary signed value (24 bit) Example: - 123456*10-3 = FDFE 1DC0(16)
T7	Bits # 31…24 Bits # 23…16 Bits # 15…00	**Power factor (32 bit)** Sign: Import/export (00/FF) Sign: Inductive/capacitive (00/FF) Unsigned value (16 bit), 4 decimal places Example: 0.9876 CAP = 00FF 2694(16)
T9	Bits # 31…24 Bits # 23…16 Bits # 15…08 Bits # 07…00	**Time (32 bit)** 1/100s 00-99 (BCD) Seconds 00-59 (BCD) Minutes 00-59 (BCD) Hours 00-24 (BCD) Example: 15:42:03.75 = 7503 4215(16)
T10	Bits # 31…24 Bits # 23…16 Bits # 15…00	**Date (32 bit)** Day of month 01-31 (BCD) Month of year 01-12 (BCD) Year (unsigned integer) 1998..4095 Example: 10, SEP 2000 = 1009 07D0(16)
T16		**Unsigned value (16 bit), 2 decimal places** Example: 123.45 = 3039(16)

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

10. Appendix B: Calculations and equations

Calculations

Definition of symbols

No.	Symbol	Definition
1	M_v	Sample factor
2	M_P	Average interval
3	U_f	Phase voltage (U_1, U_2 or U_3)
4	U_{ff}	Phase-to-phase voltage (U_{12}, U_{23} or U_{31})
5	N	Total number of samples in a period
6	n	Sample number ($0 \le n \le N$)
7	x, y	Phase number (1, 2 or 3)
8	i_n	Current sample n
9	u_{fn}	Phase voltage sample n
10	u_{fFn}	Phase-to-phase voltage sample n
11	φ_f	Power angle between current and phase voltage f (φ_1, φ_2 or φ_3)

Equations

Voltage

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

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

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

Phase-to-phase voltage
u_x, u_y − phase voltages (U_f)
N − a number of samples in a period

Current

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

Phase current
N − 128 samples in a period (up to 65 Hz)
N − 128 samples in more periods (above 65 Hz)

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

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

Power

$$P_f = \frac{1}{N} \cdot \sum_{n=1}^{N} \left(u_{fn} \cdot i_{fn}\right)$$

Active power by phases
N − a number of periods
n − a number of samples in a period
f − phase designation

$$P_t = P_1 + P_2 + P_3$$

Total active power
t − total power
1, 2, 3 − phase designation

$$\mathrm{SignQ_f}(\varphi)$$
$$\varphi \in [0° - 180°] \Rightarrow \mathrm{SignQ_f}(\varphi) = +1$$
$$\varphi \in [180° - 360°] \Rightarrow \mathrm{SignQ_f}(\varphi) = -1$$

Reactive power sign
Q_f – reactive power (by phases)
φ – power angle

$$S_f = U_f \cdot I_f$$

Apparent power by phases
U_f – phase voltage
I_f – phase current

$$S_t = S_1 + S_2 + S_3$$

Total apparent power
S_{123} – apparent power by phases

$$Q_f = \mathrm{SignQ_f}(\varphi) \cdot \sqrt{S_f^2 - P_f^2}$$

Reactive power by phases
S_f – apparent power by phases
P_f – active power by phases

$$Q_t = Q_1 + Q_2 + Q_3$$

Total reactive power
Q_f – reactive power by phases

$$\varphi_s = a\tan 2(P_t, Q_t)$$
$$\varphi_s = [-180°, 179{,}99°]$$

Total power angle
P_t – total active power
S_t – total apparent power

$$PF_t = \frac{P_t}{S_t}$$

3-phase power factor
P_t – total active power
S_t – total apparent power

$$PF_f = \frac{P_f}{S_f}$$

Power factor by phases
P_f – phase active power
S_f – phase apparent power

THD

$$I_f THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} In^2}}{I_1} \cdot 100$$

Current THD
I_1 – value of first harmonic
n – number of harmonic

$$U_f THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} U_f n^2}}{U_{f1}} \cdot 100$$

Phase voltage THD
U_1 − value of first harmonic
n − number of harmonic

$$U_{ff} THD(\%) = \frac{\sqrt{\sum_{n=2}^{63} U_{ff} n^2}}{U_{ff1}} \cdot 100$$

Phase-to-phase voltage THD
U_1 − value of first harmonic
n − number of harmonic

DEIF A/S reserves the right to change any of the above.