EN




# ME110-230.3M

## 3-Phase Power Measurement Module

## User guide

ME110-230.3M_2017.09_0261_EN
© All rights reserved
Subject to technical changes and misprints

CE



LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

## Contents


**1 Overview ..... 2**

1.1 Functions ..... 2

1.2 RS485 network ..... 2

**2 Specifications ..... 3**

2.1 Environmental conditions ..... 4

**3 Safety ..... 5**

3.1 Intended use ..... 5

**4 Design and control elements ..... 6**

**5 Installation ..... 7**

5.1 Wiring ..... 7

**6 Configuration ..... 9**

**7 Operation ..... 11**

7.1 Measurement ..... 11

7.2 Modbus addressing ..... 12

**8 Restore factory settings ..... 13**

**9 Maintenance ..... 15**

**10 Transportation and storage ..... 16**

**11 Scope of delivery ..... 17**

**Appendix A Dimensions ..... 18**

**Appendix B Modbus registers ..... 19**

**Appendix C Error and status codes ..... 25**





Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 1 Overview

## 1.1 Functions

The module ME110-230.3M is an input module for measuring the electrical data in a 3-phase AC power system and transmission of the measured and calculated data over RS485 network.

The device has three voltage analog inputs and three current analog inputs. The phase currents, phase voltages and line-to-line voltages are measured on inputs and digitalised. The digitalised values are used to calculate the effective (root mean square) values and other 3-phase AC power system values: powers (active, reactive, apparent), power factors and phase angles.

The module provides following basic functions:

- transmitting the measured and calculated values over RS485 network
- RS485 network diagnostic
- fault indication
- Slave in the RS485 network.

The module is to be configured using ‘M110 Configurator’ software (included on CD) via RS485-USB interface adapter IC4 (not included). The latest version of the configuration software is available for download on www.akytec.de.

## 1.2 RS485 network

I/O modules of series Mx110 use the common standard RS485 for data exchange.

Serial interface RS485 enables communication via two-wired line in half-duplex mode. The module supports Modbus-RTU, Modbus-ASCII and akYtec protocols. The network consists of a Master device and can contain up to 32 Slave devices. Maximum length is 1200 m. The number of Slave devices and network length can be increased using RS485 interface repeater.

Devices are connected to a network according to linear (bus) topology. It means that the line goes from the first device to the second one, from the second one to the third one, etc. Star connection and spur lines are not allowed.

Line reflections always occur at each of the 2 ends of the bus (the first and the last node). The higher the data transmission rate, the stronger they are. A terminating resistor is needed to minimize reflections. Line termination may be a 150 ohms value (0.5 W) resis-tor.

All modules can be used as Slave devices only. Master device can be PLC, computer with SCADA software or control panel.



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 2 Specifications

*Table 2.1 General data*

| | |
|---|---|
| **Power supply** | |
| Power supply | 230 (90…264) V AC, 45…65 Hz |
| Power consumption, max. | 7.5 VA |
| **Phase voltage measurement** | |
| Measuring range | 1...400 Veff |
| Measuring range with external transformer | $1x10^{-3}$...$4000x10^{3}$ Veff |
| Max. voltage for the duration of 1 s | 800 V |
| Basic accuracy | 0.25 % |
| Resolution | 0.1 V |
| Input resistance, max. | 500 kohm |
| Sampling time, max. | 1 s |
| Measuring channels | 3 |
| **Line-to-line voltage measurement** | |
| Measuring range | 2...580 Veff |
| Measuring range with external transformer | $2x10^{-3}$...$5800x10^{3}$ Veff |
| Max. voltage for the duration of 1 s | 800 V |
| Basic accuracy | 0.5 % |
| Resolution | 0.1 V |
| Input resistance, max. | 500 kohm |
| Sampling interval, max. | 1 s |
| Measuring channels | 3 |
| **Current measurement** | |
| Measuring range | 0.005…5 Aeff |
| Measuring range with external transformer | $0.005x10^{-3}$…$50x10^{3}$ Aeff |
| Max. current for the duration of 1 s | 10 A |
| Basic accuracy | 0.25% |
| Resolution | 1 mA |
| Input resistance, max. | 0.01 ohm |
| Sampling interval, max. | 1 s |
| Measuring channels | 3 |
| **Power measurement** | |
| Measuring range | 0.02…2 kW, kVA, kvar |
| Measuring range with external transformer | $0.2x10^{-6}$…$200x10^{9}$ kW, kVA, kvar |
| Basic accuracy | 0.5 % |
| Resolution | 1 kW, kVA, kvar |
| Calculating time, max. | 1 s |
| Measuring channels | 3 |
| **Frequency measurement** | |
| Measuring range | 45…65 Hz |
| Basic accuracy | 0.15% |
| Resolution | 0.01 Hz |
| Sampling interval, max. | 1 s |
| Measuring channels (active) | 1 |
| **Power factor measurement (cos φ)** | |
| Measuring range | 0…1 |
| Basic accuracy | 1.0% |
| Resolution | 0.01 |



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

| | | |
|---|---|---|
| Calculating time, max. | | 1 s |
| Measuring channels | | 3 |
| **Phase angle measurement** | | |
| Measuring range | | 10…170 grad |
| Basic accuracy | | 0.4% |
| Resolution | | 1 grad |
| Sampling interval, max. | | 1 s |
| Measuring channels | | 3 |
| **Communication** | | |
| RS485 interface | Connection | D+, D- |
| | Protocols | Modbus RTU/ASCII, akYtec |
| | Baud rate | 2.4…115.2 kbit/s |
| | Data bits | 7, 8 |
| | Parity | even, odd, none |
| | Stop bits | 1, 2 |
| **Enclosure** | | |
| Dimensions | | 96x110x73 mm |
| Weight | | approx. 500 g |
| Material | | plastic |

## 2.1 Environmental conditions

The following environment conditions must be met:

- clean, dry and controlled environment, low dust level
- closed non-hazardous areas, free of corrosive or flammable gases

*Table 2.2*

| Condition | Permissible range |
|---|---|
| Ambient operating temperature | -20…+55°C |
| Storage temperature | -25…+55°C |
| Relative humidity | up to 80% (at +35°C, non-condensing) |
| IP Code | IP20 |
| Altitude | up to 2000 m above sea level |



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 3 Safety

Explanation of the symbols and keywords used:

**DANGER**

***DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.***

**WARNING**

***WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.***

**CAUTION**

***CAUTION indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury***

**NOTICE**

***NOTICE indicates a potentially harmful situation which, if not avoided, may result in damage of the product itself or of adjacent objects.***

## 3.1 Intended use

The device has been designed and built solely for the intended use described in this guide, and may only be used accordingly. The technical specifications contained in this guide must be observed.

The device may be operated only in properly installed condition.

### Improper use

Any other use is considered improper. Especially to note:

- This device should not be used for medical devices which receive, control or otherwise affect human life or physical health.
- The device should not be used in an explosive environment.
- The device should not be used in an atmosphere with chemically active substance.



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 4 Design and control elements

– Enclosure plastic, grey, for DIN-rail or wall mounting
– Terminal blocks 2 plug-in terminal blocks with 18 screw terminals

*Table 4.1 Control elements*

| LED | Indication | Description |
|---|---|---|
| POWER (green) | lights | Power supply indicator |
| RS-485 (yellow) | blinks at the rate of data exchange | Data exchange over RS485 interface |
| | blinks at the rate of 1 Hz | Data exchange with factory settings |
| FAULT (red) | blinks at the rate of 1 Hz | 1. No connection with ADC (higher priority)<br>2. Phase reversal (lower priority) |
| FAULT lights and RS-485 is off | | Timeout error (see Table 6.1) |
| UA, UB, UC, IA, IB, IC (green) | lights | Signal within the valid range |
| | blinks at the rate of 1 Hz | No signal or the signal exceeds the valid range |

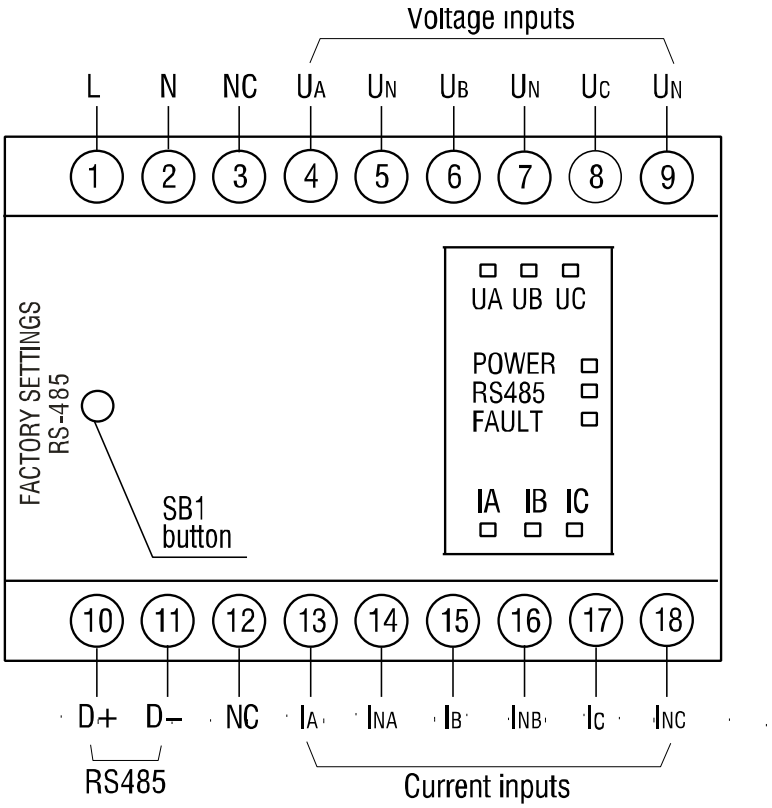



*Fig. 4.1*

Dimensional drawings are given in App. A.

There is the SB1 button “Factory settings” behind the left front cover (Fig. 4.1). With this button the default settings of the RS485 interface can be restored.



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 5 Installation

⚠ CAUTION

***Improper installation***
***Improper installation can cause serious or minor injuries or damage the device.***
***Installation must be performed only by fully qualified personnel.***

- The module is intended to be mounted in a cabinet on DIN-rail or on the wall. For the dimensional drawings see Appendix A.
- Install the module in a cabinet with clean, dry and controlled environment. For further details see 2.1.
- The module is designed for natural convection cooling. It should be taken into account when choosing the installation site.

## 5.1 Wiring

⚠ DANGER

***Dangerous voltage***
***Electric shock could kill or seriously injure.***
***All electrical connections must be performed by a fully qualified electrician.***
***Ensure that the mains voltage matches the voltage marked on the nameplate!***
***Ensure that the device is provided with its own power supply line and electric fuse!***

⚠ DANGER

***Switch on the power supply only after the wiring of the device has been completely performed.***

- The electrical connections are shown in Fig. 4.1 and the terminal assignments in Table 5.1.
- The inputs should be wired in accordance with Fig. 5.1–5.2.
- Connect the power supply to the L/N terminals.
- The maximum conductor cross-section for power supply is 1.5 mm².

▶ NOTICE

***Signal cables should be routed separately or screened from the supply cables.***
***Only a shielded cable may be used for signal lines.***

- Connect the RS485 lines to terminals D+ and D-.
- Twisted pair cable should be used for the connection to RS485 interface. Maximal cable length is 1200 m.

*Table 5.1 Terminal assignments*

| No | Indication | Description | No | Indication | Description |
|---|---|---|---|---|---|
| 1 | L | Power supply | 10 | D+ | RS485 + |
| 2 | N | | 11 | D- | RS485 - |
| 3 | NC | not connected | 12 | NC | not connected |
| 4 | $U_A$ | Voltage L1 | 13 | $I_A$ | Current L1 |
| 5 | $U_N$ | Neutral | 14 | $I_{NA}$ | Neutral |
| 6 | $U_B$ | Voltage L2 | 15 | $I_B$ | Current L2 |
| 7 | $U_N$ | Neutral | 16 | $I_{NB}$ | Neutral |
| 8 | $U_C$ | Voltage L3 | 17 | $I_C$ | Current L3 |
| 9 | $U_N$ | Neutral | 18 | $I_{NC}$ | Neutral |



LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

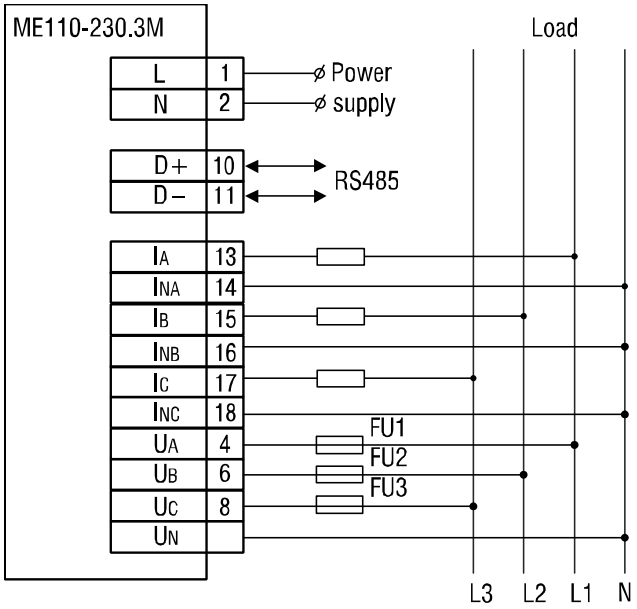



*Fig. 5.1 3-phase, 4-wire Wye, Direct connection*

FU1, FU1, FU3 – 1.0 A / 600 V fuses of type T

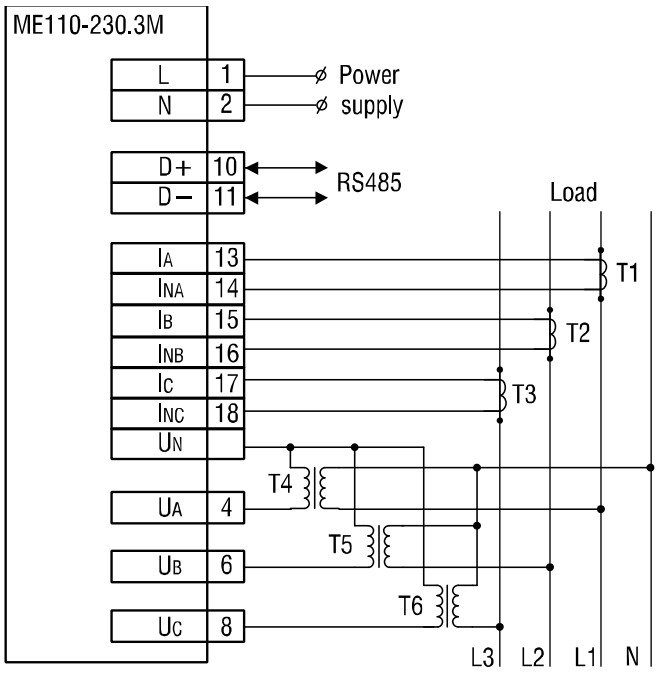



*Fig. 5.2 3-phase, 4-wire Wye, Connection with transformers*



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 6 Configuration

▶ NOTICE

***Before starting***
***Before switching on, make sure that the device was stored at the specified ambient temperature (-20 ... +55 °C) for at least 30 minutes.***

The configuration tool 'M110 Configurator' provides viewing, editing and saving of parameters. The full list of parameters is shown in the Table 6.1.

The software and the manual are included on the CD.

The module has to be configured in order to use it in RS485 network. Proceed as follows:
– Install the M110 Configurator on the PC.
– Connect the module to the USB interface of the PC over RS485-USB interface adapter IC4 (not included). Connect the D+/D- terminals of the module with the D+/D- contacts of the adapter.
– Connect 230 V AC power supply to the L/N terminals of the module.
– Turn on the power supply.
– Start the M110 Configurator.

If the factory settings of the module have not been changed, the connection to the module is established automatically, the module recognized, its configuration read out and an appropriate configuration mask opened.

Otherwise, the network parameters of the configurator have to be changed.

The complete list of Modbus Registers is represented in Appendix B.

*Table 6.1 Configuration parameters*

| Name | Parameter | Valid value | Meaning | Default |
|---|---|---|---|---|
| **Basic parameters** | | | | |
| **dev** | Device | up to 8 characters | | ME110-3M |
| **ver** | Firmware version | up to 8 characters | | manufacturer |
| **Network parameters** | | | | |
| **bPS** | Baud rate, kbit/s | 0 | 2.4 | 9.6 |
| | | 1 | 4.8 | |
| | | 2 | 9.6 | |
| | | 3 | 14.4 | |
| | | 4 | 19.2 | |
| | | 5 | 28.8 | |
| | | 6 | 38.4 | |
| | | 7 | 57.6 | |
| | | 8 | 115.2 | |
| **PrtY** | Parity * | 0 | none | none |
| | | 1 | even | |
| | | 2 | odd | |
| **Sbit** | Stop bits * | 0 | 1 | 1 |
| | | 1 | 2 | |
| **LEn** | Data bits * | 0 | 7 | 8 |
| | | 1 | 8 | |
| **A.Len** | Address bits ** | 0 | 8 | 8 |
| | | 1 | 11 | |
| **Addr** | Device address ** | 1…255 (2047) | | 16 |
| **T.pro** | Protocol ** | 0 | Modbus ASCII | 2 |
| | | 1 | Modbus RTU | |



LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

| | | | | |
|---|---|---|---|---|
| | | 2 | akYtec | |
| **t.out** | Timeout, s | 0…600 | | 600 |
| **rs.dl** | Response delay, ms | 0…255 | | 2 |
| **Input parameters** | | | | |
| **N.u** | Voltage transformation ratio | 0.001…9999 | | 1.0 |
| **N.i** | Current transformation ratio | 0.001…9999 | | 1.0 |
| **Uk.hi** | Voltage upper limit for calibration *** | 100…300 | | 300 |
| **Uk.lo** | Voltage lower limit for calibration *** | 1…10 | | 6 |
| **Ik.hi** | Current upper limit for calibration *** | 1…5 | | 5 |
| **Ik.lo** | Current lower limit for calibration *** | 0.01…0.1 | | 0.02 |

***** *Invalid network parameter combinations:*

- *prty=0; sbit=0; len=0*
- *prty=1; sbit=1; len=1*
- *prty=2; sbit=1; len=1*

****** *The values Address bits = 11 and Device address = 256…2047 are available if the Protocol = akYtec is selected*

*** *Factory calibration. Changing these parameters is not recommended.*



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 7 Operation

## 7.1 Measurement

The phase currents, phase voltages, line-to-line voltages and fundamental frequency are measured on inputs and digitalised. The digitalized values are used to calculate the effective (root mean square) values and other 3-phase AC power system values: powers (active, reactive, apparent), power factors and phase angles.

**Effective voltage**

$$V_{RMS} = K_V \sqrt{\int_0^T V^2(t)dt}$$

where
$V_{RMS}$ – effective value of phase voltage
T – integration time
$K_V$– voltage factor

**Effective current**

$$I_{RMS} = K_I \sqrt{\int_0^T I^2(t)dt}$$

where
$I_{RMS}$ – effective value of phase current
$K_I$ – current factor

**Apparent power**

$$S = V_{RMS} * I_{RMS}$$

**Active power**

$$P = V_{RMS} * I_{RMS} * cos\varphi$$

where
*cosφ* – power factor

**Reactive power**

$$Q = V_{RMS} * I_{RMS} * sin\varphi$$

**Fundamental frequency**
To measure the fundamental frequency a zero-crossing function of the ADC is used. The ADC forms signals for the microcontroller in the first voltage channel. The time difference between the signals is converted into the frequency. The frequency value must be within the range from 45 to 65 Hz.

**Power factor**

$$cos\varphi = \frac{P}{S}$$

The power factor is calculated within the power range from 0.02 to 2 kW.

**Phase angle**
The measurement of the angle between phases is carried out similarly to fundamental frequency, but the zero-crossing function for different phases is used.



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

### Using of transformers

The Voltage transformation ratio **N.u** and Current transformation ratio **N.i** (see Table 6.1) are set to 1 by default. If voltage or current transformers are used, the parameters **N.u** and **N.i** have to be set to their transformation ratios. The values can be set in the range from 0.001 to 9999.

## 7.2 Modbus addressing

In the operation mode the module is controlled by a network Master. The addresses from 1 to 247 can be used. The address 0 is reserved for broadcasting.

The following Modbus functions are supported:

- 03 (0x03) Read Holding Registers
- 04 (0x04) Read Input Registers
- 06 (0x06) Preset Single Register
- 16 (0x10) Preset Multiple Registers
- 17 (0x11) Report Slave ID

The list of Modbus Registers is represented in Appendix B.

The list of Modbus Error Codes is represented in Appendix C, Table C.1.

The list of Operation Status Codes is represented in Appendix C, Table C.2.



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 8 Restore factory settings

⚠ **DANGER**

***Dangerous voltage***
***The voltage on some components of the circuit board can be dangerous! Direct contact with the circuit board or penetration of a foreign body in the enclosure must be avoided!***

If the communication between the module and PC cannot be established and network parameters of the module are unknown, the default network settings have to be restored. Proceed as follows:

- Connect the module to PC
- Start the M110 Configurator
- Turn on the module
- Remove the left front cover with the inscription 'FACTORY SETTINGS RS-485'
- Push and hold the SB1 button for at least 5 seconds
- When the button is released the RS-485 LED starts to flash and the module starts to operate with the default network settings, while the user settings remain stored.
- Click the *'Use factory settings'* key or enter the values from the Table 8.1 in the *'Connection to device'* dialog box (see Fig. 8.1).

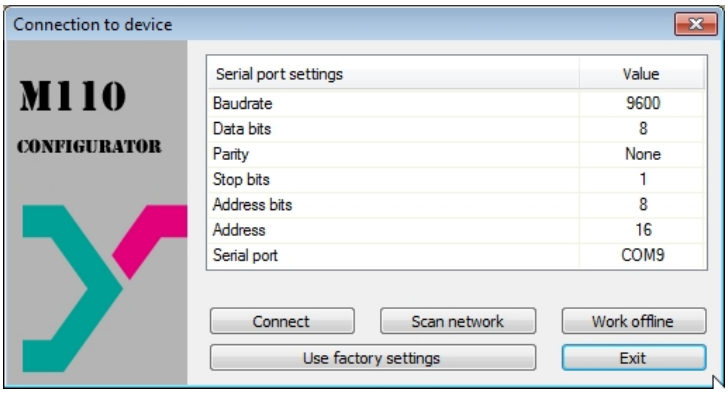



*Fig. 8.1 'Connection to device' dialog box*

- Click *'Connect'* to establish the connection with the factory settings
- The main window of the Configurator opens. Use the *'Device>Read all'* menu path to read the user network settings from the device (see Fig. 8.2).
- Open the *'Network parameters'* folder and note the user network settings.
- Close the M110 Configurator
- Push and hold the SB1 button for at least 5 seconds
- When the button is released the RS-485 LED goes out and the module starts to operate with the user network settings

**Note:** If in the 'Factory Network Settings' mode the new network settings will be applied (using the *'Device>Commands>Apply new network settings'* menu path), the module goes into operating mode, and the RS-485 LED goes out, because the command restarts the device.

- Start the M110 Configurator
- Enter the noted network settings in the *'Connection to device'* dialog box
- Click *'Connect'* to establish the connection with the user settings
- Check the connection to the device by using the *'Device>Check connection…'* menu path
- Close the cover



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

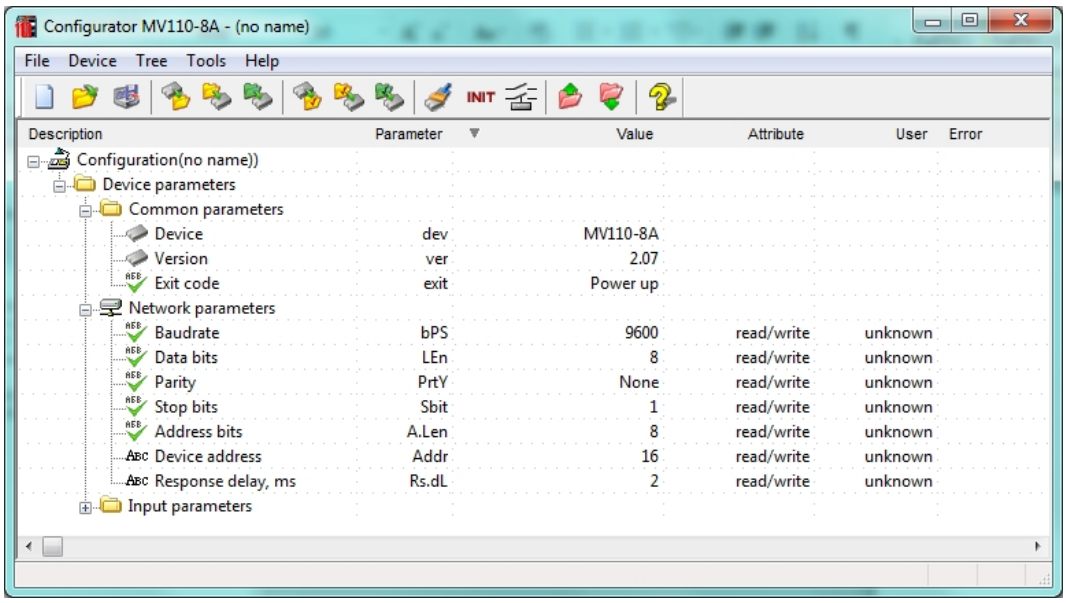



*Fig. 8.2 M110 Configurator main window*

*Table 8.1 Default network parameters*

| Parameter | Name | Default |
|---|---|---|
| Baud rate, bit/s | **bps** | 9600 |
| Data bits | **len** | 8 |
| Parity | **prty** | none |
| Stop bits | **sbit** | 1 |
| Address bits | **a.len** | 8 |
| Address | **addr** | 16 |
| Response delay, ms | **rs.dl** | 2 |



LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 9 Maintenance

The maintenance includes:

- cleaning of the housing and terminal blocks from dust, dirt and debris
- checking the fastening of the device
- checking the wiring (connecting leads, fastenings, mechanical damage).

The device should be cleaned with a damp cloth only. No abrasives or solvent-containing cleaners may be used. The safety information in section 3 must be observed when carrying out maintenance.



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 10 Transportation and storage

Pack the device in such a way as to protect it reliably against impact for storage and transportation. The original packaging provides optimum protection.

If the device is not taken immediately after delivery into operation, it must be carefully stored at a protected location. The device should not be stored in an atmosphere with chemically active substances.

Permitted storage temperature: -25...+55 °C

▶ **NOTICE**

***Transport damage, completeness***
***The device may have been damaged during transportation.***
***Check the device for transport damage and completeness!***
***Report the transport damage immediately to the shipper and akYtec GmbH!***



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

# 11 Scope of delivery

| | | |
|---|---|---|
| – | Module ME110-230.3M | 1 |
| – | User guide | 1 |
| – | CD with software and documentation | 1 |



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

## Appendix A Dimensions

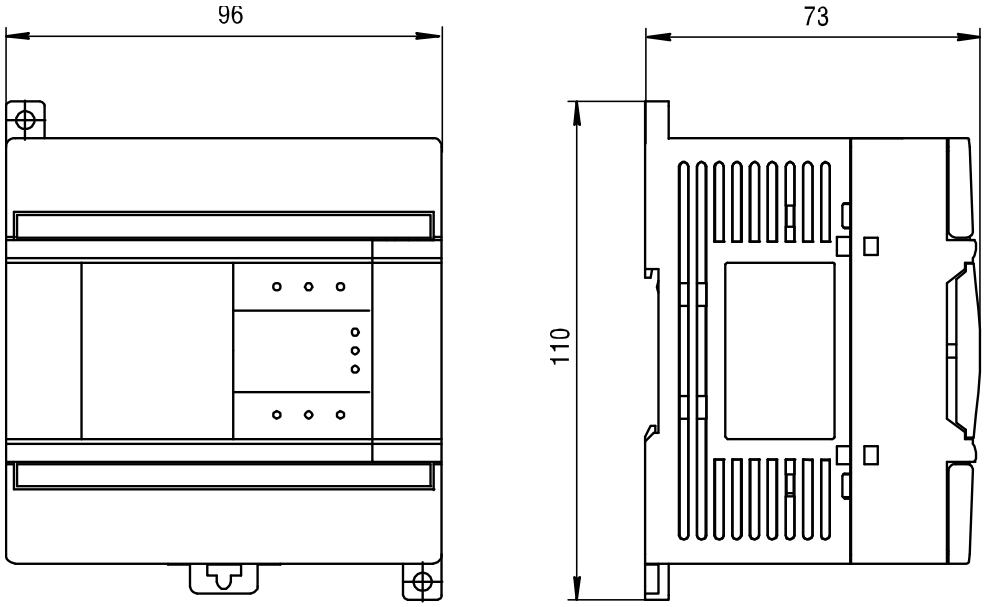



*Fig. A.1 External dimensions*

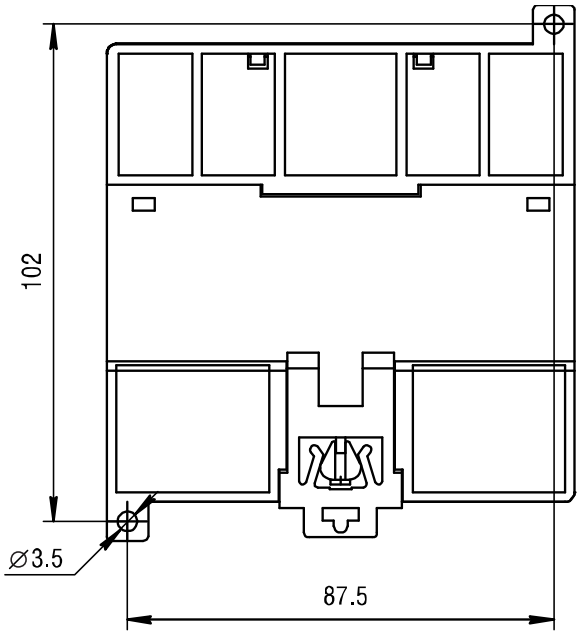



*Fig. A.2 Wall mounting dimensions*



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

## Appendix B Modbus registers

*Table B.1 Data formats*

| Type | Size (bit) | Min | Max |
|---|---|---|---|
| CHAR | 8 | -128 | 127 |
| UCHAR | 8 | 0 | 255 |
| SHORT | 16 | $-2^{15}$ | $2^{15}-1$ |
| USHORT | 16 | 0 | $2^{16}-1$ |
| LONG | 32 | $-2^{31}$ | $2^{31}-1$ |
| ULONG | 32 | 0 | $2^{32}-1$ |
| FLOAT | 32 | IEEE 754 | IEEE 754 |

*Table B.2 Modbus registers*

| No | Parameter | Register | Valid value | Meaning | Data type | Default (Note) | Access |
|---|---|---|---|---|---|---|---|
| **Basic parameters** | | | | | | | |
| 1 | Device name | 0x0000.. 0x0003 | ASCII string, 8 bytes | | CHAR [8] | ME110-3M | R |
| 2 | Firmware | 0x0004, 0x0005 | ASCII string, 4 bytes vX.YY | | CHAR [4] | Manufac-turer | R |
| **Network parameters** | | | | | | | |
| 1 | Baud rate, kbit/s | 0x0006 | 0 | 2.4 | UCHAR | 2 | RW |
| | | | 1 | 4.8 | | | |
| | | | 2 | 9.6 | | | |
| | | | 3 | 14.4 | | | |
| | | | 4 | 19.2 | | | |
| | | | 5 | 28.8 | | | |
| | | | 6 | 38.4 | | | |
| | | | 7 | 57.6 | | | |
| | | | 8 | 115.2 | | | |
| 2 | Data bits | 0x0007 | 0 | 7 bits | UCHAR | 1 | RW |
| | | | 1 | 8 bits | | | |
| 3 | Parity | 0x0008 | 0 | none | UCHAR | 0 | RW |
| | | | 1 | even | | | |
| | | | 2 | odd | | | |
| 4 | Stop bits | 0x0009 | 0 | 1 stop bit | UCHAR | 0 | RW |
| | | | 1 | 2 stop bits | | | |
| 5 | Response delay, ms | 0x000A | 0..255 | | UCHAR | 2 | RW |
| 6 | Timeout, s | 0x000B | 0..600 | | UCHAR | 600 | RW |
| 7 | Device address | 0x000C | 1..247 | | UCHAR | 16 | RW |
| 8 | Protocol | 0x000D | 0 | Modbus ASCII | UCHAR | 2 | RW |
| | | | 1 | Modbus RTU | | | |
| | | | 2 | akYtec | | | |
| 9 | Address bits | 0x000E | 0 | 8 bits | UCHAR | 0 | RW |
| | | | 1 | 11 bits | | | |



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

| No | Parameter | Register | Valid value | Meaning | Data type | Default (Note) | Ac-cess |
|---|---|---|---|---|---|---|---|
| 10 | Last Network Error Code | 0x000F | See Table C.1 | | UCHAR | | R |
| **Input parameters** | | | | | | | |
| 1 | Device Error Code | 0x0010 | 0 | EEPROM error | CHAR | | R |
| | | | 1 | ADC connection error | | | |
| | | | 2 | Error while parame-ter initialization | | | |
| | | | 4 | Phase A over range | | | |
| | | | 5 | Phase B over range | | | |
| | | | 6 | Phase C over range | | | |
| 2 | Status Code | 0x0011 | See Table C.2 | | USHORT | 0 | RW |
| 3 | DP for voltage ratio integer * | 0x0012 | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 4 | Voltage ratio integer * | 0x0013, 0x0014 | 1..9999999 | | ULONG | 1 | RW |
| 5 | DP for current ratio integer * | 0x0015 | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 6 | Current ratio integer * | 0x0016, 0x0017 | 1..9999999 | | ULONG | 1 | RW |
| 7 | DP for measured voltage integer * | 0x0018 | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 8 | DP for measured current integer * | 0x001F | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 9 | DP apparent power integer * | 0x0026 | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 10 | DP for active power integer * | 0x002D | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 11 | DP for reactive power integer * | 0x0034 | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

| No | Parameter | Register | Valid value | Meaning | Data type | Default (Note) | Access |
|---|---|---|---|---|---|---|---|
| 12 | DP for power factor integer * | 0x003B | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 13 | DP for frequency integer * | 0x0042 | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 14 | DP for phase angle integer * | 0x0045 | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 15 | Voltage ratio | 0x004C, 0x004D | 0.001..9999 | | FLOAT | 1.0 | RW |
| 16 | Current ratio | 0x004E, 0x004F | 0.001..9999 | | FLOAT | 1.0 | RW |
| 17 | APLY | 0x007C | Initializing and permanent saving of new settings | | UCHAR | 0x0000 after executing | W |
| **Operating values** | | | | | | | |
| 1 | Voltage integer, Phase A * | 0x0019, 0x001A | | | LONG | | R |
| 2 | Voltage integer, Phase B * | 0x001B, 0x001C | | | LONG | | R |
| 3 | Voltage integer, Phase C * | 0x001D, 0x001E | | | LONG | | R |
| 4 | Current integer, Phase A * | 0x0020, 0x0021 | | | LONG | | R |
| 5 | Current integer, Phase B * | 0x0022, 0x0023 | | | LONG | | R |
| 6 | Current integer, Phase C * | 0x0024, 0x0025 | | | LONG | | R |
| 7 | Apparent power integer, Phase A * | 0x0027, 0x0028 | | | LONG | | R |
| 8 | Apparent power integer, Phase B * | 0x0029, 0x002A | | | LONG | | R |
| 9 | Apparent power integer, Phase C * | 0x002B, 0x002C | | | LONG | | R |
| 10 | Real power integer, Phase A * | 0x002E, 0x002F | | | LONG | | R |
| 11 | Real power integer, Phase B * | 0x0030, 0x0031 | | | LONG | | R |
| 12 | Real power integer, Phase C * | 0x0032, 0x0033 | | | LONG | | R |
| 13 | Reactive power integer, Phase A * | 0x0035, 0x0036 | | | LONG | | R |



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

| No | Parameter | Register | Valid value | Meaning | Data type | Default (Note) | Access |
|---|---|---|---|---|---|---|---|
| 14 | Reactive power integer, Phase B * | 0x0037, 0x0038 | | | LONG | | R |
| 15 | Reactive power integer, Phase C * | 0x0039, 0x003A | | | LONG | | R |
| 16 | Power factor integer, Phase A * | 0x003C, 0x003D | | | LONG | | R |
| 17 | Power factor integer, Phase B * | 0x003E, 0x003F | | | LONG | | R |
| 18 | Power factor integer, Phase C * | 0x0040, 0x0041 | | | LONG | | R |
| 19 | Frequency integer * | 0x0043, 0x0044 | | | ULONG | | R |
| 20 | Phase angle integer A-B * | 0x0046, 0x0047 | | | LONG | | R |
| 21 | Phase angle integer B-C * | 0x0048, 0x0049 | | | LONG | | R |
| 22 | Phase angle integer C-A * | 0x004A, 0x004B | | | LONG | | R |
| 23 | Voltage Phase A | 0x0050, 0x0051 | | | FLOAT | | R |
| 24 | Voltage Phase B | 0x0052, 0x0053 | | | FLOAT | | R |
| 25 | Voltage Phase C | 0x0054, 0x0055 | | | FLOAT | | R |
| 26 | Current Phase A | 0x0056, 0x0057 | | | FLOAT | | R |
| 27 | Current Phase B | 0x0058, 0x0059 | | | FLOAT | | R |
| 28 | Current Phase C | 0x005A, 0x005B | | | FLOAT | | R |
| 29 | Apparent power Phase A | 0x005C, 0x005D | | | FLOAT | | R |
| 30 | Apparent power Phase B | 0x005E, 0x005F | | | FLOAT | | R |
| 31 | Apparent power Phase C | 0x0060, 0x0061 | | | FLOAT | | R |
| 32 | Active power Phase A | 0x0062, 0x0063 | | | FLOAT | | R |
| 33 | Active power Phase B | 0x0064, 0x0065 | | | FLOAT | | R |
| 34 | Active power Phase C | 0x0066, 0x0067 | | | FLOAT | | R |
| 35 | Reactive power Phase A | 0x0068, 0x0069 | | | FLOAT | | R |
| 36 | Reactive power Phase B | 0x006A, 0x006B | | | FLOAT | | R |



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

| No | Parameter | Register | Valid value | Meaning | Data type | Default (Note) | Access |
|---|---|---|---|---|---|---|---|
| 37 | Reactive power Phase C | 0x006C, 0x006D | | | FLOAT | | R |
| 38 | Power factor Phase A | 0x006E, 0x006F | | | FLOAT | | R |
| 39 | Power factor Phase B | 0x0070, 0x0071 | | | FLOAT | | R |
| 40 | Power factor Phase C | 0x0072, 0x0073 | | | FLOAT | | R |
| 41 | Frequency | 0x0074, 0x0075 | | | FLOAT | | R |
| 42 | Phase angle A-B | 0x0076, 0x0077 | | | FLOAT | | R |
| 43 | Phase angle B-C | 0x0078, 0x0079 | | | FLOAT | | R |
| 44 | Phase angle C-A | 0x007A, 0x007B | | | FLOAT | | R |
| 45 | Line-to-line voltage A-B | 0x007D, 0x007E | | | FLOAT | | R |
| 46 | Line-to-line voltage B-C | 0x007F, 0x0080 | | | FLOAT | | R |
| 47 | Line-to-line voltage C-A | 0x0081, 0x0082 | | | FLOAT | | R |
| 48 | Neutral current | 0x0083, 0x0084 | | | FLOAT | | R |
| 49 | DP for line-to-line voltage integer * | 0x0085 | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 50 | Line-to-line voltage AB * | 0x0086, 0x0087 | | | ULONG | | R |
| 51 | Line-to-line voltage BC * | 0x0088, 0x0089 | | | ULONG | | R |
| 52 | Line-to-line voltage CA * | 0x008A, 0x008B | | | ULONG | | R |
| 53 | DP for neutral current integer * | 0x008C | 0 | (----) | UCHAR | 0 | RW |
| | | | 1 | (---.-) | | | |
| | | | 2 | (--.--) | | | |
| | | | 3 | (-.---) | | | |
| 54 | Neutral current integer * | 0x008D, 0x008E | | | ULONG | | R |

** The measured value is in two formats available:*

- *Integer (LONG, ULONG)*
- *Floating-point (FLOAT)*

*Both formats are saved in different data registers (see Table B.2).*



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

*The integer is calculated by multiplication of the measured value by $10^{DP}$. The parameter DP is used for a decimal point and can be set within the range 0…3 as an input parameter (see Table 6.1, B.2, section 'Input parameters').*



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

## Appendix C Error and status codes

*Table C.1 – Last Network Error Code (0x000F, see Table B.2 Modbus registers)*

| Code | Description |
|---|---|
| 0 | Error-free frame reception |
| 2 | Decimal point position greater than 3 |
| 3 | Attempt to write the ‘read only’ register |
| 33 | Hardware framing error |
| 39 | Incorrect frame checksum |
| 40 | Descriptor not found |
| 49 | Actual number of registers less than specified |

*Table C.2 – Status Code (0x0011, see Table B.2 Modbus registers)*

| Bit Number | Assignment |
|---|---|
| 15 | Use the integer transformation ratio |
| 14 | Wrong phase sequence |
| 8 | Start calibration |
| 7 | Waiting for U = 100V, I = 1A, cos φ = 1. Calibration is completed |
| 6 | Waiting for U = **Uk.hi ***, I = **Ik.hi ***, cos φ = 0.5 |
| 2 | Waiting for U = **Uk.lo ***, I = **Ik.lo *** |
| 1 | Waiting for U = **Uk.hi ***, I = **Ik.hi *** |
| 0 | Calibration error / Calibration failed |

** Parameters **Uk.hi**, **Uk.lo**, **Ik.hi**, **Ik.lo** have to be set when configuring the device (see Table 6.1)*



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000