MK110-24.8D.4R

Digital input/output module 12 channel (8 DI, 4 DO)

User guide

MK110-24.8D.4R_3-EN-145144-1.1

Contents

1 Introduction

1.1 Abbreviations

MX110_configurator – configuration software
Modbus – application layer messaging protocol for client/server communication between devices connected on different types of buses or networks, originally published by Modicon (now Schneider Electric), currently supported by an independent organization Modbus-IDA *www.modbus.org*)

1.2 Symbols and key words

WARNING
WARNING indicates a potentially dangerous situation that could result in death or serious injuries.

CAUTION
CAUTION indicates a potentially dangerous situation that could result in minor injuries.

NOTICE
NOTICE indicates a potentially dangerous situation that could result in damage to property.

NOTE
NOTE indicates helpful tips and recommendations, as well as information for efficient and trouble-free operation.

1.3 Intended use

The device has been designed and built solely for the intended use described here, and may only be used accordingly. The technical specifications contained in this document must be observed.
The device may be operated only in properly installed condition.

Improper use

Any other use is considered improper. Especially to note:
– The device may not be used for medical applications.
– The device may not be used in explosive environment.
– The device may not be used in atmosphere in which there are chemically active substances.

1.4 Limitation of liability

Our company does not bear any responsibility with respect to breakdowns or damages caused by using the product in a manner other than described in the Manual or in violation of the current regulations and technical standards.

1.5 Safety

WARNING
Ensure the mains voltage matches the voltage marked on the nameplate. Ensure the device is provided with its own power supply line and electric fuse.

WARNING
The device terminals may be under a dangerous voltage. De-energize the device before working on it. Switch on the power supply only after completing all works on the device.

NOTICE
Supply voltage may not exceed 28 V. Higher voltage can damage the device.
If the supply voltage is lower than 20 V DC, the device cannot operate properly but will not be damaged.

NOTICE
If the device is brought from a cold to a warm environment, condensation may form inside the device. To avoid damage to the device, keep the device in the warm environment for at least 1 hour before powering on.

2 Overview

2.1 Basic features

Digital input/output module MK110-24.8D.4R is an expansion module with 8 digital inputs and 4 digital outputs.
The module has the following functions:

– Connection of peripherals with digital outputs
– Digital signal processing
– Pulse counter (see *Section 4.3*)
– Connection of actuators with digital inputs
– Control of digital outputs (via RS485 network or with internal logic)
– Pulse-width modulation (see *Section 4.5*)
– Network diagnostics
– Fault and alarm signals
– Slave in a Modbus protocol structure

The module uses Modbus-RTU and Modbus-ASCII protocols with automatic protocol identification. The module can be configured with the *Mx110 Configurator* software using an RS485-USB interface adapter (not included). The latest version of the configuration software is available for download on ***www.akytec.de.***

2.2 Design and indication

Table 2.1 Indication

LED	LED state	Description
POWER	ON	Power on
RS-485	Flashing	Data exchange via RS485 interface
FAULT	ON	Data exchange via RS485 interface is interrupted
INPUTS 1...8	ON	Input is on
OUTPUTS 1...4	ON	Output is on

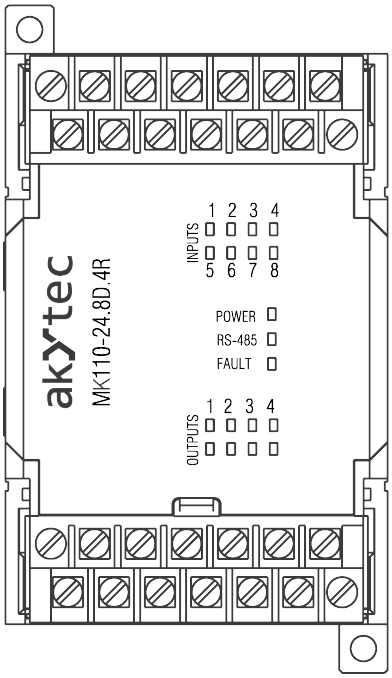


Fig. 2.1 Front view of MK110-24.8D.4R

There are three jumpers under the front cover :
– X2 – restore factory settings (see *Section 6*)
– X3 – service function
– X1 – DRAM write-protection (see *Section 4.11*)
All the jumpers are in OFF position by default.

3 Specifications

3.1 Specifications

Table 3.1 Specifications

Parameter		Value
Power supply		24 (20…28) V DC
Power consumption, max.		6 W
Inputs	digital	8
	analog	–
Outputs	digital	4
	analog	–
Permissible load		4 A, 250 V AC cos ϕ > 0.4 or 24 V DC
RS485 interface	Connection	D+, D-
	Protocols	Modbus RTU/ASCII, akYtec
	Baud rate	2.4…115.2 kbit/s
	Data bits	7, 8
	Parity	odd, even, none
	Stop bits	1, 2
Dimensions		63 × 110 × 75 mm
Weight, max.		500 g
Material		plastic
IP code		IP20

Table 3.2 Input specifications

Type	Switching contact, NPN
Galvanic Isolation	In groups
Insulation strength	1500 V
Pulse frequency, max.	1 kHz
Pulse width, min.	0.5 ms
Current, max.	7 mA
Line resistance, max.	100 Ohm

3.2 Operating conditions

The module is designed for natural convection cooling that should be taken into account when choosing the installation site.
The following environmental conditions must be observed:

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

Table 3.3 Operating conditions

Condition	Permissible range
Ambient temperature	-20…+55°C
Transportation and storage	-25…+55°C
Relative humidity	up to 80% (at +25°C, non-condensing)
Altitude	up to 2000 m above sea level

4 Configuration and operation

NOTE
Before switching on, make sure that the device was stored at the specified ambient temperature (-***20 ... +55 °C) for at least 60 minutes.***

Parameters of the module can be read, edited and saved with the Mx110 Configurator software. The full list of parameters is shown in *Table 4.1*.
The software and its user guide can be found on the *akYtec* site.
The module should be configured first before operating in the RS485 network.
The following steps are required:

1. Install the Mx110 Configurator on the PC.
2. The module should be connected to the USB-port of the PC over a USB/RS485 adapter (not included). Connect the D+/D- terminals of the module with the D+/D- contacts of the adapter.
3. Connect the power supply to the 24V/0V terminals of the module.
4. Turn on the power supply.
5. Start the Mx110 Configurator.

If the factory settings of the module have not been changed, the connection to the module is automatically established, the module is automatically recognized, its configuration parameters are read out and an appropriate configuration mask opens.
If it does not happen, parameters of the configurator have to be changed.

Table 4.1 Configuration parameters

Name	Parameter	Valid value	Meaning	Default settings
Basic parameters				
dev	Device	Up to 8 symbols		MK110-24.8D.4R
ver	Firmware version	Up to 8 symbols		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	
LEn	Data bits*	0	7	8
		1	8	
PrtY	Parity*	0	none	none
		1	even	
		2	odd	
Sbit	Stop bits*	0	1	1
		1	2	
A.Len	Address bits	0	8	8
		1	11	

Name	Parameter	Valid value	Meaning	Default settings
Addr	Device address	1…247		16
t.out	Time-out, s	0…600		0
Rs.dL	Response delay, ms	0…45		2
Input parameters				
Tin.C	Debouncing filter	0	off	0
		1	on	
Output parameters				
THPD	PWM period, s	1…900		1
O.ALr	Safe output status, %	0…100		0
Log	Output logic	0	RS485	0
		1	direct logic	
		2	NOT	
		3	AND	
		4	OR	
		5	one pulse	
		6	PWM	
		7	trigger	
O.dl	On/Off-delay*	0	no delay	0
		1	on-delay	
		2	off-delay	
Tim	Output_delay, _x0.1s	0…65535	x 0.1 s	0

NOTE
* Invalid network parameter combinations:
– *prty=0; sbit=0; len=0*
– *prty=1; sbit=1; len=1*
– *prty=2; sbit=1; len=1*

4.1 Operation modes

In the operation mode the module is controlled by a network Master in the Modbus network. It can be performed in different ways:
– Individual control in digital mode (see *Section 4.4*)
– Individual control in PWM mode (see *Section 4.5*)
– Group control (see *Section 4.6*).
Modbus functions 03, 04 can be used for reading and 15, 16 can be used for writing.

4.2 Functional test

To test the module for proper functioning the following steps are required:
– Connect the module to a USB-port of the PC using a USB/RS485 adapter.

– Start the Mx110 Configurator on the PC.
– If the connection has not been established automatically, the network parameters of the configurator have to be changed.
– Choose menu item ‘Device -> I/O status…’. A new window “Output status” will open.
– For each output the PWM duty cycle (pulse to period ratio) between 0 and 1 can be set, so that output is switched on/off or a continuous pulse train is generated.
– Output resistance for the MK110-24.8D.4R modification can be optionally measured with an ohmmeter.
  – Max resistance on closed outputs = 1 Ω
  – Min resistance on open outputs = 2 MΩ
– If there are any deficiencies in functioning, contact the akYtec service staff.

4.3 Counter Function

Additionally, the module can use all inputs as a fast 16-bit counter with the operating counting frequency up to 1 kHz. Minimum one-pulse time is 0.5 ms. Pulses with higher frequency or less one-pulse time are ignored. The counter responses on rising edge.
When switching off, the counter status is saved in the long-term memory.
In case of full filling the counter is reset to zero and counting continues.
Function of debouncing can be activated for each input. For this purpose, parameter **tin.c** (debouncing filter) should be set to "On" (refer to *Table 4.1*) during configuration. It is recommended to use this function at signal frequency up to 90 Hz and duty ratio 50% and more.
Input status can be read out as a bit mask. The appropriate Modbus registers are given in *Table 4.3*. The least significant bit of the mask corresponds to input 1.
To reset the counter, 0 should be specified in the appropriate register.

4.4 Individual ON/OFF control

Using function Modbus 15 (0x0F) "Write Multiple Coils" the certain number of outputs can be controlled. The command shall include the following:
– Start address (0x0000 to 0x0003)
– Number of described bits (0x0001 to 0x0004)
– Byte number n (0x01)
– Information (bit mask, n bytes)

Addressing of separate cells is given in *Table 4.4*.

4.5 Individual control in PWM mode

Average voltage can be changed using pulse-width modulation (PWM). Pulses with the specified period (parameter **THPD**) and duty cycle (pulse to period ratio) are generated on the output.
Possible output statuses depending on the duty cycle are shown in *Table 4.2*. Modbus function 16 should be used to transfer the duty cycle value to the module.

Table 4.2 Pulse width modulation

Duty cycle		Output status
Configuration	Modbus command	
0	0	0
1	1000	1
between 0 and 1	between 0 and 1000	Pulses with duty ratio between 0 and 100%

The PWM period (**THPD**) is usually set during configuration. The period can also be changed by a Modbus command, and the following should be observed:

NOTE
The configurator uses not the Modbus protocol but its own internal communication protocol. Therefore, the range of value in configuration and in a Modbus command can differ. For example, the duty cycle must be set to 1 for switching on the DO1 output during the functional test. In a Modbus command the duty cycle must be written as 0001 in register 0000.

NOTE
Permanent memory
As the permanent memory is not unlimited rewritable (approx. 10^6 times), it is not advisable to change parameters 'THPD' (PWM period) and 'O.ALr' (Safe output status) by Modbus commands as often as, for instance, the PWM duty cycle.

Minimum PWM period is 50 µs and cannot be changed.

4.6 Group control

Group control is performed using Modbus function 16.
Thus, the output status bitmask (see *Table 4.3*) has to be written into register 50 (0x0032). This way all outputs can be controlled simultaneously. Bit 0 corresponds to output 1.
With the transfer of the mask the generation of the pulse is stopped and the outputs are set in accordance with the mask.

4.7 Fault condition

If the data exchange via the serial port is interrupted (i. e. there is no command from the master within the time specified by the **t.out** parameter) all outputs are set to a safe status. 'Fault Condition' is a combination of all safe PWM duty cycle values set in the **O.ALr** parameter (Safe output status) for each output.
In this case:

– LED FAULT is on.
– A request from the master device terminates the Fault Condition.
– Outputs remain in the safe status until a command from the master changes the output status.
– If the **t.out** parameter is set to 0, 'Fault Condition' is not defined.

Parameters **t.out** and **O.ALr** can be set during configuration or operation. The 'Permanent memory' note in *Section 4.5* should be taken into account.

4.8 RS485 network

The I/O modules of series Mx110 use the common RS485 standard for data exchange.
The RS485 serial interface enables communication via a two-wired line in the half-duplex mode. The modules support Modbus RTU, Modbus ASCII and akYtec protocols. The network consists of a Master device and up to 32 Slave devices. The maximum length is 1200 m. The number of Slave devices and the network length can be increased using an 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 Ω value (0.5 W) resistor.
All modules can be used as Slave devices only. The Master device can be a PLC, a computer with SCADA software or a control panel.

4.9 Modbus registers

All variables and parameters in *Table 4.3* are of the UINT16 type.
Variables in *Table 4.4* are of the BOOL type.
R – read access.
W – write access

Table 4.3 Modbus registers

Parameter	Unit	Value		Access	Address	
		Configu-ration	Modbus com-mand		hex	dec
Duty cycle DO1	-	0…1	0…1000	RW	0000	0000
Duty cycle DO2	-	0…1	0…1000	RW	0001	0001
Duty cycle DO3	-	0…1	0…1000	RW	0002	0002
Duty cycle DO4	-	0…1	0…1000	RW	0003	0003
Safe output status (**O.ALr**) DO1	-	0…100	0…1000	RW	0010	0016
Safe output status (**O.Alr**) DO2	-	0…100	0…1000	RW	0011	0017
Safe output status (**O.Alr**) DO3	-	0…100	0…1000	RW	0012	0018
Safe output status (**O.Alr**) DO4	-	0…100	0…1000	RW	0013	0019
PWM period (**THPD**) DO1	s	1…900	1…900	RW	0020	0032
PWM period (**THPD**) DO2	s	1…900	1…900	RW	0021	0033
PWM period (**THPD**) DO3	s	1…900	1…900	RW	0022	0034
PWM period (**THPD**) DO4	s	1…900	1…900	RW	0023	0035
Time-out (**t.out**)	s	0…600	0…600	RW	0030	0048
Output status bitmask	-	-	0…15	RW	0032	0050
Input status bitmask	-	-	0…255	RW	0033	0051
Counter DI1	-	0…65535	0…65535	RW	0040	0064
Counter DI2	-	0…65535	0…65535	RW	0041	0065
Counter DI…	-	0…65535	0…65535	RW	…	…
Counter DI8	-	0…65535	0…65535	RW	0047	0071
Logic DO1 (**Log**)	-	0…7	0…7	RW	0050	0080
Logic DO2 (**Log**)	-	0…7	0…7	RW	0051	0081
Logic DO3 (**Log**)	-	0…7	0…7	RW	0052	0082
Logic DO4 (**Log**)	-	0…7	0…7	RW	0053	0083
Delay type DO1 (**O.dl**)	-	0…2	0…2	RW	0060	0096
Delay type DO2 (**O.dl**)	-	0…2	0…2	RW	0061	0097
Delay type DO3 (**O.dl**)	-	0…2	0…2	RW	0062	0098

Delay type DO4 (**O. dl**)	-	0…2	0…2	RW	0063	0099
Delay DO1 (**Tim**)	0.1 s	0…65535	0…65535	RW	0070	0112
Delay DO2 (**Tim**)	0.1 s	0…65535	0…65535	RW	0071	0113
Delay DO3 (**Tim**)	0.1 s	0…65535	0…65535	RW	0072	0114
Delay DO4 (**Tim**)	0.1 s	0…65535	0…65535	RW	0073	0115

Table 4.4 Output status binary addresses for Modbus function 15

Output	Access	Address	
		hex	dec
DO1	W	0000	0000
DO2	W	0001	0001
DO3	W	0002	0002
DO4	W	0003	0003

4.10 Logic Connections

As soon as for any output parameter Logic (**log)** is not equal to 0, then its control by the host device is terminated. The output status depends on parameters Logic (**log**), Delay Type (**o.dl**) and Delay (**tim**). The parameters are set during configuration (see *Section 4*). Time diagram and I/O distribution are given in *Table 4.8* and *Table 4.9*. Readout function can be used further.

4.10.1 Parameter *Logic*

In output parameter Logic (**Log**), logic connections between inputs and outputs are established.

*Table 4.5 Parameter **Log***

No.	Value	Description
0	RS485	Output is controlled by the host device
1	direct logic	Direct connection between output and input
2	NOT	Inverted connection between output and input
3	AND	Two inputs are connected with output by logic "AND"
4	OR	Two inputs are connected with output by logic "OR"
5	one pulse	When rising edge at input, at output pulse with length specified in parameter **Tim** is generated.
6	PWM	At activated input, at output pulses with repetition period **THPD** and length **Tim** are generated continuously
7	trigger	If DIa=1 and DIb=0, then DO=1 If DIb=1, then DO=0

Till parameter Time-out (**t.out**) > 0 is used and fault status is indicated (refer to *Section 4.7*), outputs with **Log** > 0 will not be set to "Safe output status" (**O.ALr**). Output status will be determined by the selected logic further.

4.10.2 Parameter *Delay Type*

Parameter Delay Type (**O.dl**) determines weather delay occurs and the delay type.

*Table 4.6 Parameter **O.dl***

No.	Value	Description
0	no delay	Without delay
1	on-delay	Delay during activation
2	off-delay	Delay during deactivation

4.10.3 Parameter *Delay*

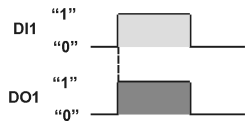
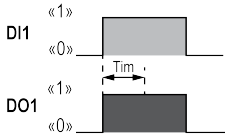
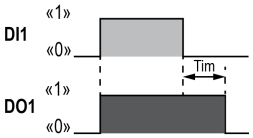
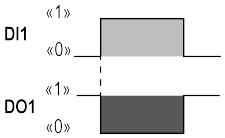
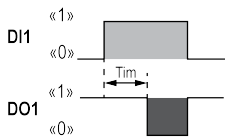
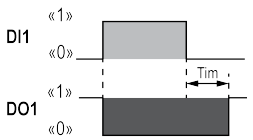
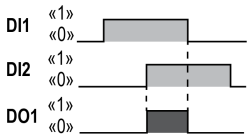
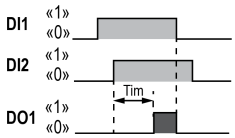
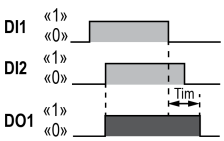
Parameter Delay (**Tim**) determines delay at output or pulse length depending on logic (**Log**) and delay type (**O.dl**). Delay value can be entered within the range from 0 to 6553.5 s with increment 0.1 s.

Table 4.7 Delay Influence

log	O.dl=0	O.dl=1	O.dl=2
0	-	-	-
1	-	Delay during activation	Delay during deactivation
2	-	Delay during activation	Delay during deactivation
3	-	Delay during activation	Delay during deactivation
4	-	Delay during activation	Delay during deactivation
5	-	Pulse length	Pulse length
6	-	Pulse length	Pulse length
7	-	-	-

4.10.4 Time Diagram and Distribution

Table 4.8 Time Diagram

log		O.dl		
No.	Value	0 (no delay)	1 (on-delay)	2 (off-delay)
1	direct logic			
2	NOT			
3	AND			

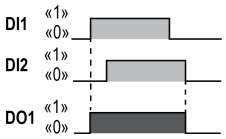
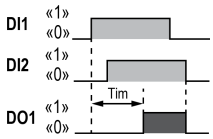
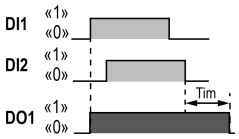
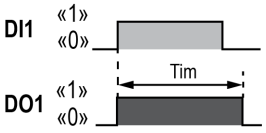
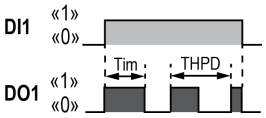
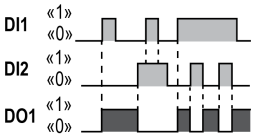
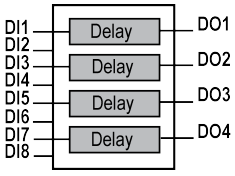
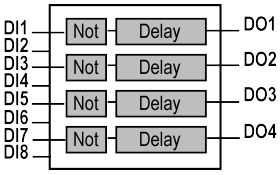
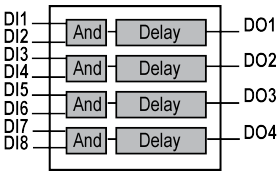
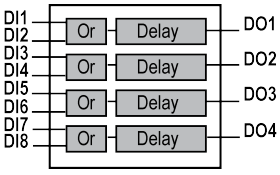
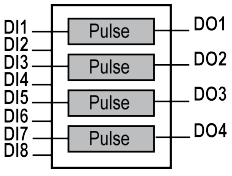
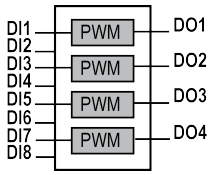
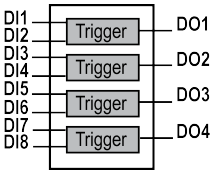
4	OR			
5	one pulse		Not used	Not used
6	PWM		Not used	Not used
7	trigger	 If DIa=1 and DIb=0, then DO=1 If DIb=1, then DO=0	Not used	Not used

Table 4.9 I/O Distribution

log		Distribution
No.	**Value**	
1	direct logic	
2	NOT	
3	AND	
4	OR	
5	one pulse	

6	PWM	
7	trigger	

4.11 Hardware write protection of permanent memory

The data in permanent memory may be lost because of strong electromagnetic interferences or similar conditions. Jumper X1 (hardware write protection) makes it possible to avoid data loss. The following steps are required:

1. Turn off the power supply.
2. Open the front cover of the module (see *Fig. 5.1*).
3. Set jumper X1 in closed position.

The following is to be observed:

– To change the configuration parameters, jumper X1 must be removed again.
– Till X1 jumper is installed, input counters will be reset after turning off the power.

5 Installation

5.1 Mounting

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

The device is designed for DIN-rail or wall mounting in a cabinet. See dimensional drawings in Appendix A.
Install the module in the cabinet with clean, dry and controlled environment. The operating conditions from the *Sect. 3.2* must be considered when choosing the installation site.
The device has been designed for natural convection cooling. Make sure that the cabinet provides sufficient clearance for natural convection.

5.2 Wiring

WARNING
Electric shock could kill or seriously injure

WARNING
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 an electric fuse!

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

The electrical connections are shown in *Fig. 5.1* and the terminal assignments in *Table 5.1*.
Wiring options for various types of signals and connection of output relays are given in *Fig. 5.2* – *Fig. 5.4*.
Connect power supply to the 24V / 0V terminals.
The maximum conductor cross-section for power supply is 1.5 mm^2.

NOTE
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 cable to terminals D+ and D-.
The twisted pair cable should be used for the connection to the RS485 interface. The maximal cable length is 1200 m.

5.2.1 Inputs

The following can be connected at input:
– Switch contacts,
– NPN transistor outputs with open collector,
Pay attention to the following during connection:
– All COM terminals are connected with each other.
– Total resistance of the sensor output with connection lines shall not exceed 100 Ohm.

5.2.2 Outputs

The module is equipped with 4 relay outputs.
– DO1, DO3 – switching contact
– DO2, DO4 – relay (NO)
– Each output can be used in pulse-width modulation mode (see *Section 4.5*)
– Outputs can be controlled via RS485 network (see *Section 4.4*- *Section 4.6*) or they can be logically connected with inputs (see *Section 4.10*).

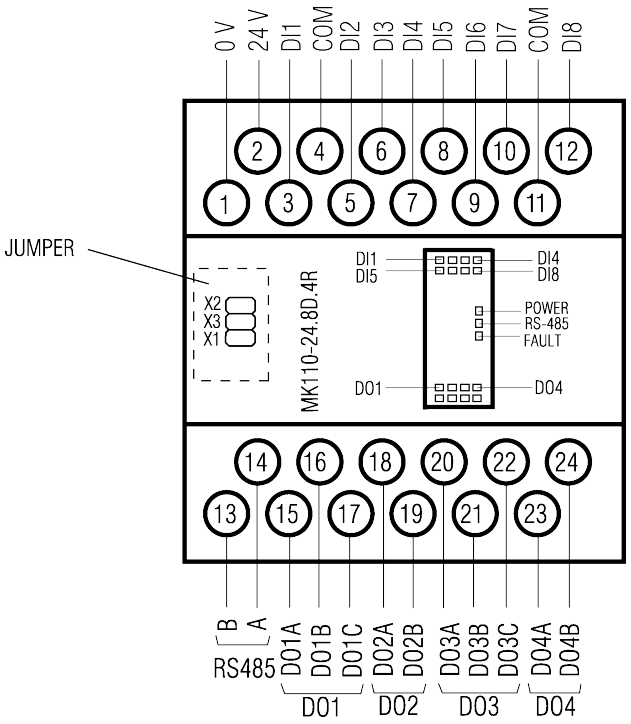


Fig. 5.1 Electrical connections

Table 5.1 Terminal assignments of MK110-24.8D.4R

No	Name	Description	No	Name	Description
1	0 V	Power supply	13	D-	RS485 D-
2	24 V		14	D+	RS485 D+
3	DI1	DI1	15	DO1A	DO1 NO
4	COM	Common negative terminal	16	DO1B	DO1 CO
5	DI2	DI2	17	DO1C	DO1 NC
6	DI3	DI3	18	DO2A	DO2 NO
7	DI4	DI4	19	DO2B	
8	DI5	DI5	20	DO3A	DO3 NO
9	DI6	DI6	21	DO3B	DO3 CO
10	DI7	DI7	22	DO3C	DO3 NC
11	COM	Common negative terminal	23	DO4A	DO4 NO
12	DI8	DI8	24	DO4B	

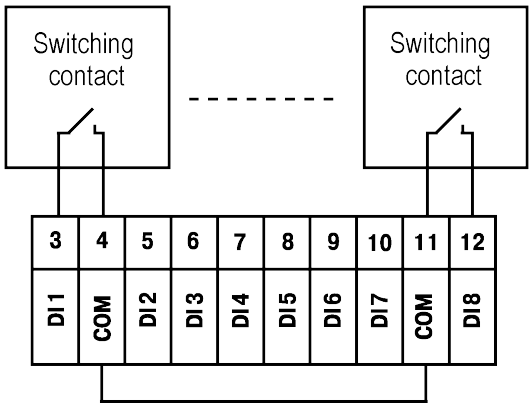


Fig. 5.2 Connection of switch contacts

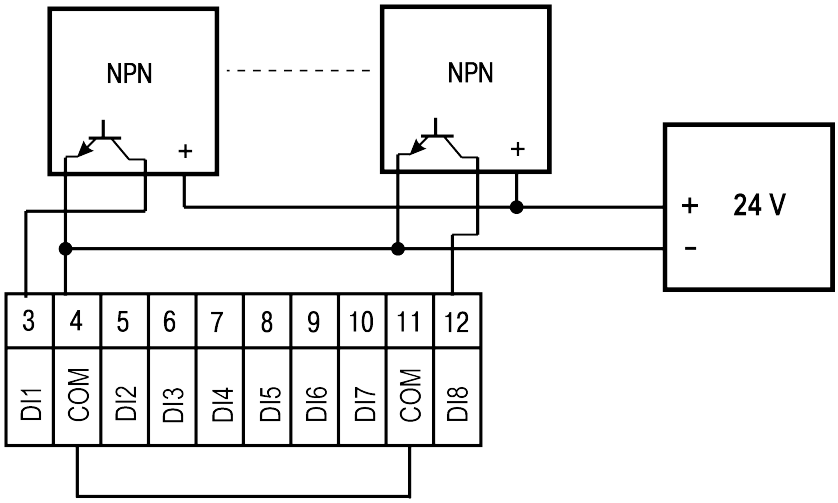


Fig. 5.3 Connection of 3-wire sensors with NPN-transistor output

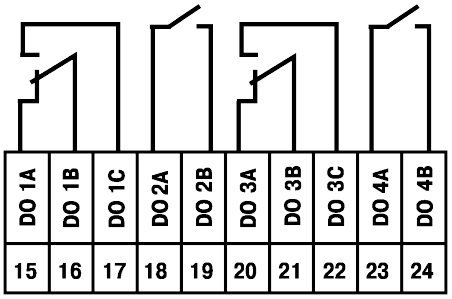


Fig. 5.4 Relay outputs

6 Factory settings restoration

If communication between the module and a PC cannot be established and network parameters of the module are unknown, the default network settings should be restored. The following steps are required:

1. Turn off the power supply.
2. Remove the left front cover of the module.
3. Insert jumper X2. The module will operate with the default network parameters, the user settings are saved.
4. Turn on the power supply again.

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

5. Start the Mx110 Configurator.
6. In the ‘Connection to device’ window, enter the values from *Table 6.1* or click ‘Use factory settings’.

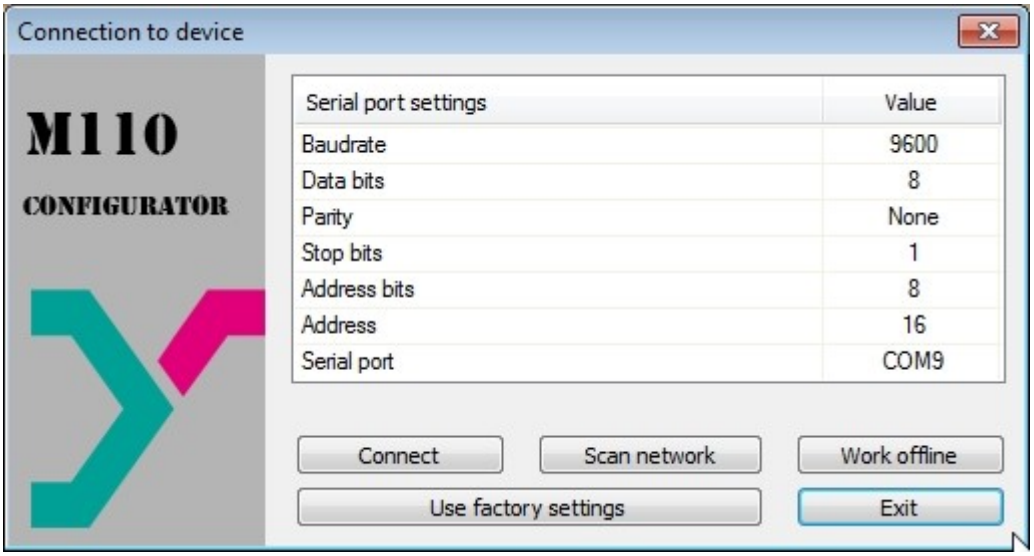


Fig. 6.1 Mx110 Configurator start window

7. Click ‘Connect’ to establish the connection with factory settings.
8. The main window of the Configurator opens. Saved user parameters of the module can be read now (see *Fig. 6.2*).
9. Open folder ‘Network parameters’ and note the user network parameters

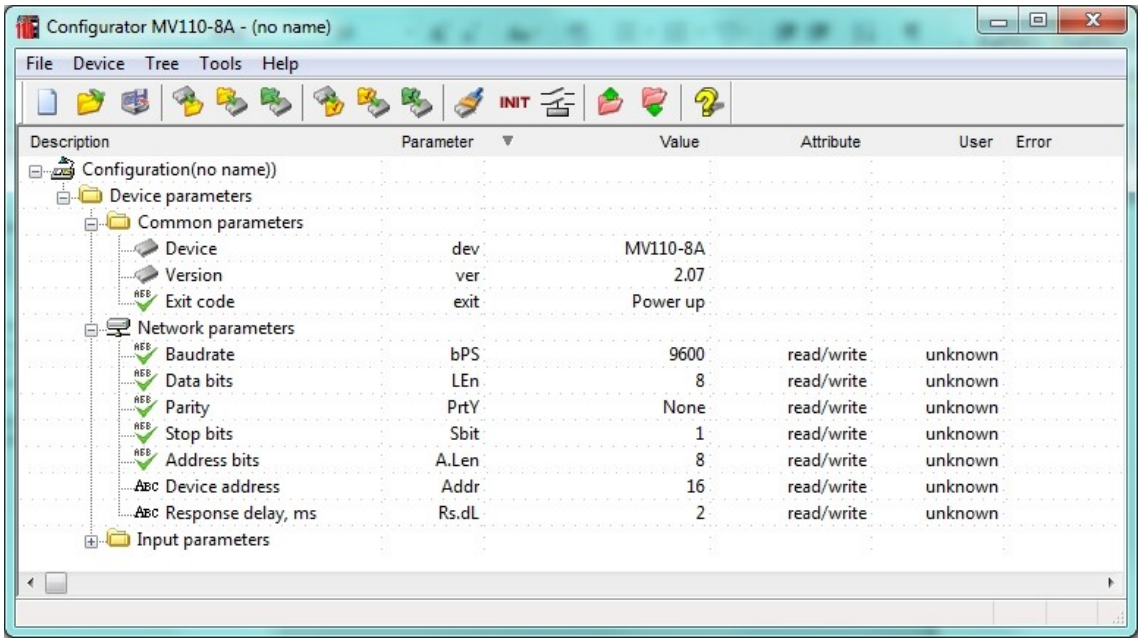


Fig. 6.2 Mx110 Configurator main window

10. Close the Mx110 Configurator.
11. Turn off the power supply.
12. Take out Jumper X2.
13. Close the front cover.
14. Turn on the power supply again.
15. Start the Mx110 Configurator.
16. Enter the noted network parameters.
17. Click ‘Connect’.

The module is now ready for operation.

Table 6.1 Factory settings for network parameters

Parameter	Name	Factory setting
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

7 Maintenance

WARNING
Cut off all power before maintenance.

The maintenance includes:

– cleaning of the housing and terminal blocks from dust, dirt and debris
– checking the device fastening
– checking the wiring (connecting wires, terminal connections, absence of mechanical damages).

NOTICE
The device should be cleaned with a damp cloth only. No abrasives or solvent-containing cleaners may be used.

8 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
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!

9 Scope of delivery

- Module MK110-24.8D.4R 1
- Short guide 1

Appendix A. Dimensions

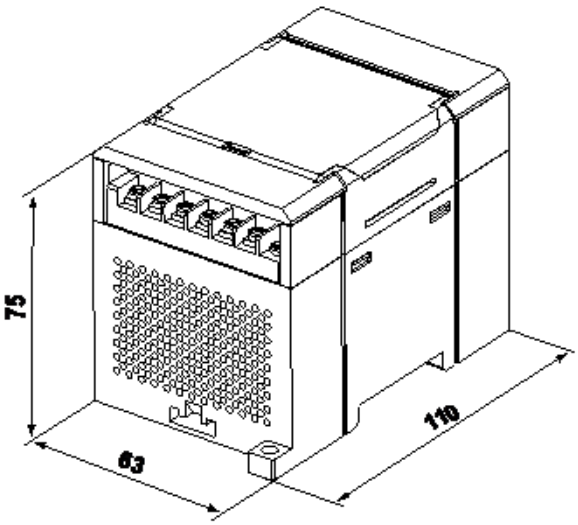


Fig. A.1 External dimensions

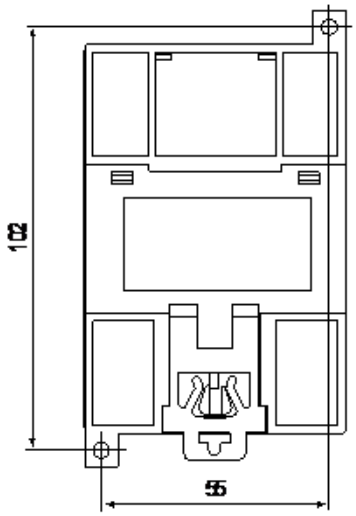


Fig. A.2 Wall mounting dimensions

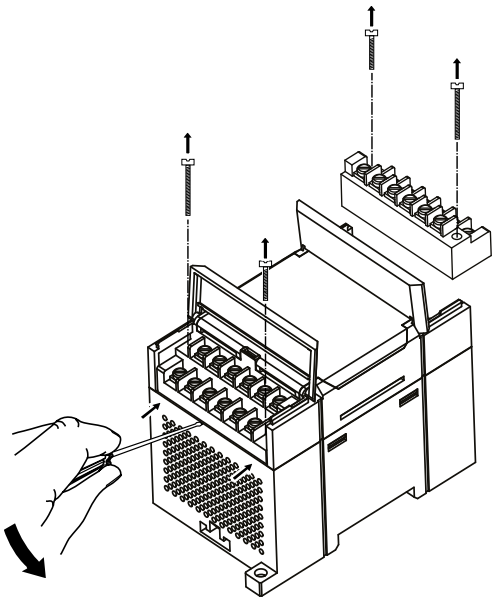


Fig. A.3 Replacement of terminal blocks

Appendix B. Galvanic isolation

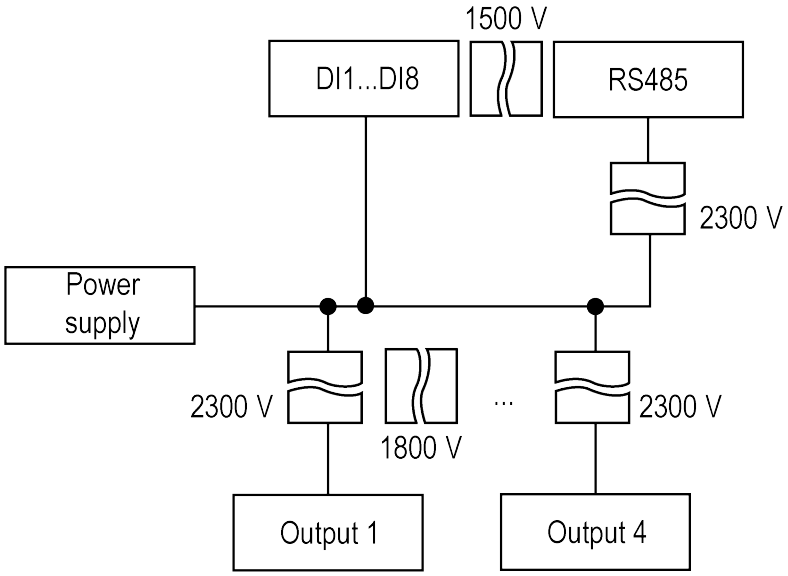


Fig. B.1 Galvanic isolation of MK110–24.8D.4R