

MV110-24.8A

Analog input module 8 channel

User guide

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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.

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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.

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2 Overview

2.1 Basic features

Analog input module MV110-24.8A is an extension module with 8 universal analog inputs.
The module has the following functions:

– Analog-digital conversion with digital signal processing
– Sensors status diagnostic
– RS485 network status diagnostic
– Error and alarm signals
– Slave device in Modbus structure

The module supports Modbus-RTU and Modbus-ASCII protocols with automatic protocol identification.
The module is to be configured using the *Mx110 Configurator* software via RS485-USB interface adapter IC4 (not included).

2.2 Design and indication

Table 2.1 Indication

LED	LED state	Description
POWER	ON	Power on
RS485	Flashing	Data exchange via RS485 interface

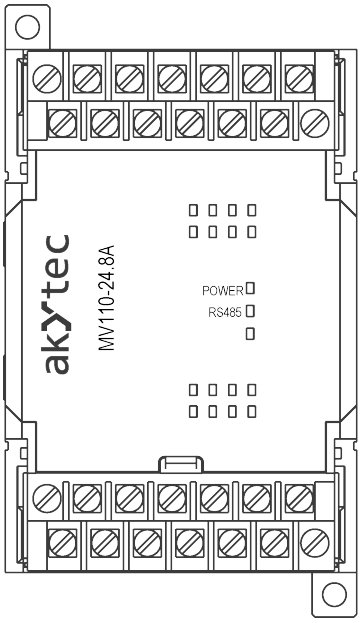


Fig. 2.1 Front view of MV110-24.8A

Under the cover on the front panel of the module there are three jumpers:

– S1 – Factory settings (see *Section 6*)
– S2 – Service function
– S3 – Service function

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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	—
	analog	8
Outputs	digital	—
	analog	—
Sampling time for each input (max.)(1)	RTD	0.9 s
	TC	0.6 s
	Standard I/U signals	0.6 s
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
Dimensions		63 × 110 × 75 mm
Weight, max.		500 g
Material		plastic
IP code		IP20

(1)Since input sampling is performed sequentially, the total sampling time is equal to the sum of times of all connected inputs.

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Table 3.2 Standard I/U signals

Signal type	Measurement range, %	Accuracy, %
Digital signal	available	
Standard signals		
0-1 V	0…100	±0.25
-50…+50 mV	0…100	
0-5 mA	0…100	
0-20 mA	0…100	
4-20 mA	0…100	
Position encoders		
Resistance sensor 25-900 Ohm	2.8(1)…100	±0.25
Resistance sensor 25-2000 Ohm	1.26(1)…100	
0(4)...20 mA	0…100	
0…5 mA	0…100	

(1)The range from 0 to 25 Ohm is valued as a short circuit.

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Table 3.3 Supported Input Signals

Signal type	Measurement range, °C	Temperature coefficient, °C^{-1}	Accuracy, %
RTD according to IEC 60751:2008			
Pt50	–200…+850	0.00385	±0.25
Pt100	–200…+850		
Pt500	–200…+850		
Pt1000	–200…+850		
RTD			
50P	-240...+1100	0.00391	±0.25
50M	-200…+200	0.00428	
Cu50	-50…+200	0.00426	
100P	-240...+1100	0.00391	
100M	-200…+200	0.00428	
Cu100	-50…+200	0.00426	
Ni100	-60…+180	0.00617	
500P	-240...+1100	0.00391	
500M	-200…+200	0.00428	
Cu500	-50…+200	0.00426	
Ni500	-60…+180	0.00617	
1000P	-240...+1100	0.00391	
1000M	-200…+200	0.00428	
Cu1000	-50...+200	0.00426	
Ni1000	-60…+180	0.00617	
Cu53	-50…+200	0.00426	
TC according to IEC 60584-1:2013			
J	-200…+1200	-	±0.5
N	-200…+1300	-	
K	-200…+1360	-	
S	-50…+1750	-	
R	-50…+1750	-	
B	+200…+1800	-	
T	-250…+400	-	
A-1	0…+2500	-	±0.5
TC			
L	-200…+800	-	±0.5
A-2	0…+1800	-	
A-3	0…+1800	-	

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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 environment conditions must be observed:

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

Table 3.4 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

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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.***

The module is controlled by the master device in Modbus network.
Modbus functions 03, 04 can be used for reading and 15, 16 can be used for writing.
The software and its user guide can be found on the *akYtec site*.
Module has to 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. Run 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.
Parameters of the module can be read, edited and saved with the 'Mx110 Configurator' software.
The full list of parameters is shown in the Table below.

Table 4.1 Configuration parameters

Name	Parameter	Valid value	Meaning	Default settings
Common parameters				
dev	Device	Up to 8 symbols		MV110-24.8A
ver	Firmware version	Up to 8 symbols		manufacturer
exit	Exit code	0	software reset	–
		6	hardware reset	
		7	power on	
		8	watchdog timer	
Network parameters				
bPS	Baud rate, kbps	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	

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Name	Parameter	Valid value	Meaning	Default settings
		2	odd	
Sbit	Stop bits*	0	1	1
		1	2	
A.Len	Address bits	0	8	8
		1	11	
Addr	Device address	1…247		16
Rs.dL	Response delay, ms	0…45		2
Inputs				
Cj-.C	Cold junction compensation	0	off	off
		1	on	
in-t	Sensor type	00	off	off
		02	Cu 50 (a=0.00426)	
		10	50M (a=0.00428)	
		08	Pt50 (a=0.00385)	
		09	50P (a=0.00391)	
		01	Cu100 (a= 0.00426)	
		15	100M (a=0.00428)	
		03	Pt100 (a=0.00385)	
		04	100P (a=0.00391)	
		30	Ni100 (a=0.00617)	
		31	Cu500 (a= 0.00426)	
		32	500M (a=0.00428)	
		33	Pt500 (a=0.00385)	
		34	500P (a=0.00391)	
		35	Ni500 (a=0.00617)	
		36	Cu1000 (a= 0.00426)	
		37	1000M (a= 0.00428)	
		38	Pt1000 (a= 0.00385)	
		39	1000P (a= 0.00391)	
		40	Ni1000 (a= 0.00617)	
		16	Cu53 (a=0.00426)	

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		05	Type L	
		21	Type J	
		20	Type N	
		06	Type K	
		18	Type S	
		19	Type R	
		17	Type B	
		22	Type A	
		23	Type A-1	
		24	Type A-2	
		25	Type T	
		13	0-5 mA	
		12	0-20 mA	
		11	4-20 mA	
		07	-50…+50 mV	
		14	0-1 V	
		26	25-900 Ohm position	
		41	25-2000 Ohm position	
		27	0(4)-20 mA position	
		28	0-5 mA position	
		29	digital input	
in.Fd	Filter time constant, s	0…1800		0.0
Itrl	Sampling period, s	0.3…30		0.5
in.SH	Offset	-999…9999		0.0
in.SL	Slope	0.9…1.1		1.0
in.FG	Filter pass band	0…9999		0.0
Ain.L	Lower limit	-999…9999		0.0
Ain.H	Upper limit	-999…9999		100
dP	Decimal point	0…3		1

NOTE

* Invalid network parameter combinations:

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

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4.1 Signal processing

Inputs are sampled cyclically. The measured values are converted into digital values, analyzed and processed in accordance with the set parameters. The results are saved in data registers (*Table 4.3*).
An analog input signal from the resistance-temperature detector or thermocouple is converted into a standard signal according to the sensor curve. The standard signal is digitized and processed.

4.2 Sampling

An input is included into the sampling list if the signal type is selected. If parameter **in-t** is set to OFF, the input is excluded from the list.
Parameter **Itrl** specifies the sampling period within the range from 0.3 to 30 s for each input. If the lower limit of 0.3 s is not physically achievable, the sampling period is automatically increased to the lowest possible value

4.3 Cold junction compensation

The precise temperature measurement using thermocouples is provided by cold junction compensation. A reference junction sensor is located near the input terminals. Set parameter **Cj-.C** to ON to enable this function. This setting is effective for all inputs.
Other filters and corrections for individual inputs are described in *Section 4.5* and *Section 4.6*.

4.4 Linear signal

To scale the linear signal (current or voltage) the measurement limits must be set. Parameters **Ain.L** 'Lower limit' and **Ain.H** 'Upper limit' are set in the specified units.
If **Ain.L**<**Ain.H**, then

$$Measured\ value = Ain.L + \frac{(Ain.H - Ain.L)\cdot(S_i - S_{min})}{S_{max} - S_{min}}$$

If **Ain.L**>**Ain.H**, then

$$Measured\ value = Ain.L - \frac{(Ain.L - Ain.H)\cdot(S_i - S_{min})}{S_{max} - S_{min}}$$

where
S_{max} – is the upper signal limit (for example, 20 for 4-20 mA signal)
S_{min} – is the lower signal limit (for example, 4 for 4-20 mA signal)
S_I – is the actual signal value

4.5 Digital Filter

The digital filter consists of two stages.
A comparator is used at the first stage. The filter bandwidth for the comparator must be specified in parameter **in.FG** in physical units of measurement. The difference between the last two measurements is determined and compared with the bandwidth. If the difference is greater than the bandwidth, the measurement must be repeated. If an error occurred during the first measurement, this is confirmed by the second measurement and the first measurement value is ignored as an error. If the bandwidth is set to '0', the comparator is switched off.
A damping is used at the second stage. The filter time constant must be set in parameter **in.Fd** in seconds. The higher the value, the higher the noise resistance and the slower the input response. When the value is set to '0', damping is switched off.

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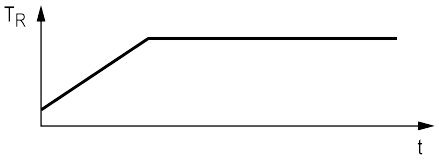


Fig. 4.1 Controlled temperature T_R



Fig. 4.2 Measured temperature T_M (filter is OFF)

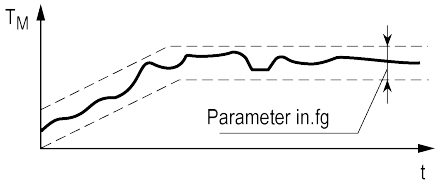


Fig. 4.3 Comparator is ON

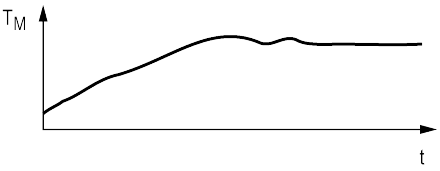


Fig. 4.4 Comparator and damping are ON

4.6 Correction

The characteristic curve of the sensor can be corrected by the user. Two correction parameters are provided for each input: offset and slope.

– Offset is set in parameter **in.SH** in units of measurement to correct the sensor initial error, for example, when you use an RTD.

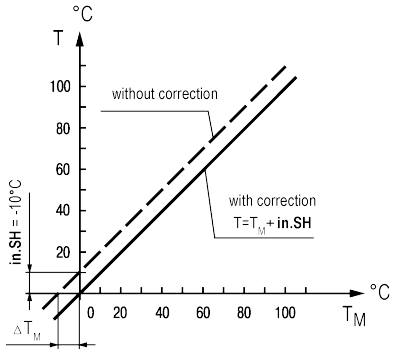


Fig. 4.5 Characteristic offset

– Slope is set in parameter **in.SL** within the range from 0.9 to 1.1.

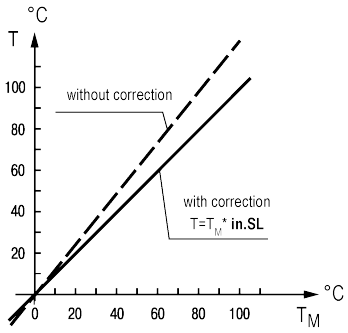


Fig. 4.6 Characteristic slope

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4.7 Error diagnostics

When sampling the inputs, the module monitors the status of the connected sensors, the process of communication and measurements. The detected errors are transmitted with the response as an error code (see *Table 4.2*).
If there is a measurement error, the last correctly saved value is transmitted.
The range from 0 to 25 Ohm for resistance sensors is considered to be a short circuit.

Table 4.2 Error Codes

Error	Comment	Code
Measurement correct	Transmission in progress	0x0000
Measured value error	Measured value incorrect (linear signal)	0xF000
Measurement not ready	Just upon restart	0xF006
Sensor switched off	in-t parameter set to OFF	0xF007
Cold junction temperature too high	>90°C	0xF008
Cold junction temperature too low	<-10°C	0xF009
Measured value too high	Exceeded the measuring range of the selected sensor type	0xF00A
Measured value too low	Below measuring range of the selected sensor type	0xF00B
Short circuit	Resistance-temperature detector, resistance sensor	0xF00C
Sensor break	Resistance-temperature detector, thermocouple, live zero linear signal	0xF00D
No connection with A/D converter	Hardware error	0xF00E
Calibration error	Calibration incorrect	0xF00F

4.8 Fault condition

If the data exchange on the serial port is interrupted (i. e. there is no command from the master within the time specified by parameter **t.out**), the following applies:

– LED FAULT flashes
– Once a request from the master device comes, the display ‘refreshes’
– If the **t.out** parameter is set to 0, ‘Fault Condition’ is not defined

4.9 RS485 network

The I/O modules of Mx110 series use a widespread standard RS485 for data transmission. The RS485 serial interface is designed as a 2-wire system in the half duplex mode. The modules support Modbus RTU, Modbus ASCII and akYtec protocols. The network consists of one master and can have up to 32 slaves. The maximum cable length is 1200 m. The number of slaves and the cable length can be increased using an RS485 interface repeater.
Devices are connected to a network according to linear (bus) topology. It means that connection is led from the first device to the second, from the second to the third, etc. Star topology and stubs are not permitted.
Reflections from cables always occur at the open cable ends (first and last bus system participant). They increase proportionately with the baud rate. To avoid reflections on long cables, it is necessary to use appropriate termination resistors. For this purpose, 150 Ohm termination resistors are the most efficient.

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The modules can be used as slave devices only. Master device can be a PLC, a PC with SCADA software or a control panel.

4.10 Modbus registers

Modbus-RTU and Modbus-ASCII protocols are supported.
Modbus functions 03 and 04 are available for the following parameters:

– Measured value
– Time mark
– Error code (see *Table 4.2*)

The measured value is available in two formats:

– Integer (16 bits)
– Floating-point (32 bits)

Both formats are saved in different data registers (see *Table 4.3*).
The integer is calculated by multiplication of the measured value by 10^{dP}. Parameter **dP** is used for a decimal point and can be set within the range of 0…3.
When a floating-point number value is transmitted, the most significant byte of 32-bit data is stored in the first register (big-endian).
The time mark is cyclic time within the range from 0 to 655.36 seconds with the increment of 0.01 second saved as a 2-byte integer. It determines the exact time of measurement within the cycle. When the module is powered on, the cycle starts from 0 and returns to the initial state in 655.36 seconds.

Table 4.3 Modbus registers

No.	Parameter	Data type	Register	
			(Hex)	(Dec)
1	Decimal point (**dP**)	INT16	0000	0
	Measured value	INT16	0001	1
	Error code	INT16	0002	2
	Time mark	INT16	0003	3
	Measured value as FLOAT	FLOAT32	0004, 0005	4, 5
2	Decimal point (**dP**)	INT16	0006	6
	Measured value	INT16	0007	7
	Error code	INT16	0008	8
	Time mark	INT16	0009	9
	Measured value as FLOAT	FLOAT32	000A, 000B	10, 11
...				
8	Decimal point (**dP**)	INT16	002A	42
	Measured value	INT16	002B	43
	Error code	INT16	002C	44
	Time mark	INT16	002D	45
	Measured value as FLOAT	FLOAT32	002E, 002F	46, 47

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. Switch off the power supply.

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2. Open the cover on the front panel of the module.
3. Put jumper X1 into position “closed”.

Thereby the following is to be observed:

– To change the configuration parameters, jumper X1 must be removed again.
– As long as jumper X1 is inserted, the input counter will be reset after any power loss.

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5 Installation

5.1 Mounting

The device is designed to be installed on a DIN rail or using two screws on a mounting panel in an electric cabinet.
The operating conditions from *Sect. 3.2* must be considered when choosing the installation site.
Dimensional drawings are given in *Appendix A A.*. Only the vertical positioning of the device is allowed.
The device is 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.

Connect power supply to the 24V / 0V terminals.
The maximum conductor cross-section for power supply is 1.5 mm².

NOTE

EMC safety

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-.
Connection to the RS485 interface is carried out via a twisted pair cable.

5.2.1 Inputs

Valid signals (see *Table 3.2*):
– Dry contacts
– Standard current/voltage signals
– Resistance/current position sensor
– Thermocouples
– Resistance-temperature detector
The following must be observed:
– All AI-R terminals are internally connected
– The total resistance of sensor output with connection lines must not exceed 100 Ohm

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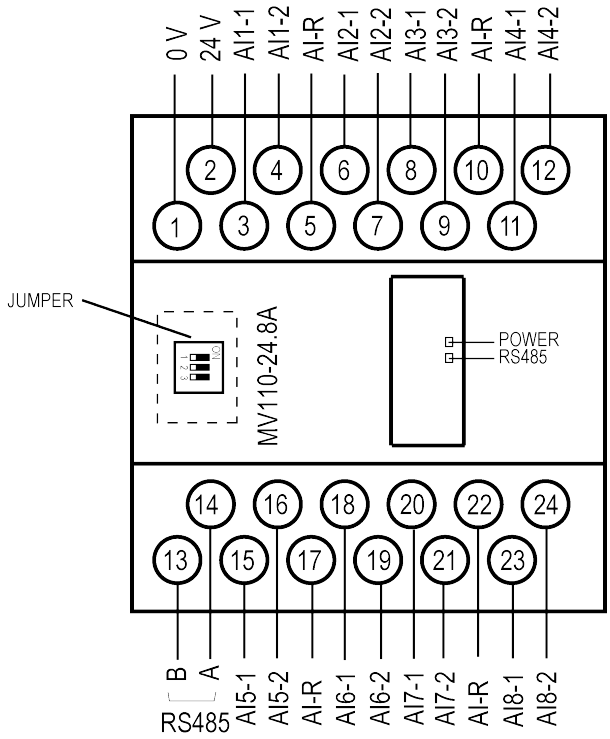


Fig. 5.1 Electrical connections

Table 5.1 Terminal assignment of MV110–24.8A

No.	Description	No.	Description
1	Power supply (0 V)	13	RS485 (D-)
2	Power supply (24 V)	14	RS485 (D+)
3	Input 1-1 (AI1-1)	15	Input 5-1 (AI5-1)
4	Input 1-2 (AI1-2)	16	Input 5-2 (AI5-2)
5	Common (AI-R)	17	Common (AI-R)
6	Input 2-1 (AI2-1)	18	Input 6-1 (AI6-1)
7	Input 2-2 (AI2-2)	19	Input 6-2 (AI6-2)
8	Input 3-1 (AI3-1)	20	Input 7-1 (AI7-1)
9	Input 3-2 (AI3-2)	21	Input 7-2 (AI7-2)
10	Common (AI-R)	22	Common (AI-R)
11	Input 4-1 (AI4-1)	23	Input 8-1 (AI8-1)
12	Input 4-2 (AI4-2)	24	Input 8-2 (AI8-2)

5.2.2 Resistance-temperature detector

Two- or three-wire sensors can be connected.

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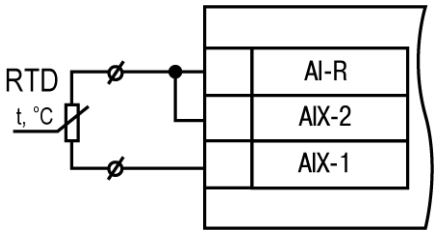


Fig. 5.2 RTD wiring

5.2.3 Thermocouples

Optional cold junction compensation is provided for connection of thermocouples.

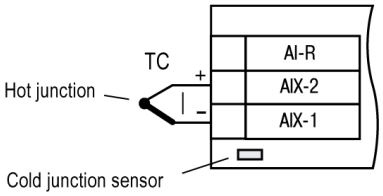


Fig. 5.3 Thermocouple wiring

NOTICE
Only thermocouples with insulated and ungrounded measuring junction can be used, because AIX-1 terminal has equal potential.

5.2.4 Current/voltage signals

– When measuring current or voltage signals, an external power supply should be taken into account.
– Voltage signal can be connected directly to the input terminals.

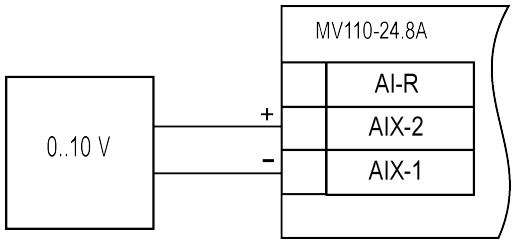


Fig. 5.4 Voltage signal wiring

– To measure a current signal a shunt resistance of 50 Ohm (±1%) should be connected in parallel. It is recommended to use resistance included in the package or other high-stable resistance.

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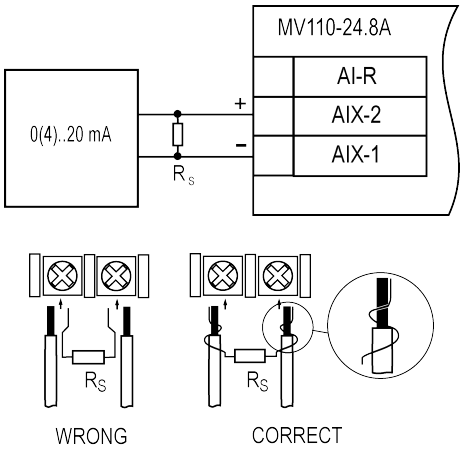


Fig. 5.5 Current signal wiring

NOTICE
It is necessary to provide safe contact between signal wires and resistance wires; otherwise the input can be damaged.

5.2.5 Resistance sensor

– Resistance sensors can be connected directly to the input terminals.

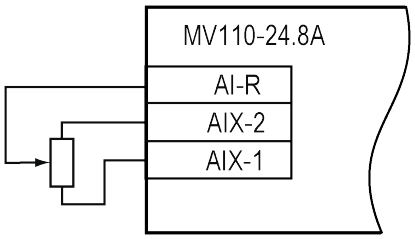


Fig. 5.6 Resistance sensor wiring

– 25-900 Ohm and 25-2000 Ohm resistance sensors are supported.
– The range from 0 to 25 Ohm is considered a short circuit.

5.2.6 Digital signals

– Up to 16 digital signals can be connected to the module.
– In order to connect digital signal, you need to connect shunt resistance from 200 Ohm to 3000 Ohm in parallel.

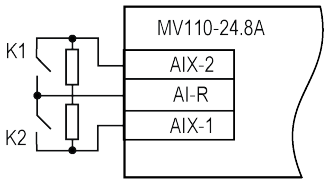


Fig. 5.7 Digital signal wiring

– In assessment of the input state, 4 different variants are distinguished. Assessment of these variants is presented in *Table 5.2*.

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Table 5.2 Input status for digital signals

K1	K2	Input status
open	open	1
closed	open	2
V	closed	3
closed	closed	4

5.2.7 Different input signals

Each input can be configured for any type of signal individually. The signal type (sensor type) must be selected for the **in-t** parameter. A full list of configuration parameters is presented in Appendix B.

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6 Factory settings restoration

If the communication between the module and 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 front cover of the module
3. Insert jumper X2. Module will operate with the default network parameters, the user settings remain stored.
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 a foreign body in the enclosure must be avoided!

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

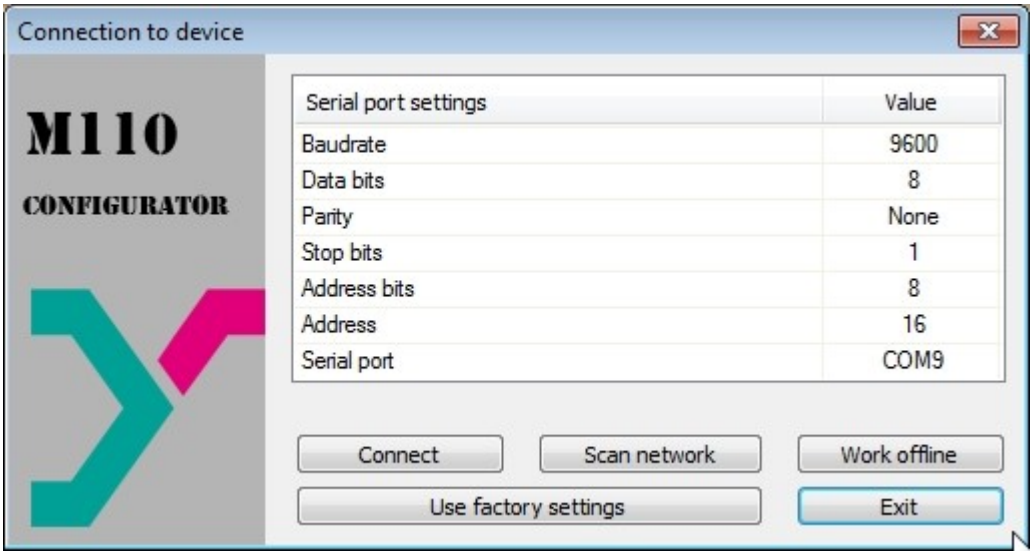


Fig. 6.1 Mx110 Configurator start window

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

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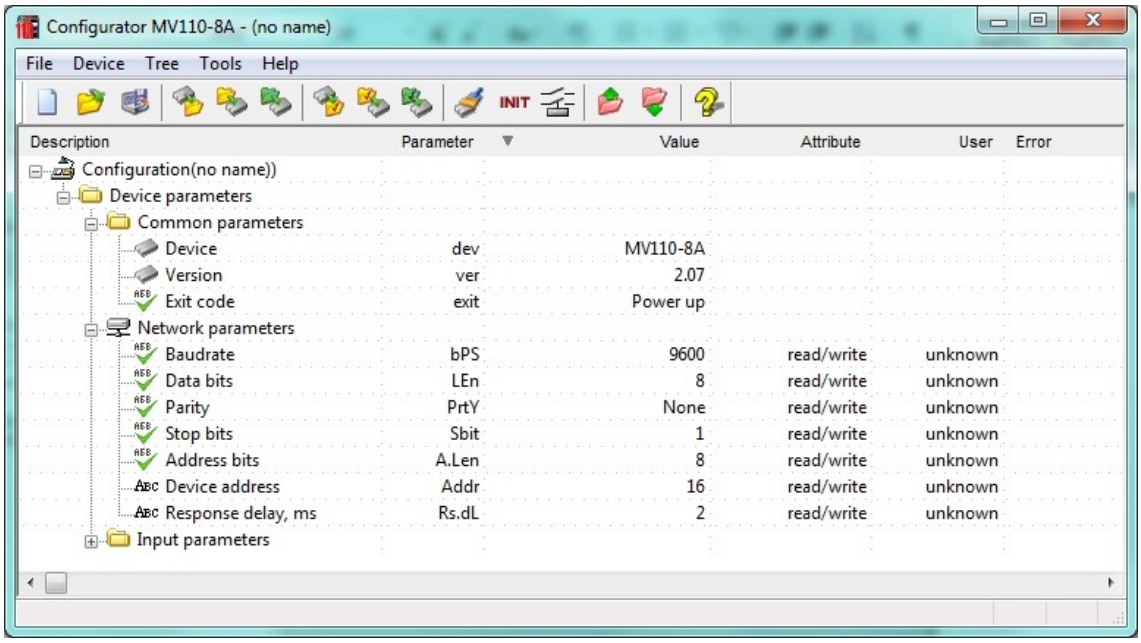


Fig. 6.2 Mx110 Configurator main window

10. Close 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 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	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

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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.

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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!

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9 Scope of delivery

– Module MV110-24.8A	1
– Short guide	1

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Appendix A. Dimensions

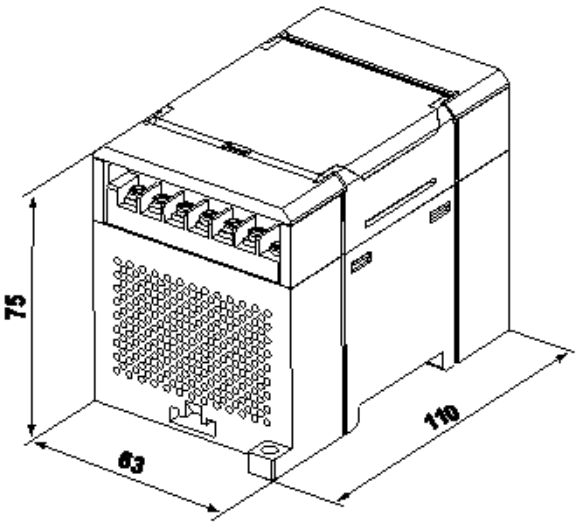


Fig. A.1 External dimensions

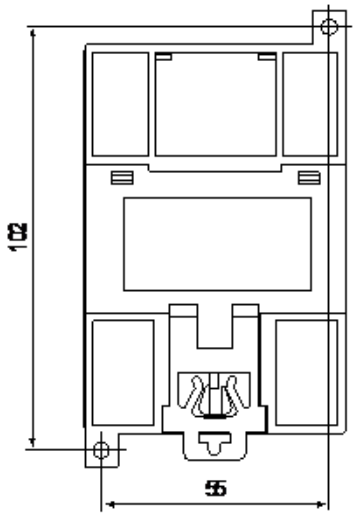


Fig. A.2 Wall mounting dimensions

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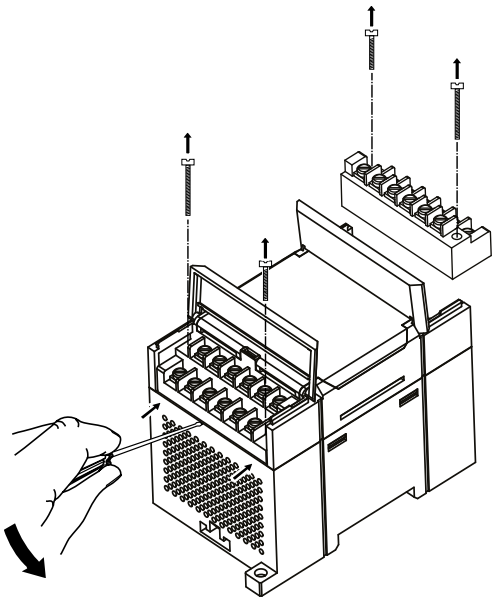


Fig. A.3 Replacement of terminal blocks

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Appendix B. Galvanic Isolation

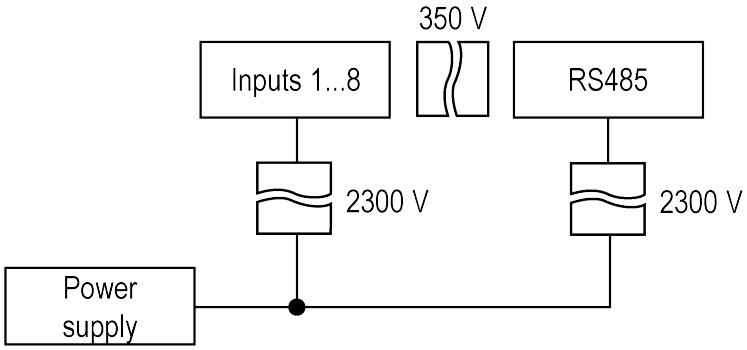


Fig. B.1 Galvanic isolation of MV110–24.8A

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