



MV210-101

Analog input module

User guide

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Warning notice system

Explanation of the symbols and keywords used:

**DANGER**

DANGER indicates an **imminent dangerous situation** that will result in death or serious injuries if not prevented.

**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.

Safety

Read this manual carefully before installing, operating or servicing the device.

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

Any other use is considered improper.

**CAUTION**

This device must not be used for medical devices which receive, control or otherwise affect human life or physical health.

When installing and using this product, all applicable state, federal and local regulations must be observed.

Based on safety considerations and compliance with the data provided in the documents, the repair of the components of the products is carried out exclusively by the manufacturer.

There is a dangerous voltage on the terminal block. Any connections to the device and maintenance operations must be carried out only when the power of the device is turned off.

The device's method of protection against electric shock meets the terms of class II, IEC 61131-2-2012.

The device installation must be performed in particularized equipment cabinet, the inner access to which is allowed only to approved specialists.

**CAUTION**

It is forbidden to use the device in corrosive environments with acids, alkalis, oils, etc. in the atmosphere.

Obey all the necessary rules and instructions when using programmable logic controllers in areas where technical safety requirements apply.

Failure to obey these warnings could result in personal injury or equipment damage.

Akytec company shall not be liable for technical or editorial errors or omissions contained in this document.

Introduction

This document provides detailed information about the operation principle, design, configuration, installation and maintenance of the analog input module MV210-101, hereinafter referred to as the Device or Module.

Order code: **MV210-101**.

Abbreviations

- **ADC** – analog-to-digital Converter.
- **DHCP**– Dynamic Host Configuration Protocol.
- **NSC** – nominal static characteristic.
- **PC** – personal computer.
- **PLC** – programmable logic controller.
- **RT**– resistance thermometer.
- **RTC** – real time clock.
- **TC**– thermoelectric Converter (thermocouple).
- **USB** – an industry standard that establishes specifications for cables, connectors and protocols for connection, communication and power supply between personal computers and their peripheral devices.
- **UTC** – coordinated universal time.

1 Overview

Module is intended for data acquisition at objects of automation and transfer of this data to PLCs, panel controllers, computers or other control devices.

Module is equipped with 8 analog inputs, intended for connection of sensors or signals of the following types:

- resistance thermometers (RT);
- thermoelectric Converter (thermocouple, TC);
- active voltage or current sensors;
- resistive sensors.

Each input can be configured to any of the types independently of each other.

Modules are used in various fields of industry and agriculture.

2 Specifications

2.1 Specifications

Table 2.1 Specifications

Characteristic	Value	
Power supply		
Power supply	24 (10 ... 48) V DC	
Power consumption	4 W	
Protection against reverse polarity of supply voltage	Yes	
Interfaces		
Data transfer interface	Dual-Port Ethernet 10/100 Mbps	
Configuration interface	USB 2.0 (MicroUSB), Ethernet10/100 Mbps	
Date transfer protocol	Modbus TCP	
Protocol version	IPv4	
Inputs		
Number of inputs	8	
ADC resolution	16 bits	
Sampling time*	RT	max. 0.9 s
	TC	max. 0.6 s
	I/U signals	max. 0.6 s
Accuracy	RT	± 0.25 %
	TC	± 0.5 %
	I/U signals	± 0.25 %
Electromagnetic interference	± 0.25 %	
Temperature influence	20 % / 10 °C	
Shunt resistance	51 Ω	
Flash-memory (log-file)		
Maximum log file size	2 KB	
Minimum log writing interval	10 s	
Maximum number of log files	1,000	
Real time clock		
Inaccuracy	at a temperature +25 °C	max. 1 s per day
	at a temperature - 40°C	max. 3 s per day
Battery type	CR2032	
Lifetime of one battery	6 years	
General specifications		
Dimensions	42 × 124 × 83 mm	
IP code	IP20	

Characteristic	Value
Average lifetime**	10 years
Weight	max. 0.4 kg

* Because the sampling of inputs is performed sequentially, the total sampling time is equal to the sum of the times of all connected inputs.

** Expect battery of RTC

Table 2.2 Sensors and input signals

Sensor or input signal	Measurement range	Unit value of the least significant bit	Accuracy
RT according to IEC 60751:2008			
Pt50 ($\alpha=0.00385 \text{ } ^\circ\text{C}^{-1}$)	-200 ... +850 $^\circ\text{C}$	0.1 $^\circ\text{C}$	$\pm 0.25 \%$
Pt100 ($\alpha=0.00385 \text{ } ^\circ\text{C}^{-1}$)	-200 ... +850 $^\circ\text{C}$		
Pt500 ($\alpha=0.00385 \text{ } ^\circ\text{C}^{-1}$)	-200 ... +850 $^\circ\text{C}$		
Pt1000 ($\alpha=0.00385 \text{ } ^\circ\text{C}^{-1}$)	-200 ... +850 $^\circ\text{C}$		
RT according to GOST 6651-2009 and 6551-94			
50P ($\alpha=0.00391 \text{ } ^\circ\text{C}^{-1}$)	-240 ... +1100 $^\circ\text{C}$	0.1 $^\circ\text{C}$	$\pm 0.25 \%$
50M ($\alpha=0.00428 \text{ } ^\circ\text{C}^{-1}$)	-200 ... +200 $^\circ\text{C}$		
Cu50 ($\alpha=0.00426 \text{ } ^\circ\text{C}^{-1}$)	-50 ... +200 $^\circ\text{C}$		
100P ($\alpha=0.00391 \text{ } ^\circ\text{C}^{-1}$)	-240 ... +1100 $^\circ\text{C}$		
100M ($\alpha=0.00428 \text{ } ^\circ\text{C}^{-1}$)	-200 ... +200 $^\circ\text{C}$		
Cu100 ($\alpha=0.00426 \text{ } ^\circ\text{C}^{-1}$)	-50 ... +200 $^\circ\text{C}$		
Ni100 ($\alpha=0.00617 \text{ } ^\circ\text{C}^{-1}$)	-60 ... +180 $^\circ\text{C}$		
500P ($\alpha=0.00391 \text{ } ^\circ\text{C}^{-1}$)	-240 ... +1100 $^\circ\text{C}$		
500M ($\alpha=0.00428 \text{ } ^\circ\text{C}^{-1}$)	-200 ... +200 $^\circ\text{C}$		
Cu500 ($\alpha=0.00426 \text{ } ^\circ\text{C}^{-1}$)	-50 ... +200 $^\circ\text{C}$		
Ni500 ($\alpha=0.00617 \text{ } ^\circ\text{C}^{-1}$)	-60 ... +180 $^\circ\text{C}$		
1000P ($\alpha=0.00391 \text{ } ^\circ\text{C}^{-1}$)	-240 ... +1100 $^\circ\text{C}$		
1000M ($\alpha=0.00428 \text{ } ^\circ\text{C}^{-1}$)	-200 ... +200 $^\circ\text{C}$		
Cu1000 ($\alpha=0.00426 \text{ } ^\circ\text{C}^{-1}$)	-50 ... +200 $^\circ\text{C}$		
Ni1000 ($\alpha=0.00617 \text{ } ^\circ\text{C}^{-1}$)	-60 ... +180 $^\circ\text{C}$		
Cu53 ($\alpha=0.00426 \text{ } ^\circ\text{C}^{-1}$)	-50 ... +200 $^\circ\text{C}$		

Sensor or input signal	Measurement range	Unit value of the least significant bit	Accuracy
TC according to IEC 60584-1:20131			
J	-200 ... +1200 °C	0.1 °C	±0.5 %
N	-200 ... +1300 °C		
K	-200 ... +1360 °C		
S	-50 ... +1750 °C		
R	-50 ... +1750 °C		
T	-250 ... + 400 °C		
B	+200 ... +1800 °C		
A-1	0 ... + 2500 °C		
TC according to GOST 8.585			
L	-200 ... +800 °C	0.1 °C	±0.5 %
A-2	0 ... +1800 °C		
A-3	0 ... +1800 °C		
TC according to DIN 43710			
L	0 ... 100 %	1 °C	not regulated
Standard I / U signals			
-1 ... 1 V	0 ... 100 %	0.1 %	±0.25 %
-50 ... 50 mV	0 ... 100 %		
0 ... 5 mA	0 ... 100 %		
0 ... 20 mA	0 ... 100 %		
4 ... 20 mA	0 ... 100 %		
Resistive signals			
0 ... 2 kΩ	0 ... 100%	1	±0.25
0 ... 5 kΩ			

2.2 Isolation of the Device Components

The circuit of galvanic isolated components and the strength of galvanic isolation are shown in *Figure 2.1*.

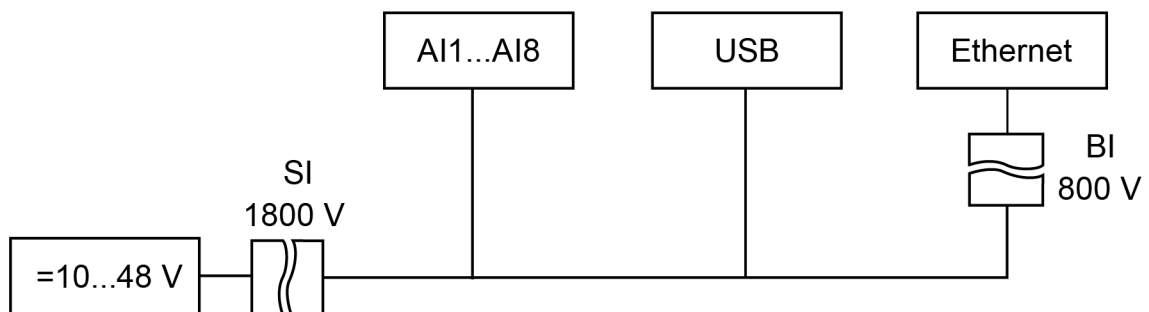


Fig. 2.1 Isolation of the Device Components

Table 2.3 *Insulation types*

Type	Description
Basic insulation (BI)	The insulation used for active parts of equipment to provide protection against electric shock. The electrical strength of the basic insulation is checked by type tests: by applying a test AC voltage, the value of which is different for different circuits of the Device
Supplementary insulation (SI)	Independent insulation used in addition to the basic insulation in order to guarantee protection against electric shock in the event of a failure of the main insulation. The electrical strength of the supplementary insulation is checked by type tests: by applying an alternating test AC voltage of various levels (RMS value)



NOTICE

The strength of the isolation is indicated for testing under normal climatic conditions (exposure time is 1 minute).

2.3 Environmental conditions

The Module meets the requirements for immunity to interference in accordance with IEC 61000-6-4:2006. According to the level of emission of radio interference (noise emissions) the Device complies with the standards established for equipment of class A by CISPR 22-97. The Device is designed for operation in the following conditions:

- ambient temperature: –40 ... +55 °C;
- relative humidity: up to 95% (at +35 °C, non-condensing);
- closed non-hazardous areas, free of corrosive or flammable gases.
- permitted pollution degree 1 according to IEC 61131-2.

The resistance to mechanical influences during operation of the Device is in accordance with IEC 61131-2-2012.

The resistance to climatic influences during the operation of the Device is in accordance with IEC 61131-2-2012.

3 Installation

Module is to install in the electrical cabinet. The design of the cabinet must protect Module from moisture, dirt and foreign objects.

To install Module:

1. Make sure that there is enough free space to connect the wire harness. You need 50 mm above the Module and below it.
2. Fasten the Device to the DIN rail or to a vertical surface using screws (see [Figure 3.1](#)).

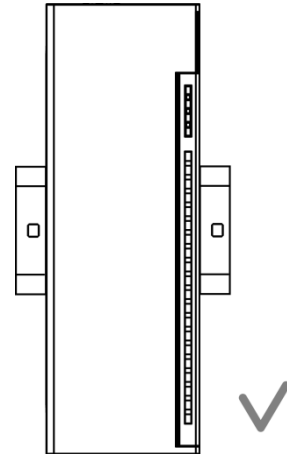


Fig. 3.1 Proper installation

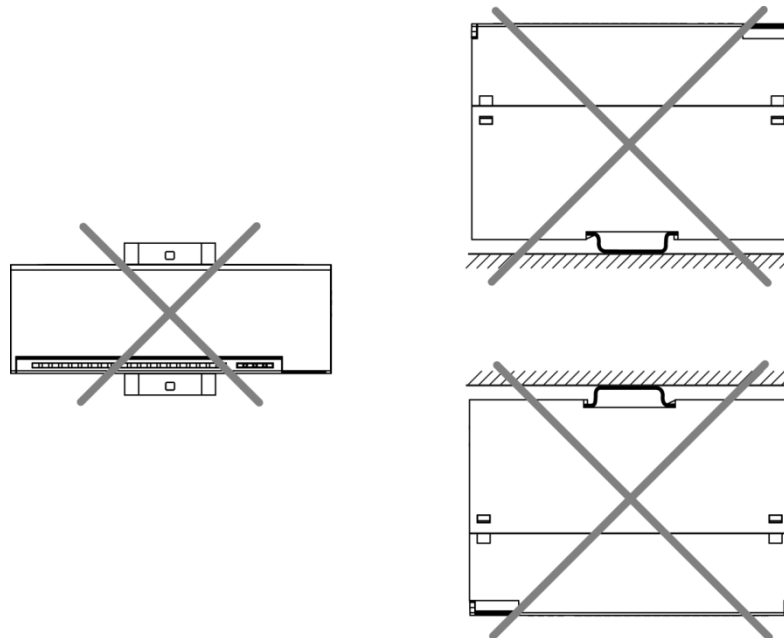


Fig. 3.2 Improper installation



CAUTION

Long-term operation of Module with improper installation can lead to damage (see [Figure 3.2](#)).

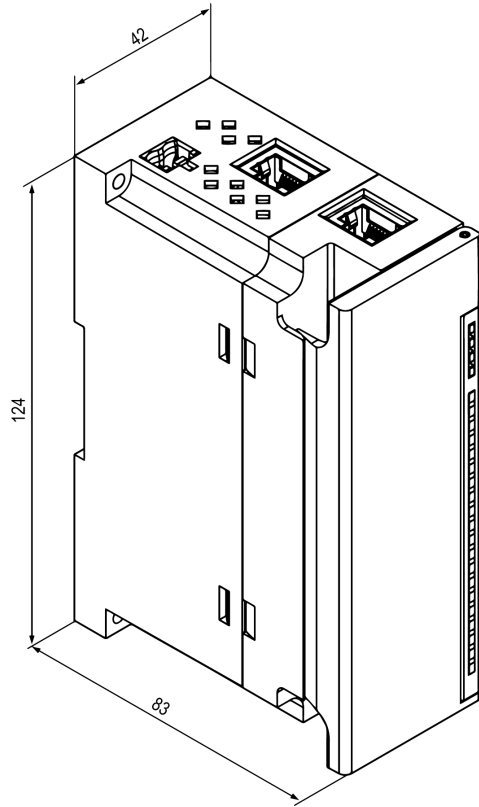


Fig. 3.3 Dimension drawing

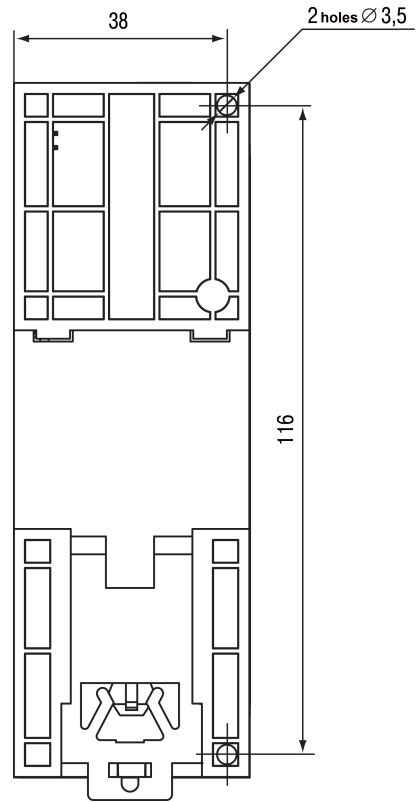


Fig. 3.4 Mounting dimensions

4 Connection

4 Connection

4.1 Connection recommendations

Mounting of external connections must be carried out by a wire with a cross section of not more than 0.75 mm².

For stranded wires, use end sleeves.

After mounting, put the wires into the cable channel of Module housing and close the cover.

If necessary, remove the terminal blocks of Module, loosen the two screws at the corners of the terminal blocks.

The power wires must be mounted using the supplied return terminal block.



CAUTION

Connection and maintenance is performed only when power of Module and devices connected to it is turned off.



CAUTION

Do not connect wires of different cross-sections to one terminal.



CAUTION

Do not connect more than two wires to one terminal.

4.2 Connectors

The connectors of the interfaces and of the power supply of the Device are shown in Figure 4.1.

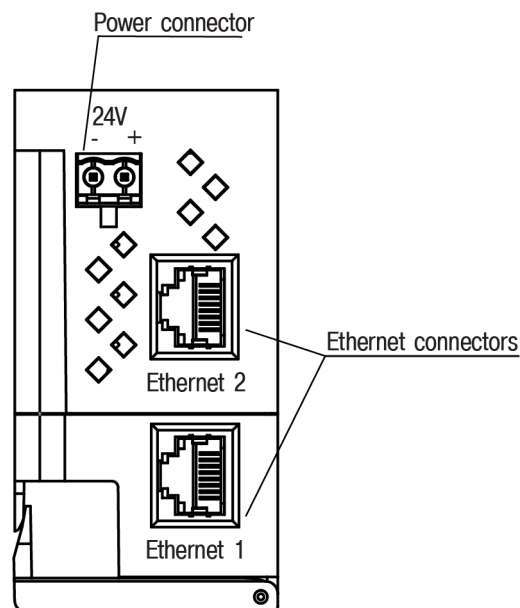


Fig. 4.1 Device's connectors

4.3 Power supply

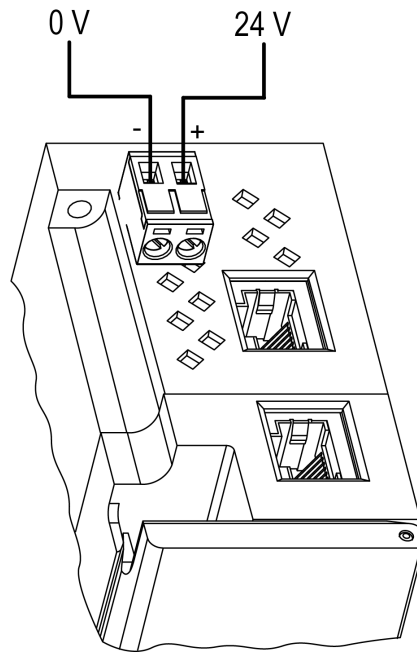


Fig. 4.2 Power supply contacts



CAUTION

Using power supplies without potential isolation or with basic isolation of low voltage circuits from AC lines can lead to dangerous voltage in the circuits.

4.4 Electrical connection

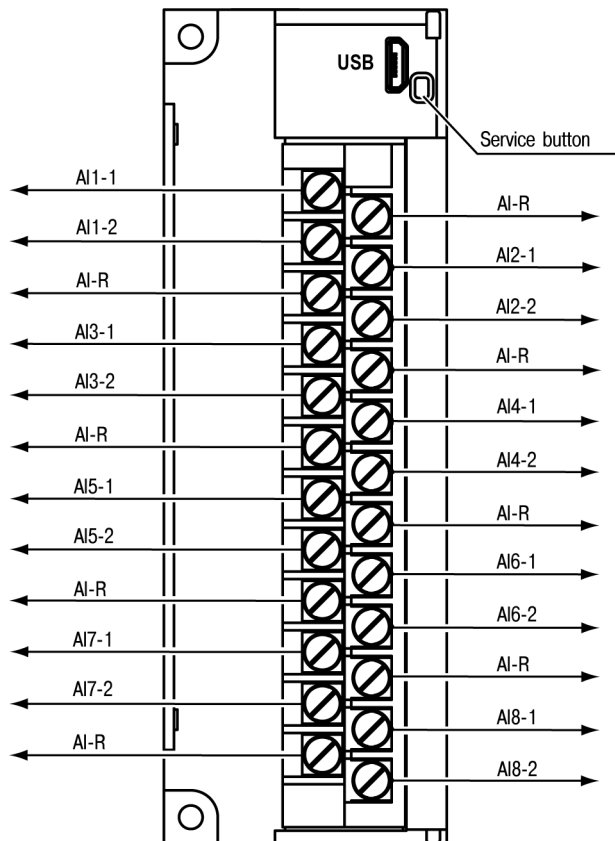


Fig. 4.3 Terminal block layout

Denomination	Function
AI1-1, AI1-2–AI8-1, AI8-2	Analog inputs AI1–AI8
AI-R	Common points of analog inputs

4.5 Connection to the inputs

4.5.1 Overview

Device inputs are universal. You can connect any primary transducers (sensors) and standard signals from the listed in Table 2.2 to them. You can connect to the Device inputs simultaneously sensors of different types in any combination.

NOTICE To protect the input circuits of the Device from possible breakdown of static electricity charges accumulated on communication lines "Device-sensor", their conductors should be connected for 1 to 2 seconds with the functional-earth screw (FE) of the board before connecting to the terminal block of the device.

When checking the serviceability of the sensor and the communication line, it is necessary to disconnect the Device from the mains. In order to prevent the Device from getting out of order during the checking of the connections, it is necessary to use measurement equipment with a voltage of not more than 4.5 V. At higher supply voltages of these devices, the sensor must be disconnected from the module.

Sensors connection parameters given in Table 4.1.

Table 4.1 Sensors connection parameters

Sensor type	Max. line length (m)	Max. line resistance (Ω)	Line type
RT	100	15	Three-wire, wire of equal length and cross-section
TC	20	100 ¹⁾	Thermoelectrode cable (compensating)
Current signal	100	100	Two-wires
Voltage signal	100	50	Two-wires
Resistance signal	10	5	Two-wires

1) the resistance of the line can be more than 100 ohms if there is sufficient voltage in the power supply circuit.

4.5.2 Resistance thermometer (RT)

Output parameters of the RT are determined by their NSC, standardized by IEC 60751:2008 and GOST 6651–2009 and 6651–94.

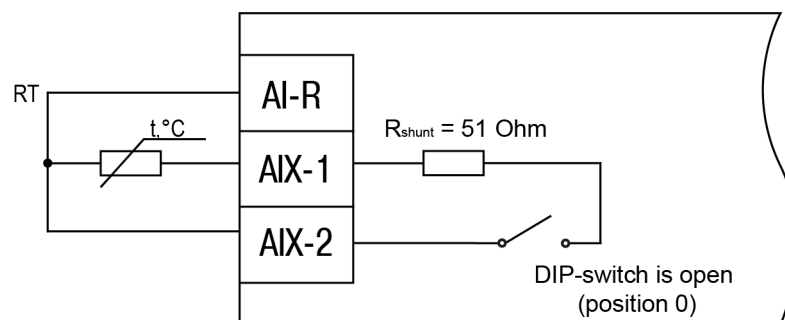


Fig. 4.4 Resistance thermometer wiring

4 Connection

In order to avoid the influence of the connecting wires resistance on the measurement results, the connection of the sensor to Module should be carried out in a three-wire scheme. In this scheme, two wires connecting the RT to Module are simultaneously connected to one of its terminals, and to the other terminal — the third connecting wire. **The resistance of the connecting wires must be equal** in order to exclude their influence on the measurement results. To do this, use the same wires of equal length.

4.5.3 Thermocouples (TC)

NSC of thermocouples of different types are standardized in IEC 60584-1:2013 and GOST 8.585.



NOTICE

Only thermocouples with insulated and ungrounded measuring junction can be used, because the negative terminals of their free ends are combined at the input of Module.

If it is not possible to connect the free ends of the TC directly to the Device contacts, then the connection must be performed using compensating thermoelectric wires or cables with the obligatory observance of the polarity. Using thermoelectrode cables allows to increase the length of the thermocouple conductors and to "transfer" its free ends to the Device terminal block.

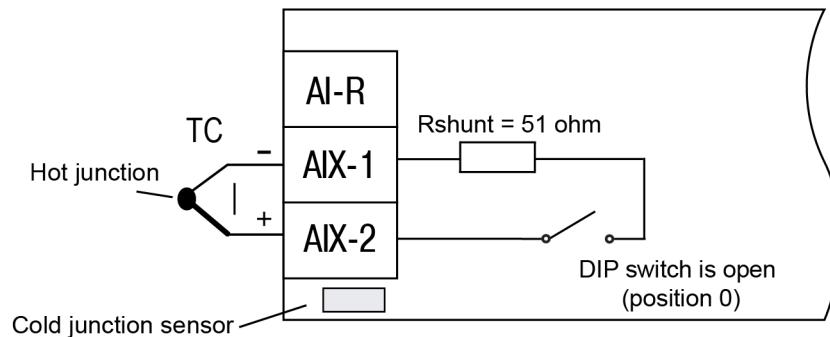


Fig. 4.5 Thermocouple wiring

For correct calculation of the parameters cold junction compensation is provided for connection of thermocouples. The temperature of the cold junction is measured by a built-in sensor. There are three cold junctions sensors in Module.

Automatic cold junction compensation ensures correct measuring of Module if the temperature of its environment changes.

In some cases (for example, during Module calibration) the automatic cold junction compensation can be disabled by setting the value in the parameter **Cold junction compensation** to **Off**.

4.5.4 Current / voltage signals

When measuring current or voltage signals an external power supply must be taken into account.

Connect the active converters with the output signal as a constant voltage (-1 ... +1 V) and current (0 ... 5 mA and 4 ... 20 mA) directly to the input contacts of the device.

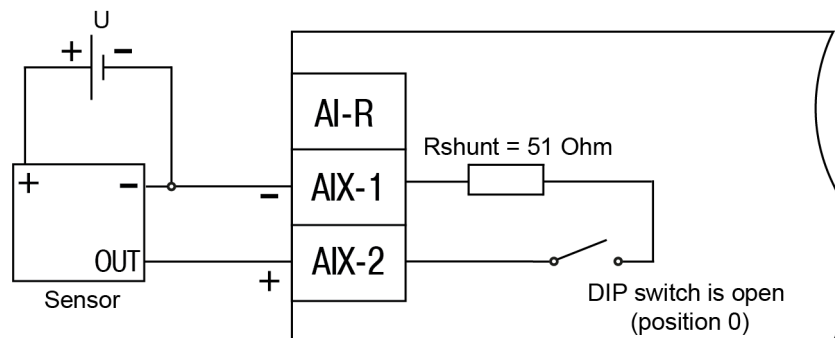


Fig. 4.6 Voltage signal wiring (-50 ... +50 mV and -1 ... 1 V)

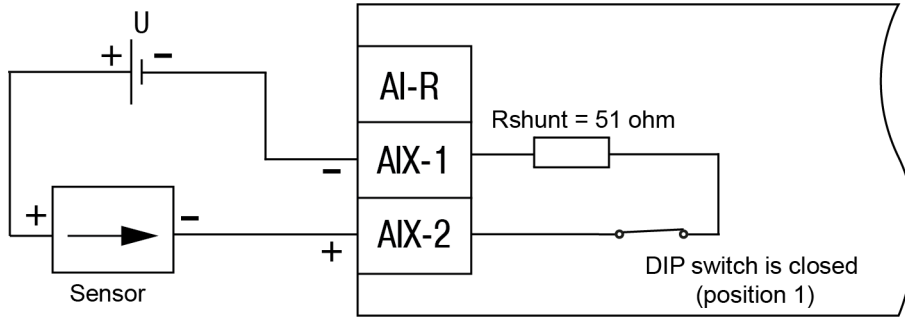


Fig. 4.7 Current signal wiring (4...20 mA)

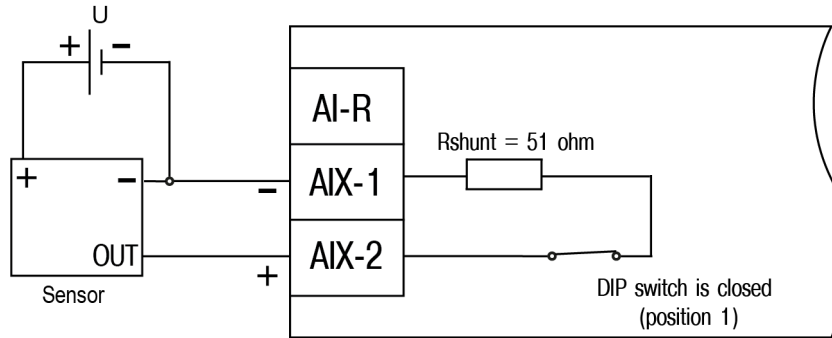


Fig. 4.8 Current signal wiring (4...20 mA)



NOTICE

When using active sensors, it should be borne in mind that the "minus" pins of their output signals in Module are interconnected.



CAUTION

When connecting an active current sensor, it is necessary to connect a built-in 51 Ω resistor. To do this, set the DIP switch of the corresponding channel, which is on the side of the Module housing, to position 1.

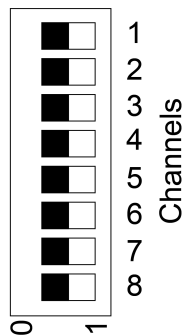


Fig. 4.9 DIP-switches on Device housing



NOTICE

If the DIP switches are in position 1 while using other sensors, their values will not be displayed correctly.

4 Connection

4.5.5 Resistance sensor

0 ... 2 k Ω or 0 ... 5 k Ω resistance sensors are supported by Module.

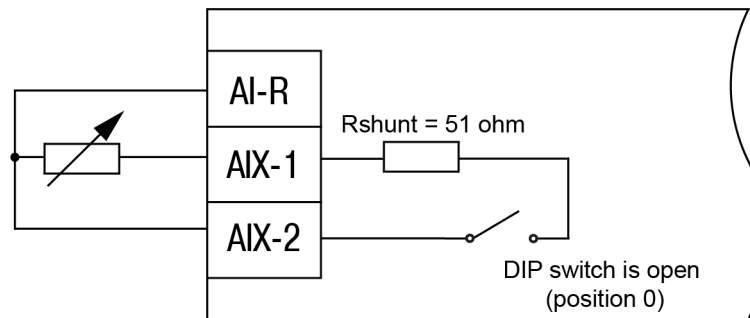


Fig. 4.10 Resistance sensor wiring

4.5.6 Señales digitales

Hasta 16 señales digitales pueden ser conectadas al módulo.

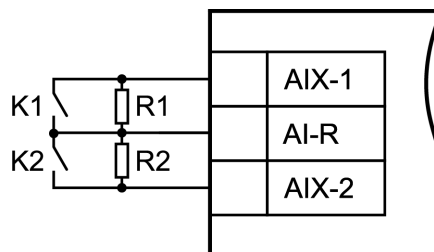


Fig. 4.11 Digital signal wiring

Para conectar la entrada digital es necesario conectar en paralelo una resistencia Shunt entre 200 y 3000 Ω .

Al evaluar el estado en la entrada pueden ser tomados cuatro diferentes valores. Los posibles valores se presentan en la [tabla 4.2](#).

Table 4.2 Estado de la entrada para señales digitales

Valor en la entrada	K1	K2
0	abierto	abierto
1	abierto	cerrado
2	cerrado	abierto
3	cerrado	cerrado

4.6 Ethernet connection

To connect modules to an Ethernet network, you can use the following schemes:

- Wye ([Figure 4.12](#)),
- Daisy-chain ([Figure 4.13](#)).

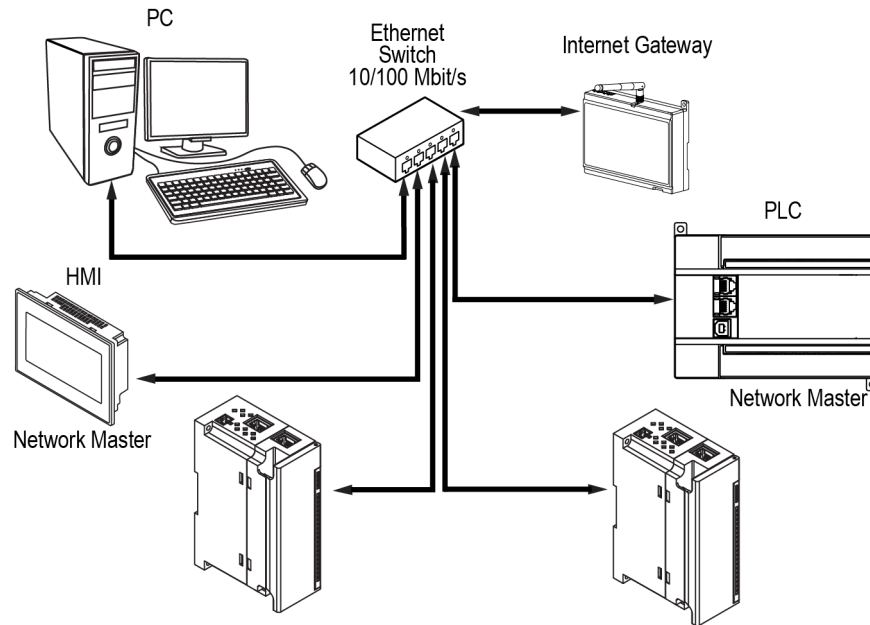


Fig. 4.12 Wye connection

**NOTICE**

1. Maximum length of communication lines: 100 m.
2. Connection is possible to any Ethernet port of the module.
3. The unused Ethernet port must be closed with a blanking plug.

To connect to the Daisy-chain scheme, you must use both Ethernet ports of Module. If Module fails or the power is turned off, the data will be transferred from port 1 to port 2 without disconnecting.

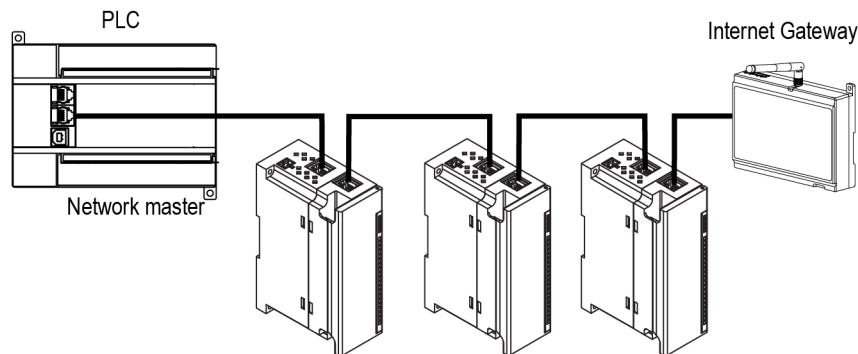


Fig. 4.13 Daisy-chain connection

**NOTICE**

1. The maximum length of the communication line between two adjacent active devices when connected with the "Daisy-Chain" must be not more than 100 m.
2. An adjacent connection scheme is allowed.
3. The unused Ethernet port should be closed with a blanking plug.

5 Construction and operation

5.1 Operation principle

The operation of Module is controlled by the Network Master. Module transmits to the network the status of the inputs when requested from the Master.

The following devices can be used as a Network Master:

- PC;
- PLC;
- Operator panel.

The signal from the sensor measuring the physical parameter of the object (temperature, pressure, etc.) is fed into the Device as a result of successive polling of the Device inputs. The received signal is converted according to the NSC data into digital values. While signal processing, interference filtering and correction of the input values are performed in accordance with the specified parameters.

The sensors are polled and their signals processed by the measuring device in series in a closed cycle.

5.2 Indication and control

Indication elements are located on the front panel of Module, see [Table 5.1](#).



Fig. 5.1 Module faceplate

The IP field is located at the bottom of the front panel.



NOTICE

The IP field is intended for applying the IP address of the Module with a thin marker or on a paper sticker.

Table 5.1 Indication

LED	LED Status	Overview
Power (green)	ON	Device operating voltage is applied
Eth 1 (green)	Flashing	Data transfer via Ethernet port 1

LED	LED Status	Overview
Eth 2 (green)	Flashing	Data transfer via Ethernet port 2
Fault \triangle (red)	OFF	Normal operation
	ON	Main application and / or configuration failure
	Lights 200 ms once every 3 seconds	It is necessary to replace the battery of RTC
	Lights 100 ms twice a second (after a pause of 400 ms)	Module is in a safe state
	900 ms on, 100 ms off	Hardware peripheral failure (Flash, RTC, Ethernet Switch)
Input status indicators (see Table 5.9)	Green	Input is ON
	OFF	Input is OFF
	Green turns off for a short time	Measurement at the input
	Orange	Non-critical input error
	Red	Critical input error

Under Module faceplate there are terminal blocks and a service button ([Figure 4.3](#)).

The service button performs the following functions:

- Factory settings restore ([Section 6.6](#));
- IP-address assignment ([Section 6.2](#));
- Firmware update ([Section 6.4](#)).

5.3 Real time clock

The Module has a built-in real time clock (RTC). Its source of power is a battery.

The timing is in seconds, starting with January 1, 2000 at midnight UTC. RTC indication is used for writing entries into the log file.

5.4 Log file

The module has built-in encrypted flash memory. The encryption algorithm is Data Encryption Standard (DES) in cipher block chaining (CBC) mode. The key is the string **superkey**. An initialization vector is generated using a hash function. The function argument is the password specified in akYtecToolPro. A checksum is calculated by the CRC32 algorithm and saved in the file end. The checksum is also encrypted.

Log file of Module will be saved as a few files. The log interval, the restriction on the size of one file and their number is set by the user in akYtecToolPro. If the log file is full, then the data is overwritten, starting with the oldest data in the oldest file.

A log file is a collection of records. Entries are separated by line break characters (0x0A0D). Each entry corresponds to one parameter and consists of fields separated by the “;” character (without quotes). Entry format is shown in table.

Table 5.2 Entry format

Parameter	Type	Size	Comment
Time stamp	binary data	4 bytes	In seconds from 00:00 01.01.2000 (UTC+0)
Separator	string	1 byte	Character “;” (without quotes)
Unique identifier of the parameter (UID)	string	8 byte	As a string of HEX characters with leading zeros

5 Construction and operation

Parameter	Type	Size	Comment
Separator	string	1 byte	Character ";" (without quotes)
Parameter value	string	depending on the parameter	As a string of HEX characters with leading zeros
Separator	string	1 byte	Character ";" (without quotes)
Parameter Status	binary data	1 byte	parameter status in the log file (0 – the parameter value is correct, 1 – the parameter value is incorrect and its further processing is not recommended).
Line break	binary data	2 bytes	\n\r (0x0A0D)

Example of decrypted entry:

```
0x52 0x82 0xD1 0x24 0x3B 0x30 0x30 0x30 0x30 0x61 0x39 0x30 0x30 0x3B 0x30 0x30 0x30 0x30
0x30 0x30 0x30 0x31 0x3B 0x31 0x0A 0x0D
```

where

- 0x52 0x82 0xD1 0x24 – time stamp. To get the date and time in UnixTime format, it is necessary to reverse the byte order and add the offset constant (number of seconds between 00:00:00 01/01/1970 and 00:00:00 01/01/2000): 0x24D18252 (HEX) + 946684800 (DEC) = 1564394971 (DEC, corresponding to July 29, 2019, 10:09:31);
- **0x3B** – separator;
- 0x30 0x30 0x30 0x30 0x30 0x61 0x39 0x30 0x30 – unique identifier of the parameter (00003ba00);
- **0x3B** – separator;
- 0x30 0x30 0x30 0x30 0x30 0x30 0x30 0x31 – parameter value (00000001);
- **0x3B** – separator;
- 0x31 – parameter status (1 – parameter value is correct);
- **0x0A 0x0D** – line break characters.

The time is written to the file from the built-in real time clock. You can also set the time zone, which will be read by external software.

The log file in the Device is written with a interval specified by user. Writing occurs with a certain frequency, calculated in such a way that the resource of Device flash memory is sufficient for a period of at least 10 years of operation.

Log file can be read:

- by akYtecToolPro;
- by user software (using Modbus function 20).

The list of logged parameters is available in the akYtecToolPro software on the **Device Information** tab. The order of writing parameters to the log file corresponds to the order of parameters on the tab.



NOTE

After updating the firmware, all device settings except the network settings will be reset to the factory settings.

The log file is read using the Modbus function 20 (0x14). This function returns the contents of the registers of the memory file. The function allows using one request to read one or several records from one or several files.

The file read request for each entry indicates:

- link type, 1 byte (should be equal to 6);
- file number, 2 bytes;
- starting address of the register inside the file, 2 bytes;
- number of registers to read, 2 bytes.



NOTE

The file number in the Modbus request is calculated as 4096 + the file sequence number. Sequential file numbering is from scratch. The Last log file index contains the sequential number of the log file for the last time data were written.

5 Construction and operation

The number of readable registers in the request should be selected so that the length of the response does not exceed the allowable length of the Modbus packet (256 bytes).

The size of the log file is not known in advance, so you should read portions of the data using separate queries. If in response to the request a message is received with error code 0x04 (MODBUS_SLAVE_DEVICE_FAILURE), then you can conclude that the addresses of the registers in the request are outside the file. To read the latest file data, you need to reduce the number of registers in the request.



CAUTION

When the Module power is turned off, the last entry made at the time of power off may not be saved.

5.5 Data exchange modes

The Module has the following data exchange modes:

- exchange with the Master via the Modbus TCP protocol (port 502) – up to 4 simultaneous connections with different Network Masters;
- connection and data exchange with a PC using the akYtec Tool Pro.

5.5.1 Sampling list

Any sensor is included into the sampling list if the **signal type** is selected. If the parameter **Sensor type** is set to **OFF**, then the sensor is excluded from the list.

Parameter **Sampling period** is set for each input. Sampling period can be specified in the range from 0.6 to 10 s. If the sampling of the input is not possible at a specified periodicity (for example, if the sampling period is set to 0.6 seconds at all inputs), the Device automatically increases the sampling period to the lowest possible.

The Module provides a mode **Maximum ADC load**. In this mode, the sampling period will be automatically set to the lowest possible for the corresponding sensor type.

5.5.2 Measurement range

The Device provides the possibility of scaling the measured values when working with active current and voltage signals. Calculation of the current values of the monitored parameters is carried out using scaling values, set individually for each input. Using the scaling values allows to display the monitored physical parameters in units of their measurement (bars, kilopascals, meters, etc.).

To scale the linear signal (current or voltage) the measurement limits must be set.

- **Ain.L** is the lower limit, corresponds to the minimum level of the sensor output signal;
- **Ain.H** is upper limit, corresponds to the maximum level of the output signal of the sensor.

The calculation of the parameter value monitored by the sensor is made using the formula:

$$P_{MEAS} = Ain.L + \frac{(Ain.H - Ain.L) \cdot (V_{INPUT} - V_{MIN})}{V_{MAX} - V_{MIN}}$$

where

Ain.L, **Ain.H** are specified values of the parameters **Ain.L** and **Ain.H**;

V_{INPUT} is the current value of the input signal;

V_{MIN}, **V_{MAX}** are the minimum and maximum values of the sensor input signal according to the data in Table 2.2 (mA, mV or V);

P_{MEAS} is the measured value of the parameter.

Example:

When using a sensor with an output current of 4 ... 20 mA (sensor type 11 in the parameter **Sensor type**) monitoring the pressure in the range of 0 ... 25 bar, the parameter **Ain.L** is set to **00.00**, and the parameter **Ain.H** — to **25.00**. After this, the processing and display of the readings will be made in bar.

5.5.3 Digital Filter

The Device provides a programmable digital low-pass filter for additional protection against electromagnetic interference. Digital filtering is carried out in two stages.

At the **first stage of the filtering**, Device calculates the difference between the last two measurements and compares it with a given value, called the **filter bandwidth**. If the calculated difference exceeds the specified limit, the result is discarded, the measurement is repeated, and the value of the filter bandwidth is doubled. If the new value is confirmed, the filter is switched to a new stable state of the measured value (i.e., the filter bandwidth is reduced to the initially specified). Such an algorithm makes it possible to protect the Device from the effects of single impulse and commutation interferences arising in the environment of power equipment.

Filter bandwidth is set in units of the measured value in the "akYtec Tool Pro" program individually for each sensor. Reducing the filter bandwidth improves the noise immunity of the measurement input, but leads to a slow response to a rapid change in the input value. Therefore, if the level of interference is low or when working with rapidly changing processes, it is recommended to increase the value of the filter bandwidth or to disable this parameter. When operating in the presence of strong interference, in order to eliminate their impact on the operation of the device, it is necessary to reduce the value of the filter bandwidth. This filter can be disabled by setting the value **0** to the **Filter bandwidth** parameter.

At the **second stage of the filtering**, the signal is damped in order to eliminate the noise components. The main characteristic of the damping is the filter time constant.

Filtering occurs according to the formula:

$$P = P_{MEAS} \cdot T + P'_{MEAS} \cdot (1 - T)$$

where

P is value in the register "Analog input value"

P_{MEAS} is the current value measured on the input.

P'_{MEAS} is the value measured on the input during previous sampling.

T = 1 / (K / 10 + 1) is damping factor;

K is filter time constant.

Filter time constant is specified in seconds for each input in the corresponding parameter using the akYtec ToolPro program.

Increasing its value improves the noise immunity of the measurement input, but at the same time increases its time lag. That means the response of the Device to rapid changes in the input value slows down.

This filter can be disabled by setting the value **0** to the **Filter time constant** parameter.

The time diagrams of the digital filters operation are shown in [Figure 5.2](#).

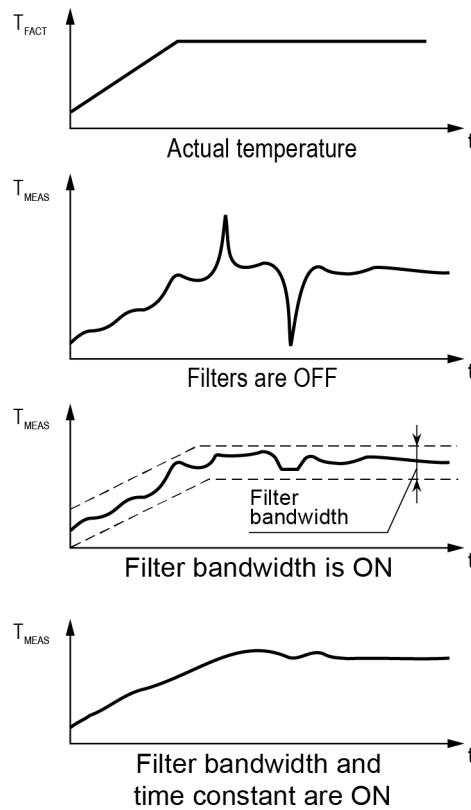


Fig. 5.2 Time diagrams of the digital filter operation

5.5.4 Correction of measuring characteristics of sensors

To eliminate the initial error of the input signal converters, the value measured by the Device can be corrected. There are two types of correction provided by the Module, which allow you to shift or slope the characteristic by a given amount.

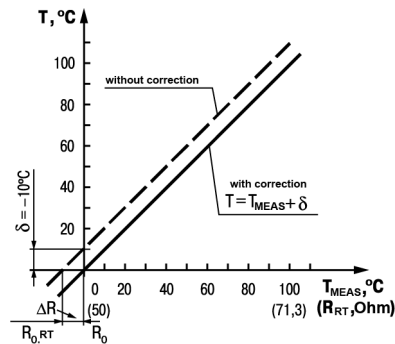


Fig. 5.3 Characteristic offset

The characteristic offset is used in following cases:

- to compensate for errors that occur when connecting a RT using a two-wire circuit;
- by deviation of the R_0 value of the RT.

This correction is carried out by adding to the measured value the value of δ . The value of δ is set by the **Offset** parameter in the "akYtec Tool Pro" program. An example of the characteristic offset is shown graphically in [Figure 5.3](#).

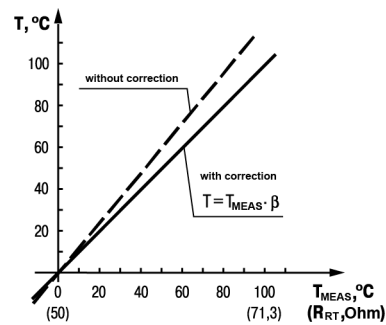


Fig. 5.4 Characteristic slope

The change in the characteristic slope is accomplished by multiplying the measured and corrected in offset (if it's necessary) value by the correction factor β , the value of which is set by the **Slope** parameter. An example of the change in the slope of the measuring characteristic is shown graphically in *Figure 5.4*. This type of correction is used to compensate for the errors of the sensors (for example, if the resistance of the parameter α deviates from the standard value) or errors related to the spread of the resistances of the shunt resistors (when working with converters whose output signal is current). The value of the correction factor β is given in dimensionless units in the range from $-1 \dots 10$ and before installation is determined by the formula:

$$\beta = \frac{P_{FACT}}{P_{MEAS}}$$

where

P_{FACT} is the actual value of the controlled input magnitude;

P_{MEAS} is the value of the same magnitude measured by the Device.

The need to introduce a correction factor can be determined by measuring the maximum or close to it value of the parameter, where the deviation of the measurement characteristic slope is most noticeable.



NOTICE

Setting correction values that differ from the factory settings (**Offset = 000.0** and **Slope = 1.000**), changes the standard metrological characteristics of the Device and must be performed only in technically justified cases by approved specialists.

The values obtained after filtering and correcting the input signals are fed into the network for their further transmission.

5.5.5 Modbus TCP communication

The measurement results are presented in the following formats:

- floating-point values (4 bytes, no time);
- integer (2 bytes).

Integer is the result of a measurement multiplied by 10 obtained to the power given by the parameter **Decimal point position**. The value of this parameter can be specified in range from 0 to 7 and is set separately for each channel.



NOTICE

When setting the **Decimal Point Position** to 6 and 7, a situation may arise when the measured value multiplied by 10 to the **Decimal Point Position** power is greater than 32767 or less -32768 (for signed values) or greater than 65535 (for values unsigned). Such values can not be transferred into int16 format. This should be taken into account when specifying the value of **decimal point position**.

Both formats are saved in different data registers (see *Table 5.3*).

Time mark is cyclic time with the increment of 0.01 second saved as a 2 byte integer. Time accurately corresponds to the time of measurement in the channel and when working with this value (for example, when calculating the differential component while PID control), the delay of transmission over the Ethernet network can be ignored. When the module is powered on, the cycle starts from 0 and returns to the initial state in 655.36 seconds.

Following Modbus functions are available: **3 (0x03)** or **4 (0x04)** for reading and **16 (0x10)** for writing.

Table 5.3 ModBus communication registers

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Float value 1	—	4000	0xFA0	Read only	FLOAT 32
Current sampling time for input 1	0...65535 (ms)	4002	0xFA2	Read only	UINT 16
Float value 2	—	4003	0xFA3	Read only	FLOAT 32
Current sampling time for input 2	0...65535 (ms)	4005	0xFA5	Read only	UINT 16
Float value 3	—	4006	0xFA6	Read only	FLOAT 32
Current sampling time for input 3	0...65535 (ms)	4008	0xFA8	Read only	UINT 16
Float value 4	—	4009	0xFA9	Read only	FLOAT 32
Current sampling time for input 4	0...65535 (ms)	4011	0xFAB	Read only	UINT 16
Float value 5	—	4012	0xFAC	Read only	FLOAT 32
Current sampling time for input 5	0...65535 (ms)	4014	0FAE	Read only	UINT 16
Float value 6	—	4015	0FAF	Read only	FLOAT 32
Current sampling time for input 6	0...65535 (ms)	4017	0xFB1	Read only	UINT 16
Float value 7	—	4018	0FB2	Read only	FLOAT 32
Current sampling time for input 7	0...65535 (ms)	4020	0FB4	Read only	UINT 16
Float value 8	—	4021	0FB5	Read only	FLOAT 32
Current sampling time for input 8	0...65535 (ms)	4023	0FB7	Read only	UINT 16
Integer value 1	—	4064	0xFE0	Read only	INT 16
Integer value 2	—	4065	0xFE1	Read only	INT 16
Integer value 3	—	4066	0xFE2	Read only	INT 16
Integer value 4	—	4067	0xFE3	Read only	INT 16
Integer value 5	—	4068	0xFE4	Read only	INT 16
Integer value 6	—	4069	0xFE5	Read only	INT 16
Integer value 7	—	4070	0xFE6	Read only	INT 16
Integer value 8	—	4071	0xFE7	Read only	INT 16
Safe state activation timeout	0...60 (s)	700	0x2BC	Read and write	UINT 8
Battery status (power supply)	0...3300 (mV)	801	0x321	Read only	UINT 16
Log interval	10...3600 (s)	900	0x384	Read and write	UINT 16
Maximum ADC load	0 – off 1 – on	4097	0x1001	Read and write	UINT 16

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Sensor type for input 1	see Table 5.4	4100	0x1004	Read and write	UINT 32
Filter bandwidth for input 1	0...100	4102	0x1006	Read and write	UINT 16
Decimal point position for input 1	0...7	4103	0x1007	Read and write	UINT 16
Characteristic offset for input 1	-10000... 10000	4104	0x1008	Read and write	FLOAT 32
Characteristic slope for input 1	-1...10	4106	0x100A	Read and write	FLOAT 32
AIN.H upper limit for input 1	-10000... 10000	4108	0x100C	Read and write	FLOAT 32
AIN.L lower limit for input 1	-10000... 10000	4110	0x100E	Read and write	FLOAT 32
Filter time constant for input 1	0...65535	4112	0x1010	Read and write	UINT 16
Sampling time for input 1	600...10000 ms	4113	0x1011	Read and write	UINT 16
Sensor type for input 2	see Table 5.4	4116	0x1014	Read and write	UINT 32
Filter bandwidth for input 2	0...100	4118	0x1016	Read and write	UINT 16
Decimal point position for input 2	0...7	4119	0x1017	Read and write	UINT 16
Characteristic offset for input 2	-10000... 10000	4120	0x1018	Read and write	FLOAT 32
Characteristic slope for input 2	-1...10	4122	0x101A	Read and write	FLOAT 32
AIN.H upper limit for input 2	-10000... 10000	4124	0x101C	Read and write	FLOAT 32
AIN.L lower limit for input 2	-10000... 10000	4126	0x101E	Read and write	FLOAT 32
Filter time constant for input 2	0...65535	4128	0x1020	Read and write	UINT 16
Sampling time for input 2	600...10000 (ms)	4129	0x1021	Read and write	UINT 16
Sensor type for input 3	see Table 5.4	4132	0x1024	Read and write	UINT 32
Filter bandwidth for input 3	0...100	4134	0x1026	Read and write	UINT 16
Decimal point position for input 3	0...7	4135	0x1027	Read and write	UINT 16
Characteristic offset for input 3	-10000... 10000	4136	0x1028	Read and write	FLOAT 32
Characteristic slope for input 3	-1...10	4138	0x102A	Read and write	FLOAT 32

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
AIN.H upper limit for input 3	-10000... 10000	4140	0x102C	Read and write	FLOAT 32
AIN.L lower limit for input 3	-10000... 10000	4142	0x102E	Read and write	FLOAT 32
Filter time constant for input 3	0...65535	4144	0x1030	Read and write	UINT 16
Sampling time for input 3	600...10000 (ms)	4145	0x1031	Read and write	UINT 16
Sensor type for input 4	see Table 5.4	4148	0x1034	Read and write	UINT 32
Filter bandwidth for input 4	0...100	4150	0x1036	Read and write	UINT16
Decimal point position for input 4	0...7	4151	0x1037	Read and write	UINT 16
Characteristic offset for input 4	-10000... 10000	4152	0x1038	Read and write	FLOAT 32
Characteristic slope for input 4	-1...10	4154	0x103A	Read and write	FLOAT 32
AIN.H upper limit for input 4	-10000... 10000	4156	0x103C	Read and write	FLOAT 32
AIN.L lower limit for input 4	-10000... 10000	4158	0x103E	Read and write	FLOAT 32
Filter time constant for input 4	0...65535	4160	0x1040	Read and write	UINT 16
Sampling time for input 4	600...10000 (ms)	4161	0x1041	Read and write	UINT 16
Sensor type for input 5	see Table 5.4	4164	0x1044	Read and write	UINT 32
Filter bandwidth for input 5	0...100	4166	0x1046	Read and write	UINT 16
Decimal point position for input 5	0...7	4167	0x1047	Read and write	UINT 16
Characteristic offset for input 5	-10000... 10000	4168	0x1048	Read and write	FLOAT 32
Characteristic slope for input 5	-1...10	4170	0x104A	Read and write	FLOAT 32
AIN.H upper limit for input 5	-10000... 10000	4172	0x104C	Read and write	FLOAT32
AIN.L lower limit for input 5	-10000... 10000	4174	0x104E	Read and write	FLOAT 32
Filter time constant for input 5	0...65535	4176	0x1050	Read and write	UINT 16
Sampling time for input 5	600...10000 (ms)	4177	0x1051	Read and write	UINT 16
Sensor type for input 6	see Table 5.4	4180	0x1054	Read and write	UINT 32

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Filter bandwidth for input 6	0...100	4182	0x1056	Read and write	UINT 16
Decimal point position for input 6	0...7	4183	0x1057	Read and write	UINT 16
Characteristic offset for input 6	-10000... 10000	4184	0x1058	Read and write	FLOAT 32
Characteristic slope for input 6	-1...10	4186	0x105A	Read and write	FLOAT 32
AIN.H upper limit for input 6	-10000... 10000	4188	0x105C	Read and write	FLOAT 32
AIN.L lower limit for input 6	-10000... 10000	4190	0x105E	Read and write	FLOAT 32
Filter time constant for input 6	0...65535	4192	0x1060	Read and write	UINT 16
Sampling time for input 6	600...10000 (ms)	4193	0x1061	Read and write	UINT 16
Sensor type for input 7	see Table 5.4	4196	0x1064	Read and write	UINT 32
Filter bandwidth for input 7	0...100	4198	0x1066	Read and write	UINT 16
Decimal point position for input 7	0...7	4199	0x1067	Read and write	UINT 16
Characteristic offset for input 7	-10000... 10000	4200	0x1068	Read and write	FLOAT 32
Characteristic slope for input 7	-1...10	4202	0x106A	Read and write	FLOAT 32
AIN.H upper limit for input 7	-10000... 10000	4204	0x106C	Read and write	FLOAT 32
AIN.L lower limit for input 7	-10000... 10000	4206	0x106E	Read and write	FLOAT 32
Filter time constant for input 7	0...65535	4208	0x1070	Read and write	UINT16
Sampling time for input 7	600...10000 (ms)	4209	0x1071	Read and write	UINT 16
Sensor type for input 8	see Table 5.4	4212	0x1074	Read and write	UINT 32
Filter bandwidth for input 8	0...100	4214	0x1076	Read and write	UINT 16
Decimal point position for input 8	0...7	4215	0x1077	Read and write	UINT 16
Characteristic offset for input 8	-10000... 10000	4216	0x1078	Read and write	FLOAT 32
Characteristic slope for input 8	-1...10	4218	0x107A	Read and write	FLOAT 32
AIN.H upper limit for input 8	-10000... 10000	4220	0x107C	Read and write	FLOAT 32

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
AIN.L lower limit for input 8	-10000... 10000	4222	0x107E	Read and write	FLOAT 32
Filter time constant for input 8	0...65535	4224	0x1080	Read and write	UINT16
Sampling time for input 8	600...10000 (ms)	4225	0x1081	Read and write	UINT 16
Time (ms)	—	61563	0xF07B	Read only	UINT 32
New time	Date/Time in seconds from January 1, 2000	61565	0xF07D	Read and write	UINT 32
Write the new time	0 – do not write 1 – write	61567	0xF07F	Read and write	UINT 16
Time and date (UTC)	Date/Time in seconds from January 1, 2000	61568	0xF080	Read only	UINT 32
Time zone	offset in minutes from Greenwich	61570	0xF082	Read and write	INT 16
Module status	—	61620	0xF0B4	Read only	UINT 32
DNS server 1	—	12	0xC	Read and write	UINT 32
DNS server 2	—	14	0xE	Read and write	UINT 32
Assign IP address	—	20	0x14	Read and write	UINT 32
Enter subnet mask	—	22	0x16	Read and write	UINT 32
Set the gateway IP address	—	24	0x18	Read and write	UINT 32
MAC-address	—	61696	0xF100	Read only	UINT 48
Current IP address	—	26	0x1A	Read only	UINT 32
Current subnet mask	—	28	0x1C	Read only	UINT 32
Current gateway IP address	—	30	0x1E	Read only	UINT 32
DHCP Mode	0 – off; 1 – on; 2 – one-off setting with service button	32	0x20	Read and write	UINT 16

When controlling via Modbus protocol, you must specify the type of sensor for each input by writing its code in the appropriate register. The default value is **0**.

Table 5.4 Sensor types codes

Register value	Sensor type
0	Sensor is not connected
1	Cu 100 ($\alpha = 0.00426 \text{ } ^\circ\text{C}^{-1}$)
2	Cu 50 ($\alpha = 0.00426 \text{ } ^\circ\text{C}^{-1}$)
3	Pt 100 ($\alpha = 0.00385 \text{ } ^\circ\text{C}^{-1}$)
4	100P ($\alpha = 0.00391 \text{ } ^\circ\text{C}^{-1}$)
5	L
6	K
7	-50...+50 mV
8	Pt 50 ($\alpha = 0.00385 \text{ } ^\circ\text{C}^{-1}$)
9	50P ($\alpha = 0.00391 \text{ } ^\circ\text{C}^{-1}$)
10	50M ($\alpha = 0.00428 \text{ } ^\circ\text{C}^{-1}$)
11	4...20 mA
12	0...20 mA
13	0...5 mA
14	-1...1 V
15	100M ($\alpha = 0.00428 \text{ } ^\circ\text{C}^{-1}$)
16	Cu53
17	B
18	S
19	R
20	N
21	J
22	A-1
23	A-2
24	A-3
25	T
26	Dry contact sensor
27	Ni 100 ($\alpha = 0.00617 \text{ } ^\circ\text{C}^{-1}$)
28	Cu 500 ($\alpha = 0.00426 \text{ } ^\circ\text{C}^{-1}$)
29	500M ($\alpha = 0.00428 \text{ } ^\circ\text{C}^{-1}$)
30	Pt 500 ($\alpha = 0.00385 \text{ } ^\circ\text{C}^{-1}$)
31	500P ($\alpha = 0.00391 \text{ } ^\circ\text{C}^{-1}$)
32	Ni 500 ($\alpha = 0.00617 \text{ } ^\circ\text{C}^{-1}$)
33	Cu 1000 ($\alpha = 0.00426 \text{ } ^\circ\text{C}^{-1}$)
34	1000M ($\alpha = 0.00428 \text{ } ^\circ\text{C}^{-1}$)
35	Pt 1000 ($\alpha = 0.00385 \text{ } ^\circ\text{C}^{-1}$)
36	1000P ($\alpha = 0.00391 \text{ } ^\circ\text{C}^{-1}$)

Register value	Sensor type
37	Ni 1000 ($\alpha = 0.00617 \text{ } ^\circ\text{C}^{-1}$)
38	Resistance sensor 2.0 k Ω
39	Resistance sensor 5.0 k Ω

5.5.6 Error codes for Modbus protocol

When working on the Modbus protocol, errors may occur. These errors are described in [Table 5.5](#). In case of an error, Module sends a response to the Network Master with an error code.

Table 5.5 List of possible errors

Name	Code	Description
MODBUS_ILLEGAL_FUNCTION	01 (0x01)	Illegal function code. The error occurs if Module does not support the Modbus function specified in the request.
MODBUS_ILLEGAL_DATA_ADDRESS	02 (0x02)	Illegal register address. The error occurs if the request contains register addresses that are not in Module.
MODBUS_ILLEGAL_DATA_VALUE	03 (0x03)	Illegal data value. The error occurs if the request contains an invalid value for writing to the register
MODBUS_SLAVE_DEVICE_FAILURE	04 (0x04)	The error occurs if the requested action cannot be completed.

During the exchange via the Modbus protocol, Module checks the compliance of the requests with the Modbus specification. Requests that fail verification are ignored by the module. Requests that specify an address that does not match the module address are also ignored.

Next, the function code is checked. If a request is received by the module with a function code not specified in [Table 5.6](#), a MODBUS_ILLEGAL_FUNCTION error occurs.

Table 5.6 List of supported functions

Name	Code	Description
MODBUS_READ_HOLDING_REGISTERS	3 (0x03)	Reading values from one or more holding registers
MODBUS_READ_INPUT_REGISTERS	4 (0x04)	Reading values from one or more input registers
MODBUS_WRITE_SINGLE_REGISTER	6 (0x06)	Writing a value to single register
MODBUS_WRITE_MULTIPLE_REGISTERS	16 (0x10)	Writing values to multiple registers
MODBUS_READ_FILE_RECORD	20 (0x14)	Reading log from file
MODBUS_WRITE_FILE_RECORD	21 (0x15)	Writing log to file

Situations leading to errors during operation with registers are described in [Table 5.7](#).

Table 5.7 Errors while working with registers

Function	Error name	Possible causes
MODBUS_READ_HOLDING_REGISTERS	MODBUS_ILLEGAL_DATA_ADDRESS	<ul style="list-style-type: none"> – number of requested registers is greater than the maximum possible number (125); – request for nonexistent parameter
MODBUS_READ_INPUT_REGISTERS	MODBUS_ILLEGAL_DATA_ADDRESS	<ul style="list-style-type: none"> – number of requested registers is greater than the maximum possible number (125); – request for nonexistent parameter
MODBUS_WRITE_SINGLE_REGISTER	MODBUS_ILLEGAL_DATA_ADDRESS	<ul style="list-style-type: none"> – attempt to write a parameter whose size exceeds 2 bytes; – attempt to write a parameter, access to which is denied; – attempt to write a parameter of this type, which cannot be written to by this function. Supported Types: <ul style="list-style-type: none"> – signed and unsigned integers (max. 2 bytes); – enumerated type; – float16 (currently this type is not used for Module). – request for nonexistent parameter
	MODBUS_ILLEGAL_DATA_VALUE	<ul style="list-style-type: none"> – value outside the parameter limits
MODBUS_WRITE_MULTIPLE_REGISTERS	MODBUS_ILLEGAL_DATA_ADDRESS	<ul style="list-style-type: none"> – writing of a nonexistent parameter; – attempt to write a parameter, access to which is denied; – number of writable registers is greater than the maximum possible number (123)
	MODBUS_ILLEGAL_DATA_VALUE	<ul style="list-style-type: none"> – no terminating character (\0) was found in the string parameter; – size of the requested data is less than the size of the first or last parameter in the request; – value outside the parameter limits

Situations leading to errors during operation with the log file are described in [Table 5.8](#).

Table 5.8 Errors while working with the log file

Function	Error name	Possible causes
MODBUS_READ_FILE_RECORD	MODBUS_ILLEGAL_FUNCTION	<ul style="list-style-type: none"> – illegal data size (0x07 <= data length <= 0xF5)
	MODBUS_ILLEGAL_DATA_ADDRESS	<ul style="list-style-type: none"> – reference type does not meet specification; – could not open the file for reading (it may be missing)
	MODBUS_ILLEGAL_DATA_VALUE	<ul style="list-style-type: none"> – could not move to the desired offset in the file

Function	Error name	Possible causes
	MODBUS_SLAVE_DEVICE_FAILURE	<ul style="list-style-type: none"> – file deletion error when deleting; – request too much data (more than 250 bytes); – illegal record number (more than 0x270F); – illegal record length (more than 0x7A)
MODBUS_WRITE_FILE_RECORD	MODBUS_ILLEGAL_FUNCTION	<ul style="list-style-type: none"> – illegal data size (0x09 <= data length <= 0xFB)
	MODBUS_ILLEGAL_DATA_ADDRESS	<ul style="list-style-type: none"> – reference type does not meet specification; – could not open file for writing
	MODBUS_SLAVE_DEVICE_FAILURE	<ul style="list-style-type: none"> – requested file is missing; – requested file is read-only; – failed to write the required number of bytes

5.5.7 Diagnostics of primary sensors

During operation, the Device monitors the operability of the primary transducers connected to it. If any of them is faulty, the Device sends an error message via the Ethernet interface.

Error messages are generated in the following cases:

- break or short circuit of RT;
- break of TC, as well as when the temperature of the free ends of TC exceeds 90°C or decreases below -40°C;
- obtaining measurement results that go beyond the limits of the control range set for the sensor.

Some types of faults in the primary transducers can not be diagnosed by the Device. These include breaks in the current and voltage sensors (the measured input gives a zero value or diagnoses as a fault "Value is too small").

Due to the TC short-circuit fault monitoring in the Device, the Device senses resistance signals less than 25 ohms as unreliable. So, for example, a 0 ... 2000 ohm sensor can not measure signals in the range from 0 to 25 Ohm (from 0 to 1,26% of the range).

5.5.8 Errors

If an error occurs during the Modbus communication, the error code is transferred to the value register.

Table 5.9 Error codes

Error	Code	Indication
Measurement correct	Transmission in progress	Green
Measured value error	0xF0	Orange
Measurement not ready*	0xF6	Orange
Sensor is disconnected	0xF7	Off
Cold junction temperature too high	0XF8	Orange
Cold junction temperature too low	0XF9	Orange
Measured value too high	0xFA	Orange

Error	Code	Indication
Measured value too low	0xFB	Orange
Short circuit	0xFC	Red
Sensor break	0xFD	Red
No connection with ADC	0xFE	Red
Incorrect calibration coefficient	0xFF	Orange

* – wait for the results of the first measurement after switching on the Device.

6 Configuration

6.1 Connection to akYtec Tool Pro

The Module is configured in the akYtec Tool Pro program.

The Device can be connected to a PC using the following interfaces:

- USB (microUSB),
- Ethernet.

To select an interface:

1. Connect the module to the PC using a USB cable or Ethernet interface.



NOTICE

If the module is connected to the USB port, the main module power supply is not required.
In case of connecting via Ethernet interface it is necessary to supply the main power to the module.

2. Run akYtec Tool Pro.
3. Click the icon **Add devices** on the tool bar.
4. In the drop-down menu "Interface" select:
 - Ethernet (or other network card to which the module is connected): for Ethernet connection;
 - STMicroelectronics Virtual COM Port: for USB connection.

Connection settings

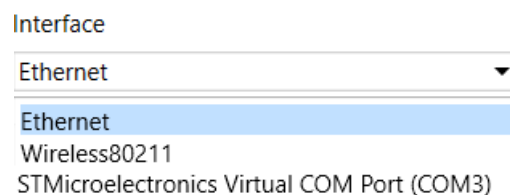


Fig. 6.1 Interface selection menu

The next steps for finding a Device depend on the choice of interface.

To find and add a Device connected to the Ethernet interface to the project:

1. Select "Find device"
2. Enter IP-address of the connected device.
3. Click Find. A Module with the specified IP address is displayed in the window.



NOTICE

The default IP address (factory setting) is **192.168.1.99**.

4. Select the Device (place a check mark) and click OK. If the Device is password protected, you must enter the correct password. The Device will be added to the project.

To find and add a device connected via USB interface to the project:

1. In the drop-down menu, select the akYtec Auto Detection Protocol.

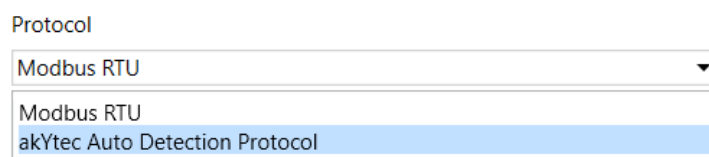


Fig. 6.2 Select Protocol

2. Select **Find device**.

6 Configuration

3. Enter the address of the connected device (default is 1).
4. Click **Find**. The module with the specified address is displayed in the window.
5. Select the device (place a check mark) and click OK. If the device is password protected, you must enter the correct password. The device will be added to the project.

For more information on connecting and working with Devices, see the AkYtec Tool Pro Help. To call help in the program, press **F1**.

6.2 Configuring Network Settings

The parameters shown in the table must be set for the Module for Ethernet connection:

Table 6.1 Module's network parameters

Parameter	Note
MAC-address	Set at the factory and is unchanged
IP address	Can be static or dynamic. The factory setting is 192.168.1.99 .
Subnet mask	Specifies the subnet of the IP addresses of other devices visible by the Module. The factory setting is 255.255.255.0
Gateway IP Address	Specifies the gateway address to access the Internet. The factory setting is 192.168.1.1

The IP address can be:

Static. This IP address is set using the akYtecToolPro program or the Service button.

To set a static IP address using the akYtecToolPro, proceed as follows:

1. Click on the line **Connection Settings** in the parameter field.
2. Select the **Ethernet settings**.
3. Specify new values for fields **Enter IP Address**, **Enter Subnet Mask** and **Assign gateway IP address**.
4. Set **DHCP Mode** to **Off**.
5. Click on symbol "Save data" in the menu bar.

With help of service button, you can set IP addresses immediately for the group of Modules.

To assign IP address using service button:

1. Connect a module or group of Modules to an Ethernet network.
2. Start the akYtecToolPro program on a PC connected to the same Ethernet network.
3. Click on symbol "IP addresses" in akYtecToolPro program.
4. Enter IP address for the first Module or Module group.
5. Push the service buttons sequentially on the Modules, monitoring the result in the program window. In this case, the information about the Module on which the button was pressed will be displayed in the program window, this Module will be assigned a specified static IP address and other network parameters. The program automatically increments the address by 1.



NOTICE

If the IP address assignment with service button does not work, set the **DHCP mode** to **One-off setting with service button** in the akYtecToolPro program (default setting).

Ethernet settings	
Current IP address	10.2.20.15
Current subnet mask	255.255.0.0
Current gateway IP address	10.2.1.1
Enter IP address	10.2.11.122
Enter subnet mask	255.255.0.0
Assign gateway IP address	10.2.1.1
DHCP mode	One-off setting with service butt <input type="button" value="v"/>
	Off
	On
	One-off setting with service button

Fig. 6.3 DHCP mode settings

Dynamic. A dynamic IP address is used to work with the cloud service (not available yet) and does not imply working with the Modbus TCP Master. The IP address of the Module is set by the DHCP server of the Ethernet network.



CAUTION

Check with the system administration services if there is a DHCP server in the network area to which Module is connected. If using a dynamic IP address, you must enable the DHCP mode.



NOTICE

To use the new network settings, you need to restart Module. If the module is connected via USB, it must also be disconnected.

6.3 Module access password

To limit access to read and write configuration parameters, a password is used. You can set or change the password when configuring using the akYtec Tool Pro. If the password is lost, the factory settings must be restored (see [Section 6.6](#)). By default, the password is not set.

6.4 Firmware update

Firmware can be updated by the following ways:

- by using the USB interface;
- by using Ethernet (recommended).

To update via USB, follow the steps:

1. When the Module is powered on, press and hold the service button. The Module will enter the downloader mode.
2. Update the software with a special utility. The utility is available at www.akytec.de.

To update via Ethernet, follow the steps:

1. In the akYtec Tool Pro, click on **Firmware update**.
2. Follow the program's instructions (the firmware file is available on www.akytec.de);
3. Restart the Module.

During the update via Ethernet, the integrity of the firmware file and the checksum are checked.



NOTICE

A restart of the Module is required to complete the update. If the Module is connected via USB, it must also be disconnected.

6.5 Real-time clock setting

The real-time clock (RTC) can be set or read from the Module via Modbus registers and also using the akYtec Tool Pro program (see the program help).

To set a new time via Modbus registers:

1. Write the time value in the appropriate registers.
2. Set the value **1** in the current time update register for at least 1 second.
3. Write the value **0** in the current time update register.

The next writing of the current time can be made after 1 second.

6.6 Restore default settings



CAUTION

After restoring the factory settings, all previously configured settings, except network settings, will be deleted.

To restore the factory settings and reset the installed password:

1. Switch on the power.
2. Press and hold the service button for more than 12 seconds.
3. Switch off and switch on the Device.

After turning on, the Device will work with default settings.

7 Maintenance

7.1 General Instructions

During the maintenance work on the Device, the safety requirements must be considered. Maintenance of the Device is carried out at least once every 6 months and includes the following procedures:

- checking the Device mounting;
- checking the screw connections;
- removal of dust and dirt from the device terminal block.

7.2 Battery replacement

A replaceable CR2032 type battery is used to power the real-time clock.

Replace the battery if at least one of the following events occurs:

- LED Fault blinks (it lights for 200 ms with a 3 second interval).
- The last battery change was 6 years ago.

To replace the battery:

1. Power off the module and all connected devices.
2. Remove the module from the DIN rail.
3. Raise cover 1.
4. Remove two screws 3.
5. Remove the terminal block 2 as shown in *Figure 7.1*.

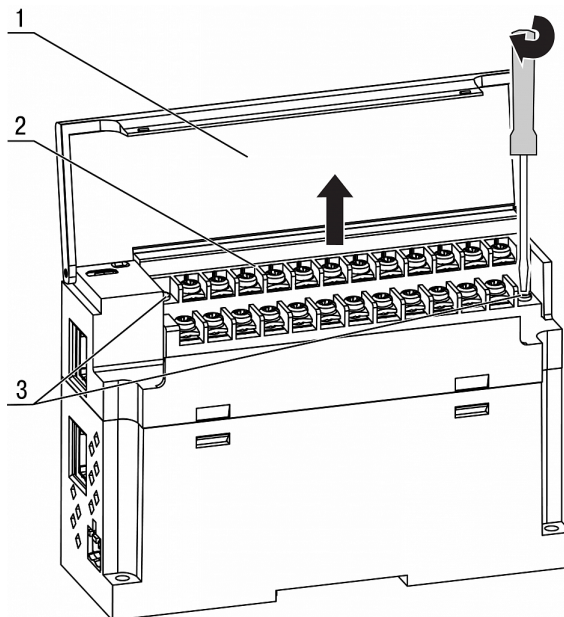


Fig. 7.1 Remove terminal block

6. Alternately remove the hooks from the holes on one side and on the other side and remove the top cover.

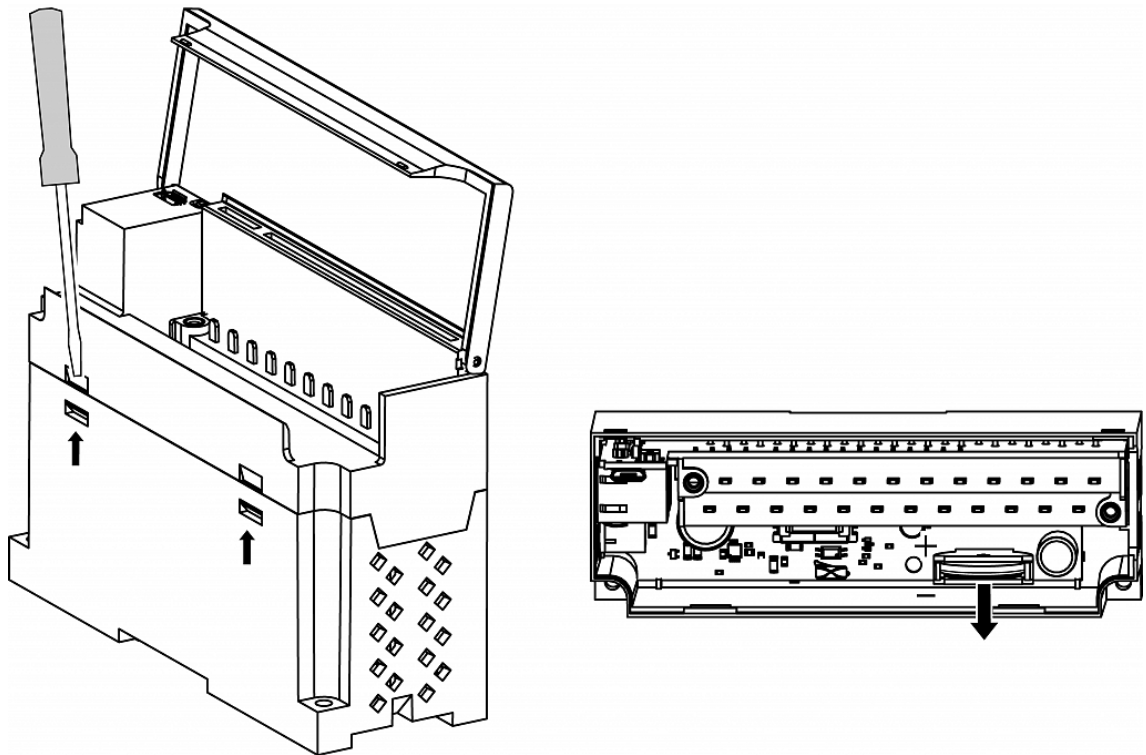


Fig. 7.2 Battery replacement

7. Replace the battery. Recommended time for replacing the battery is not more than 1 minute. If the battery is missing for a longer time, the real-time clock must be set up again.
8. Assembly and installation should be carried out in the reverse order.

**NOTICE**

Do not use a different type of battery. When installing the battery, observe the polarity.

After Module is assembled and turned on, make sure that the system time is correct. If necessary, configure the real-time clock in the akYtecToolPro program.

When loosening the fastening screws, the terminal block rises, so it is recommended to unscrew the screws by turns several turns at a time.

8 Transportation and storage

Device must be transported in closed transport of any kind. The fastening of containers during transport should be carried out in accordance with the rules applicable to the respective modes of transport.

The transport conditions must be in accordance with IEC 61131-2-2012 at ambient temperature from – 40 to + 55 °C in compliance with the protection measures against impacts and vibrations.

Transportation should be carried out in a shipping container individually or in over-packs.

The storage conditions in the packaging at the manufacturer's and consumer's warehouse must comply with IEC 61131-2-2012. In the air no aggressive impurities must be present.

Device should be stored in the racks.

9 Scope of delivery

Denomination	Quantity
Device	1 unit
Short guide	1 ex.
UTP patch cable 5e 150 mm	1 unit
Power supply terminal 2EGTK-5-02P-14	1 unit
Ethernet connector plug	1 unit

**NOTICE**

The manufacturer reserves the right to introduce amendments to the scope of delivery.

Appendix A Encrypting the log file

When decrypting the log file, a hash function should be used as the initialization vector. The hash function returns 8 bytes (type long long).

An example implementation of a hash function in C:

```
typedef union {
    struct {
        unsigned long lo;
        unsigned long hi;
    };
    long long hilo;
}LONG_LONG;

long long Hash8(const char *str) {    // Based on Rot13
    LONG_LONG temp;
    temp.lo = 0;
    temp.hi = 0;

    for ( ; *str; )
    {
        temp.lo += (unsigned char) (*str);
        temp.lo -= (temp.lo << 13) | (temp.lo >> 19);
        str++;
        if (!str) break;
        temp.hi += (unsigned char) (*str);
        temp.hi -= (temp.hi << 13) | (temp.hi >> 19);
        str++;
    }
    return temp.hilo;
}
```