



MK210-311

Digital I/O-Module

User guide

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Warning notice system

Explanation of the symbols and keywords used:

**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.

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 digital I/O module MK210-311, hereinafter referred to as the Device or Module.

Connection, adjustment and maintenance of the device must be carried out only by approved personnel after reading this operating manual.

Order Code: **MK 210-311**.

Abbreviations

- **PC** – personal computer.
- **PLC** – programmable logic controller.
- **PWM** – pulse width modulation.
- **RTC** – real time clock.
- **UTC** – coordinated universal time.

1 Overview

The Module is designed to collect data and connect executive devices to automation facilities. The Device is controlled by a PLC, panel controller, PC or other control device.

The Device has:

- 6 digital inputs of a dry contact type;
- 8 digital outputs (relays).

In the Module, the digital outputs have the function of the load interruption and relay operation monitoring.

Modules are used in various fields of industry and agriculture.

2 Specifications

Table 2.1 Specifications

Characteristic	Value
Power supply	
Power supply	24 (10 ... 48) V DC
Power consumption	6 W
Protection against reverse polarity of supply voltage	Yes
Interfaces of communication	
Data transfer interface	Split Ethernet 10/100 Mbps
Configuration interface	USB 2.0 (MicroUSB), Ethernet 10/100 Mbps
Data transfer protocol	Modbus TCP
Protocol version	IPv4
Digital inputs	
Inputs quantity	6
Signal type	– Dry contact – Transistor switch of a npn type
Operation mode	Logical level definition
Minimum duration of a single pulse	1 ms (up to 400 Hz)
Resistance of contacts (switch) and wires connected to the digital input	max. 100 Ω
Digital outputs	
Outputs quantity	8
Output type	Electromagnetic relay
Contact type	Normally open contact
Operation modes:	– Logic state switch – PWM signal generation
Maximum voltage on relay contacts	250 V AC, 30 V DC
Switching current	– 5 A (at max. 250 V AC, 50 Hz and $\cos\varphi > 0.4$); – 3 A (at max. 30 V DC)
Turn-on time	15 ms
Turn-off time	15 ms
Relay mechanical durability	min. 5,000,000 switches
Relay electrical durability at maximum load current	min. 50,000 switches
Load interruption monitoring	Yes

Characteristic	Value
PWM output parameters	
Maximum frequency	1 Hz (at duty cycle of 0.5)
Minimum Pulse Width	50 ms
Flash-memory (log-file)	
Maximum log file size	2 KB
Maximum number of log files	1,000
Minimum log writing interval	10 s
Real time clock	
Inaccuracy	at +25 °C
	max. 1 s per day
Inaccuracy	at -40 °C
	max. 3 s per day
Battery type	CR2032
Average life of one battery	6 years
General specifications	
Dimensions	42 × 124 × 83 mm
Ingress protection rating	IP20
Average service life	10 years
Weight	about 0.4 kg

2.1 Isolation of the Device Components

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

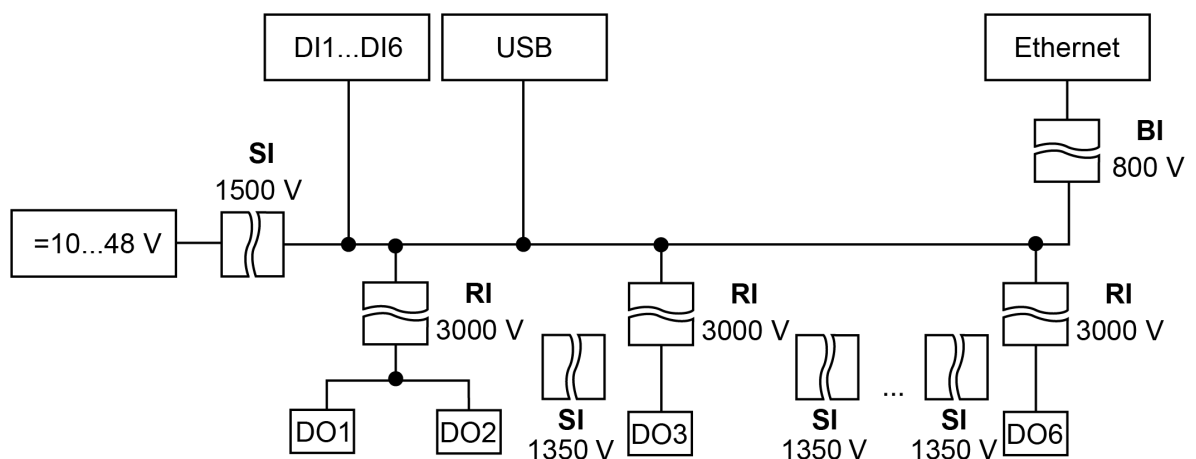


Fig. 2.1 Isolation of the Device Components

Table 2.2 *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)
Reinforced insulation (RI)	Separate insulation system used for active parts, which provides a degree of protection against electric shock, equivalent to double.



NOTICE

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

The digital outputs (relays) are galvanic isolated from each other (except for outputs 1 and 2, which are connected to one terminal). Isolation strength is 1780 V.

2.2 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: $-40 \dots +55 \text{ }^{\circ}\text{C}$;
- relative humidity: up to 95% (at $+35 \text{ }^{\circ}\text{C}$, 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](#)).

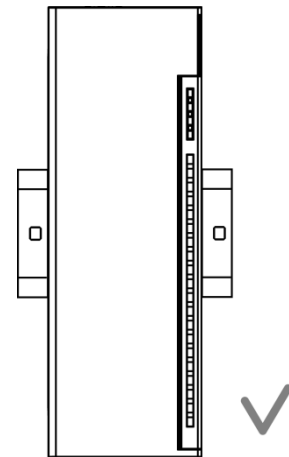


Fig. 3.1 Proper installation

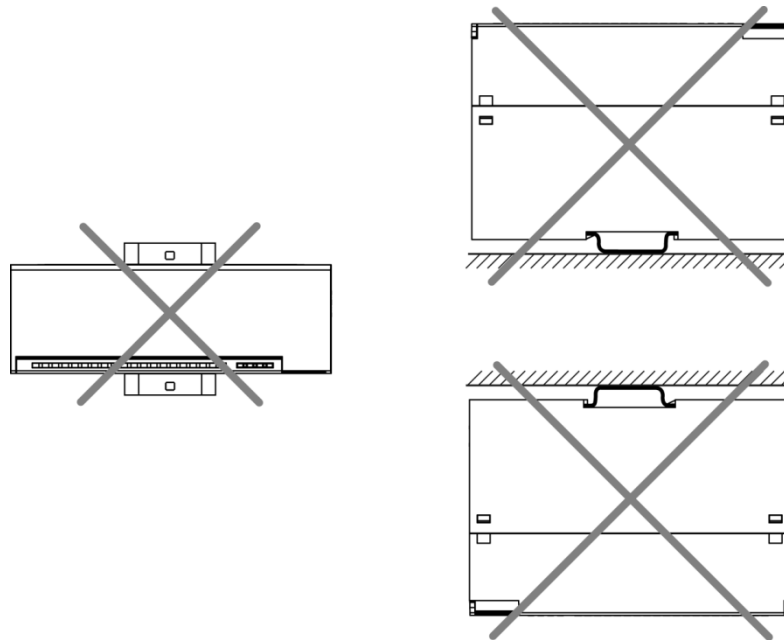


Fig. 3.2 Improper installation



CAUTION

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

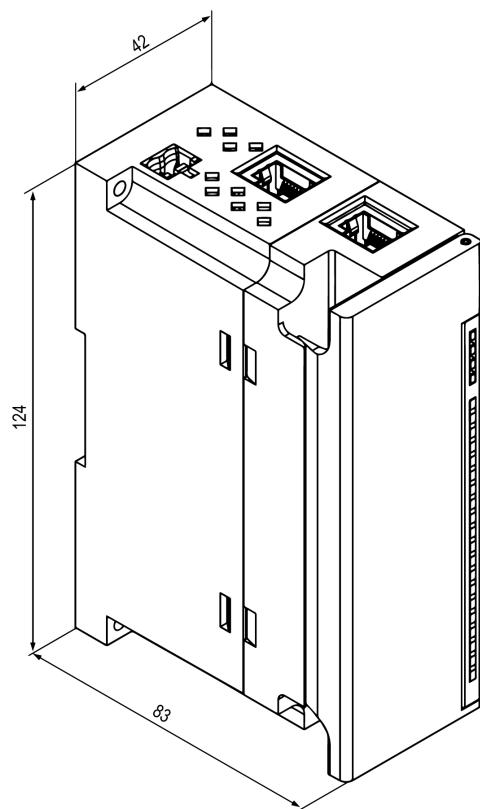


Fig. 3.3 Dimension drawing

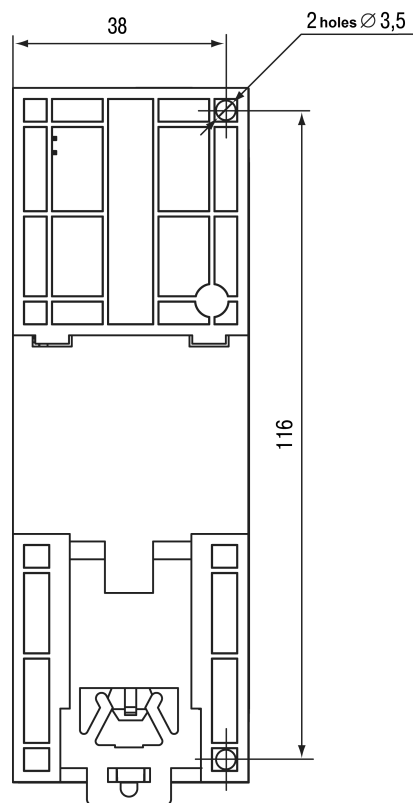


Fig. 3.4 Mounting dimensions

4 Connection

4.1 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.

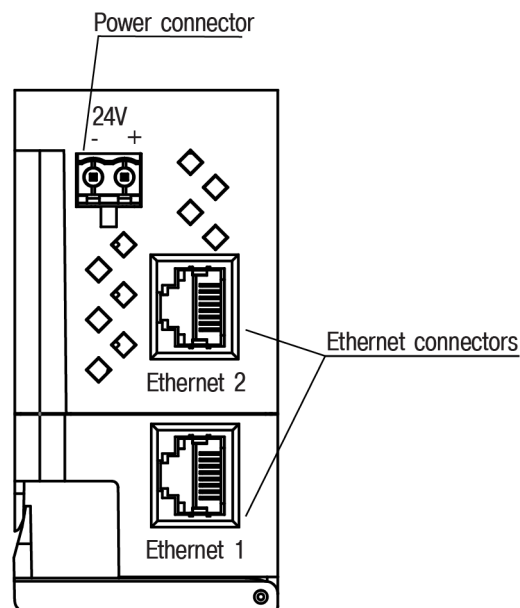


Fig. 4.1 Device's connectors

4.3 Power supply

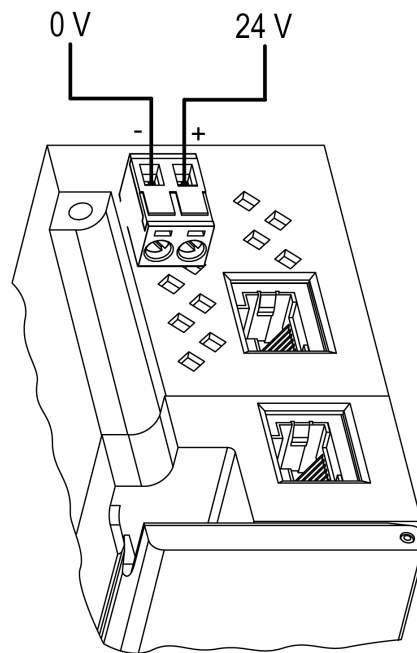


Fig. 4.2 Power supply contacts



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

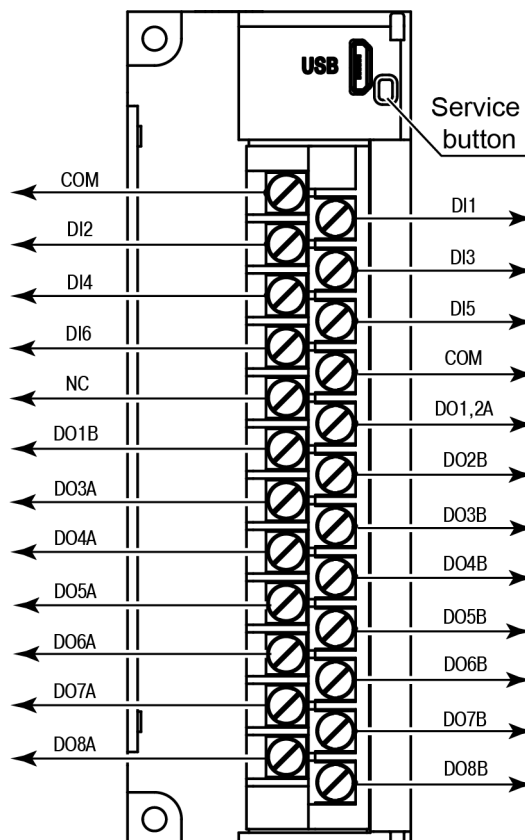


Fig. 4.3 Terminal block layout

Table 4.1 Terminal assignments

Marking	Description
DI1-DI6	Inputs DI1-DI6
COM	Common input power supply point
DO1A, DO1B- DO8A, DO8B	Outputs DO1-DO8
NC	Not connected



NOTICE
At outputs 1 and 2 the common contact A.

4.4.1 Inputs

These sensors can be connected to the DI1–DI6 inputs:

- dry contact type;
- transistor switch of a NPN type.

The COM circuits are internally connected.

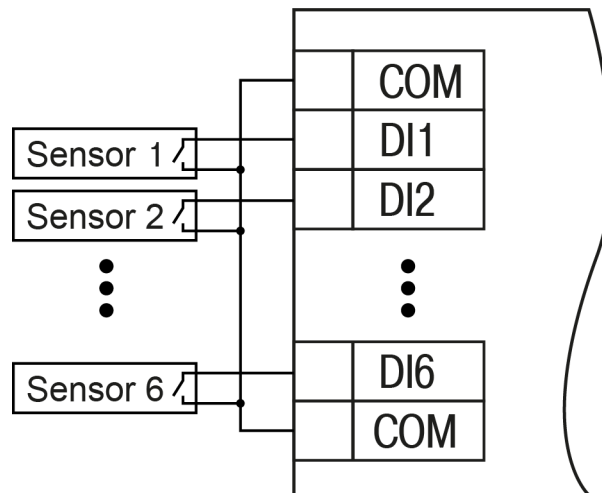


Fig. 4.4 Connection to inputs DI1-DI6

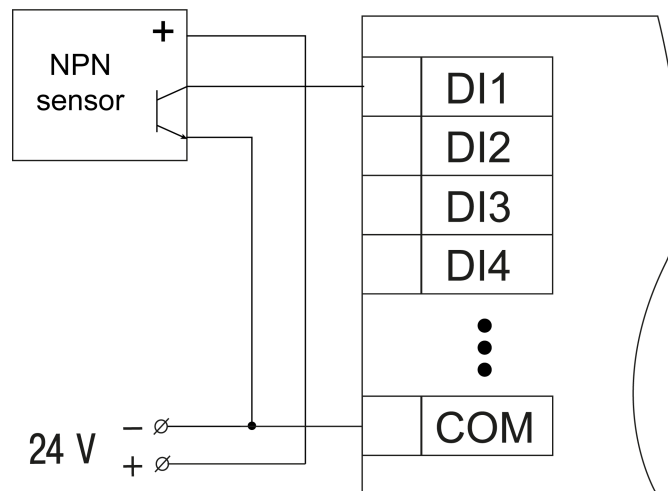


Fig. 4.5 Connection of NPN transistor

4.4.2 Outputs

Figure 4.6 shows the connection diagram to the outputs of the relay type.

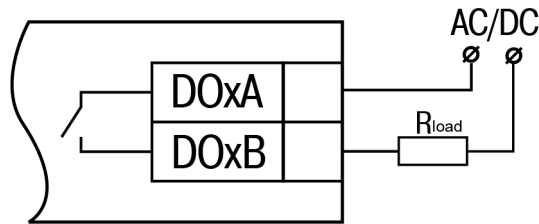


Fig. 4.6 External connections to digital outputs of the relay type

4.5 Ethernet connection

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

- Wye (Figure 4.7),
- Daisy-chain (Figure 4.8).

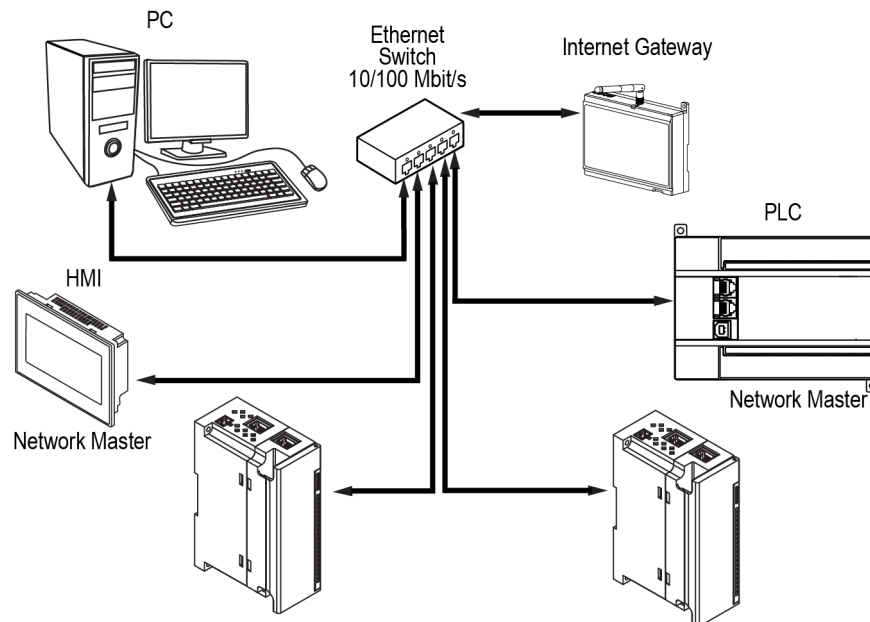


Fig. 4.7 Wye connection



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.

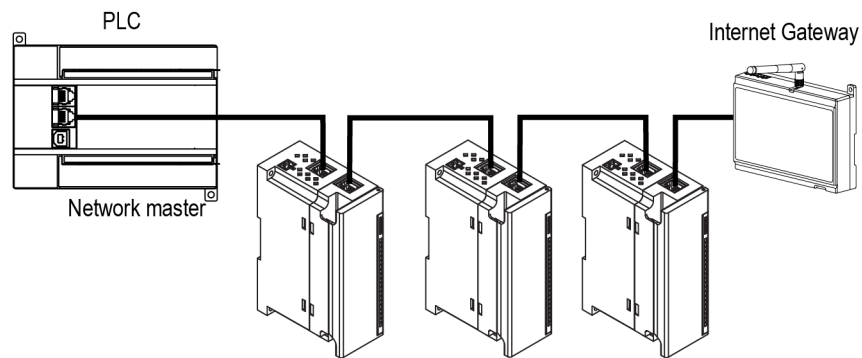


Fig. 4.8 Daisy-chain connection

**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 Function principle

The operation of the Module is controlled by the Network Master. The Module transmits to the network the input status when requested and receives commands to control the outputs from the Network Master.

As a Network Master you can use:

- PC;
- PLC;
- Operator panel.

5.2 Indication and control

On the front panel of the Module there are indication LEDs. The decoding of the values is given in Table 5.1.

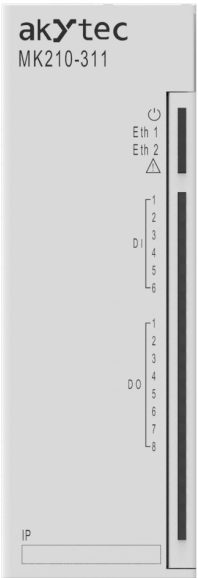


Fig. 5.1 Faceplate

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 State	Description
Power  (green)	ON	Device operating voltage is applied
Eth 1 (green)	Flashing	Data transfer over Ethernet port 1
Eth 2 (green)	Flashing	Data transfer over Ethernet port 2

LED	LED State	Description
Fault $\triangle$ (red)	OFF	Normal operation
	ON	Main application and/or configuration failure
	Lights 200 ms every 3 seconds	It is necessary to replace the battery of RTC
	Lights 100 ms twice a second (after a pause of 400 ms)	The module is in a safe state
	900 ms on, 100 ms off	Hardware peripheral failure (Flash, RTC, Ethernet Switch)
Input status indicators (green)	ON	Input is closed
	OFF	Input is open
Output status indicators (green/red)	Green	Output is closed
	OFF	Output is open
	Red	Accident (break of load, sintering of contacts, etc.)

Under the module cover there are terminal blocks and a service button ([Figure 4.3](#)).

The service button performs the following functions:

- Factory settings restore ([Section 6.5](#));
- 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

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.

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 Modbus TCP communication

Table 5.3 Reading and writing parameters using the Modbus TCP protocol

Operation	Function
Reading	3 (0x03) or 4 (0x04)
Writing	6 (0x06) or 16 (0x10)

The list of Modbus registers is read from the device using the akYtecToolPro program in the “Device Parameters” tab. The list of Modbus registers is presented in the tables below.

Table 5.4 General Registers for Online Modbus Communication

Name	Register	Size/type/description
Device name (DEV)	0xF000	Character string up to 32 bytes, Win1251 encoding
Firmware version (VER)	0xF010	Character string up to 32 bytes, Win1251 encoding
Time	0xF080	4 bytes, in seconds since 2000
Time zone	0xF082	2 bytes, signed short, offset in minutes from Greenwich
Serial number	0xF084	Character string 32 bytes, encoding Win1251, 17 characters are used

Table 5.5 Modbus communication registers

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Status of digital inputs DI1-DI6, bit mask	0...63	51	0x33	Read only	UINT 8
Debounce filter for input DI1	0 – off 1 – on	96	0x60	Read and write	UINT 16
Debounce filter for input DI2	0 – off 1 – on	97	0x61	Read and write	UINT 16

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Debounce filter for input DI3	0 – off 1 – on	98	0x62	Read and write	UINT 16
Debounce filter for input DI4	0 – off 1 – on	99	0x63	Read and write	UINT 16
Debounce filter for input DI5	0 – off 1 – on	100	0x64	Read and write	UINT 16
Debounce filter for input DI6	0 – off 1 – on	101	0x65	Read and write	UINT 16
Value of the pulse counter for input DI1	0...4294967295	160	0xA0	Read only	UINT 32
Value of the pulse counter for input DI2	0...4294967295	162	0xA2	Read only	UINT 32
Value of the pulse counter for input DI3	0...4294967295	164	0xA4	Read only	UINT 32
Value of the pulse counter for input DI4	0...4294967295	166	0xA6	Read only	UINT 32
Value of the pulse counter for input DI5	0...4294967295	168	0xA8	Read only	UINT 32
Value of the pulse counter for input DI6	0...4294967295	170	0xAA	Read only	UINT 32
Reset pulse counter on input DI1	0 – reset 1 – do not reset	224	0xE0	Read and write	UINT 16
Reset pulse counter on input DI2	0 – reset 1 – do not reset	225	0xE1	Read and write	UINT 16
Reset pulse counter on input DI3	0 – reset 1 – do not reset	226	0xE2	Read and write	UINT 16
Reset pulse counter on input DI4	0 – reset 1 – do not reset	227	0xE3	Read and write	UINT 16
Reset pulse counter on input DI5	0 – reset 1 – do not reset	228	0xE4	Read and write	UINT 16
Reset pulse counter on input DI6	0 – reset 1 – do not reset	229	0xE5	Read and write	UINT 16
Mode for output DO1	0 – switching of logic signal 1 – PWM	272	0x110	Read and write	UINT 16

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Mode for output DO2	0 – switching of logic signal 1 – PWM	273	0x111	Read and write	UINT 16
Mode for output DO3	0 – switching of logic signal 1 – PWM	274	0x112	Read and write	UINT 16
Mode for output DO4	0 – switching of logic signal 1 – PWM	275	0x113	Read and write	UINT 16
Mode for output DO5	0 – switching of logic signal 1 – PWM	276	0x114	Read and write	UINT 16
Mode for output DO6	0 – switching of logic signal 1 – PWM	277	0x115	Read and write	UINT 16
Mode for output DO7	0 – switching of logic signal 1 – PWM	278	0x116	Read and write	UINT 16
Mode for output DO8	0 – switching of logic signal 1 – PWM	279	0x117	Read and write	UINT 16
Period of PWM generator on output DO1	1000...60000 (ms)	308	0x134	Read and write	UINT 16
Period of PWM generator on output DO2	1000...60000 (ms)	309	0x135	Read and write	UINT 16
Period of PWM generator on output DO3	1000...60000 (ms)	310	0x136	Read and write	UINT 16
Period of PWM generator on output DO4	1000...60000 (ms)	311	0x137	Read and write	UINT 16
Period of PWM generator on output DO5	1000...60000 (ms)	312	0x138	Read and write	UINT 16
Period of PWM generator on output DO6	1000...60000 (ms)	313	0x139	Read and write	UINT 16
Period of PWM generator on output DO7	1000...60000 (ms)	314	0x13A	Read and write	UINT 16
Period of PWM generator on output DO8	1000...60000 (ms)	315	0x13B	Read and write	UINT 16
Duty cycle of PWM-generator for output DO1	0...1000 (0.10 %)	340	0x154	Read and write	UINT 16

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Duty cycle of PWM-generator for output DO2	0...1000 (0.10 %)	341	0x155	Read and write	UINT 16
Duty cycle of PWM-generator for output DO3	0...1000 (0.10 %)	342	0x156	Read and write	UINT 16
Duty cycle of PWM-generator for output DO4	0...1000 (0.10 %)	343	0x157	Read and write	UINT 16
Duty cycle of PWM-generator for output DO5	0...1000 (0.10 %)	344	0x158	Read and write	UINT 16
Duty cycle of PWM-generator for output DO6	0...1000 (0.10 %)	345	0x159	Read and write	UINT 16
Duty cycle of PWM-generator for output DO7	0...1000 (0.10 %)	346	0x15A	Read and write	UINT 16
Duty cycle of PWM-generator for output DO8	0...1000 (0.10 %)	347	0x15B	Read and write	UINT 16
Diagnosis of a relay failure and load interruption for output DO1	0 – off 1 – on	436	0x1B4	Read and write	UINT 16
Diagnosis of a relay failure and load interruption for output DO2	0 – off 1 – on	437	0x1B5	Read and write	UINT 16
Diagnosis of a relay failure and load interruption for output DO3	0 – off 1 – on	438	0x1B6	Read and write	UINT 16
Diagnosis of a relay failure and load interruption for output DO4	0 – off 1 – on	439	0x1B7	Read and write	UINT 16
Diagnosis of a relay failure and load interruption for output DO5	0 – off 1 – on	440	0x1B8	Read and write	UINT 16
Diagnosis of a relay failure and load interruption for output DO6	0 – off 1 – on	441	0x1B9	Read and write	UINT 16
Diagnosis of a relay failure and load interruption for output DO7	0 – off 1 – on	442	0x1BA	Read and write	UINT 16
Diagnosis of a relay failure and	0 – off 1 – on	443	0x1BB	Read and write	UINT 16

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
load interruption for output DO8					
Bit mask of the output state (DO1-DO8)	0...255	468	0x1D4	Read only	UINT 8
Bit mask of setting the output state (DO1-DO8)	0...255	470	0x1D6	Read and write	UINT 8
Bit mask of the relay state and load interruption (DO1-DO8)	0...255	472	0x1D8	Read only	UINT 8
Safe state value for output DO1	0...1000 (0.10 %)	474	0x1DA	Read and write	UINT 16
Safe state value for output DO2	0...1000 (0.10 %)	475	0x1DB	Read and write	UINT 16
Safe state value for output DO3	0...1000 (0.10 %)	476	0x1DC	Read and write	UINT 16
Safe state value for output DO4	0...1000 (0.10 %)	477	0x1DD	Read and write	UINT 16
Safe state value for output DO5	0...1000 (0.10 %)	478	0x1DE	Read and write	UINT 16
Safe state value for output DO6	0...1000 (0.10 %)	479	0x1DF	Read and write	UINT 16
Safe state value for output DO7	0...1000 (0.10 %)	480	0x1D0	Read and write	UINT 16
Safe state value for output DO8	0...1000 (0.10 %)	481	0x1E1	Read and write	UINT 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) default – 30	900	0x384	Read and write	UINT 16
New time	since 2000 (s)	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)	since 2000 (s)	61568	0xF080	Read only	UINT 32
Time zone	offset in minutes from Greenwich	61570	0xF082	Read and write	UINT 16
Device status	—	61620	0xF0B4	Read only	UINT 32
MAC-address	—	61696	0xF100	Read only	UINT 48
DNS server 1	—	12	0xC	Read and write	UINT 32

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
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
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

5.5.2 Error codes for Modbus protocol

When working on the Modbus protocol, errors may occur. These errors are described in [Table 5.6](#). In case of an error, Module sends a response to the Network Master with an error code.

Table 5.6 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 5.7](#), a MODBUS_ILLEGAL_FUNCTION error occurs.

Table 5.7 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

Name	Code	Description
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 5.8](#).

Table 5.8 Errors while working with registers

Function	Error name	Possible causes
MODBUS_READ_HOLDING_REGISTERS	MODBUS_ILLEGAL_DATA_ADDRESS	– number of requested registers is greater than the maximum possible number (125); – request for nonexistent parameter
MODBUS_READ_INPUT_REGISTERS	MODBUS_ILLEGAL_DATA_ADDRESS	– number of requested registers is greater than the maximum possible number (125); – request for nonexistent parameter
MODBUS_WRITE_SINGLE_REGISTER	MODBUS_ILLEGAL_DATA_ADDRESS	– 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: – 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	– value outside the parameter limits
MODBUS_WRITE_MULTIPLE_REGISTERS	MODBUS_ILLEGAL_DATA_ADDRESS	– 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	– 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 5.9](#).

Table 5.9 Errors while working with the log file

Function	Error name	Possible causes
MODBUS_READ_FILE_RECORD	MODBUS_ILLEGAL_FUNCTION	– illegal data size (0x07 <= data length <= 0xF5)
	MODBUS_ILLEGAL_DATA_ADDRESS	– reference type does not meet specification; – could not open the file for reading (it may be missing)
	MODBUS_ILLEGAL_DATA_VALUE	– could not move to the desired offset in the file
	MODBUS_SLAVE_DEVICE_FAILURE	– 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	– illegal data size (0x09 <= data length <= 0xFB)
	MODBUS_ILLEGAL_DATA_ADDRESS	– reference type does not meet specification; – could not open file for writing
	MODBUS_SLAVE_DEVICE_FAILURE	– requested file is missing; – requested file is read-only; – failed to write the required number of bytes

5.6 Operation modes of the digital inputs

The group of inputs DI1-DI6 of the module performs the definition of the logical level. There is a pulse counter for each input.



NOTE

By default, counters are always on. Counters on inputs with additional modes are enabled only if the additional mode at the input is disabled.

Table 5.10 Pulse counter parameters

Parameter	Value
Capacity	32 Bits
Maximum input frequency	400 Hz
Debounce	On/Off: Configurable in the akYtec Tool Pro
Debounce time	25 ms (not configurable)



CAUTION

To work with signals with a frequency of more than 40 Hz at a duty cycle of 0.5 or less, do not turn on the debounce, since the useful signal will be received for bounce and skipped.

If the counter is full, the corresponding register is automatically reset. The sequence of actions for forced counter resetting is given in the [Section 6.7](#).

**NOTICE**

Counters are non-volatile, their values are saved after a reboot. Counters on inputs with additional modes after reboot are reset.

The state values of the digital inputs are stored as a bit mask and read from the corresponding register.

5.7 Digital outputs operation modes

Each digital output can operate in one of the following modes:

- switching of a logic signal;
- PWM signal generation.

To select a mode and change the output parameters, write the values to the corresponding Modbus registers.

5.8 Safe output status

A safe output status is possible for each output.

The output goes into a safe state if there are no commands from the Network Master during the timeout period. The value of the **Safe status** is set in percentage (from 0 to 100%) at the module output. This value determines the duty ratio of the PWM.

The timeout is set by the user, if the setting timeout is equal to **0**, then the safe output status is not set. When the module is switched on, it will go into the state that was last installed before shutdown, and will remain in it until a new command is received from the Network Master.

5.9 Load interruption monitoring

For the module, a load and relay contact monitoring is implemented when the load is connected.

To control, in parallel to the normally open contacts of the relay a high-resistance resistor with a nominal resistance of 200 kΩ is connected. The state of the output is determined by the voltage drop, on which the following is monitored:

- If the current passing through the resistor is present when the relay contacts are open (relay is off), the output is working normally. If there is no voltage drop and a load break or sintering of the relay contacts occurred, a failure is detected.
- If there is no current through the resistor when the relay contacts are closed (relay is on), the output is working normally. If the current is present when the relay contacts are closed and the relay or contacts have been damaged, a failure is detected.

Failure monitoring is enabled when the module is configured.

**CAUTION**

If the load interruption monitoring in the settings of the Module is turned off, the 200 kΩ resistor is not electrically disconnected from the output circuit, and a small current through the load continues to flow.

When the failure is detected, the LED of the corresponding output lights up red.

The state of the outputs is written to the status register.

The diagram of the load interruption monitoring is shown in Figure 5.2.

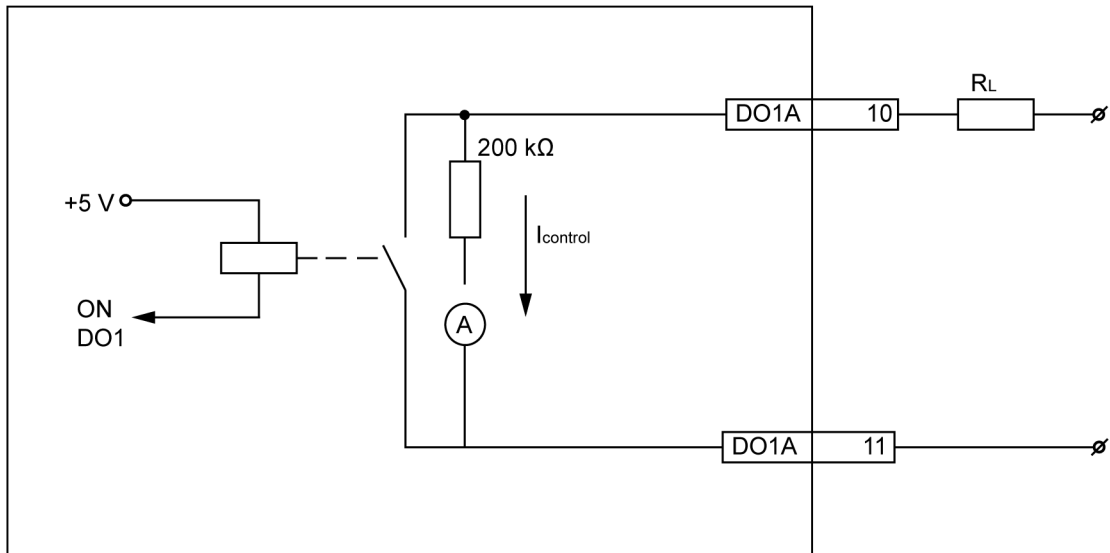


Fig. 5.2 Load interruption monitoring

An interruption monitoring operates at a load supply voltage of at min. 18 V DC with a load resistance of max. 10 kΩ and at min. 90 V AC at a load resistance of max. 20 kΩ.

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.
If the Module is powered with USB, the outputs do not function.
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.

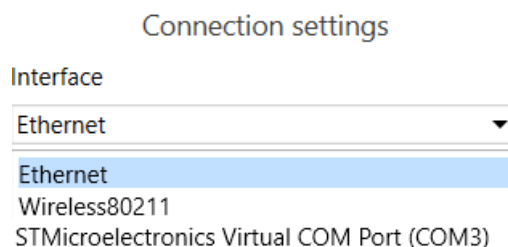


Fig. 6.1 Interface selection menu

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.

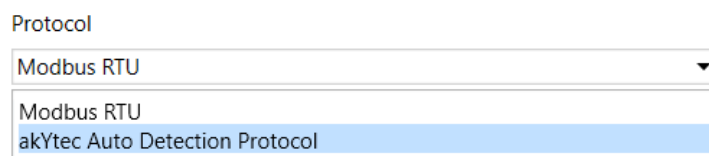


Fig. 6.2 Select Protocol

2. Select **Find device**.

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

For data exchange in the Ethernet network, the module parameters listed in the table should be specified:

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 .
IP address gateway	Specifies the gateway address to Internet access. The factory setting is 192.168.1.1 .

IP address can be:

Static This IP address is set using the akYtec Tool Pro program or the Service button.

To set a static IP address using the akYtec Tool Pro:

1. Click line **Connection settings** in the parameter field.
2. Select **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 **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 akYtec Tool Pro program on a computer connected to the same Ethernet network.
3. Click on symbol "IP addresses".
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 akYtec Tool Pro 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	192.168.1.99
Enter subnet mask	255.255.0.0
Assign gateway IP address	192.168.1.1
DHCP mode	One-off setting with service butt 
	Off
	On
	One-off setting with service button

Fig. 6.3 DHCP Mode Setting

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. To use a dynamic IP address, you must enable the **DHCP Mode-On** parameter.

**NOTICE**

To use the new network settings, you need to restart the 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 6.5](#)). 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 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.

6.6 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.

6.7 Counter reset

If the input state counter overflows, then the corresponding register is reset automatically. To force the counter to zero, write the value 0 to the counter reset register.

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*.

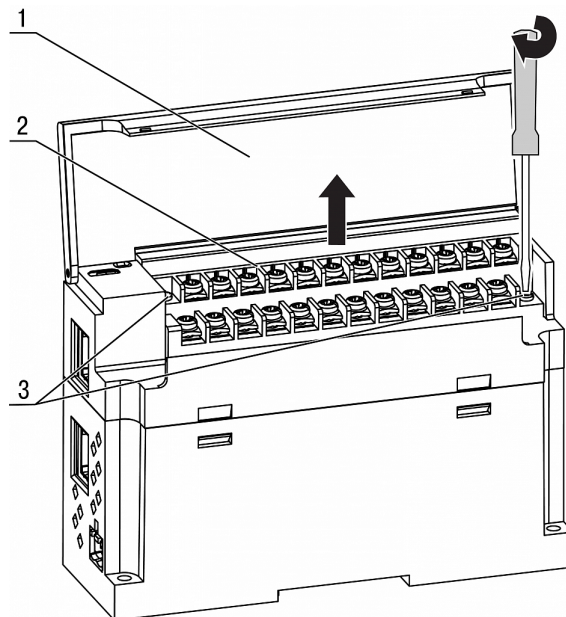


Fig. 7.1 Remove terminal block

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

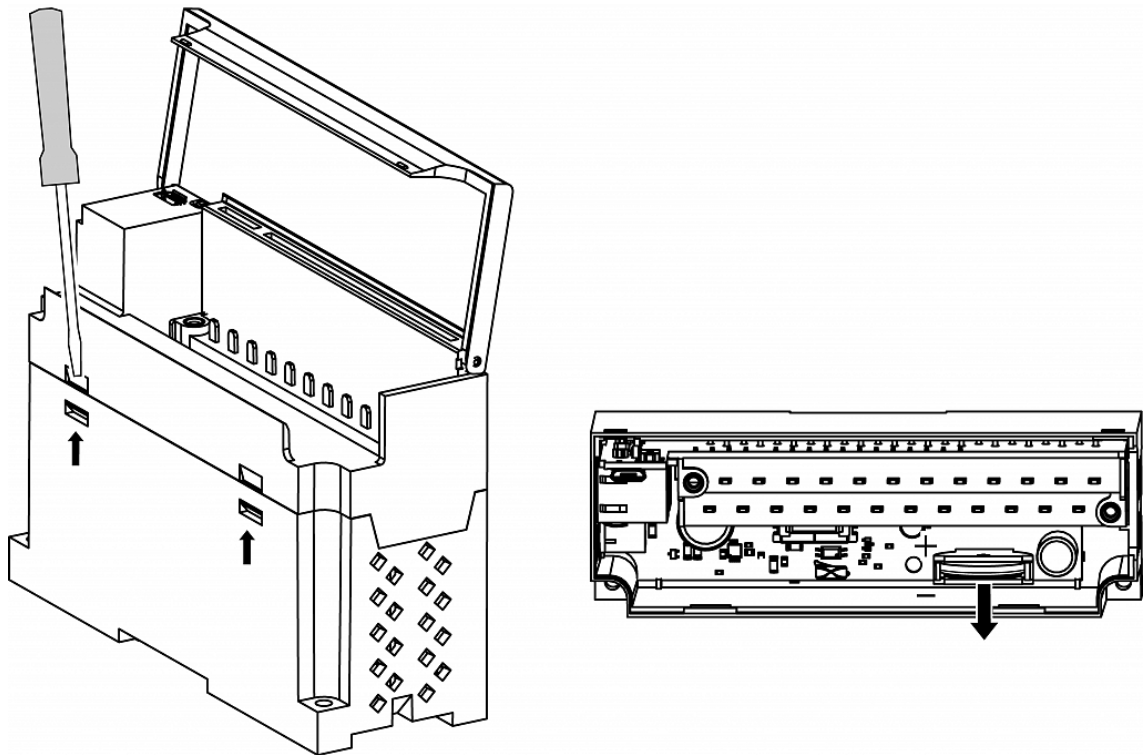


Fig. 7.2 Battery replacement

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

The device must be transported in closed transport of any kind. The fastening of containers in 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 should not be present aggressive impurities.

The 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;
}
```