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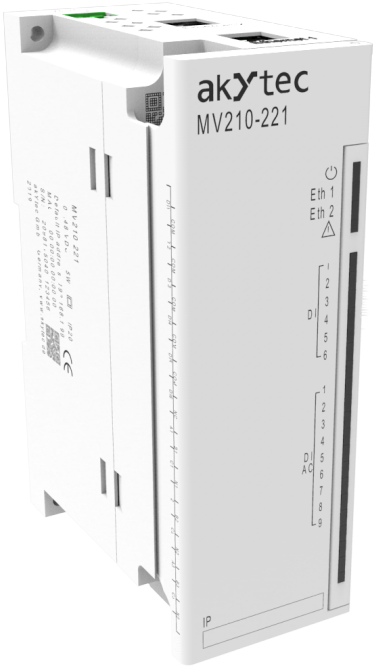

MV210-221

Digital input module

User guide

MV210-221_3-EN-38998-1.9
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Contents

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 input module MV210-211, hereinafter referred to as the Device or Module.

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

Order code: **MV210-221**.

Abbreviations

- **DAC** – digital-to-analog converter
- **PC** – personal computer.
- **PLC** – programmable logic controller.
- **RTC** – real time clock.
- **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

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

For data acquisition, the Device has 15 digital inputs:

– 9 digital inputs for connecting 230 V AC signals;
– 6 digital inputs for connecting dry contact sensors.

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		5 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), Ethernet 10/100 Mbps
Date transfer protocol		Modbus TCP
Protocol version		IPv4
Digital inputs for connecting 230 V AC signals		
Inputs number		9
AC voltage signal	Frequency	47…63 Hz
	Voltage of logical 1	20…264 V
	Voltage of logical 0	0…10 V
Operation mode		– determination of the presence or absence of voltage in the network; – phase break diagnostics in a three-phase network; – phase rotation control; – operation time counter; – voltage switching counter; – time of last switching on and off of input voltage
Input current of logical 1		max. 2 mA
Digital inputs for dry contact sensors		
Inputs number		6
Signal type		– dry contact – npn transistor
Operation mode		– logical level detection; – pulse count
Minimum duration of a single pulse		1 ms (up to 400 Hz)
Resistance of contacts (switch) and connecting wires connected to a digital input		max. 100 Ω
Flash-memory (log-file)		
Number of write and erase cycles		up to 100,000
Maximum log file size		2 KB

Characteristic		Value
Maximum number of log files		1000
Minimum log writing interval		10 s
Real time clock		
Inaccuracy	at +25 °C	max. 3 s per day
	at -40 °C	max. 10 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
Error-free running time		60,000 h
Weight		0.4 kg

* Except real-time clock battery

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*.

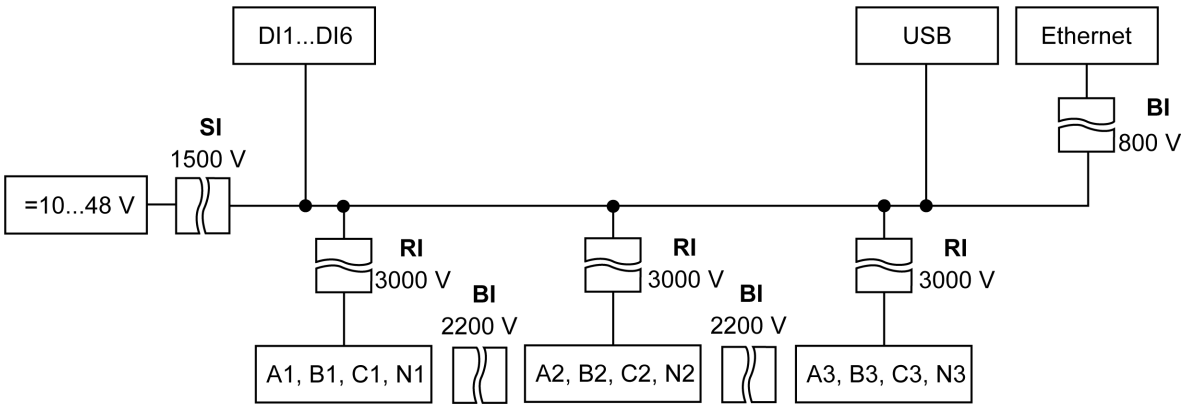


Fig. 2.1 Isolation of the Device Components

Table 2.2 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 that provides a degree of protection against electric shock equivalent to double insulation.

NOTICE
The value of the insulation strength is indicated for testing under normal climatic conditions, the exposure time is 1 minute according to IEC 61131-2.

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*).

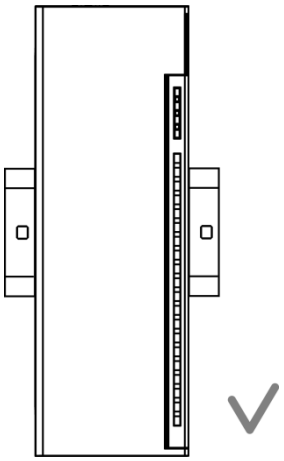


Fig. 3.1 Proper installation

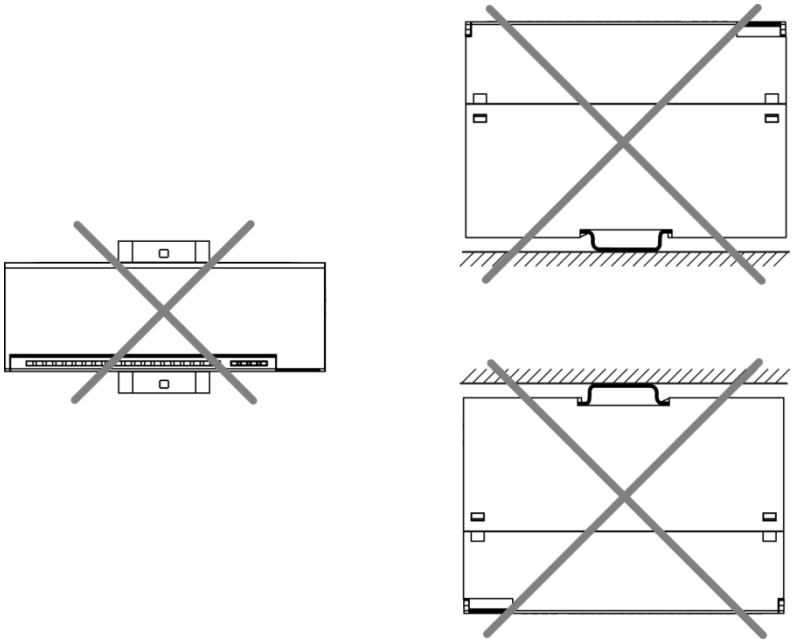


Fig. 3.2 Improper installation

CAUTION
Long-term operation of Module with improper installation can lead to damage (see *Figure 3.2*).

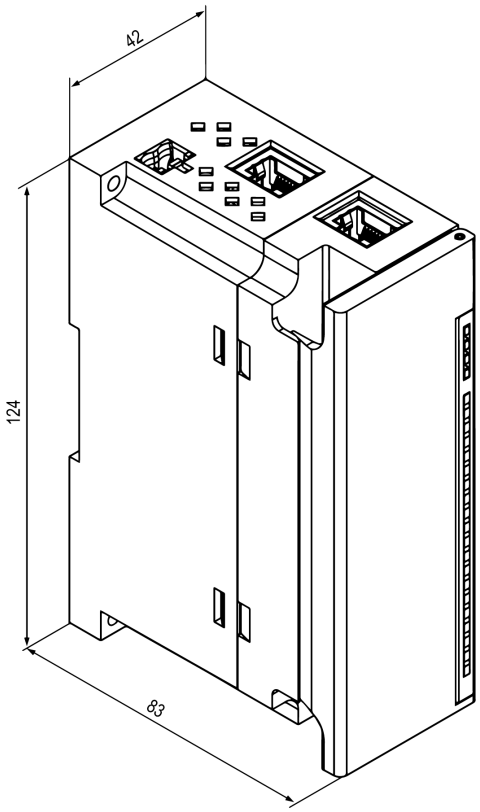


Fig. 3.3 Dimension drawing

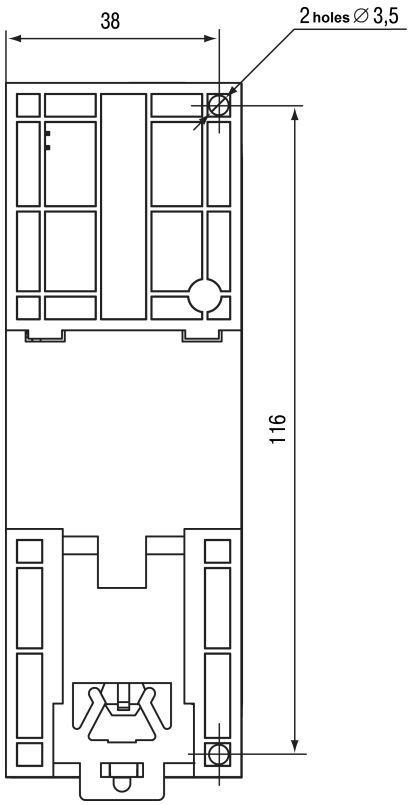


Fig. 3.4 Mounting dimensions

4 Connection

4.1 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 Terminal block layout

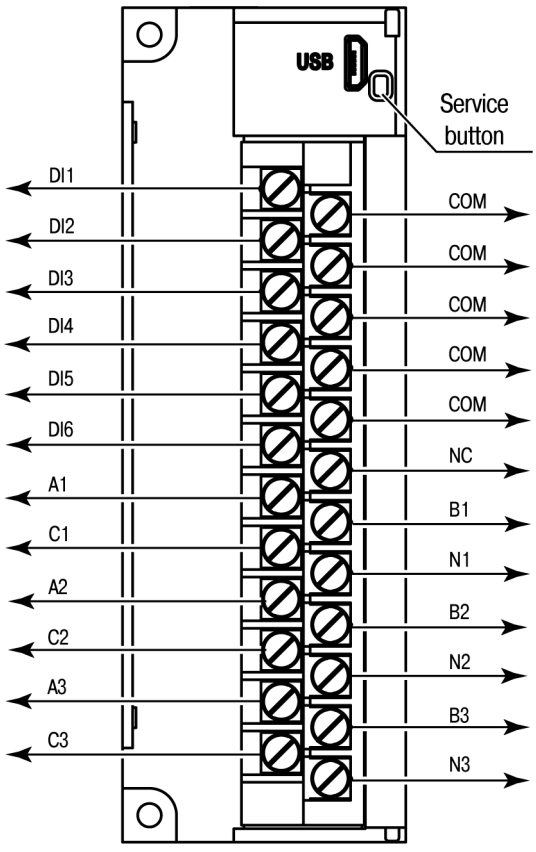


Fig. 4.1 Terminal block layout

Denomination	Function
DI1–DI6	Digital inputs DI1-DI6
COM	Common reference points for inputs DI1–DI6
A1–A3, B1–B3, C1–C3	Inputs for connecting the 3 AC signal phases A, B, C of the groups 1, 2, 3

Denomination	Function
N1–N3	Inputs for connecting neutral point for groups 1-3
NC (Not connected)	No connection

CAUTION
It is not allowed to connect wires to NC contacts (Not connected).

4.3 Connectors

The connectors of the interfaces and of the power supply of the Device are shown in *Figure 4.2*.

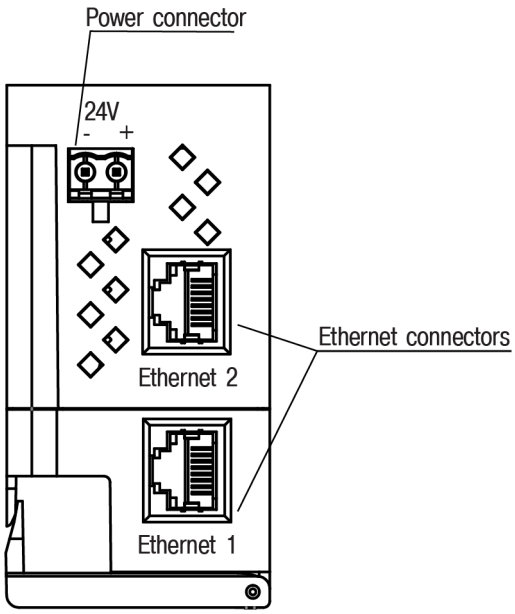


Fig. 4.2 Device's connectors

4.4 Power supply

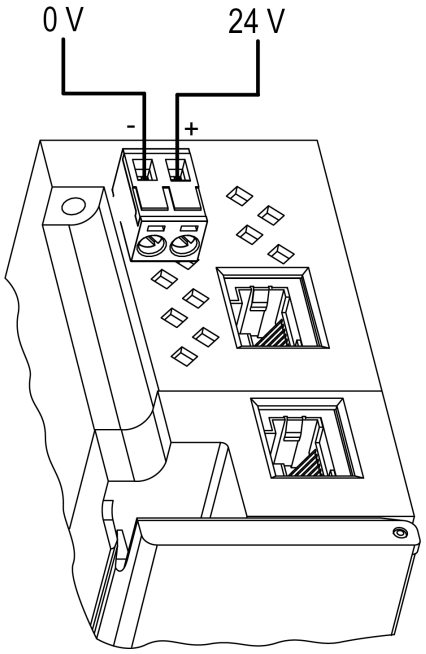


Fig. 4.3 Power supply contacts

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.

4.5 Connection to inputs

4.5.1 Connection of dry contact type sensors to digital inputs

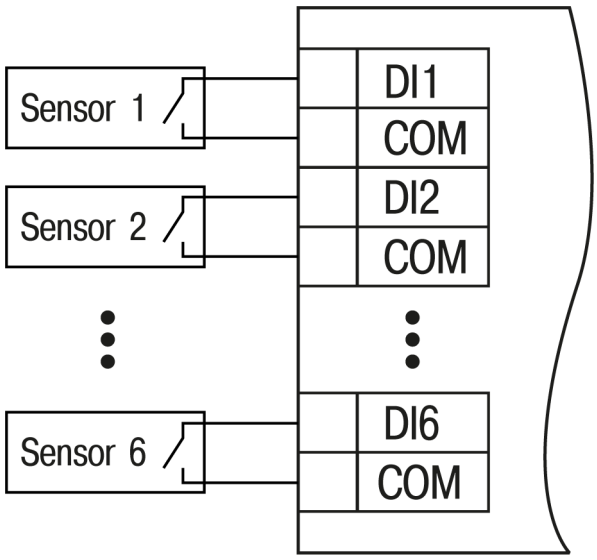


Fig. 4.4 Connection diagram for inputs DI1-DI6

Inputs DI1 – DI6 are intended for connecting thr following signals:
– "dry contact" type;
– transistor switch of a npn type.
The COM circuits are connected inside the device.

4.5.2 Connection of single-phase AC signals (230 V AC)

Connection of single-phase AC signals to the inputs is shown in *Figure 4.5*.

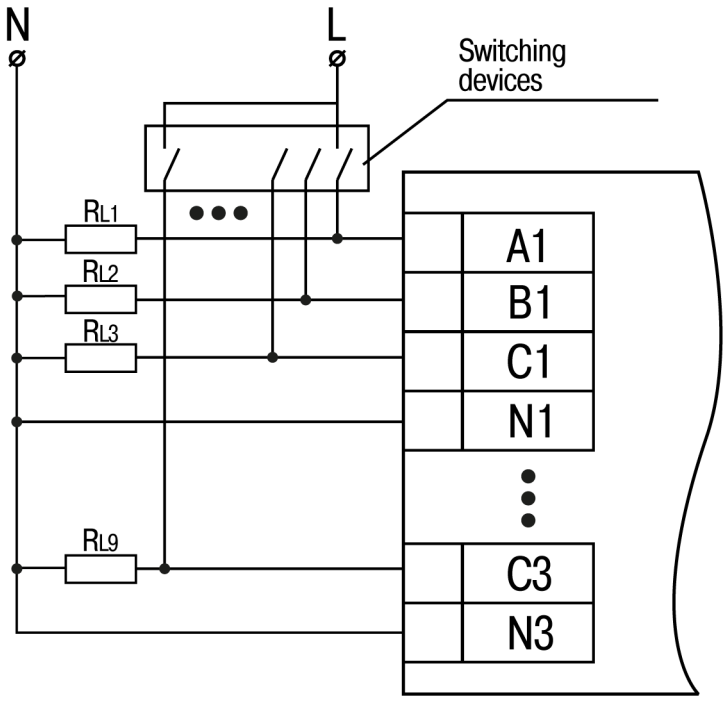
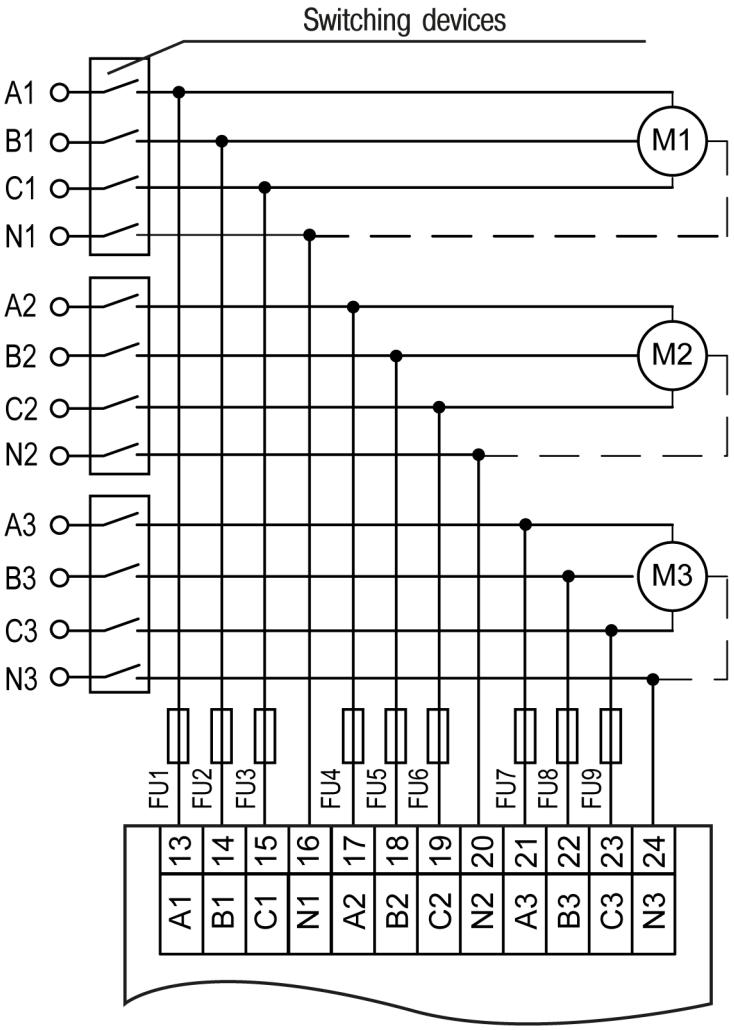


Fig. 4.5 Connection diagram of single-phase circuits

Neutrals N1, N2 and N3 are not combined inside the Device. To connect a single-phase circuits, the terminals N1, N2 and N3 should be combined outside the Device.

4.5.3 Connection of three-phase AC circuits (230 V AC)

Three separate three-phase circuits can be connected to nine inputs.
The neutral points of these circuits are not combined inside the module.
Connection diagram of three-phase circuit is shown in *Figure 4.6*.



FU1 – FU9 - 1.0 A / 600 V fuses

Fig. 4.6 Connection diagram of three-phase circuits

CAUTION
For correct operation of the device, it is necessary to correctly connect the input circuits to the Device, as shown in *Figure 4.6*.

To configure a group of inputs into the three-phase connection mode, do one of the following actions:
– enable the corresponding mode in akYtec Tool Pro;
– write the value **1** to the corresponding Modbus register.

4.6 Ethernet connection

To connect modules to an Ethernet network, you can use the following schemes:
– Wye (*Figure 4.7*),
– Daisy-chain (*Figure 4.8*).

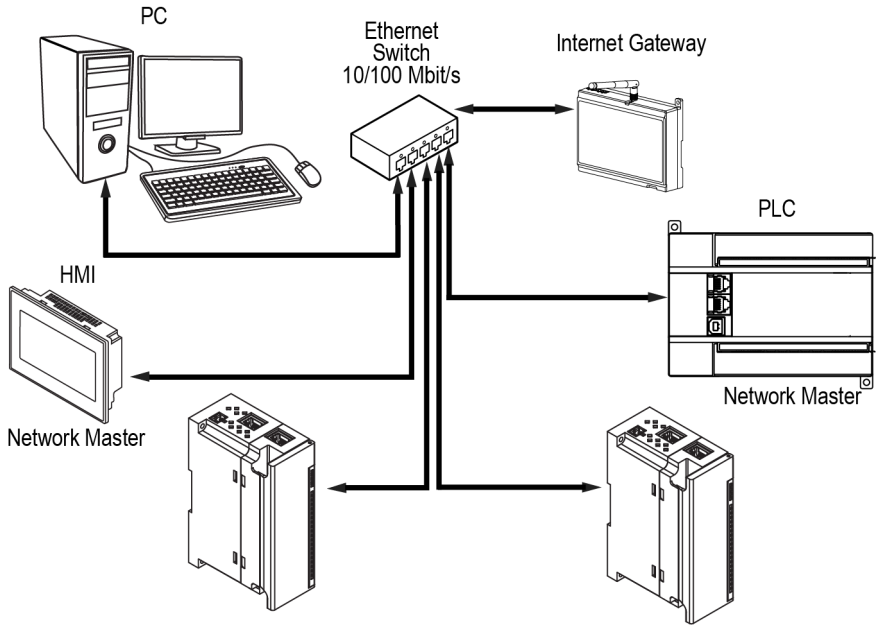


Fig. 4.7 Wye connection

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.

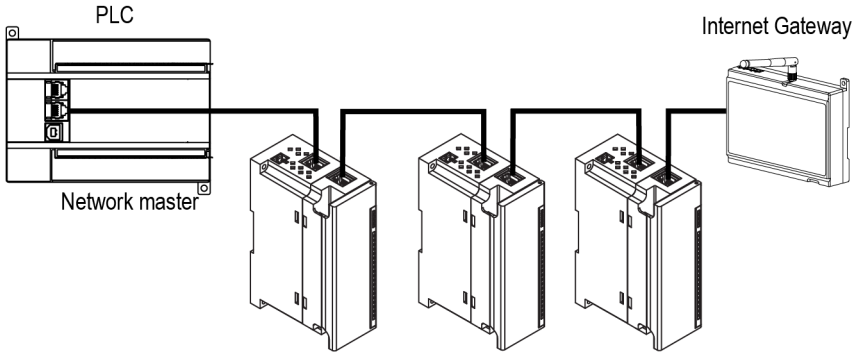


Fig. 4.8 Daisy-chain connection

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 Operation principle

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

The following devices can be used as a Network Master:

– 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*.

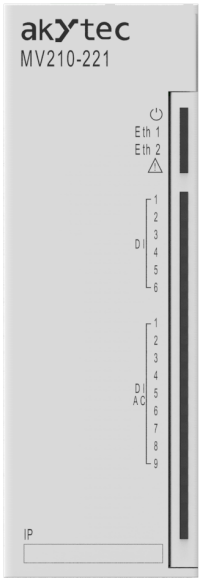


Fig. 5.1 Device faceplate

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 LED States

LED	LED Status	Function
Power ⏻ (green)	ON	Device operating voltage is applied
Eth 1 (green)	Flashing	Data transfer via Ethernet port 1
Eth 2 (green)	Flashing	Data transfer via Ethernet port 2
Fault ⚠ (red)	OFF	Normal operation
	ON	Main application and / or configuration failure

LED	LED Status	Function
	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 the safe state
	900 ms on, 100 ms off	Hardware peripheral failure (Flash, RTC, Ethernet Switch)
Input status indicators (red/ green)	Green	Input is closed
	OFF	Input is open
	Red (for DI AC inputs)	Phase loss or incorrect phase rotation in a three-phase network

Under the module faceplate there are terminal blocks and a service button (*Figure 4.1*).

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
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	Type	Size	Comment
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 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 Mobus 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 “akYtec Tool Pro” program in the “Device Parameters” tab. This 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
Platform name	0xF020	Character string up to 32 bytes, Win1251 encoding
Platform version	0xF030	Character string up to 32 bytes, Win1251 encoding
Hardware version	0xF040	Character string up to 16 bytes, Win1251 encoding
Additional character information	0xF048	Character string up to 16 bytes, Win1251 encoding
Time and date	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

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Debounce filter for input DI2	0 – Off 1 – On	97	0x61	Read and write	UINT 16
Debounce filter for input 3	0 – Off 1 – On	98	0x62	Read and write	UINT 16
Debounce filter for input 4	0 – Off 1 – On	99	0x63	Read and write	UINT 16
Debounce filter for input 5	0 – Off 1 – On	101	0x64	Read and write	UINT 16
Debounce filter for input 6	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
Safe state activation timeout	0...60 (seconds)	700	0x2BC	Read and write	UINT 8
Battery status (power supply)	0…3300 (mV)	801	0x321	Read only	UINT 16

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Log interval	10…3600 (s) default settings – 30	900	0x384	Read and write	UINT 16
Voltage at the inputs A1-B1 -...- C3, bit mask	0...511	5000	0x1388	Read only	UINT 16
Group inputs A1, B1 and C1 into a three-phase network	0 – do not group; 1 – group	5001	0x1389	Read and write	UINT 16
Group inputs A2, B2 and C2 into a three-phase network	0 – do not group; 1 – group	5002	0x138A	Read and write	UINT 16
Group inputs A3, B3 and C3 into a three-phase network	0 – do not group; 1 – group	5003	0x138B	Read and write	UINT 16
Interruption failure or phase loss of inputs group 1	0 – no failure; 1 – failure	5007	0x138F	Read only	UINT 16
Interruption failure or phase loss of inputs group 2	0 – no failure; 1 – failure	5008	0x1390	Read only	UINT 16
Interruption failure or phase loss of inputs group 3	0 – no failure; 1 – failure	5009	0x1391	Read only	UINT 16
Operating Time Input A1	0…4294967295 (s)	5010	0x1392	Read only	UINT 32
Operating Time Input B1	0…4294967295 (s)	5012	0x1394	Read only	UINT 32
Operating Time Input C1	0…4294967295 (s)	5014	0x1396	Read only	UINT 32
Operating Time Input A2	0…4294967295 (s)	5016	0x1398	Read only	UINT 32
Operating Time Input B2	0…4294967295 (s)	5018	0x139A	Read only	UINT 32
Operating Time Input C2	0…4294967295 (s)	5020	0x139C	Read only	UINT 32
Operating Time Input A3	0…4294967295 (s)	5022	0x139E	Read only	UINT 32
Operating Time Input B3	0…4294967295 (s)	5024	0x13A0	Read only	UINT 32
Operating Time Input C3	0…4294967295 (s)	5026	0x13A2	Read only	UINT 32
Reset pulse counter of input A1	0 – do not reset; 1 – reset	5028	0x13A4	Read and write	UINT 16

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Reset pulse counter of input B1	0 – do not reset; 1 – reset	5029	0x13A5	Read and write	UINT 16
Reset pulse counter of input C1	0 – do not reset; 1 – reset	5030	0x13A6	Read and write	UINT 16
Reset pulse counter of input A2	0 – do not reset; 1 – reset	5031	0x13A7	Read and write	UINT 16
Reset pulse counter of input B2	0 – do not reset; 1 – reset	5032	0x13A8	Read and write	UINT 16
Reset pulse counter of input C2	0 – do not reset; 1 – reset	5033	0x13A9	Read and write	UINT 16
Reset pulse counter of input A3	0 – do not reset; 1 – reset	5034	0x13AA	Read and write	UINT 16
Reset pulse counter of input B3	0 – do not reset; 1 – reset	5035	0x13AB	Read and write	UINT 16
Reset pulse counter of input C3	0 – do not reset; 1 – reset	5036	0x13AC	Read and write	UINT 16
Counter of inclusions for input A1	0...4294967295	5037	0x13AD	Read only	UINT 32
Counter of inclusions for input B1	0...4294967295	5039	0x13AF	Read only	UINT 32
Counter of inclusions for input C1	0...4294967295	5041	0x13B1	Read only	UINT 32
Counter of inclusions for input A2	0...4294967295	5043	0x13B3	Read only	UINT 32
Counter of inclusions for input B2	0...4294967295	5045	0x13B5	Read only	UINT 32
Counter of inclusions for input C2	0...4294967295	5047	0x13B7	Read only	UINT 32
Counter of inclusions for input A3	0...4294967295	5049	0x13B9	Read only	UINT 32
Counter of inclusions for input B3	0...4294967295	5051	0x13BB	Read only	UINT 32
Counter of inclusions for input C3	0...4294967295	5053	0x13BD	Read only	UINT 32
Reset counter of inclusions for input A1	0 – do not reset; 1 – reset	5055	0x13BF	Read and write	UINT 16

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Reset counter of inclusions for input B1	0 – do not reset; 1 – reset	5056	0x13C0	Read and write	UINT 16
Reset counter of inclusions for inputs C1	0 – do not reset; 1 – reset	5057	0x13C1	Read and write	UINT 16
Reset counter of inclusions for inputs A2	0 – do not reset; 1 – reset	5058	0x13C2	Read and write	UINT 16
Reset counter of inclusions for inputs B2	0 – do not reset; 1 – reset	5059	0x13C3	Read and write	UINT 16
Reset counter of inclusions for inputs C2	0 – do not reset; 1 – reset	5060	0x13C4	Read and write	UINT 16
Reset counter of inclusions for inputs A3	0 – do not reset; 1 – reset	5061	0x13C5	Read and write	UINT 16
Reset counter of inclusions for inputs B3	0 – do not reset; 1 – reset	5062	0x13C6	Read and write	UINT 16
Reset counter of inclusions for inputs C3	0 – do not reset; 1 – reset	5063	0x13C7	Read and write	UINT 16
Last time switching on and off of input A1	since 2000, dd.mm.yyyy hh:mm:ss	5064	0x13C8	Read only	UINT 32
Last time switching on and off of input B1	since 2000, dd.mm.yyyy hh:mm:ss	5066	0x13CA	Read only	UINT 32
Last time switching on and off of input C1	since 2000, dd.mm.yyyy hh:mm:ss	5068	0x13CC	Read only	UINT 32
Last time switching on and off of input A2	since 2000, dd.mm.yyyy hh:mm:ss	5070	0x13CE	Read only	UINT 32
Last time switching on and off of input B2	since 2000, dd.mm.yyyy hh:mm:ss	5072	0x13D0	Read only	UINT 32
Last time switching on and off of input C2	since 2000, dd.mm.yyyy hh:mm:ss	5074	0x13D2	Read only	UINT 32
Last time switching on and off of input A3	since 2000, dd.mm.yyyy hh:mm:ss	5076	0x13D4	Read only	UINT 32

Parameter	Value (unit)	Register address		Access	Data format
		DEC	HEX		
Last time switching on and off of input B3	since 2000, dd.mm.yyyy hh:mm:ss	5078	0x13D6	Read only	UINT 32
Last time switching on and off of input C3	since 2000, dd.mm.yyyy hh:mm:ss	5080	0x13D8	Read only	UINT 32
Time (ms)	—	61563	0xF07B	Read only	UINT 32
New time	since 2000 (seconds)	61565	0xF07D	Read and write	UINT 32
Save new time	0 – do not save; 1 – write	61567	0xF07F	Read and write	UINT 16
Time and date (UTC)	since 2000 (seconds)	61568	0xF080	Read only	UINT 32
Time zone	offset in minutes from Greenwich	61570	0xF082	Read and write	INT 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
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 – absolute prohibition 1 – only reading 2 – only writing down	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
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;

Function	Error name	Possible causes
		– 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

Function	Error name	Possible causes
	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 digital inputs

5.6.1 Operation modes of the inputs of a "dry contact" type

The group of inputs DI1-DI6 of the module performs the determination of the logical level.
For each input, the counter of incoming pulses is used.

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 bit
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 considered as 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 *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 bitmask and read from the corresponding register.

5.6.2 Modes of inputs with 230 AC signals

The groups of inputs A1-A3, B1-B3 and C1-C3 of the Module are designed for connecting signals of alternating voltage with a level from 20 V_{rms} to 264 V_{rms} and a frequency from 47 to 63 Hz. Such an input level will be recognized as a logical 1.

Various circuits of both single-phase and three-phase networks can be connected to the discrete inputs.

Table 5.11 Input functions

Function	Description
When connecting a single-phase network	
Determination of the presence or absence of voltage in the network	The state values of the digital inputs are stored as a bitmask and read from the corresponding register.
Operating time (hours)[1)]	For each of the inputs, a 32-bit counter is used, in which the operating time is recorded in seconds
Voltage switch counter[1)]	For each of the inputs a 32-bit voltage switch counter is used.

Function	Description
Time of last switching on and off of the input voltage	Time is written in UTC format. The next time the device is turned on or off, the value in the register is overwritten.
When connecting a three-phase network	
Phase break diagnostics in a three-phase network[2)]	If there is no input voltage on any of the three phases, the red LED on the diagnosed input lights up. The LEDs of the other inputs of the group light up yellow. The error value is recorded in the “Rotation failure or phase failure” register of the corresponding group.
Phase rotation control in a three-phase network[1)]	If the phase rotation is incorrect, the red LEDs of these circuit light up, in which the rotation control occurs. The error value is recorded in the “Rotation failure or phase failure” register of the corresponding group.
[1)] In case of counter overflow, the register is reset. To reset the counter manually, see *Section 6.7*. [2)] Diagnostics is enabled if the module is configured accordingly using the “akYtec Tool Pro” program or via the Modbus TCP protocol. The module has the ability to connect one to three control circuits of a three-phase network.	

In order to determine the failure when connecting a three-phase network, in the “Network Master” you need to set up register control for each group of inputs:

– **Voltage at the inputs A1–B1 –...– C3**;
– **Failure of rotation or loss of phases**.

If the phase of any of the input circuits of the group is cut off, the registers will take the values:

– **Failure of rotation or loss of phases** = 1;
– bit of the corresponding input in the register **Voltage at the inputs A1–B1 –...– C3** = 0.

In case of a group phase rotation error, the registers will take the values:

– **Failure of rotation or loss of phases** = 1;
– bit of the corresponding input in the register **Voltage at the inputs A1–B1 –...– C3** = 1.

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.

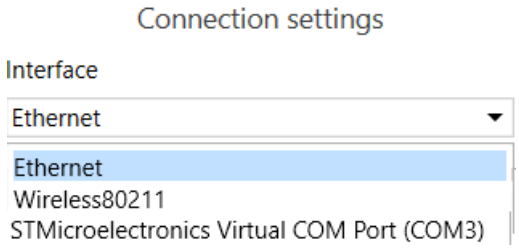


Fig. 6.1 Interface selection menu

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.

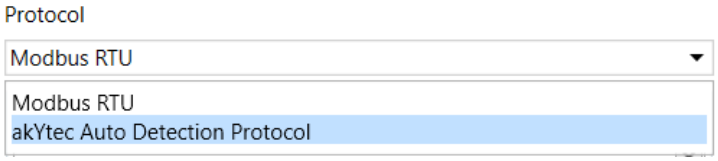


Fig. 6.2 Select Protocol

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

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).

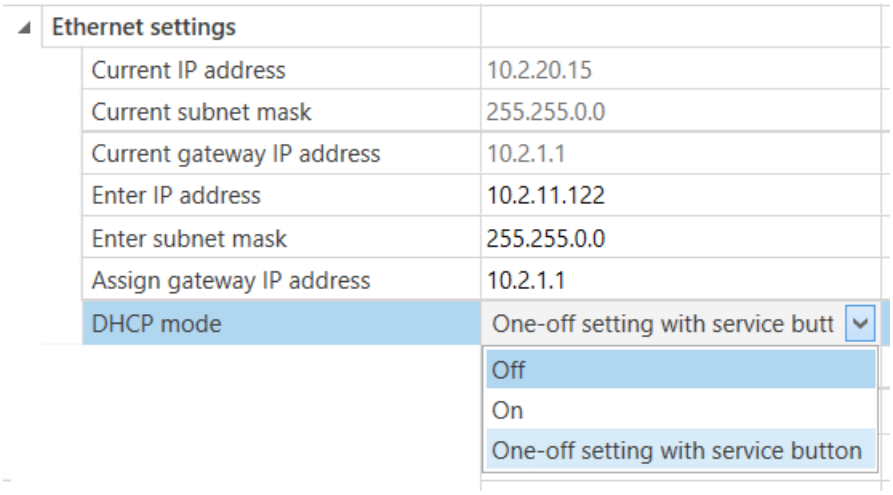


Fig. 6.3 DHCP mode settings

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 6.5*).
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 Forcing 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*.

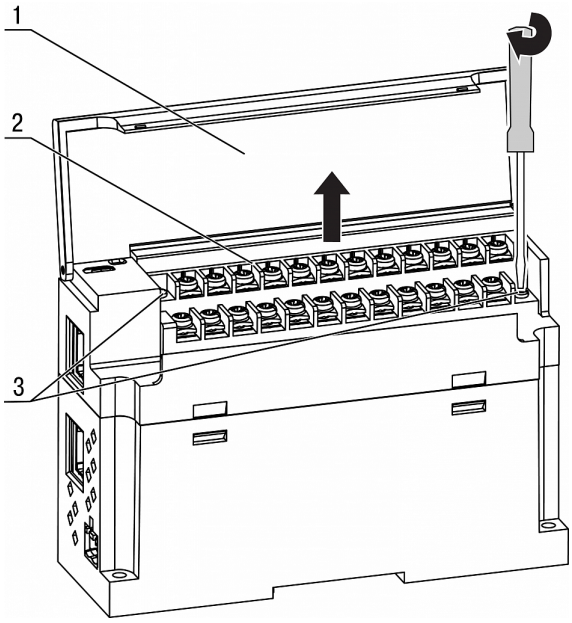


Fig. 7.1 Remove terminal block

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

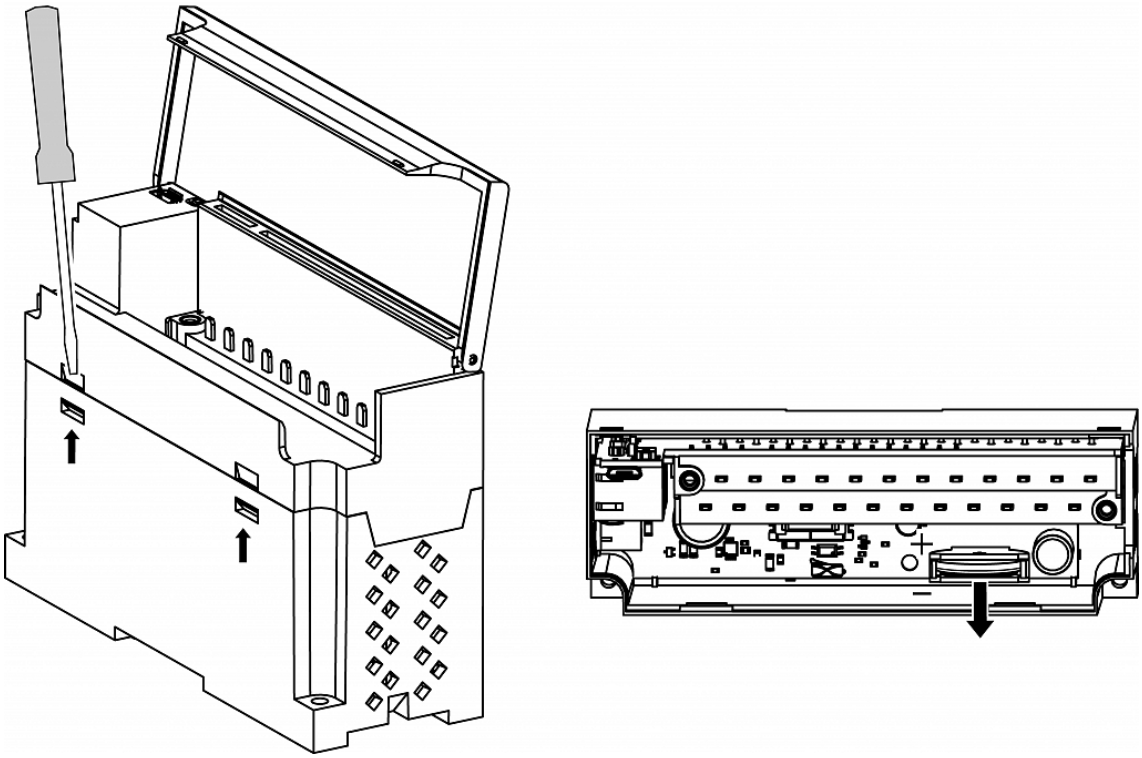


Fig. 7.2 Battery replacement

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 loosing 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;
}
```