EN



PR225

Programmable relay

User guide

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1 Introduction

This manual describes functions, configuration, operating instructions, programming and troubleshooting of the PR225 multifunctional programmable relay (hereinafter referred to as PR225, device, or relay).

1.1 Terms and abbreviations

- **ALP** – programming software akYtec ALP for programming PR series relays, based on Function Block Diagram programming language (FBD)
- **ADC** – analog-digital converter
- **DAC** – digital-analog converter
- **DNS** (Domain Name System) – decentralized naming system for computers, services, or other resources connected to the Internet or a private network. It translates domain names to the numerical IP addresses.
- **EMI** – electromagnetic interference
- **Modbus** – application layer messaging protocol for client/server communication between devices connected on different types of buses or networks, originally published by Modicon (now Schneider Electric), currently supported by an independent organization *Modbus-IDA*
- **Modbus TCP** – Modbus protocol, adapted to transfer information over TCP
- **NTC** – negative temperature coefficient sensor
- **Project** – user application created in ALP software that also includes the device configuration
- **PTC** – positive temperature coefficient sensors
- **PWM** – pulse-width modulation
- **RAM** – random access memory, volatile part of the device memory
- **Retain memory** – non-volatile device memory for retain variables
- **Retain variable** – type of variable that keeps its value after device restart (power off/on cycle)
- **ROM** – read-only memory, non-volatile part of the device memory
- **RTC** – real time clock
- **RTD** – resistance temperature detectors
- **UTC** (Coordinated Universal Time) – world-wide primary time standard

1.2 Symbols and key words

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

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

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

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

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1.3 Intended use

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

Improper use

Any other use is considered improper. Especially to note:

– The device may not be used for medical applications.
– The device may not be used in explosive environment.
– The device may not be used in atmosphere in which there are chemically active substances.

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1.4 Safety requirements

WARNING
All electrical connections must be performed only by a qualified electrician.
The device terminals may be under a dangerous voltage. Cut off all power lines before working on the device.
Switch on the power supply only after completing all work on the device.

WARNING
Ensure the mains voltage matches the voltage marked on the nameplate.
Ensure the device is provided with its own power supply line and electric fuse.
Do not feed any external devices from the power contacts of the device.

NOTICE
Supply voltage may not exceed 30 V. Higher voltage can damage the device.
If the supply voltage is lower than 9 V DC, the device cannot operate properly but will not be damaged.

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

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2 Overview

The programmable relay PR225 is a small controller, developed for automated control systems in industry, agriculture, building technology and household applications.
User program is created as a function plan with the ALP programming software.

2.1 Basic features

PR225 has the following modifications:
– PR225.230.2.2
– PR225.24.2.2
The basic features of both modifications are described below:

PR225.230.2.2	PR225.24.2.2
– 8 digital inputs – 4 analog inputs (can be used as digital) – 8 relay outputs – 2 analog outputs (4-20 mA, 0-10 V) – IPS LCD – 2 programmable LEDs F1, F2 – front panel buttons for View and Edit modes – Master or Slave in Modbus network over RS485 interface – Master or Slave in Modbus network over Ethernet interface – real-time clock – data logging and archiving – configuration and programming with ALP software (free) – mounting into a control board – quick and easy device replacement with plug-in terminal blocks	– 8 digital inputs – 4 analog inputs (can be used as digital) – 8 relay outputs – 2 analog outputs (4-20 mA, 0-10 V) – IPS LCD – 2 programmable LEDs F1, F2 – front panel buttons for View and Edit modes – Master or Slave in Modbus network over RS485 interface – Master or Slave in Modbus network over Ethernet interface – real-time clock – data logging and archiving – configuration and programming with ALP software (free) – mounting into a control board – quick and easy device replacement with plug-in terminal blocks

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2.2 Design

The PR225 front panel is shown in the figure.



Fig. 2.1 Front panel

On the front panel:
– color graphic LCD
– seven buttons
– five LEDs

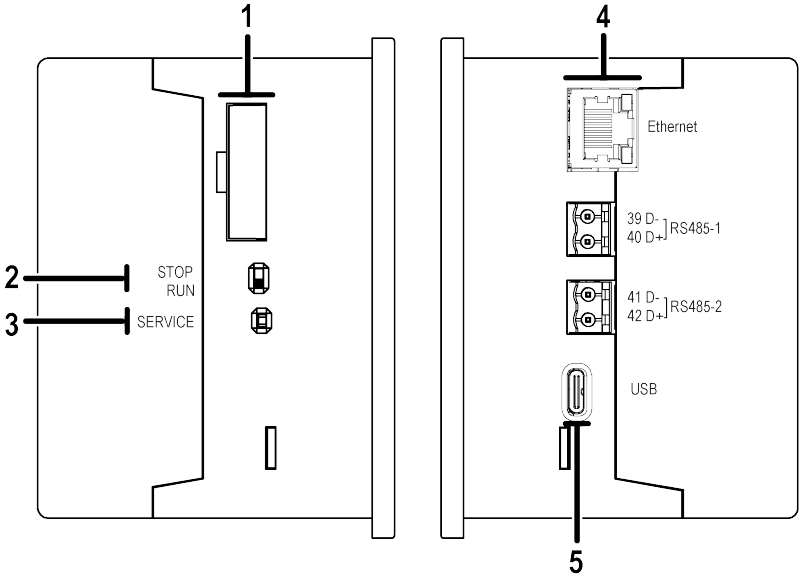


Fig. 2.2 Side surfaces

On the side surfaces of the device:

1. RTC battery slot
2. Run/Stop switch

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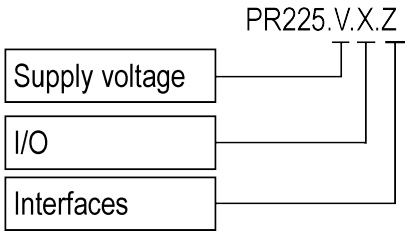
3. Service button (see *Section 4.13*)
4. Ethernet connector
5. USB type-C port for programming

For detailed description of the PR225 indication, controls and interfaces, see *Section 7.1*.

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2.3 Ordering key

Relay PR225 can be ordered in various designs depending on the required supply voltage, number and type of inputs, outputs and interfaces:



Supply voltage
230 – 230 (90…264) V AC
24 – 24 (19…29) V DC

I/O
2 – 8 DI, 4 DI/AI, 8 DO (relay), 2 AO

Interfaces
1 – 1 × RS485, 1 × Ethernet
2 – 2 × RS485, 1 × Ethernet

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3 Specifications

3.1 Specification tables

Table 3.1 Power supply specifications

Parameter	Value	
	230.2.2	**24.2.2**
Power supply	230 (90…264) V AC; 50 Hz	24 (19…29) V DC
Power consumption, max.	15 VA	15 W
Galvanic isolation (between the power input and other circuitry parts)	2300 V	—
Reverse polarity protection	—	yes

Table 3.2 General specifications

Parameter	Value
Computing capabilities and auxiliaries	
Minimum program execution cycle (depends on user's program complexity)	1 ms
Network variables' memory size: Slave mode Master mode	 2040 Bytes 384 Bytes
Built-in real-time clock (RTC)	yes
RTC accuracy (at +25 °C)	± 3 s/day
RTC backup battery life	5 years
Backup battery	CR2032
Flash memory (logging)	
Number of program/erase cycles	100 000
Maximum log file size, max.	2048 Bytes
Maximum number of log files	50
Minimum logging interval	30 s
Programming and configuration	
Programming and configuration interfaces	USB, Ethernet
Programming software	akYtec ALP
Configuration software	akYtec ToolPro
Retain memory size	1024 Bytes
ROM	64 kB
RAM	320 kB
User program footprint	128 kB
Communication interfaces	
Types of network interfaces	RS485 and Ethernet
Ethernet	
Communication protocol	Modbus TCP
Operation modes	Master/Slave
Baud rate	10/100 Mbit/s
Galvanic isolation (between Ethernet port and other circuitry parts)	1000 V
RS485	
Number of RS485 ports	2
Communication protocol	Modbus-RTU, Modbus ASCII
Operation modes	Master/Slave
Baud rate	9600, 14400, 19200, 38400, 57600, 115200 bit/s
Galvanic isolation (between RS485 ports and other circuitry parts)	1500 V
Cloud service	

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Parameter	Value
akYtec Cloud	supported
Cloud interface	Ethernet
General	
Mounting	In a control board
Dimensions	100 × 100 × 71 mm
IP code	IP20
Weight, max.	0.5 kg
Average service life	10 years

Table 3.3 Indication and controls

Parameter	Value
Display	
Display type (matrix)	graphic IPS LCD
Backlight	LED
Colour gamut	65535
Size	3.5“
Work area	73.4 × 48.9 mm
Resolution	480 × 320 px
Brightness	250 cd/m²
Contrast ratio	800:1
Top/Right/Bottom/Left Viewing Angle	80°/80°/80°/80°
Backlight MTBF, min	50 000 hours at 25 °C
Backlight control	Yes*
Supported languages	English, German
LEDs	
LED description	see *Section 4.4*
Buttons	
Description of function buttons	see *Section 7.1*

NOTE
* Setting a timeout (see *Section 4.10*) and brightness. Backlight is switched on by pressing any button.

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Table 3.4 Digital inputs (DI)

Parameter	Value	
	230.X.X	24.X.X
Input voltage	230 V AC	24 V DC
Input voltage, max.	264 V AC	29 V DC
HIGH level	164…264 V / 0.4…15 mA	9…30 V / 2…15 mA
LOW level	0…40 V / 0…0.5 mA	-3…+5 V / 0…15 mA
Pulse length, min.	85 ms	2 ms
Response time, max.	105 ms	30 ms
Pulse frequency, max. (depends on program cycle)	—	150 Hz
Galvanic isolation	in groups of 4	
Galvanic isolation against other circuits	2300 V	510 V
Galvanic isolation between each input group	2300 V	

Table 3.5 Digital/Analog inputs (AI)

Parameter		Value
ADC resolution		12 bit
Sampling time, max.		1 ms
Galvanic isolation		no
Analog mode 1 (Linear input)		
Input signal types	Voltage (unipolar)	0...10 V
	Current (unipolar)	4...20 mA
Max input voltage for digital input mode and 0-10 V input		30 V
Basic error		±0.5 %
Temperature influence		±0.5 % of basic error per each 10 °C
Input resistance (at measuring voltage signal 0...10 V), min.		10 kΩ
Analog mode 2 (Temperature sensors)		
Input signal range		0...300 kΩ
Types of temperature sensors supported		see *Table 3.6*
Least significant bit value, max.		1 °C

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Parameter		Value
Basic error	for the resistance range 0...150 kΩ	±1.0 %
	for the resistance range 150...300 kΩ	±2.0 %
	for RTD and thermistors (NTC and PTC)	±1.5 %
Temperature influence		±0.5 % of basic error per each 10 °C
Digital mode		
HIGH/LOW threshold (adjustable in ALP)		1…8 V
LOW/HIGH threshold (adjustable in ALP)		2…9 V
Input current		2...15 mA
Pulse length, min.		15 ms
Signal frequency, max.		25 Hz

NOTE
Interferences can increase the value of basic error.

Table 3.6 Sensors (analog mode 2)

Sensor	Measurement range
RTD	
Pt 500 (α = 0.00385 °C⁻¹) *	–200…+850 °C
500P (α = 0.00391 °C⁻¹)	–200…+850 °C
Cu 500 (α = 0.00426 °C⁻¹)	–50…+200 °C
500M (α = 0.00428 °C⁻¹)	–180…+200 °C
Ni500 (α = 0.00617 °C⁻¹)	–60…+180 °C
Cu 1000 (α = 0.00426 °C⁻¹)	–50…+200 °C
1000M (α = 0.00428 °C⁻¹)	–180…+200 °C
Pt 1000 (α = 0.00385 °C⁻¹)	–200…+850 °C
1000P (α = 0.00391 °C⁻¹)	–200…+850 °C
Ni 1000 (α = 0.00617 °C⁻¹)	–60…+180 °C
Thermistors (NTC)	
B57861S series, 2 kΩ, $B_{25/100}$ = 3560K	–55…+100 °C
B57861S series, 3 kΩ, $B_{25/100}$ = 3988K	–55…+145 °C
B57861S series, 5 kΩ, $B_{25/100}$ = 3988K	–35…+145 °C
B57861S series, 10 kΩ, $B_{25/100}$ = 3988K	–35…+155 °C
B57861S series, 30 kΩ, $B_{25/100}$ = 3964K	–20…+155 °C
B57861S series, 50 kΩ, $B_{25/100}$ = 3760K	–10…+155 °C
NTC 3435, 10 kΩ	–40…+105 °C
NTC 3977, 10 kΩ	–40…+125 °C
Thermistors (PTC)	
KTY82-110	–55…+150 °C
KTY82-120	
KTY82-121	
KTY82-122	
KTY82-150	
KTY82-151	
KTY82-152	

NOTE
Temperature coefficient of resistance (α) is determined by the formula:
$\alpha = \frac{R_{100} - R_0}{R_0 \cdot 100\ °C}$***, where R_{100}, R_0 are RTD performance curve resistance values at 100 °C and 0 °C correspondingly. The coefficient value is rounded to the fifth significant figure.***

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Table 3.7 Digital outputs (DO)

Parameter		Value
Type of digital outputs		relay (NO)
Galvanic isolation (between outputs and other circuitry parts)		2300 V
Maximum switching load voltage	AC	250 V (resistive load)
	DC	30 V (resistive load)
Maximum load current	AC	5 A (at maximum load voltage 250 V AC and cos(φ) > 0,95)
	DC	3 A (at maximum load voltage 30 V DC)
Minimum load current at 5 V DC		10 mA
Service life, electrical	at 250 V AC, 5 A	200 000 switching cycles
	at 250 V AC, 7 A	50 000 switching cycles
	at 30 V DC, 3 A (resistive load)	100 000 switching cycles

Table 3.8 Analog outputs (AO)

Parameter		Value
DAC resolution		12 bit
Output signal	Current	4...20 mA
	Voltage	0...10 V
External supply voltage		15…30 V
Load resistance	R_I (4...20 mA), max.	600 Ω
	R_U (0...10 V), min.	600 Ω
Basic error, max.		±0.5%
Temperature influence		±0.5 % of basic error per each 10 °C
Galvanic isolation		no

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3.2 Operating conditions

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

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

Table 3.9 Environmental conditions

Condition	Permissible range
Ambient temperature	-40…+55 °C
Relative humidity	up to 80 % (at +35 °C, non-condencing)
Transportation and storage temperature	-25…+55 °C
Transportation and storage relative humidity	up to 80 %
Altitude	up to 2000 m above sea level
EMC immunity	conforms to IEC 61000-6-2
EMC emission	conforms to IEC 61000-6-4

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4 Configuration and programming

4.1 Putting into operation

It is necessary to observe safety measures (see *Section 1.3*) when putting the device into operation. It is recommended to configure and program the device prior to installation and wiring. Configuration and programming are carried out with ALP after creating a user project.
The software can be downloaded from our homepage *www.akYtec.de*.
Follow the steps below to put the device into operation:

1. Connect the USB programming connector of the device to PC over a USB connection cable (not included). Please refer to *Fig. 2.2* for location of the USB programming connector on the device.
2. Unplug the removable terminal block from the device power connector and then connect the terminal block to the external power supply.

   NOTICE
   Check the supply voltage level and polarity before connecting the power supply PR225-230.X:
   – ***the device fails to operate properly with no risk of damage if the supply voltage is below 90 V.***
   – ***there is a high risk of the device damage if the supply voltage is above 264 V.***
   Check the supply voltage level and polarity before connecting the power supply PR225-24.X:
   – ***the device fails to operate properly with no risk of damage if the supply voltage is below 19 V.***
   – ***there is a high risk of the device damage if the supply voltage is above 29 V.***
   – ***the device does not turn on if the supply voltage polarity is reversed.***

3. Plug the removable terminal block into the device mating the power connector.

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

4. Apply the power supply voltage to the device.
5. Make sure that there are no errors indicated by the device (see *Section 7.9.2*).
6. Start ALP and akYtec Tool Pro to set the date and the time required.
7. Remove the supply voltage from the device and then disconnect the USB cable.
8. Connect the USB cable to the device and apply the supply voltage again. Check the date and the time set. Replace the RTC battery if the date and time set are not retained being caused by RTC reset. Please refer to *Section 8.2* for the RTC battery replacement.
9. Using ALP, configure the device and create a user program. The completed project can be transferred to the device memory. The user program is retained in the nonvolatile memory of the device and starts after powering the device on or its reset. See ALP Help for detailed information about configuration.
10. Remove the supply voltage from the device.
11. Connect cables from external devices and sensors to the removable terminal blocks.
12. Plug the removable terminal blocks into the appropriate mating connectors of the device. The terminal blocks layout and the assignment of the terminals are given in *Appendix A.*

If the user program does not start after the device is powered on, it is necessary to repeat transfer of the user program to the device. If the user program was transferred to the device with errors, it may cause the device incorrect operation. In this case, it is necessary to stop the user program by setting the RUN/STOP switch to STOP position.

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4.2 Inputs

4.2.1 Analog inputs

Open the node ***Device > Analog inputs*** in the configuration dialog to access the analog inputs configuration menu (see the figure below).

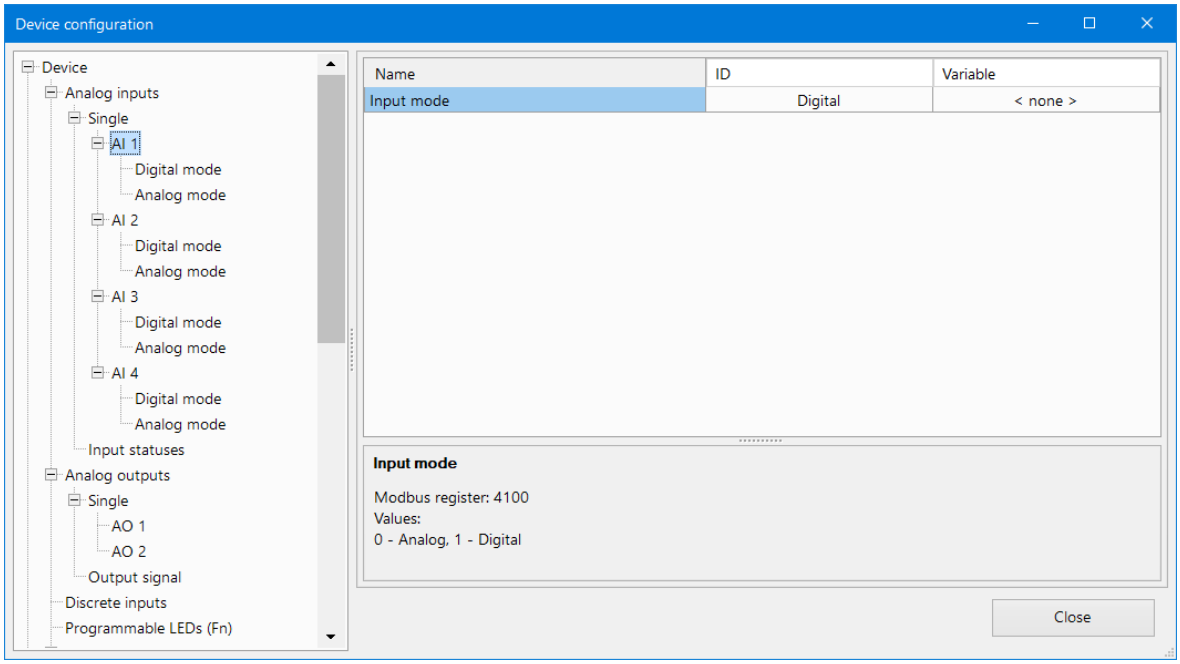


Fig. 4.1 Analog input, mode selection in ALP

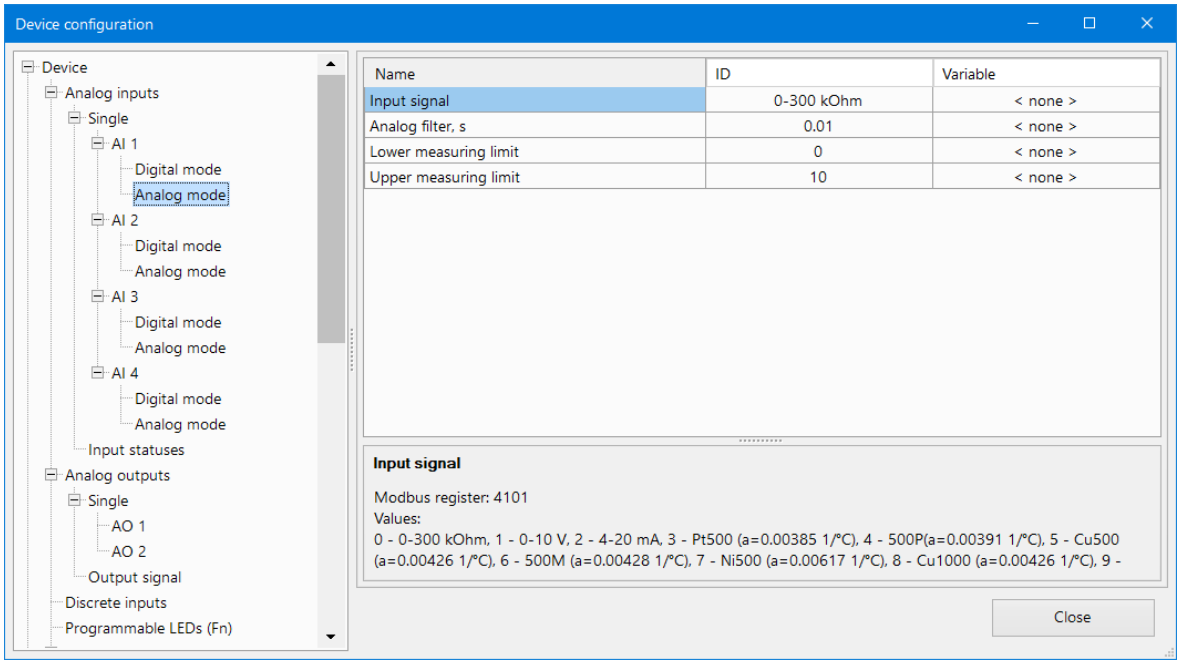


Fig. 4.2 AI analog mode parameters in ALP

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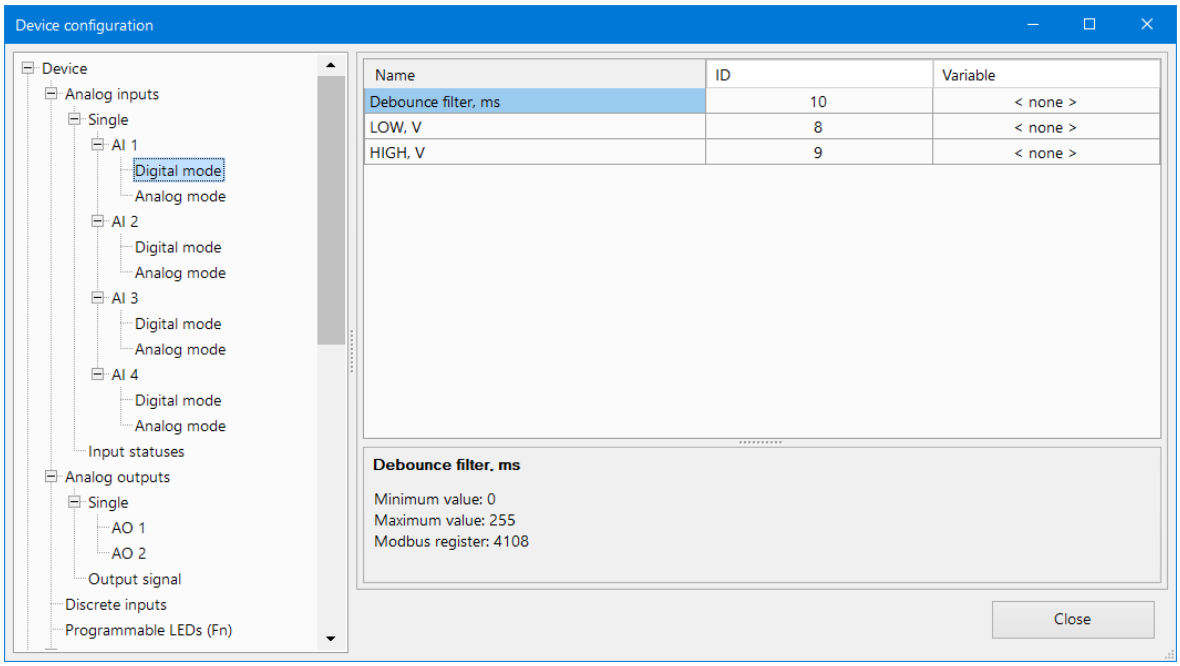


Fig. 4.3 AI digital mode parameters in ALP

Table 4.1 AI configuration parameters

Parameter	Description
Input mode	AI mode selection: analog mode or digital mode
Analog mode configuration parameters	
Input signal	Selection of the input signal type from sensors: 0...300 kΩ 0...10 V 4...20 mA RTD and NTC/PTC
Analog filter	The time constant of the built-in digital anti-aliasing filter. The time constant value sets the time of the input signal processing. The more the time constant value, the better the input channel noise immunity. On the other hand, increasing the time constant value reduces the input channel bandwidth, thus resulting in a slower device response while processing fast changing analog input signals.
Lower measuring limit	Minimum signal strength of the input signal measured. It is used for scaling the input signal.
Upper measuring limit	Maximum signal strength of the input signal measured. It is used for scaling the input signal.
Digital mode configuration parameters	
Debounce filter	The debouncing time of the built-in digital debouncing filter. The value sets a bandwidth limit for the digital input signal processing. The more the value, the better the input channel noise immunity. On the other hand, increasing the value reduces the input channel bandwidth, thus resulting in a slower device response while processing fast changing digital input signals.
LOW	Switching threshold from high level to low level
HIGH	Switching threshold from low level to high level

4.2.1.1 Analog mode

In order to ensure measuring the 4...20 mA current signals, each analog input channel of the device is equipped with the built-in 121 Ω shunt resistor.

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The device supports the scaling of the measured 0...10 V and 4...20 mA input signals by setting the lower and upper measuring limit parameters. Thus, as the scaling is applied, the measured input signals are displayed in initial units of input parameters measured by sensors, e. g. atm (kg/cm²), kPa, etc. Please refer to the example below for the explanation of the signal scaling.

Example:
Example of the input signal scaling
Given the following:
– the used sensor: 4...20 mA output pressure sensor having input measurement range of 0... 25 atm,
– the “Lower measuring limit” parameter value set: 0.00,
– the “Upper measuring limit” parameter value set: 25.00,
the analog input signal is now measured to correspond to the unit of atm (see the figure below).

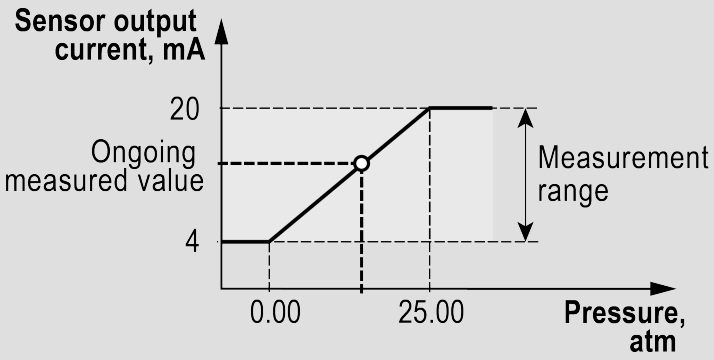


Fig. 4.4 Example of the input signal scaling

The device is operating with absolute parameter values (FLOAT32) of parameters.
The resistive signals are measured by the 2–wire resistance measurement method, for this reason the additional measurement error caused by the resistance of sensor wires must be taken into account. The value of the additional measurement error depends on the used sensor type and the length of the sensor wires. A correction of the additional measurement error must be implied in the user program.

4.2.1.2 Digital mode

The input operates as a comparator with parameters ***LOW*** and ***HIGH*** which determine the hysteresis (see the figure).

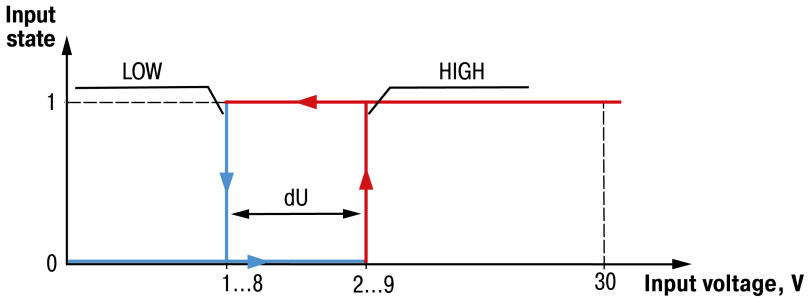


Fig. 4.5 Analog input, digital mode diagram

To avoid the ambiguity of determining the input state, the parameter ***HIGH*** must be set higher than the parameter ***LOW*** by at least 0.5 V.
The input state will not change if the input voltage is within the dU interval. The input state will change:
– from **logic low** to **logic high** only if the input voltage reaches the parameter ***HIGH*** set value.
– from **logic high** to **logic low** only if the input voltage reaches the parameter ***LOW*** set value.

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4.2.2 Digital inputs

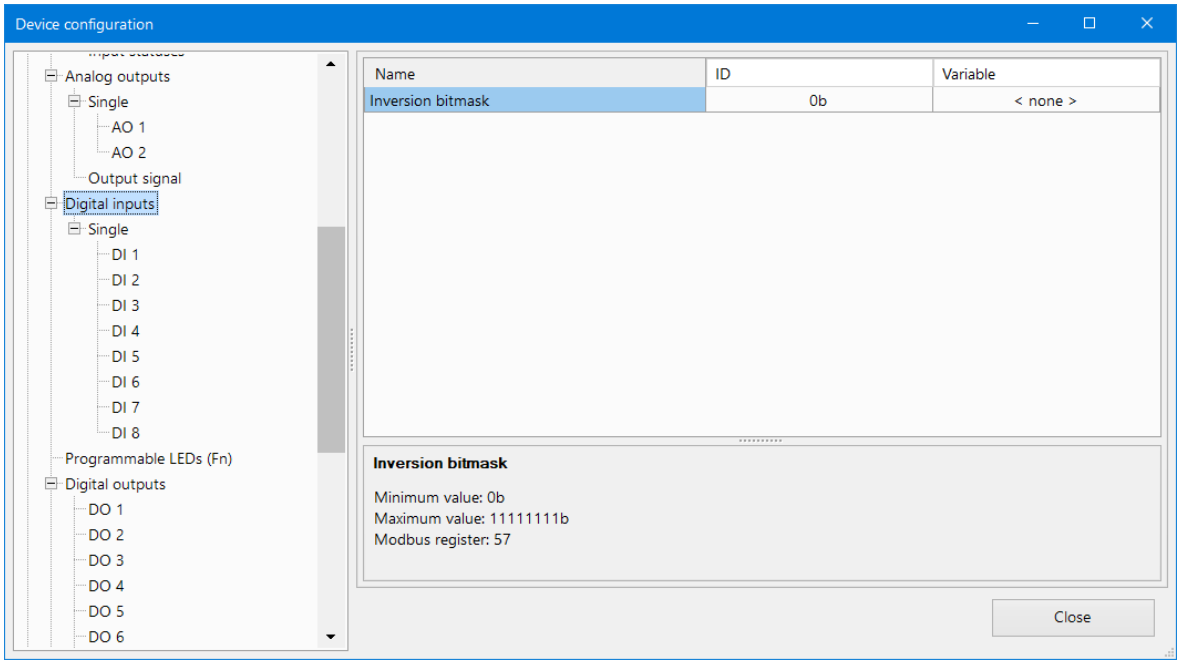


Fig. 4.6 DI inversion configuration parameter

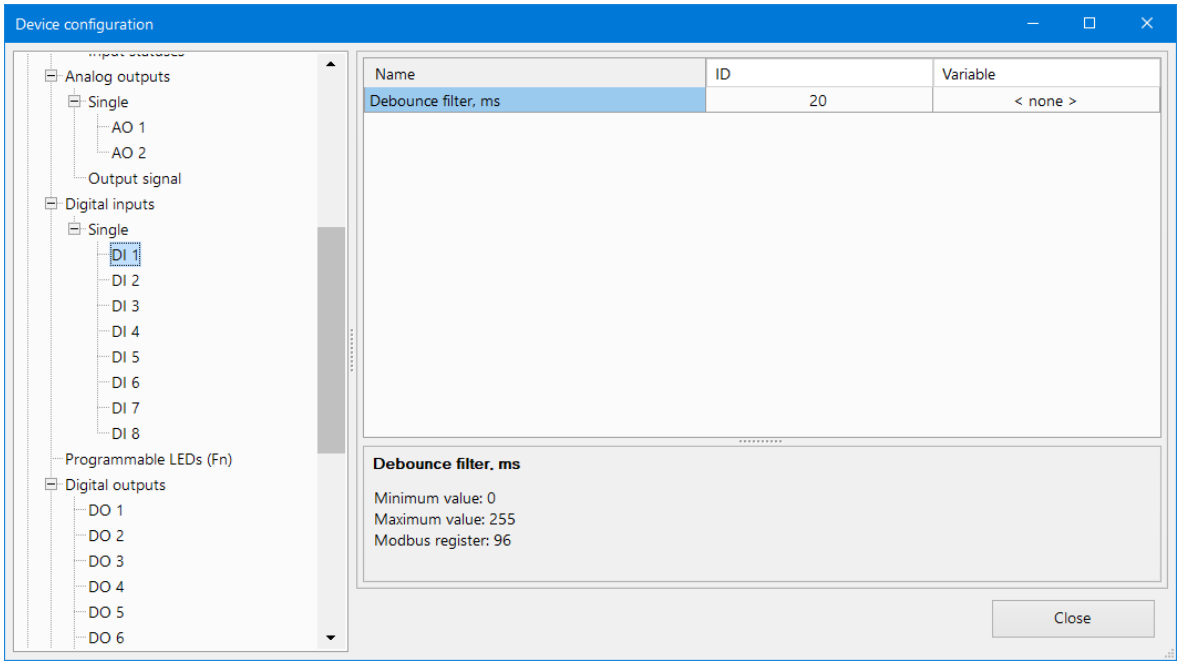


Fig. 4.7 DI debounce filter configuration parameter

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Table 4.2 DI configuration parameters

Parameter	Description
Inversion bitmask	Inversion bitmask is to invert single or multiple digital inputs by setting the bitmask variable value (Little Endian byte order).
Debounce filter	The debouncing time of the built-in digital debouncing filter. The value sets a bandwidth limit for the digital input signal processing. The more the value, the better the input channel noise immunity. On the other hand, increasing the value reduces the input channel bandwidth resulting in a slower device response while processing fast changing digital input signals.

4.3 Outputs

4.3.1 Digital outputs

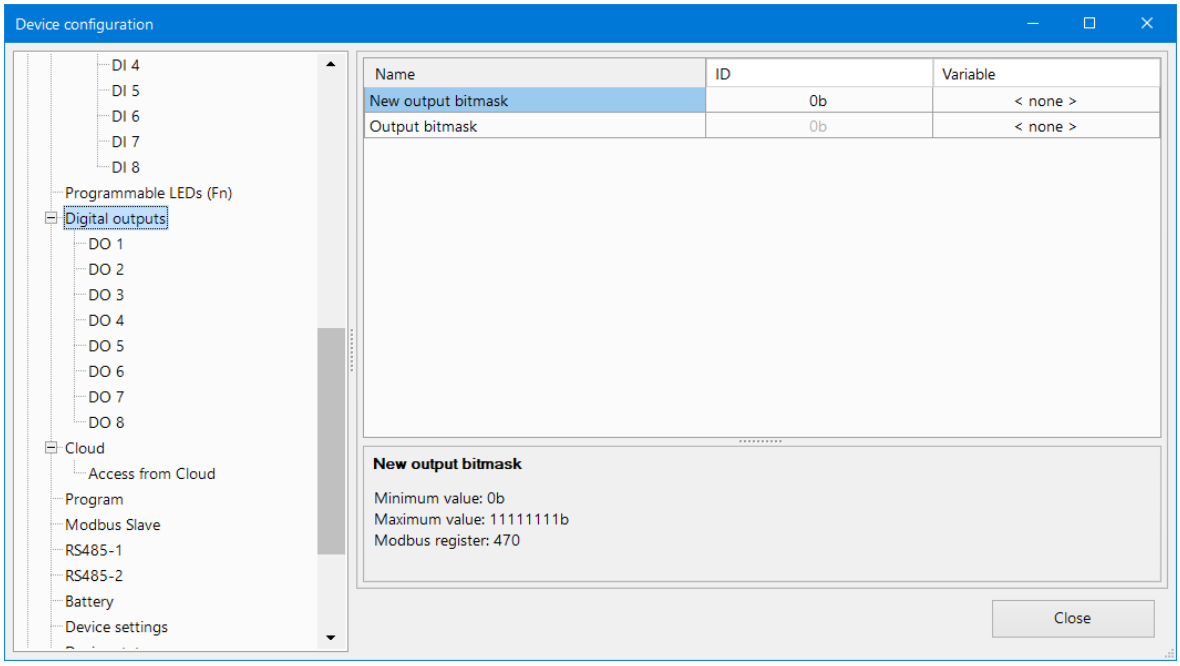


Fig. 4.8 DO configuration parameters

Table 4.3 DO configuration parameters

Parameter	Description
New output bitmask	Bitmask, Little Endian byte order.
Output bitmask	**NOTE** 00000000 = 0b, 11111111 = 11111111b

Safe state can be assigned for each of the device digital outputs.

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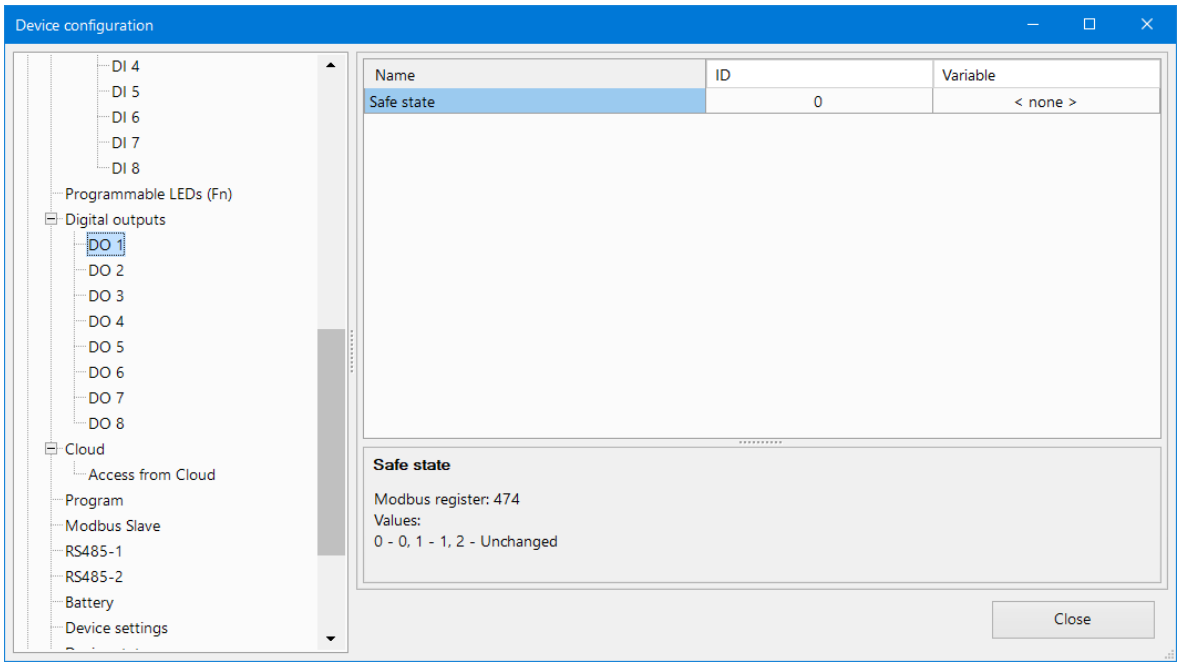


Fig. 4.9 DO safe state configuration parameters

Table 4.4 DO safe state configuration parameters

Parameter	Description
Safe state	The parameter is to assign an output state for the digital outputs when the device does not receive network Master commands within the time-out period (communication loss). The following values are to be set to assign appropriate output states: value “0” – 0 (digital output is open), value “1” – 1 (digital output is closed), value “2” – unchanged (digital output remains unchanged).

4.3.2 Analog outputs

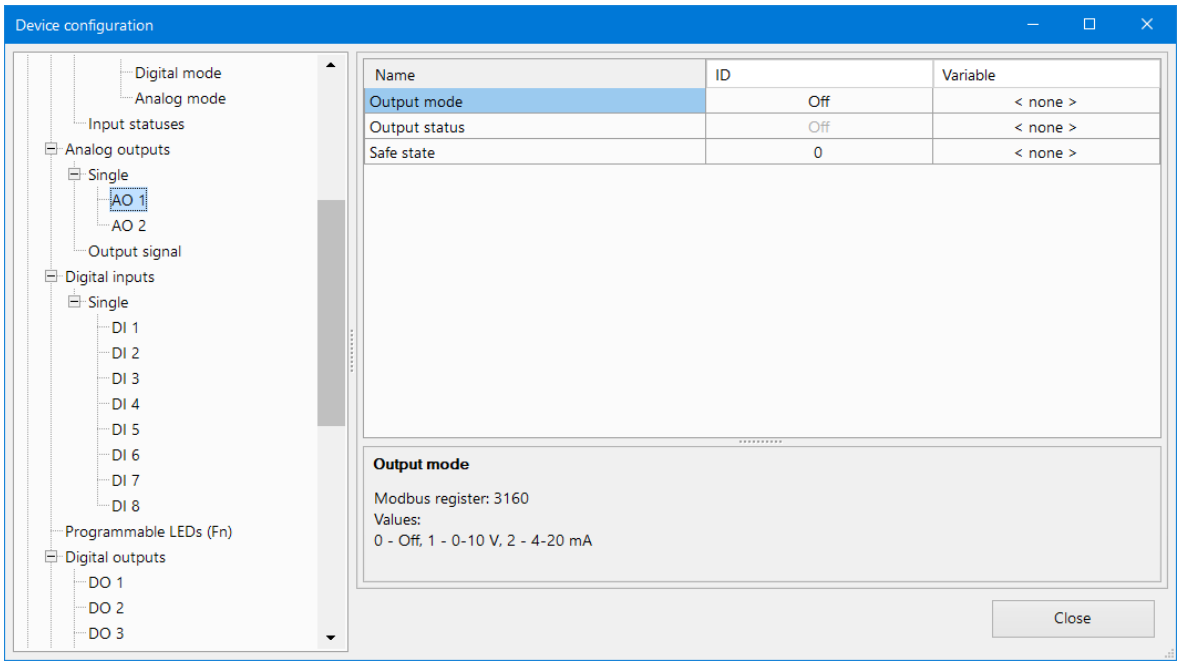


Fig. 4.10 AO parameters in ALP

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Table 4.5 AO configuration parameters

Parameter	Description
Output mode	The parameter is to select the type of the analog output signal. The following values are to be set to select appropriate signal types: value “0” – Off (no analog output signal). value “1” – 0...10 V (the analog output is configured for 0...10 V output). value “2” – 4...20 mA (the analog output is configured for 4...20 mA output).
Output status	The read-only diagnostic parameter. The following values are available for reading: 0 – Off 1 – Normal operation 2 – No connection 3 – Failure 4 – No power 5 – No load
Safe state	The safe state parameter is to set a required analog output signal level when the device does not receive network Master commands within the time-out period (communication loss). The safe state parameter value is set within the range from 0 to 1.

To control an analog output, a floating-point value of type FLOAT32 within the range from 0.0 to 1.0 has to be assigned to it in the user program.

Example:
Given the analog output is configured for 4...20 mA output and the value of 0.5 is applied, the output current is 12 mA.

Example:
Given the analog output is configured for 0...10 V output and the value of 0.5 is applied, the output voltage is 5 V.

4.4 LED indicators

PR225 has two programmable LED indicators: F1 and F2. A variable can be assigned to the states of the LED indicators to control the LED states in the user program.

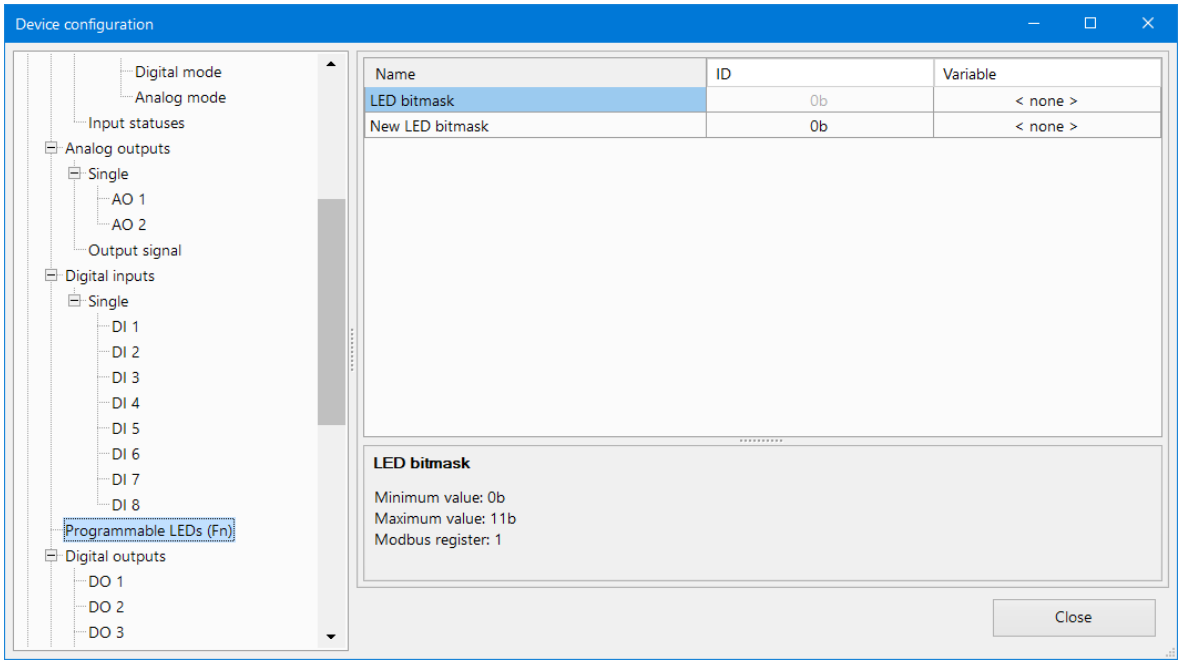


Fig. 4.11 LED parameters in ALP

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Table 4.6 User defined LEDs

Parameter	Description
LED bitmask	Bitmask, little endian byte order

4.5 Data logging

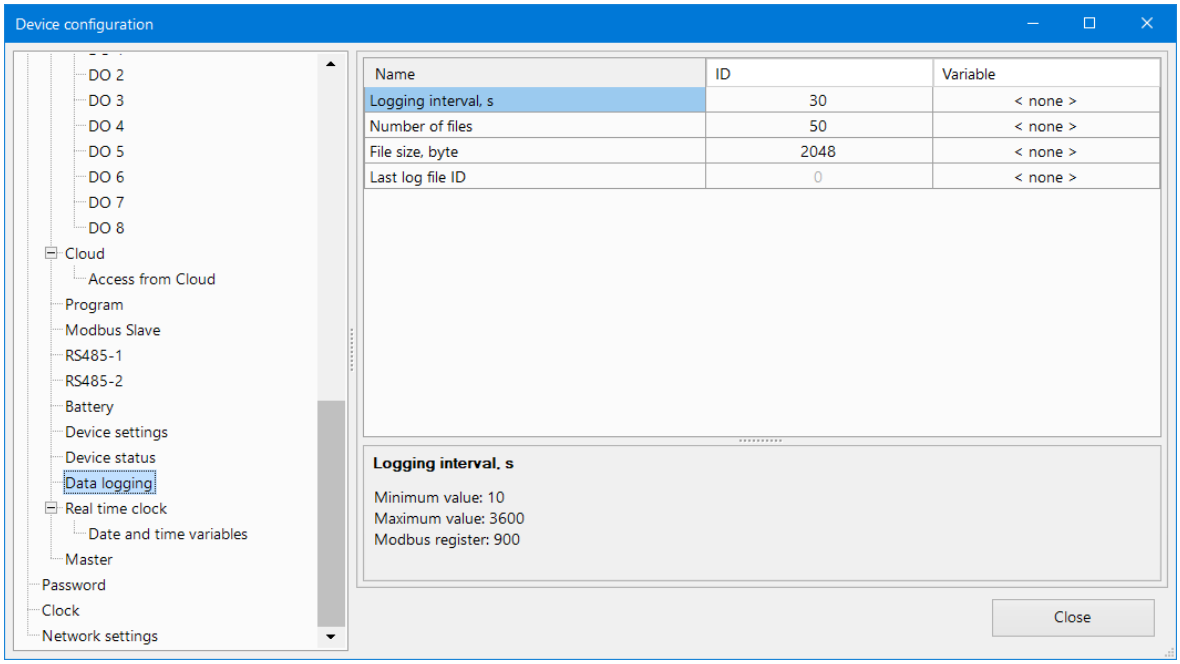


Fig. 4.12 Data logging parameters in ALP

Table 4.7 Data logging parameters

Parameter	Description
Logging interval	Time interval in seconds at which the values of the variables selected for logging are recorded
Number of files	Maximum number of files the archive consists of
File size, byte	Log file size in Bytes

4.6 Working with akYtec ToolPro

Configuration with ***akYtec ToolPro*** is performed "in real time". The configuration parameters can be read from the device, viewed, modified and saved to it. For configuration over Ethernet, the device must be powered on. When being configured over USB, the device is powered by USB and the main power supply is not required.

1. Start ***akYtec ToolPro***.
2. Click menu item ***Add device***
3. Select interface in a drop-down list ***Interface***:
   – Ethernet – for connection via Ethernet
   – STMicroelectronics Virtual COM Port – for connection via USB or RS485

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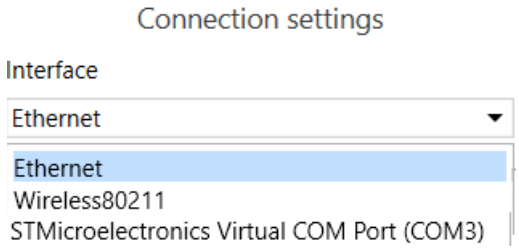


Fig. 4.13 Interface selection

Further steps for finding device in a network depend on the selected interface.

1. To find a device in an Ethernet network:
   – Select radio button ***Find device***
   – Specify the device IP address (default – 192.168.1.99)
   – Click ***Find***. The found device will be displayed in the right field
   – Select the device and press ***OK***
   – If the device is password protected (*Sect. 4.7.1*), enter the correct password
2. To find a device connected over USB or RS485:
   – Select ***akYtec Auto Detection Protocol*** in the drop-down list ***Protocol***.

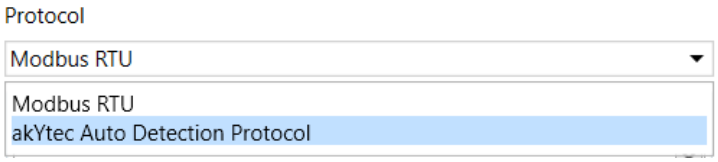


Fig. 4.14 Protocol selection

   – For USB, select ***Connection setup*** – ***Auto***
   – For RS485, select ***Connection setup*** – ***Manually*** and specify the connection parameters:
      – Baud rate – **9600** kbit/s
      – Data bits – **8**
      – Parity – **none**
      – Stop bits – **1**.
   – Select radio button ***Find device***.
   – Specify the device address (default — **16**).
   – Click the button ***Find***. The found device will be displayed in the right field.
   – If the device is password protected (*Sect. 4.7.1*), enter correct password

4.7 Password and archives

4.7.1 Password

You can protect your configuration parameters and user program with a password. There is no password by default.

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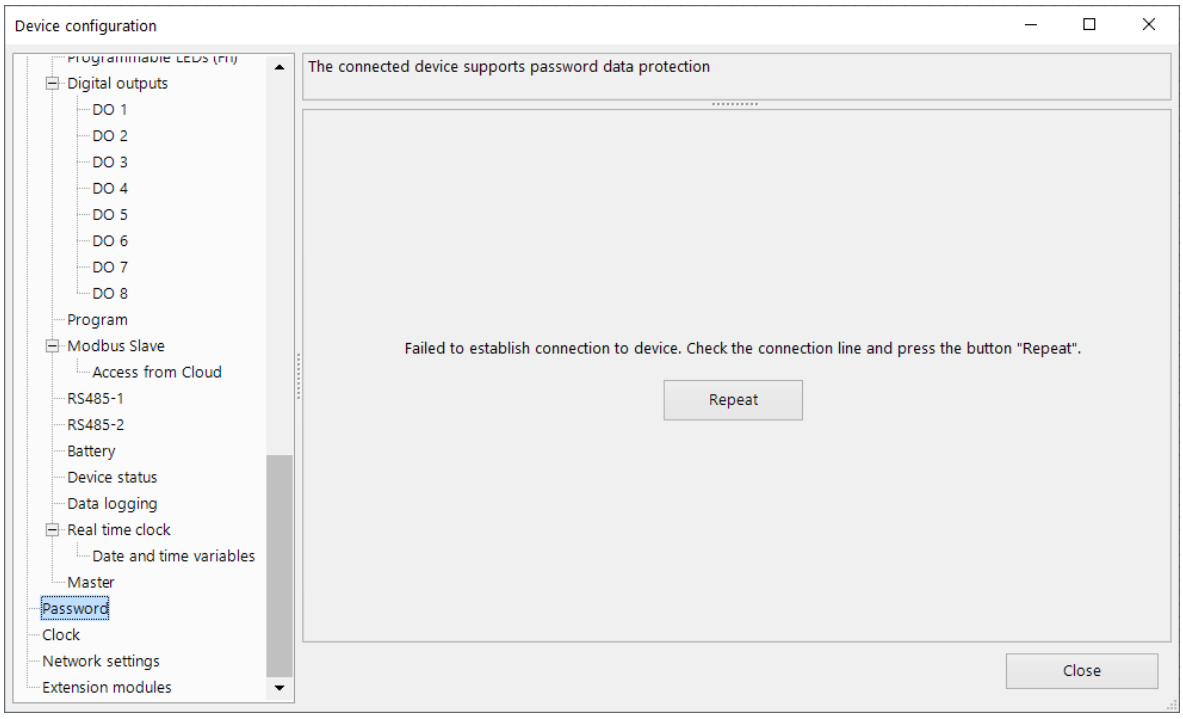


Fig. 4.15 Password setting in ALP

If you forgot the password, restore the factory setting (*section 4.13*).

4.7.2 Archives

The device is equipped with a built-in flash memory, formatted for the cryptographic file system which supports the file encryption.
Data Encryption Standard algorithm is used for data encryption. *Superkey* type key is used as a key. The initialization vector is generated by a hash function. Please see details in *Appendix C.*
By default, the following data is stored in the log file:

– Battery status.
– Device status - service information for the technical support.

An archive is saved as a set of encrypted log files. The log file consists of a set of records separated by Newline (0x0D0A). Each record corresponds to one parameter and consists of fields separated by semicolon. The record format is represented in the table below.

Table 4.8 Record format

Field	Type	Size	Description
Timestamp	binary	4 Bytes	In seconds, beginning from 00:00 01.01.2000 (UTC+0)
Separator	string	1 Byte	Semicolon (;)
UID (parameter ID)	string	8 Bytes	String of HEX characters with leading zeros
Separator	string	1 Byte	Semicolon (;)
Parameter value	string	parameter depending	String of HEX characters with leading zeros
Separator	string	1 Byte	Semicolon (;)
Parameter status	binary	1 Byte	1 – value correct 0 – value incorrect, further processing not recommended
Newline	binary	2 Bytes	\n\r (0x0A0D)

Data logging is a cyclic process.

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The data logging parameters (the logging interval, the number of files and the maximum file size) can be set by user in akYtec ToolPro or in ALP (see *Section 4.5*). When the archive overflows, the data will be overwritten, starting with the oldest record in the oldest file.
The archive files are time-tagged by the device built-in RTC.
The time zone is not contained in the file but can be read from the parameter ***Time zone***.
The archive can be read with akYtec ToolPro.
It can be also read via Modbus using the read function 20 (0x14) Read File Record. For details see *Modbus specifications*.

CAUTION
The last archive file may be not retained on powering the device down.

4.8 Network

4.8.1 General

Network parameters can be set with akYtec Tool Pro or in ALP.
The device operates:

– under the Modbus TCP protocol (Slave/Master) over the Ethernet interface (see *Section 4.8.4*)

NOTE
The device supports four threads per request when operating under Modbus TCP.

– under the Modbus RTU protocol (Slave/Master) over the RS485 interface (see *Section 4.8.3* and *Section 6.8*)

4.8.2 Network parameters

4.8.2.1 Ethernet – Modbus TCP

NOTICE
In order to apply new Ethernet settings, restart the device. Disconnect the device from the USB interface before the device is restarted.

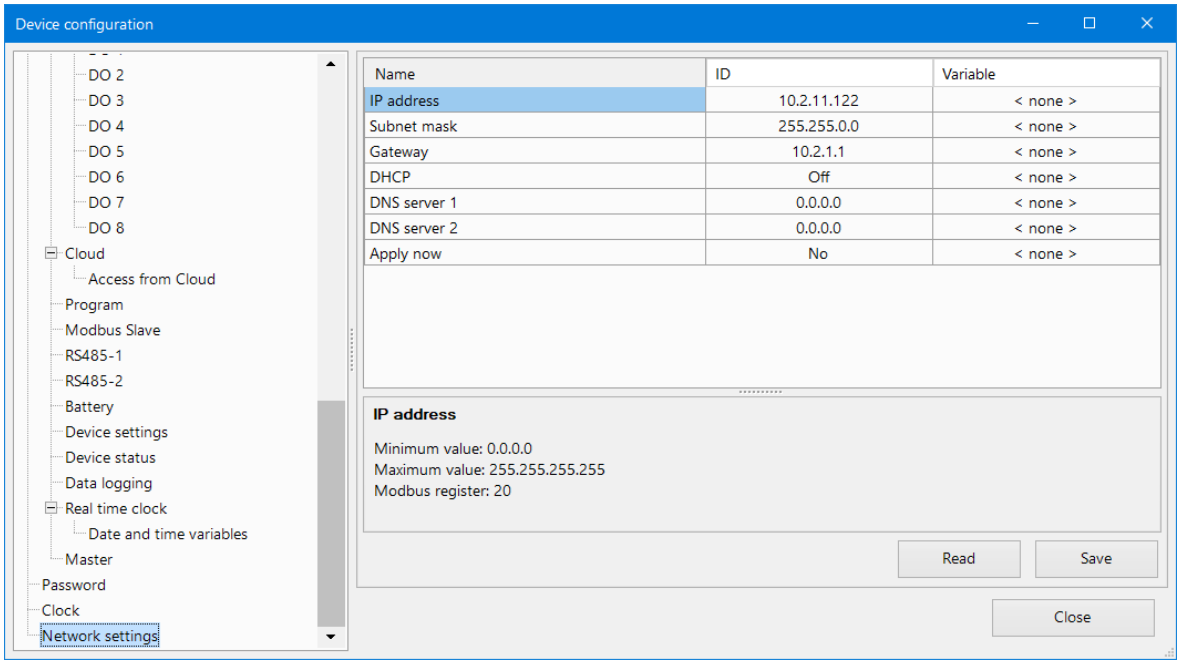


Fig. 4.16 Ethernet parameters in ALP

There are the two types of the IP address: a static IP address and a dynamic IP address. The static IP address can be set with akYtec ToolPro or ALP.
The network parameters listed in the table below must be set to ensure communication over the Ethernet.

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Table 4.9 Ethernet parameters

Parameter	Description
IP address	IP address: it can be static IP or dynamic IP. The IP address default factory setting is **10.2.11.122**
Subnet mask	IP address recognition area in the subnet. The default factory setting is **255.255.0.0**
Gateway	IP address of the gateway. The default factory setting is **10.2.1.1**
DHCP	DHCP mode settings. The following values are available for setting: 0 – On (DHCP mode is on). 1 – Off (DHCP mode is off).
DNS server 1	Used to translate the host name to the numerical IP addresses. The minimum value is **0.0.0.0**, the maximum is **255.255.255.255**
DNS server 2	
Apply now	0 – No 1 – Yes

To configure the Ethernet interface, proceed as follows:

1. Open node ***Network settings*** in ALP configuration dialog.
2. Set parameters ***New IP address***, ***New subnet mask***, ***New gateway***.

The DHCP parameter must be set to “Off”.

4.8.2.2 RS485

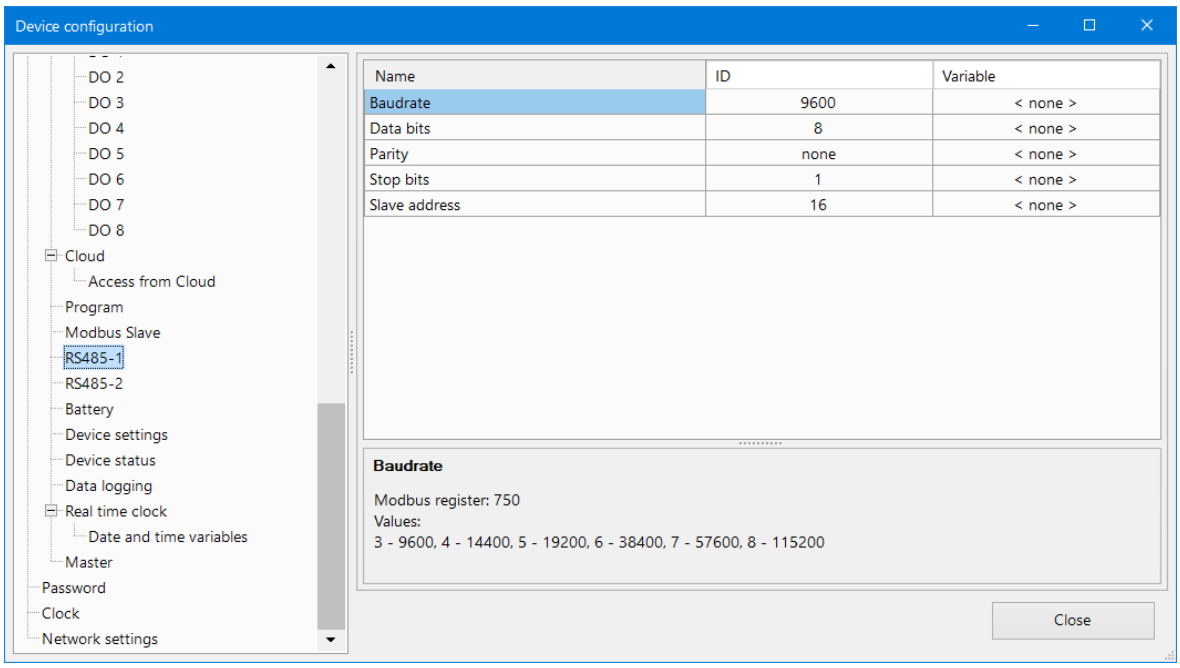


Fig. 4.17 RS485 configuration parameters

Table 4.10 RS485 parameters

Parameter	Description
Baud rate	The parameter is to set the COM port baud rate. The following values can be set: 3 – 9600 bit/s 4 – 14400 bit/s 5 – 19200 bit/s 6 – 38400 bit/s 7 – 57600 bit/s 8 – 115200 bit/s
Data bits	Size of the data packet. The following values can be set:

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	0 – 8 bit 1 – 7 bit
Stop bits	Number of stop bits. The following values can be set: 0 – no 1 – odd 2 – even
Parity	Parity settings. The following values can be set: 0 – 1 stop bit 1 – 2 stop bits
Slave address	The device RS485 network address. The address set by default: 16

4.8.3 Modbus RTU and Modbus ASCII

Depending on the used RS485 interface protocol, the device can operate either in the Modbus RTU (Master/Slave) mode or the Modbus ASCII (Master/Slave) mode. The device recognizes Modbus RTU and Modbus ASCII protocols automatically. Please, refer to *Section 4.8.5* for configuration parameters.

4.8.4 Modbus TCP

Modbus TCP protocol is used only for communication over the device Ethernet port. Please, refer to *Section 4.8.2.1* for the Modbus TCP configuration parameters.

NOTE
Disable DCHP mode when:
– ***there is no DCHP server in the local network.***
– ***the point-to-point network is used to connect the device and PC.***

4.8.5 Modbus Master and Slave modes

Master mode

Only one Master device is allowed in the network. The following functions are supported when the device operates in the Master mode:
– reading by timer
– reading/writing by event
– writing by change (set by default)
The device is capable to control up to 32 slave-devices including:
– up to 64 variables at one operation (either read or write operation)
– up to 32 variables at two simultaneous operations (both read and write operations)
Using the same addresses and variables' names for each of the controlled devices is allowed.
Network variables' memory size for the device Master mode is 384 Bytes.
In order to ensure the device communication in the Master mode, appropriate controlled devices must be added and configured in the Modbus Master configuration parameters as shown in the figure below.

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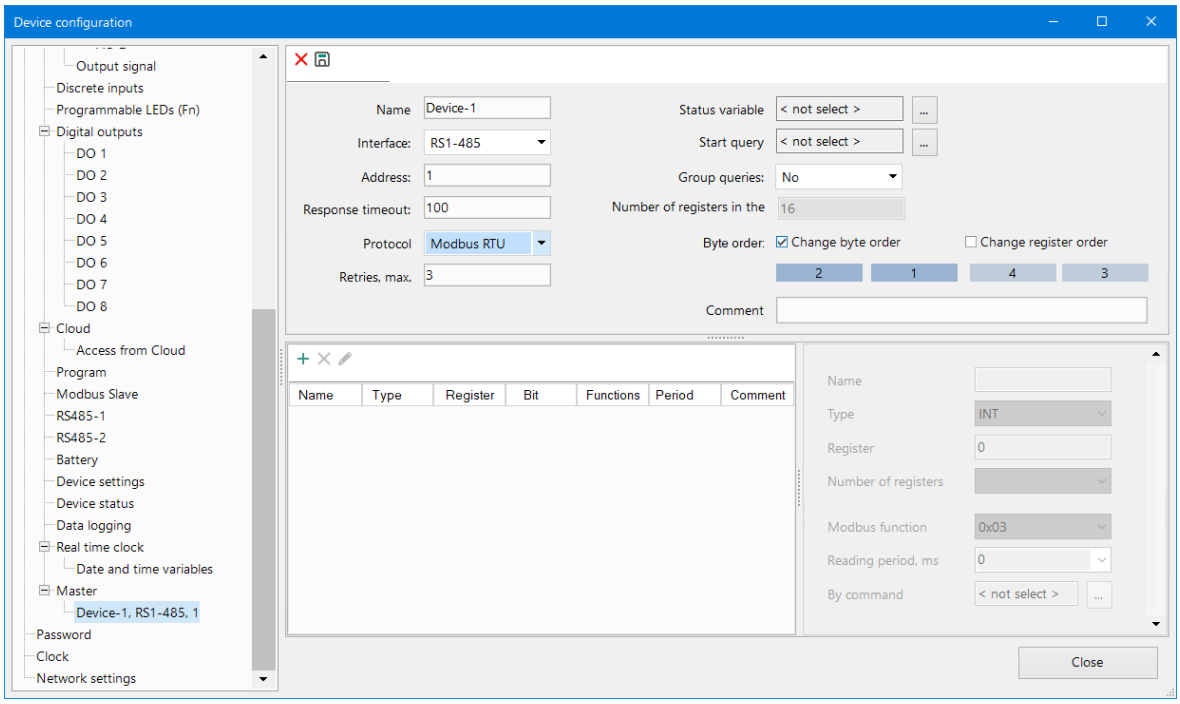


Fig. 4.18 Modbus Master configuration parameters

Table 4.11 Modbus Master configuration parameters

Parameter		Description
Name		Setting a name of the controlled device to be displayed in the configuration tree.
Interface		Setting the communication interface (RS485 or Ethernet).
Address		The controlled device network address.
Response timeout		Setting the request timeout. The request is failed if there is no response after the set timeout.
Protocol		Setting the communication protocol.
Retries, max		Maximum number of requests followed by changing the controlled device status.
Byte order	***Change register order***	Setting the sequential order of sending registers for the two-register variables. The least register first as the box unchecked.
	Change byte order	Setting the sequential order of sending registers. The most significant byte first as the box checked.

For detailed description please refer to ALP user manual available on the homepage *www.akYtec.de*.

Slave mode

The following functions are supported when the device operates in the Slave mode:

– reading data from the multiple flag, holding and input registers
– reading data from the single flag, holding and input registers
– writing data to the multiple flag, holding and input registers
– writing data to the single flag, holding and input registers

Use ALP to configure the device for the Slave mode operation. Please refer to the Modbus register map to ensure the device Slave mode communication. The Modbus register map is given in *Appendix B.*

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Network variables' memory size for the device Slave mode is 2040 Bytes.

4.8.6 Safe mode timeout

The device supports entering the safe state as communication with the network Master is lost.

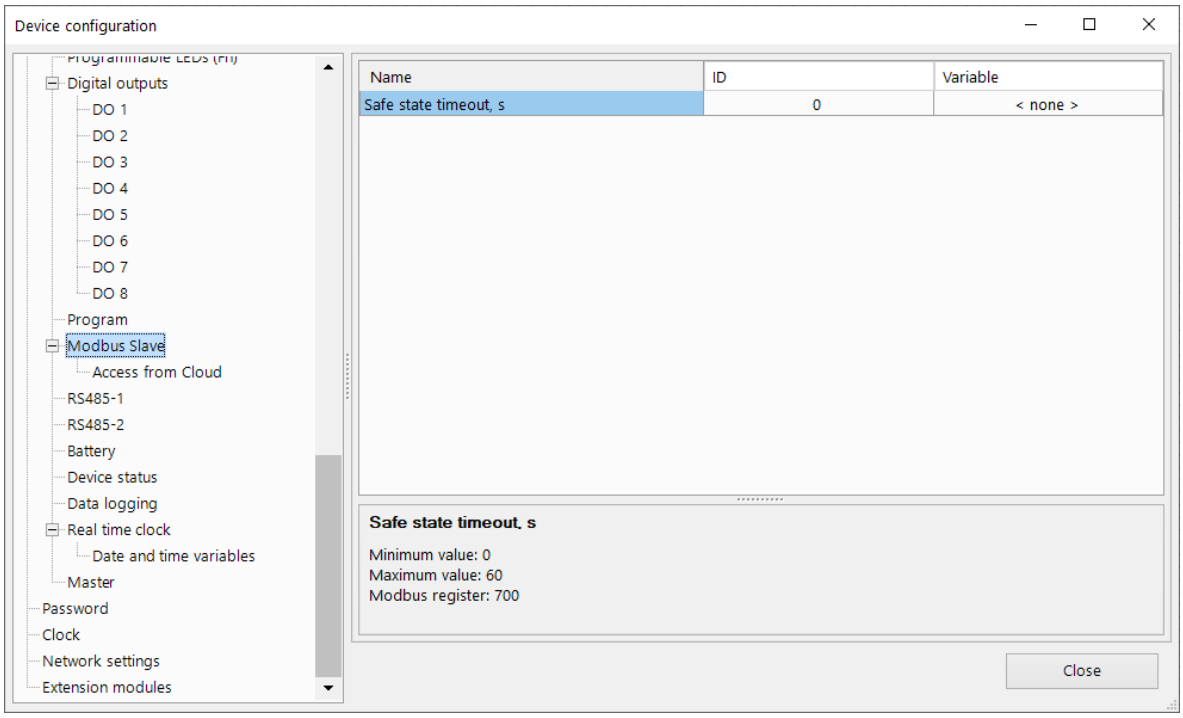


Fig. 4.19 Safe mode timeout configuration parameters

Table 4.12 Safe mode timeout configuration parameters

Parameter	Description
Safe state timeout, s	The device enters the safe state as no commands received from the network Master after the set timeout. The device does not enter safe state upon communication loss if the parameter value is set to 0.

4.8.7 Modbus application

Table 4.13 Supported Modbus functions

Function	Code	Description
MODBUS_READ_HOLDING_ REGISTERS	03 (0x03)	Reading data from one or more holding registers
MODBUS_READ_INPUT_ REGISTERS	04 (0x04)	Reading data from one or more input registers
MODBUS_WRITE_SINGLE_ REGISTER	06 (0x06)	Writing data to a single holding register
MODBUS_WRITE_MULTIPLE_ REGISTERS	16 (0x10)	Writing data to multiple holding registers
MODBUS_READ_FILE_ RECORD	20 (0x14)	Read record file as a set of records
MODBUS_WRITE_FILE_ RECORD	21 (0x15)	Write record file as a set of records

The bitmask parameters can be read by functions 0x03 and 0x01.

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If you are using function 0x01 for reading, multiply the register number by 16 and add the number of the required bit to determine the start bit.

Table 4.14 Basic registers

Parameter	Register	Size (Byte)	Type	Comments
Device name to appear for user (DEV)	0xF000	32	String	Win-1251
Firmware version to appear for user (VER)	0xF010	32	String	Win-1251
Series	0xF020	32	String	Win-1251
Subseries	0xF030	32	String	Win-1251
Hardware version	0xF040	16	String	Win-1251
Additional information	0xF048	16	String	Win-1251
Time and date	0xF080	4	Unsigned 32	UTC in seconds, starting from 0:00 01.01.2000
Time zone	0xF082	2	Signed short	Offset from Greenwich time in minutes
S/N	0xF084	32	String	Win-1251, 17 symbols used

Table 4.15 Basic data formats

Format	Number of registers	Size (Byte)	Description
Unsigned 16	1	2	Unsigned integer
Unsigned 32	2	4	
Signed 16	1	2	Signed integer
Datetime 32	2	4	UTC date/time in seconds, starting from 0:00 01.01.2000

Table 4.16 Special data formats

Format	Number of registers	Size (Byte)	Description
Enum 1...Enum 37	1	1	Specifies a selected parameter position in the list of parameters (e.g. the sensor type used with the analog inputs)
Float 32	2	4	The format representing a real number
Unsigned 8	1	1	Unsigned integer
String 48	3	6	String of 6 characters
String 64	4	6	String of 8 characters
String 128	8	16	String of 16 characters

Please refer to the Modbus register map for the list of the Modbus registers. The Modbus register map is given in *Appendix B.*.
When using two-register (or more) variables, the sending sequential order is as follows:

– the byte order: the most significant byte first.
– the register order: the least significant register first.

4.8.8 Modbus error codes

Table 4.17 Modbus error codes

Code	Description
01	Function code received in the query is not recognized or allowed by slave
02	Data address of some or all the required entities are not allowed or do not exist in slave
03	Value is not accepted by slave
04	Unrecoverable error occurred while slave was attempting to perform requested action. The device is in error mode.

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Code	Description
05	Slave has accepted the request and is processing it, but it takes time. This response is returned to prevent a timeout error in the master.
06	Slave is engaged in processing a long-duration command. Master should retry later.
08	Specialized use in conjunction with function codes 20 and 21. Slave detected a parity error in memory. Master can retry the request, but service may be required on the slave device.

The data packages are processed according to the steps as follows:

1. The data package validity check is performed. The data package is ignored if the check fails.
2. The data package address (Slave ID) check is performed. The data package is ignored if the check fails.
3. The Modbus function check is performed.

If the received request specifies a not supported Modbus function (see *table 4.13* for supported Modbus functions), the error MODBUS_ILLEGAL_ FUNCTION is issued.
The description of the data and files errors is given in the tables below.

Table 4.18 Processing data errors

Modbus function used	Error name	Possible reason causing the error
MODBUS_READ_ HOLDING_ REGISTERS	MODBUS_ILLEGAL_DATA_ ADDRESS	The number of the requested registers exceeds the maximum possible number (125). The requested parameter does not exist.
MODBUS_READ_INPUT_ REGISTERS	MODBUS_ILLEGAL_DATA_ ADDRESS	The number of the requested registers exceeds the maximum possible number (125). The requested parameter does not exist.
MODBUS_WRITE_SINGLE_ REGISTER	MODBUS_ILLEGAL_DATA_ ADDRESS	The size of the parameter to be written exceeds 2 Bytes. Write access is denied for the parameter. The function does not support the type of the parameter to be written. The requested parameter does not exist. The data types supported: – signed and unsigned integer (up to 2 Bytes). – enumerated.
	MODBUS_ILLEGAL_DATA_ VALUE	The parameter falls outside its upper or lower value limits
MODBUS_WRITE_ MULTIPLE_REGISTERS	MODBUS_ILLEGAL_DATA_ ADDRESS	The parameter to be written does not exist. Write access is denied for the parameter. The number of the registers to be written exceeds the maximum permissible number (123).

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Modbus function used	Error name	Possible reason causing the error
	MODBUS_ILLEGAL_DATA_ VALUE	The terminal null symbol (\0) is missing in the string parameter. The size of data requested is less than the size of the first or the last requested parameters. The parameter falls outside its upper or lower value limits.

Table 4.19 Archive files' errors

Modbus function used	Error name	Possible reason causing the error
MODBUS_READ_FILE_ RECORD	MODBUS_ILLEGAL_ FUNCTION	Invalid data size (0×07 ≤ data length ≤ 0×F5)
	MODBUS_ILLEGAL_DATA_ ADDRESS	Reference type does not meet the specification. The file to be read failed to open or does not exist.
	MODBUS_ILLEGAL_DATA_ VALUE	Failed to move to the file offset required.
	MODBUS_SLAVE_DEVICE_ FAILURE	File deletion error occurred when requested for deletion. The size of the data requested is too large (exceeding 250 Bytes). Invalid record number (exceeding 0×270F). Invalid record length (exceeding 0×07A).
MODBUS_WRITE_FILE_ RECORD	MODBUS_ILLEGAL_ FUNCTION	Invalid data size (0×09 ≤ data length ≤ 0×FB).
	MODBUS_ILLEGAL_DATA_ ADDRESS	Reference type does not meet the specification. The file to be written failed to open.
	MODBUS_SLAVE_DEVICE_ FAILURE	The requested file does not exist. The requested file is read-only. Failed to write the required number of bytes.

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4.9 Device status

The parameters of the device status and the device battery status are available in the parameter tree dialogue.

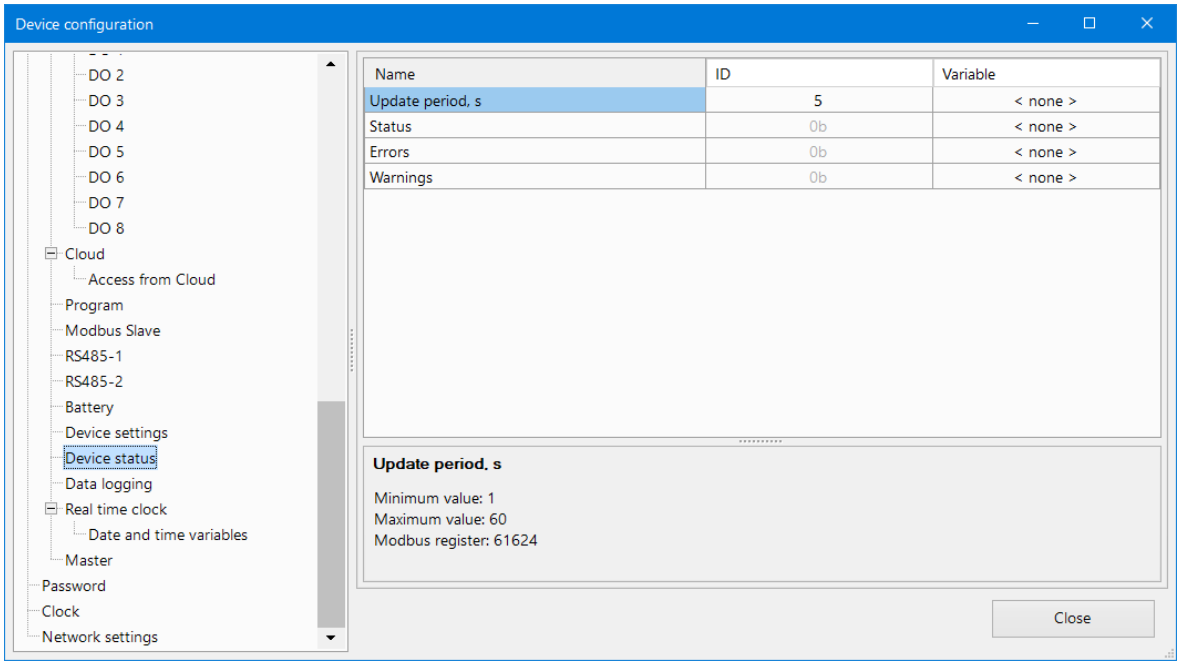


Fig. 4.20 Device status parameters in ALP

Table 4.20 Description of the parameter Errors values

Value	Description	Note
0	No base clock frequency	The errors are checked once at the device start
1	Microcontroller ID is not correct	
2	Microcontroller freezing caused by a hardware-dependent software error	
3	The flash-memory SPI bus is not initialized or a not supported flash-memory type installed	
4	RTC error	
5	Watchdog timer error	The errors are checked periodically during the device operation
6	Retain error	
7	Logic initialization error	

Table 4.21 Description of the parameter Warning values

Value	Description	Note
0	Battery warning	The errors are checked periodically during the device operation
1	Ethernet warning	
2	Safe state warning	

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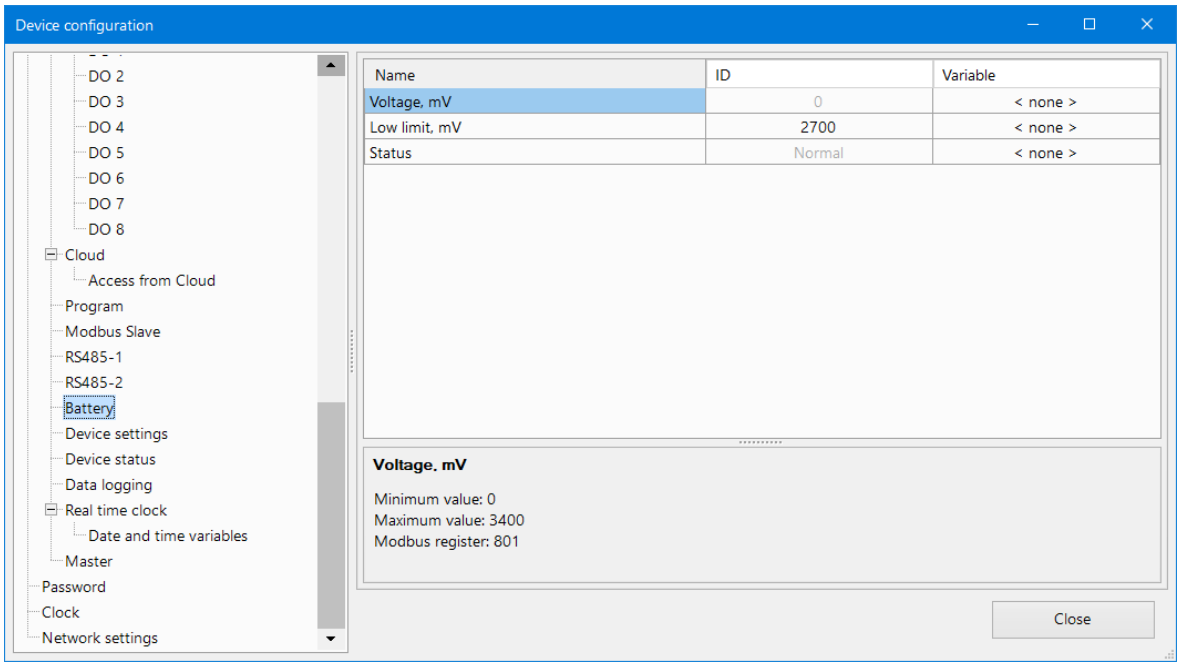


Fig. 4.21 Battery status parameters

Table 4.22 Possible states of battery parameter Status

Value	Description
0	Battery is OK
1	Battery is discharged

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4.10 Device configuration

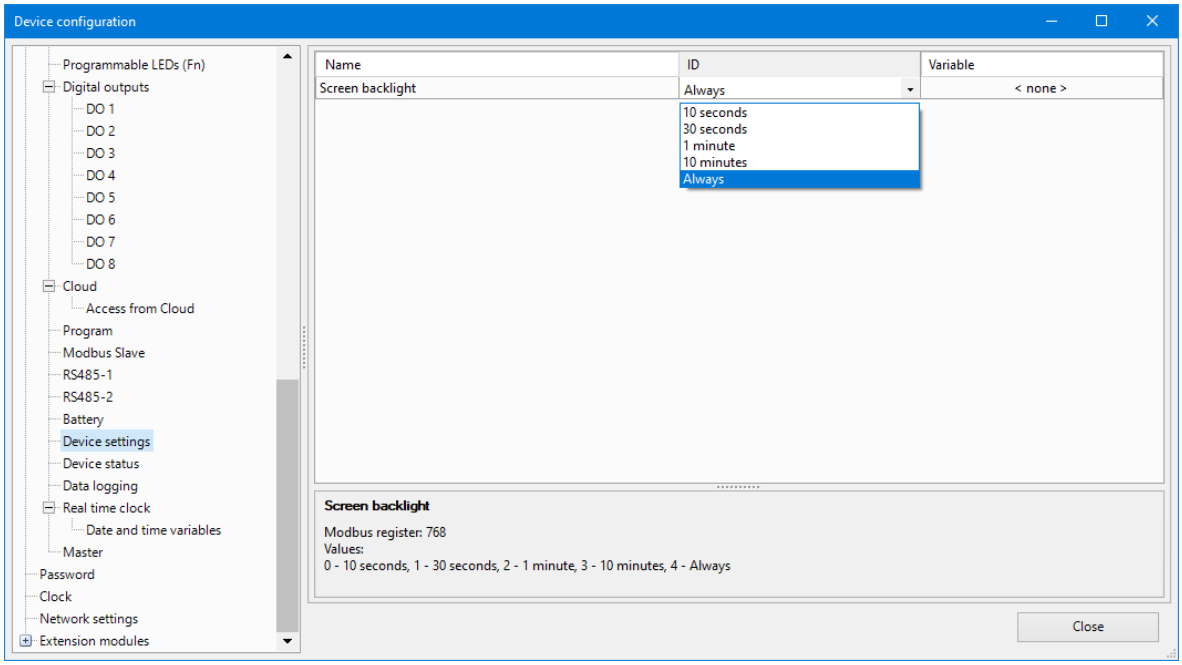


Fig. 4.22 Device configuration

Parameter	Description
Backlight	Display backlight duration. Settings: – Always – 10 seconds – 30 seconds – 1 minute – 10 minutes

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4.11 Operation with akYtec Cloud

NOTE
To connect to the akYtec Cloud server, open port 26502 in the local area network. Specify Google Public DNS (8.8.8.8) as a DNS server in the settings of the connected devices.

The device must be powered externally and connected to the Internet via the Ethernet interface. To connect to akYtec Cloud you should:

1. Connect the device to the PC and create a project using network variables.
2. Set a password to access the device (see *Section 4.7.1*).
3. In the Device configuration window, allow access to akYtec Cloud.

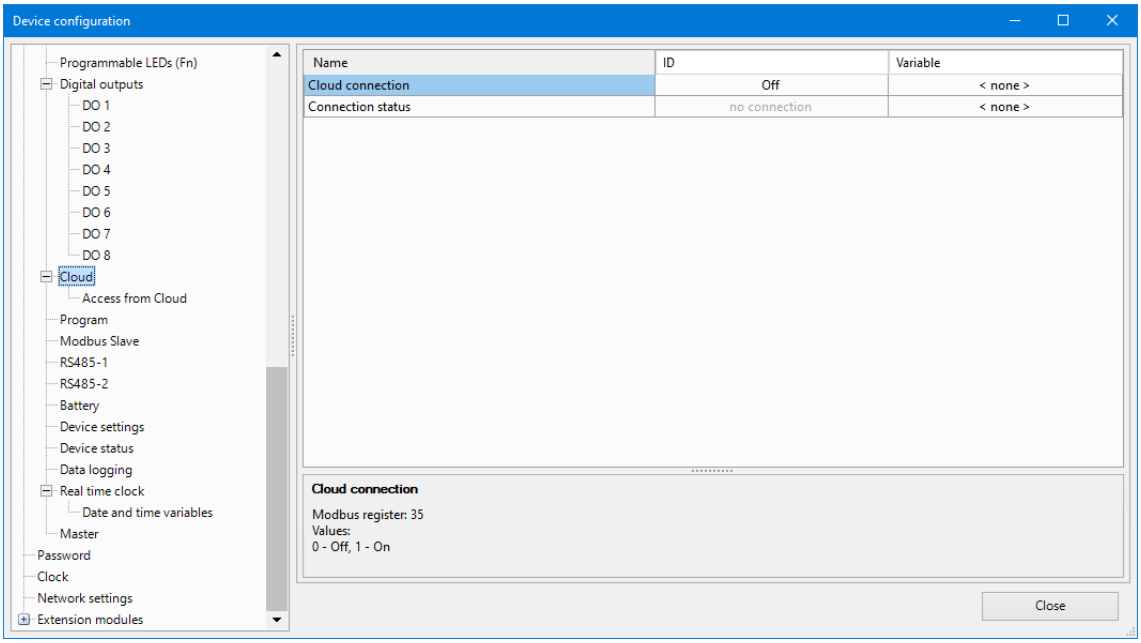


Fig. 4.23 Device configuration window

NOTE
The value of the **Cloud connection** status parameter can be read via Modbus or a user program variable can be linked. The parameter description is given in the table below.

Table 4.23 Possible states of the Cloud connection parameter

State	Value	Description
no connection	0	Cloud sharing is disabled
identification	1	Establishing connection to Cloud
normal operation	2	Cloud controls the device, no errors
network error	3	The device cannot establish a connection to the Cloud server
no password	4	The password for the device is not set

4. Allow remote access to Modbus registers.

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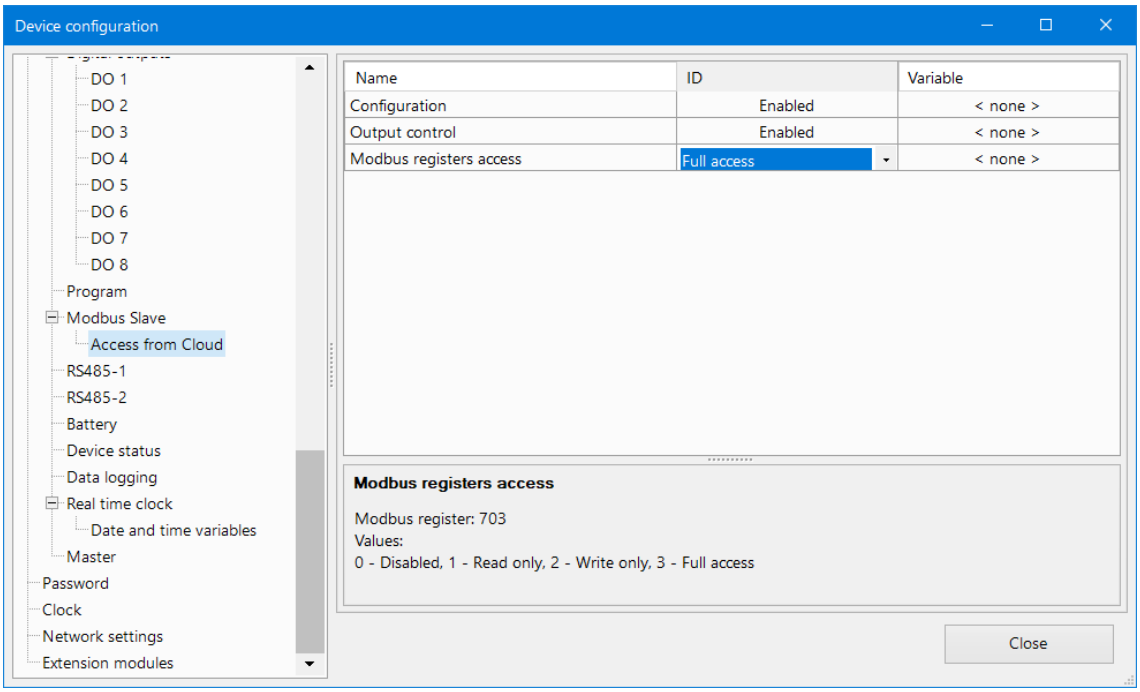


Fig. 4.24 Modbus registers access

NOTE
It is also possible to configure the device for akYtec Cloud operation using akYtec ToolPro. However, network variables will not be available if the program is not loaded.

5. Load the program into the device **(Device → Load the program into the device**).

NOTE
Make sure the **Run/Stop** switch is in the **ON** position.

6. Go to the main page of the *Cloud* service. If there is no registration, then you need to go through the registration procedure.
7. Go to the **Administration** tab, open the **Devices** tab and click the **Add device** button (Add).
8. A window will appear with a choice of the device type.

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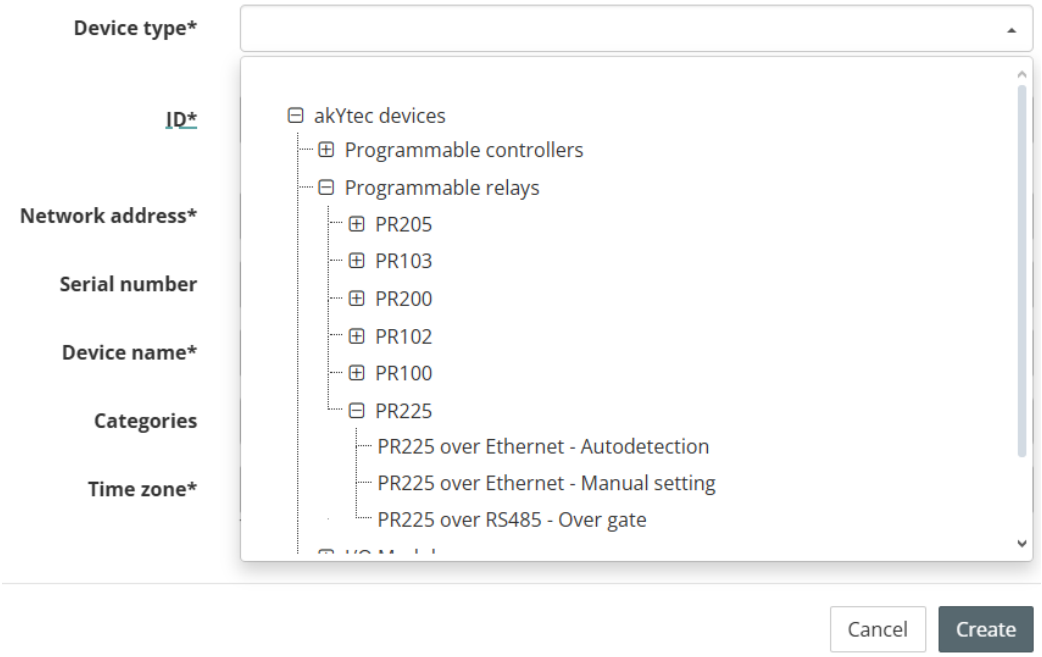


Fig. 4.25 Selecting the device type

Option **PR225 via Ethernet - Autodetection**:

a. In the resulting window, in the fields:
   – **ID**: enter the serial number of the device
   – **Network address**: leave unchanged address **1**
   – **Device name**: enter the name of the device
   – **Time zone**: specify the time zone in which the device is located

b. Click the "Add" button. The basic settings interface of the device will open.

c. Enter the password for the device. If necessary, you can change other settings (for example, the polling period).

d. Click the "Save" button to apply the new settings.

e. Cloud will connect to the device and read all parameters from it.

Option **PR225 via Ethernet - Manual setup**:

a. In the resulting window, in the fields:
   – **ID**: enter the serial number of the device
   – **Network address**: leave unchanged address 1
   – **Device name**: enter the name of the device
   – **Time zone**: specify the time zone in which the device is located

b. Click the "Add" button. The general settings interface of the device will open.

c. Click the **Create** button to apply the new settings.

d. In the Parameters/Parameter settings tab, add the network parameters of the device in the following way:
   – As a *.json file, if you use the **Device Export** extension in akYtec Cloud ALP. To add parameters, click on the **Import** drop-down list and select the **Load from JSON** option. In the menu that opens, select the previously created file in *.json format and click the **Load parameters** button.

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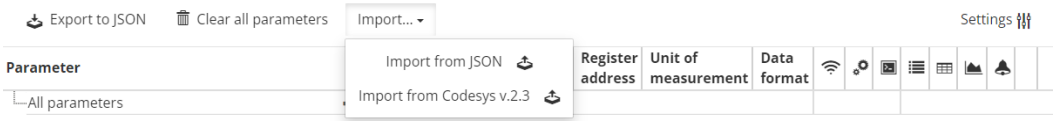


Fig. 4.26 Import parameters

Option **PR225 via RS485 - Through a gateway**:

a. In the resulting window, in the fields:
   - **ID**: enter the factory number of the gateway
   - **Network address**: set the network address in accordance with the address of the port to which the gateway is connected
   - **Device name**: enter the name of the device
   - **Time zone**: specify the time zone in which the device is located

b. Click the "Add" button. The Cloud sharing setup window will appear.

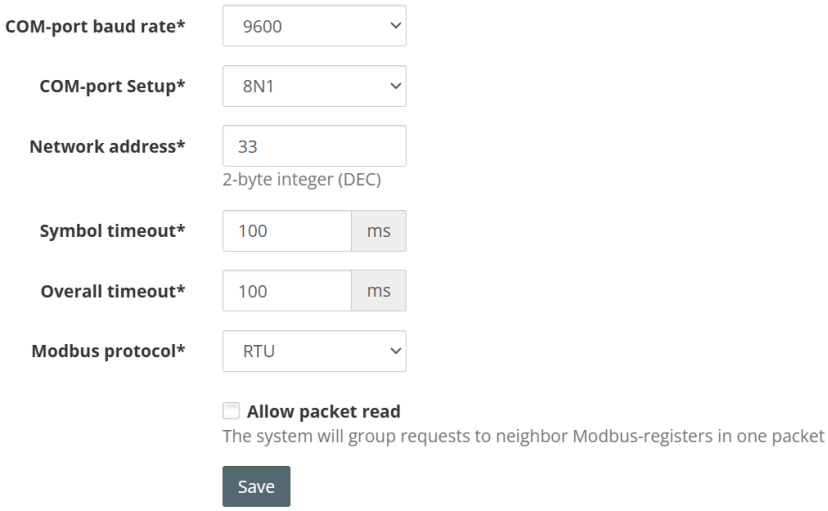


Fig. 4.27 Cloud Sharing Settings

Fields:
- **COM-port Baud rate**
- **COM-port**: set the **COM port** according to the address of the port to which the gateway is connected
- **Modbus protocol**: enter the name of the device

The fields must correspond to the similar settings of the port to which the gateway is connected.

c. Click the **Create** button to apply the new settings.

d. In the **Parameters/Parameter settings** tab, add the network parameters of the device in the following way:
   - as a *.json file, if you use the **Device Export** extension in akYtec Cloud ALP. To add parameters, click on the **Import** drop-down list and select the **Load from JSON** option. In the menu that opens, select the previously created file in *.json format and click the **Load parameters** button.

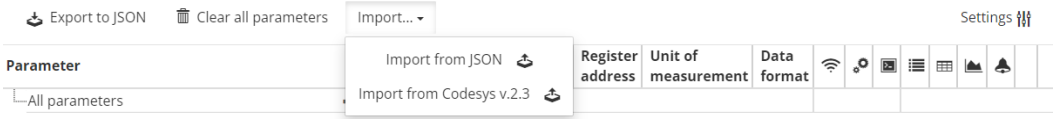


Fig. 4.28 Import parameters

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If all settings were correct, then the **General Data** tab will display data from the device. If the device is not polled from Cloud, then you should check the network settings, the connection status to Cloud.



Fig. 4.29 Example display of connection to Cloud

If the values are not written to the device from Cloud, you should check if the checkbox in the **Manageable Parameter** column is checked:



Fig. 4.30 Controlled parameter

4.12 Real-time clock

For setting the clock, open the ***Clock*** node in the ALP configuration dialog.

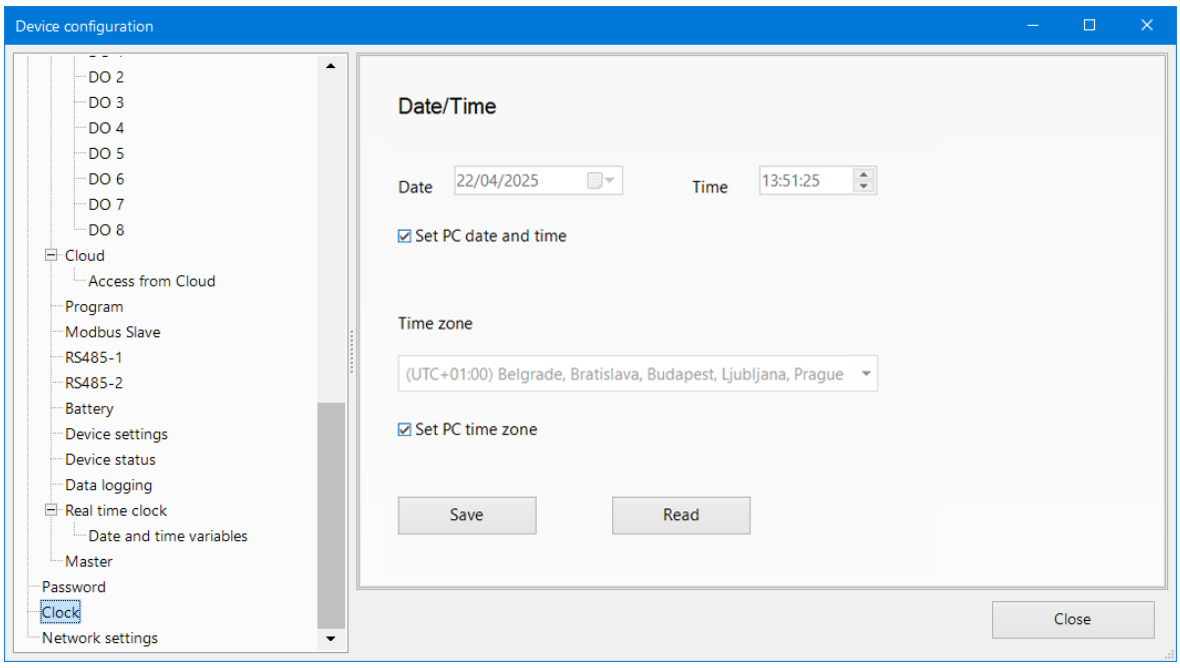


Fig. 4.31 Date and time settings

Table 4.24 Clock settings

Parameter	Description
Set PC date and time	As the box is checked, the PC date and time will be recorded to the device after pressing the ***Save*** button
Set PC time zone	As the box is checked, the PC time zone value will be recorded to the device after pressing the ***Save*** button

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The user program variables can be assigned to the settings of the RTC parameters in order to change the RTC settings in the user program. Proceed to the ***Real time clock*** tree to assign the user program variables.

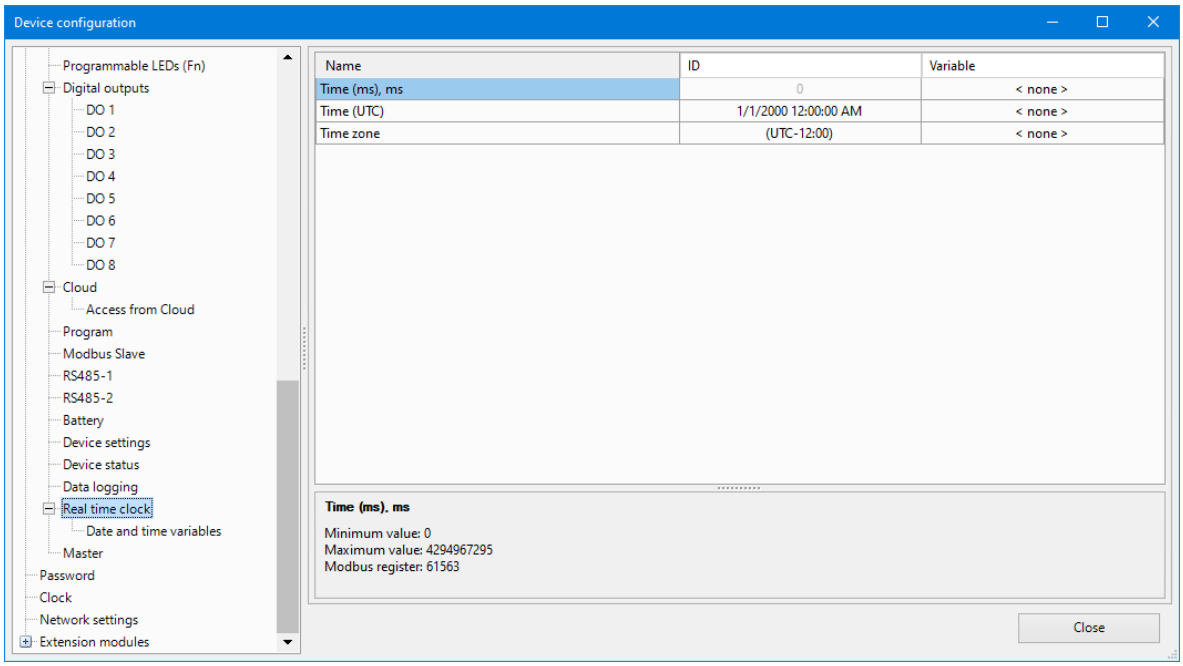


Fig. 4.32 Assignment of variables to the RTC settings

Table 4.25 RTC setting parameters

Parameter	Description
Time (ms)	The device operation time starting from the powering the device from either USB or external power supply
Time (UTC)	The real time counted as UTC in seconds, starting from 0:00 01.01.2000
Time zone	The parameter is for setting the appropriate time zone of the device location

The user program variables can be assigned to the RTC date and time setting values. In the same ALP dialog tree, proceed to node ***Date and time variables*** to assign the user program variables.

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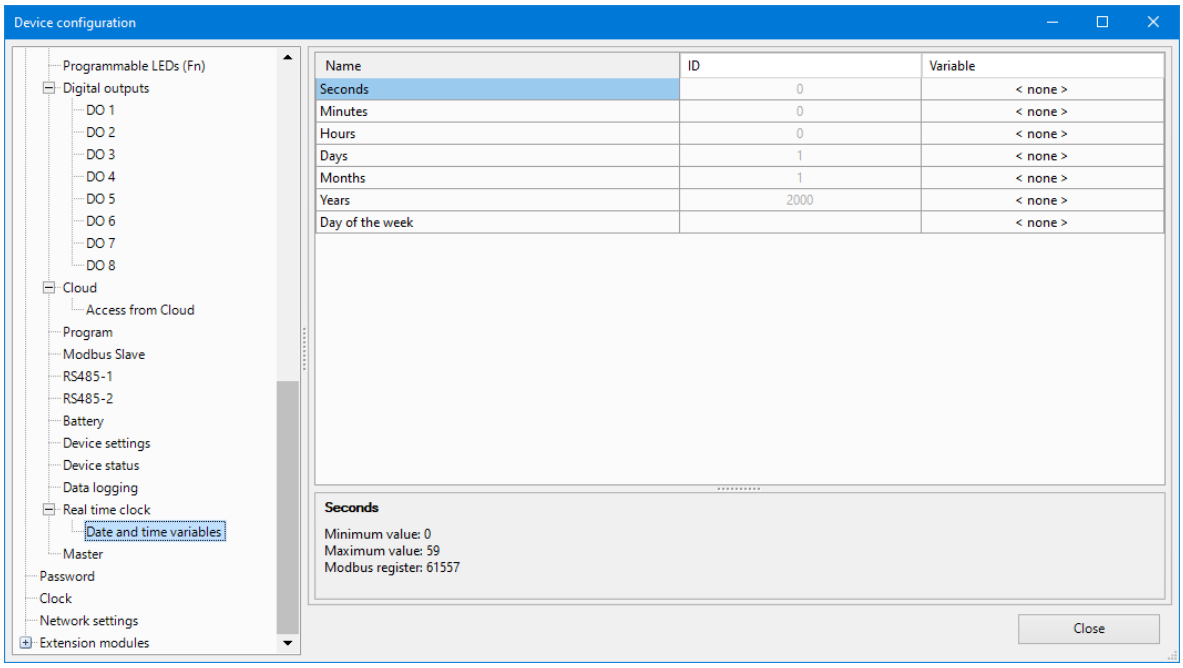


Fig. 4.33 Assignment of variables to the RTC date and time setting values

4.13 Factory settings restoration

CAUTION
After restoring the factory settings:
- ***user program is deleted***
- ***password is deleted***
- ***all parameters (except for the Ethernet IP addresses) are reset to factory values***

To restore the factory settings:

1. Power on the device.
2. Using a thin tool, press and hold the service button for at least 12 seconds.
3. Release the button. The device will restart and all parameters will be reset to factory values.
4. Power off the device.

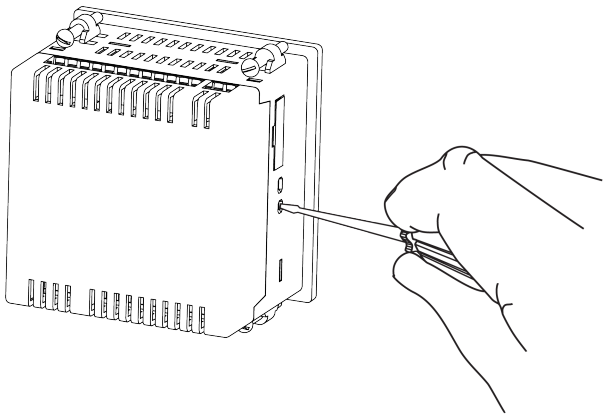


Fig. 4.34 Factory settings restoration

When switched on again, the device starts with the factory settings.

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5 Installation

5.1 Montage

The relay is designed for mounting into a control board. The operating conditions (see *Section 3.2*) should be taken into account when choosing the installation site.
The device is to be mounted in enclosures, cabinets, etc. with protection of the device from dust, moisture, and foreign objects.
To install the device:

1. Prepare an installation cut-out in the control board (see *Fig. 5.2*).
2. Make sure that the gasket is not damaged and seated properly on the device housing.
3. Insert the device into the installation cut-out.
4. Insert the supplied brackets into the holes on the upper and lower surfaces of the device.
5. Screw the supplied screws into the holes of each bracket so that the device is firmly and evenly pressed against the front side of the board.

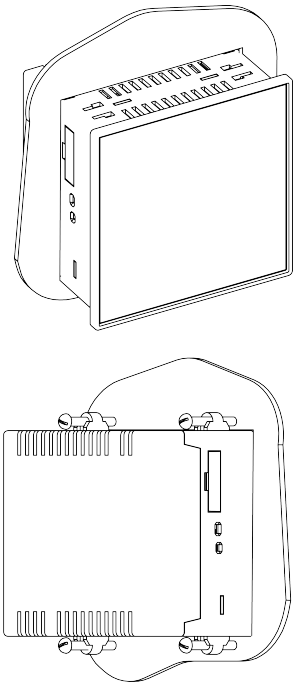


Fig. 5.1 Installation

Reverse the procedure to dismantle the device.

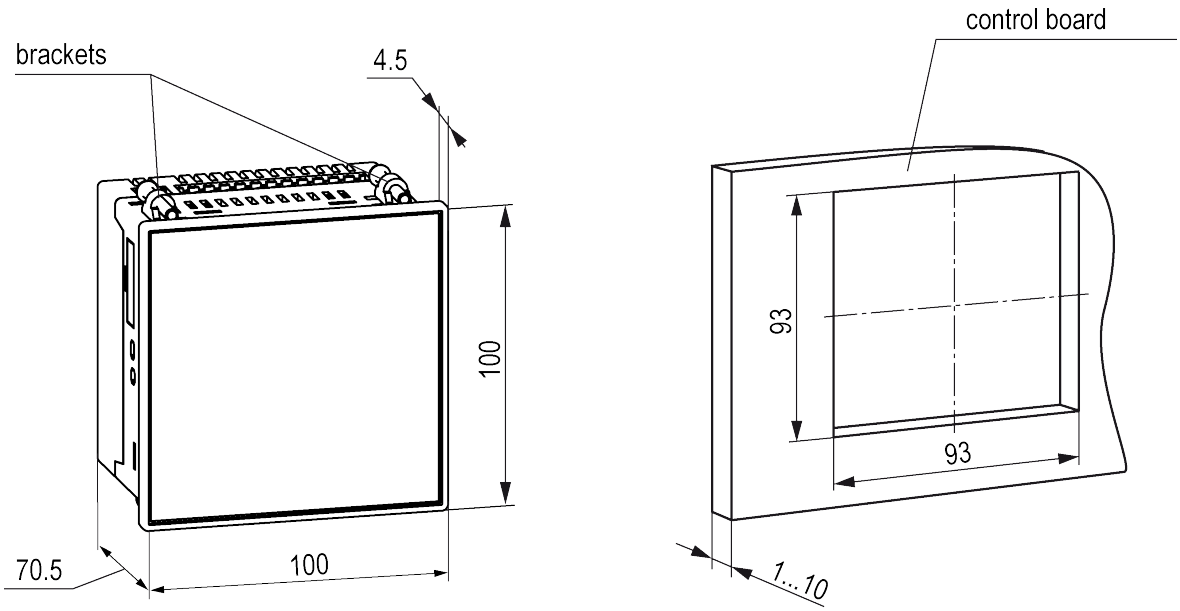


Fig. 5.2 Overall and installation cut-out dimensions

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5.2 Quick replacement

Relay is equipped with plug-in terminal blocks which enable quick replacement of the device without disconnecting the existing wiring.
For the device quick replacement, follow the steps below:

1. Power off all connected lines including power supply.
2. Using a screwdriver or a similar tool, unplug the terminal blocks with existing wiring connected (see *Fig. 5.3*).
3. Unscrew the screws and remove the brackets.
4. Remove the device out of the installation cut-out and install another PR225 of the same modification (with the terminal blocks unplugged).
5. Plug the terminal blocks with existing wiring into mating connectors of the PR225 installed.

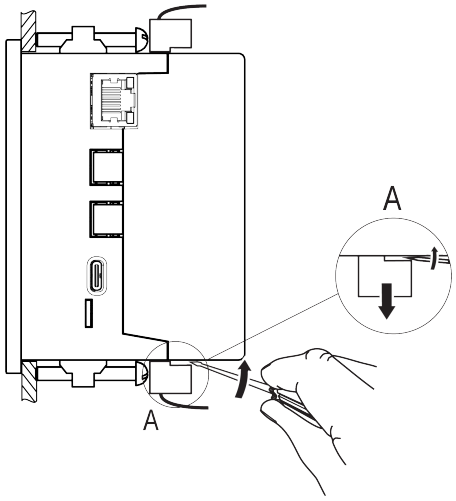


Fig. 5.3 Quick replacement

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6 Wiring

6.1 Wiring recommendations

CAUTION
Do not use the device power terminals for powering any other equipment !

In order to ensure reliable electrical connections, use stranded copper wire cables. Twist and tin the wire conductors or terminate them using cable ferrules. Strip off the wire insulation, so that the exposed wire ends would not extend beyond the terminal blocks when connected. The wire cross-section must not exceed 2.5 mm^2.
Connect the USB Type-C programming connector of the device to PC USB port for transferring the user program to the device.

CAUTION
The device must be powered off before connecting to peripheral equipment or PC. Switch on the power supply only after the wiring of the device is completed.

Analog inputs and outputs, as well as transistor outputs and the USB interface of the device are not galvanically isolated. In order to prevent the device damaging, ensure the equipotential grounding of the equipment which are connected to these inputs and outputs. If it is not possible, do not connect the external equipment to the analog inputs and outputs, the transistor outputs and the USB interface simultaneously. Disconnect external cables from the analog inputs and outputs, as well as from the transistor outputs, when programming the device over the USB interface or use galvanic isolators (e. g. USB isolators, a battery-powered laptop, etc.).

NOTICE
It is prohibited to tie together the common grounds of the device inputs and outputs as well as connecting them to the earth ground of the enclosure where the device is installed.

NOTICE
In order to avoid a risk of high voltage at the device connectors, use power supplies with the reinforced isolation for powering sensors and other peripheral equipment connected to the analog and digital inputs of the device.

CAUTION
It is prohibited to power the device and the connected sensors from the same power supply!

6.2 Interference suppression

The device operation may be affected by electromagnetic interference (EMI) caused by external electromagnetic fields. EMI is induced in the device circuitry and the connected cables.
The following measures should be provided for EMI suppression:

– Use shielded signal cables. The cable shields must be electrically isolated from the peripheral equipment all along their routes. The shields of signal cables must be connected to an earthing terminal.
– Install the device in a metal enclosure with no any power equipment inside. The enclosure must be earthed.

In order to reduce the interference effect, use the program debouncing filters which can be set individually for each of the device inputs. The program debouncing filters are available for the following device inputs:

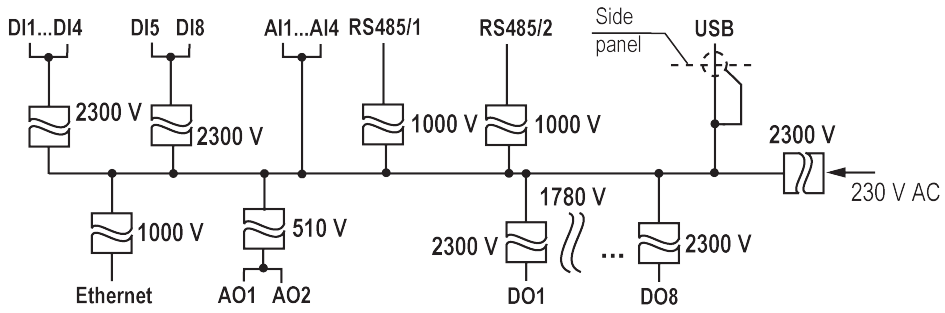
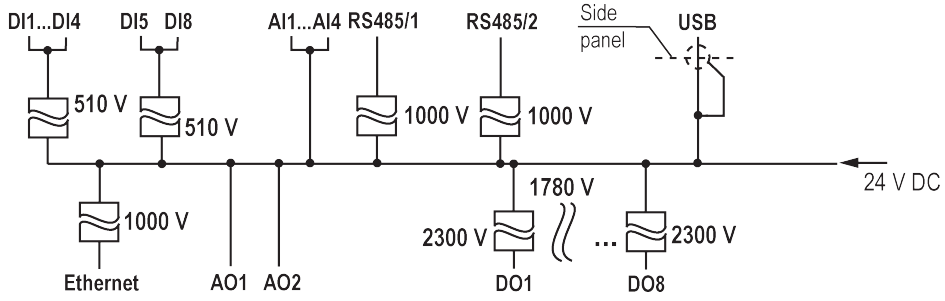
– Analog inputs.
– 24 V digital inputs.

NOTE
Increasing the debouncing time results in a slower device response while processing fast changing input signals.

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6.3 Galvanic isolation

Table 6.1 PR225 galvanic isolation

PR225 model	Galvanic isolation diagram
PR225.230.2.2	
PR225.24.2.2	

6.4 Sensors wiring

6.4.1 Digital inputs – switch contacts wiring

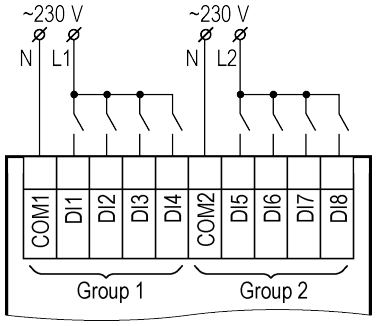


Fig. 6.1 DI – 230 V switch contacts wiring

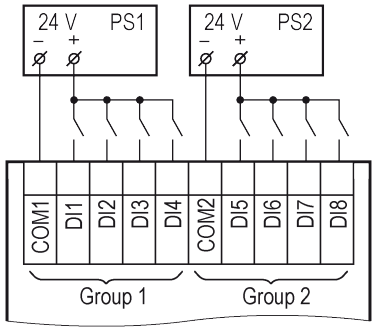


Fig. 6.2 DI – 24 V switch contacts wiring

NOTE
Check the connection polarity if the digital inputs do not operate.

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6.4.2 Digital inputs – push-pull, NPN and PNP output sensors wiring

Push-pull output sensor

The push-pull output of the sensor is wired directly to the device digital input.

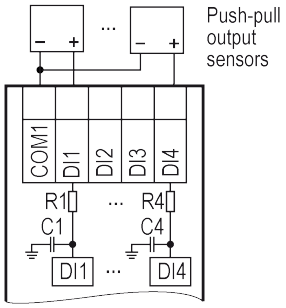


Fig. 6.3 Push-pull output sensor wiring

NPN output sensor

An additional resistor (R_D) must be used when connecting the sensor NPN transistor output to the device digital input (see the figure below).

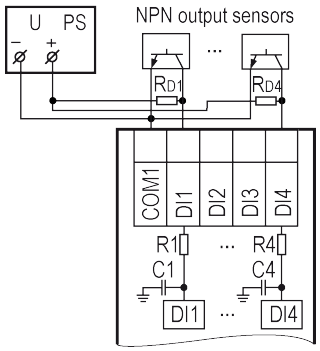


Fig. 6.4 DI – NPN output sensor wiring

The R_D maximum permissible value is calculated by the formula below:

$$R_D = \frac{U_{p.min} - U_{in.h.max}}{I_{in.max}} - R_{in} \qquad (6.1)$$

where
$U_{p.min}$ – minimum possible power voltage applied to the resistor (R_D).
$I_{in.max}$ = 2.75 mA – maximum input current of the digital input.
$U_{in.h.max}$ = 8.55 V – LOW to HIGH threshold maximum voltage.
R_{in} = 56 Ω – serial resistor in the device.

Example:
Given R_D is powered with 12 V,
assume $U_{p.min}$ is equal to 9 V.
Thus, resistance R_D calculated by *formula 6.1* must not exceed the value of 107.636 Ω.

Example:
Given R_D is powered with 24 V,
assuming the possible supply voltage decline is up to 15%,
determine the minimum possible power voltage as $U_{p.min}$ = *24 V · (100 % - 15 %) = 20.4 V*
Thus, resistance R_D calculated by *formula 6.1* must not exceed the value of 4.253 kΩ.

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PNP output sensor

There is no need for an additional resistor when connecting a PNP output sensor to the device digital input.

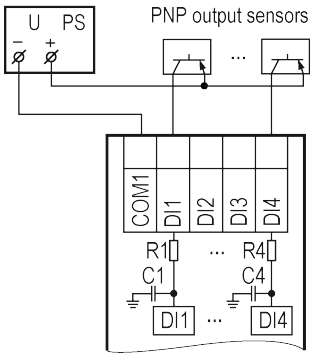


Fig. 6.5 DI – PNP output sensor wiring

Table 6.2 The applicable additional resistor R_D values

Type of sensor output	Power supply voltage (U)	R_D maximum permissible value
NPN transistor	12 V	107 Ω
	24 V	4253 Ω
PNP transistor	Not required	

6.4.3 Analog inputs – digital output sensors wiring

NOTICE
Before connecting digital output sensors to the analog inputs, make sure that the analog inputs are configured for operation in the digital mode.

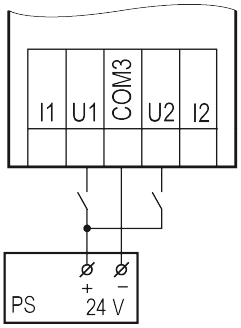


Fig. 6.6 AI (digital mode) – 24 V switch contacts wiring

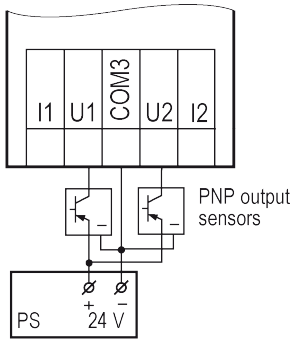


Fig. 6.7 AI (digital mode) – 3−wire PNP open collector output sensor wiring

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NOTE
The COM3 terminals are internally connected.

6.4.4 Analog inputs – analog output sensors wiring

NOTICE
Before connecting analog output sensors to the analog inputs, make sure that the analog inputs are configured for operation in the analog mode.

Please refer to *Section 4.2.1* for configuration of the analog inputs.

CAUTION
Before connecting analog output sensors, make sure that the input signal selected in the configuration settings corresponds to the connected one.

NOTICE
In order to protect the device input circuitry from a possible ESD damage caused by a possible static charge accumulated on "the device - sensor" cables, connect the cable conductors to a functional earth (FE) terminal for 1–2 seconds before connecting to the device.

Disconnect the device from the power supply when checking the functionality of the sensors and the connection cables.
In order to prevent the device damage, use the measuring instruments with the maximum supply voltage of 4.5 V for ring-out. Disconnect sensors from the device if the supply voltage of the measuring instruments exceeds 4.5 V.
The parameters of the connection cables used for connecting sensors to the device are given in the table below.

Table 6.3 Sensor cable requirements

Type of the sensor output	Cable length, max. (m)	Total resistance, max. (Ω)	Type of the connection wiring
Resistive output signal	100	* see note below	2-wire (two wires of the same length and cross-section)
Unified current output signal (DC)	100	100	2-wire
Unified voltage output signal (DC)	100	5	2-wire

NOTE
**** For the resistive sensor 2-wire connection, the resistance of the wires connected to the sensor is added to the sensor output resistance, thus, introducing a proportional error into the measurement. The additional resistance of the connecting wires must be taken into account when connecting the sensor to the device. Also, the additional resistance of the connecting wires must be considered to correlate with the sensor output operating range.***
For example, having an RTD Cu 500 (α = 0.00428 °C^{-1}) for measuring the temperature in the range from –50 °C to +200 °C, the RTD output resistance range is from 393.5 Ω to 926 Ω. Therefore, the sensor output operating range is 532.5 Ω. Thus, the additional resistance of the wires of 1 Ω will introduce the error (1×100) / 532.5 = 0.19% into the temperature measurement.

The 2-wire connection is used for the RTD wiring.

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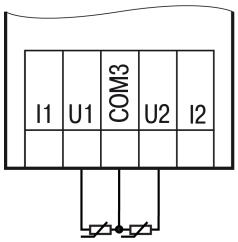


Fig. 6.8 RTD sensors wiring

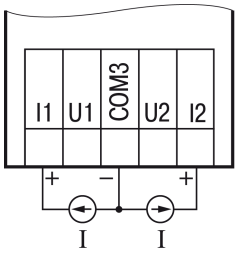


Fig. 6.9 Current sensors wiring

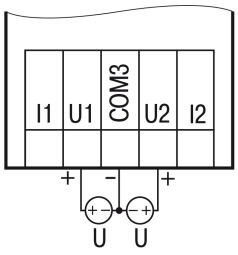


Fig. 6.10 Voltage sensors wiring

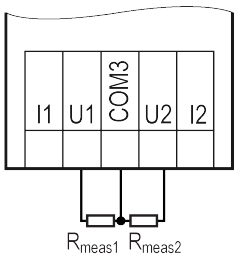


Fig. 6.11 Resistance sensors wiring

6.5 Output wiring

6.5.1 Digital outputs

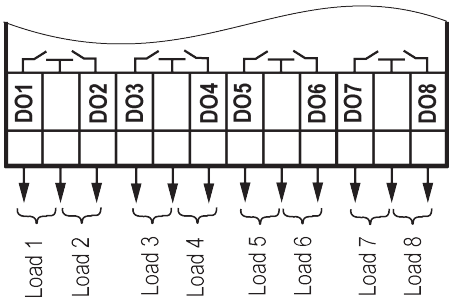


Fig. 6.12 Relay outputs wiring

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6.5.2 Analog outputs

NOTE
Analog outputs require external voltage supply.

CAUTION
The external supply voltage may not exceed 30 V. Higher voltage can damage the device.

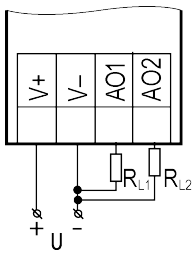


Fig. 6.13 Current output wiring (4-20 mA output mode)

Load resistance for the 4-20 mA output signal must not exceed 600 Ω.

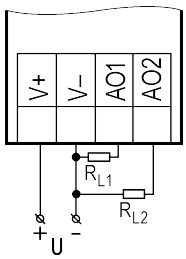


Fig. 6.14 Voltage output wiring (0-10 V output mode)

Load resistance for the 0-10 V output signal must not be lower than 600 Ω.

6.6 RS485 connection

Line reflections can occur at the open bus ends (the first and the last node) resulting in data transfer errors. The higher the chosen data transmission rate, the stronger reflections are. A termination resistor (R_T) can minimize reflections and, therefore, the data transfer errors. In order to ensure the efficient elimination of the data transfer errors, the termination resistor value must be as close to the characteristic impedance of the RS485 bus as possible. The characteristic impedance of standard RS485 bus cables is 120 Ω.

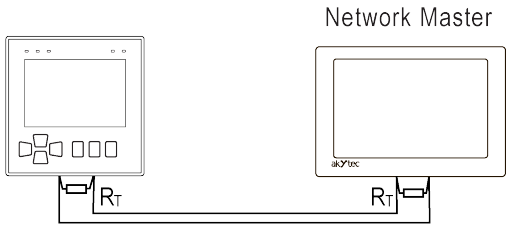


Fig. 6.15 Typical RS485 connection – PR225 as Slave

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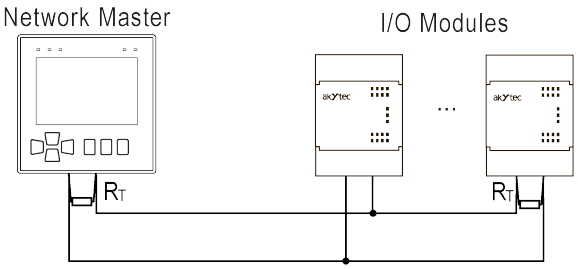


Fig. 6.16 Typical RS485 connection – PR225 as Master

6.7 Ethernet connection

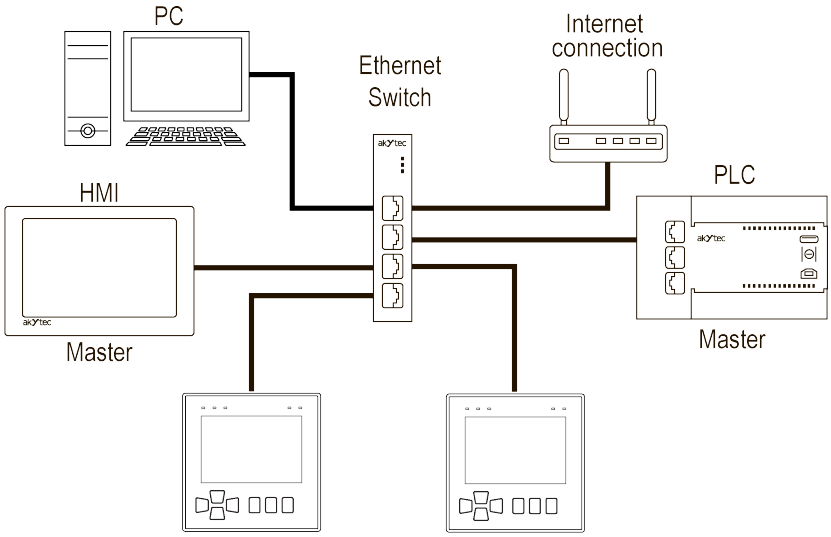


Fig. 6.17 Star topology

6.8 Connection to akYtec Cloud

NOTE
Only a configured device should be connected to akYtec Cloud.

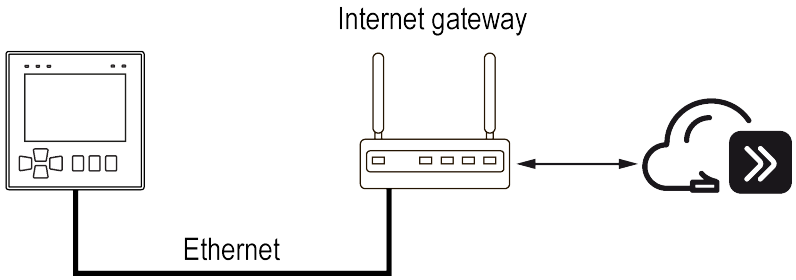


Fig. 6.18 akYtec Cloud connection

Use the Ethernet interface for the connection. Communication with akYtec Cloud and device polling via Modbus TCP can be performed simultaneously.
Settings of akYtec Cloud operation are given in *Section 4.11*.

6.9 PC connection

Use the USB type-C to USB A cable for connecting the device to PC over USB interface or use the Ethernet cable for connecting the device to PC over Ethernet.

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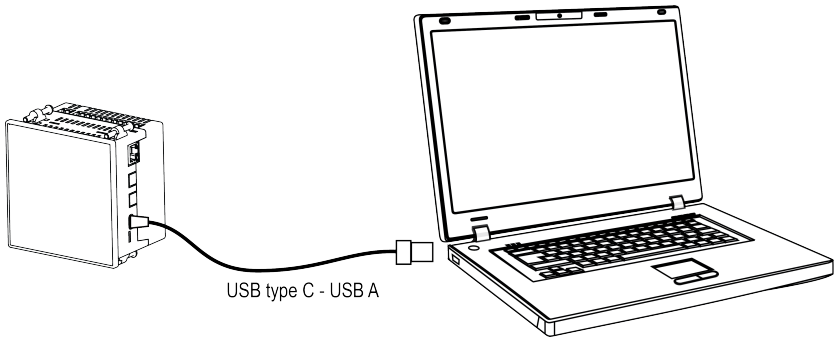


Fig. 6.19 Connecting PR225 to PC over USB

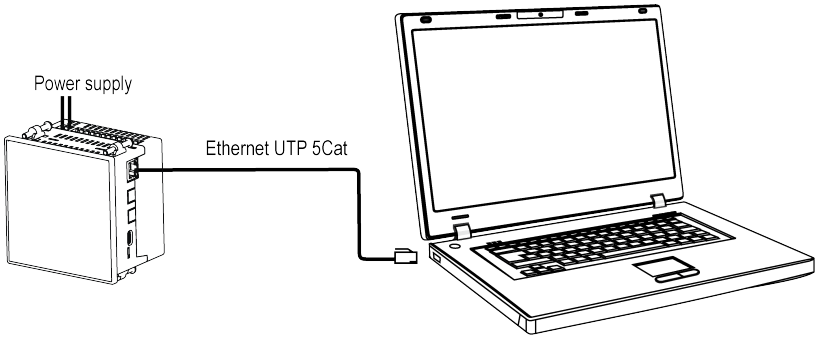


Fig. 6.20 Connecting PR225 to PC over Ethernet

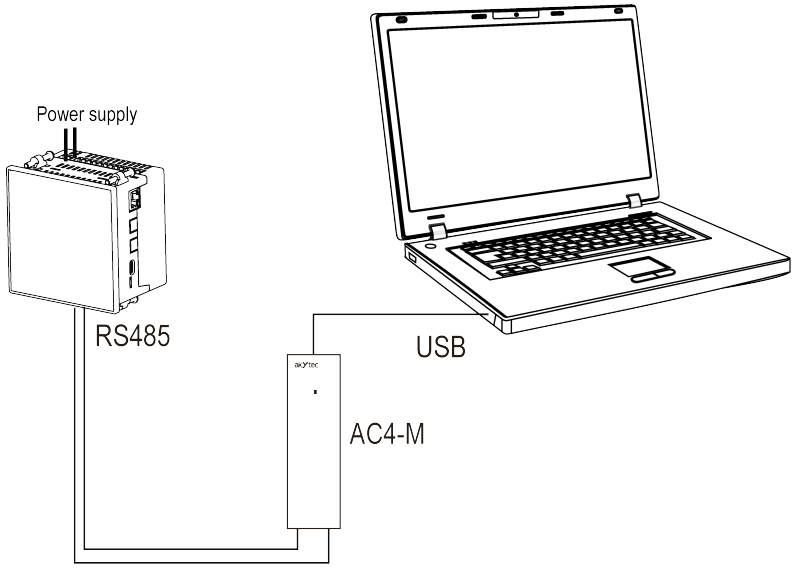


Fig. 6.21 Connecting PR225 to PC over RS485

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7 Operation

7.1 Indication, controls and interfaces

Functions of the PR225 buttons can be divided into two groups: basic and programmable. The basic functions are given in the table below. The programmable functions are described in *Section 7.7*.

Table 7.1 Buttons

Button	Description
View mode	
and	Screen navigation. Move to the next screen when the selected area is on the border of the current screen.
OK	Press and hold for 6 seconds to enter the system menu.
ESC	Press and hold for 6 seconds to exit the system menu.
SEL + ESC	Move to the Error panel.
Edit mode	
SEL	Enter the edit mode on the current screen. When pressed, the first editable element on the screen becomes available for editing and starts flashing. Apply a value and move to the next parameter.
and	Change the parameter value. Press and hold to accelerate the value change.
and	Move one level higher or lower. When moving to the maximum level, it jumps to the lowest one.
+	Move to a lower level.
+	Move to a higher level.
ESC	Exit the edit mode without saving the edited value.
OK	Exit the edit mode and save the edited value.

Table 7.2 Functional assignment of the LED indicators

LED	Color	Status	Description
⏻	green	ON	Power is on
⚠	red	ON	Error (see *Section 7.9.2*)
		Flashing*	Failure in the device. Contact the service center
F1	green	—	To be defined by user's program
F2	red		
⏀	red green	OFF Flashing	The RUN/STOP switch is in the **STOP** position. The device operates in the I/O mode (see *Section 7.9.3*)
	red green	ON OFF	No power on terminals 13 and 14. Powered by USB.

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LED	Color	Status	Description
	red green	OFF OFF	User's program is not loaded. PR225 is not configured
	red green	OFF ON	The RUN/STOP switch is in the **RUN** position. User's program is running
	red green	Flashing* ON	The RUN/STOP switch is in the **RUN** position
	red green	OFF Flashing*	The RUN/STOP switch is in the **STOP** position
	red green	Flashing* OFF	PR225 is not configured
	red green	Flashing with a period ON	Error (see *Section 7.9.2*)
	red green	ON ON	Expecting for the start of the firmware boot
	red green	Flashing Flashing	Boot is in progress
* Flashing together with ⚠ means that the RTC battery is discharged			

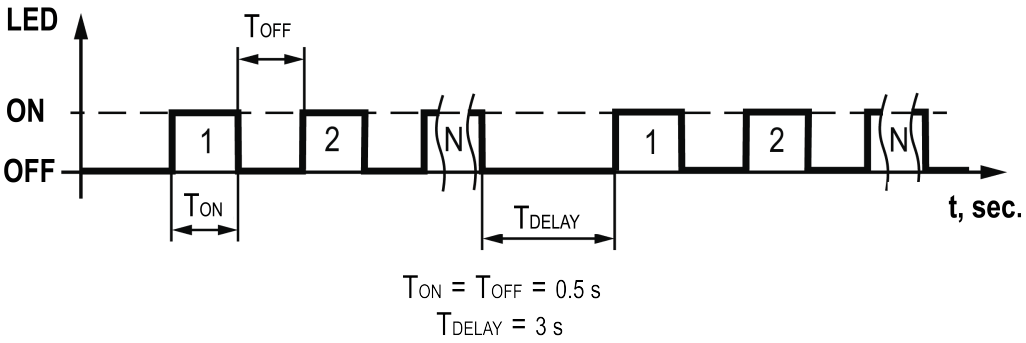


Fig. 7.1 Fatal and non-fatal errors indication diagram

Table 7.3 Fatal errors indication

Number of LED pulses (N)	Description
1	PR225 built-in microcontroller error
2	
3	
4	Internal bus initialization failure
5	Built-in RTC pulse generator failure
6	Cyclic reboot caused by incorrect user's program
7	Retain error
8	Memory size is not sufficient for user's program
9	PCB version installed is not correct

Table 7.4 Non-fatal errors indication

Number of LED pulses (N)	Description
1	RTC and retain memory battery discharged
3	Ethernet interface failure

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For detailed information on PR225 errors, see *Section 7.9.2*.

Table 7.5 RUN/STOP switch

Position	Function
RUN	When the device is powered on, the user program starts.
STOP	When the device is powered on, it functions as an I/O module. The user program is stopped.

Table 7.6 Service button

Duration of pressing	Function
12 s	Restoration of the device factory settings (see *Section 4.13*)

The Ethernet port is equipped with the two status LEDs. The LEDs indication modes are described in the figure and the table below.

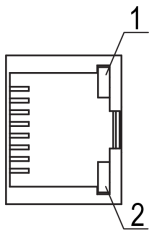


Fig. 7.2 Location of the Ethernet LEDs: 1 – green, 2 – amber

Table 7.7 Functional assignment of the Ethernet port LEDs

LED	Status	Description
Green	OFF	No connection established
	ON	Connection established
	Flashing	Data transfer is in progress
Amber	OFF	Data transfer rate is 10 Mbit/s
	ON*	Data transfer rate is 100 Mbit/s

NOTE
**** With the Ethernet cable disconnected it indicates that the Ethernet port is powered.***

7.2 LCD functions

The LCD is designed to display graphical and textual information. You can create controls in the user-defined forms. In ALP, it is possible to create several forms displaying the state of a managed object including controls. The forms are interconnected by jumps.
The following types of graphic objects are supported:

– indicator,
– progress bar,
– dynamic text,
– label,
– float/int,

etc.
The full list of supported items is presented in the *akYtec ALP User Manual*.
The LCD can display a set of characters within the Windows-1251 encoding. Additional supported symbols and characters see in the table below:

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Table 7.8 Additional characters

Description	Symbol
Degree	°
Squared	²
Cubed	³
Alpha lowercase*	α
Beta lowercase*	β
Gamma lowercase*	γ
Delta uppercase*	Δ
Eta lowercase*	η
Sigma uppercase*	Σ
Tau lowercase*	τ
Phi lowercase*	φ
Psi lowercase*	ψ
Omega uppercase*	Ω
Number	№

NOTE
* Supported in ALP 2.8.361 and later versions.

Display elements can be editable and non-editable, depending on the type of element and its properties set using ALP.

7.3 Working with the menu

The device has a user menu and a system menu.
The user menu is created in ALP with the help of **Display Manager**. To specify “jumps”, use buttons or change a variable. The system menu is always present in the device, even if there is no user program written to it. The principles of working with the user menu and the system menu are similar.
It is possible to work with the menu in the following modes:

– view mode;
– edit mode.

In the **View** mode, you can view the device parameters or the user menu.
In the **Edit** mode, you can edit the device parameters in the system menu or the user program from the front panel without stopping the device. When you re-enter the Edit mode, the last edited element is selected.

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7.4 System menu

The device system menu is available from any program screen, when there is no user program in the device memory. Press and hold button OK for 6 seconds to access the menu. Press and hold button ESC for 6 seconds to exit the menu.
The menu structure is presented in the figure below.

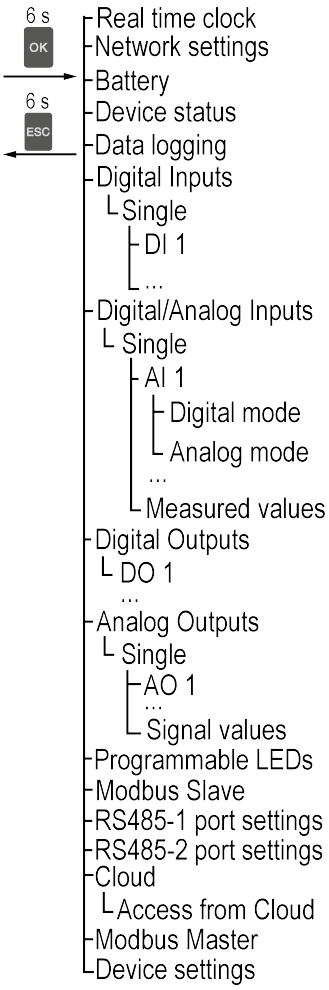


Fig. 7.3 Menu structure

Table 7.9 System menu items

Item	Description
Program	Cycle time values and user program status are displayed
Digital inputs	The parameters are similar to those described in *Section 4.2.2*
Digital outputs	The parameters are similar to those described in *Section 4.3.1*
Digital/Analog inputs	The parameters are similar to those described in *Section 4.2.1*
Analog outputs	The parameters are similar to those described in *Section 4.3.2*
Programmable LEDs	The parameters are similar to those described in *Section 4.4*
Modbus Slave	The parameters are similar to those described in *Section 4.8.4*
Modbus Master	The node contains the device polling parameters, similar to those configured in ALP

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Item	Description
Cloud	Settings and permissions for akYtec Cloud (see *Section 4.11*)
RS485 port settings 1 (2)	The parameters are similar to those described in *Section 4.8.2.2*
Data logging	The parameters are similar to those described in *Section 4.5*
Network settings	Contains the Ethernet settings (see *Section 4.8.2.1*)
Real time clock	The parameters are similar to those described in *Section 4.12*
Battery	The parameters are similar to those described in *Section 4.9*
Device status	The parameters are similar to those described in *Section 4.9*
Device settings	The parameters are similar to those described in *Section 4.10*
Password	The parameters are similar to those described in *Section 4.7.1*
Clock	The parameters are similar to those described in *Section 4.12*

NOTE
If there is a user program recorded in the device, branch **Program** is displayed in the settings tree with the only unchangeable parameter in it: **Cycle time, ms**.

7.5 Error panel

The Error panel displays the errors containing status register bits (see *Table 7.11*). To switch to the error panel, press buttons SEL + ESC.

7.6 Jumps between display forms

To navigate between display forms, a user can create “jumps” in akYtec ALP. Jumps are performed by pressing buttons and by changing a variable. For more information about jumps, see the akYtec ALP help.

NOTE
When assigning a jump condition to a function button, don't forget that the user function of the button has a higher priority than its system function.

Example:
Buttons ▲▲ and ▼▼ cannot be used to scroll the lines inside a display if they are used as the jump condition for it. Button SEL with the jump condition assigned to it does not allow a user to switch to edit mode.

7.7 Programmable buttons

Besides the main functions (see *Table 7.1*), the device buttons can have additional functions assigned to them. Additional functions are assigned with the help of *Button Editor* in akYtec ALP. User-defined functions are assigned to:

– short press (less than 2 seconds),
– long press (more than 2 seconds),
– hold.

NOTE
In akYtec ALP, you cannot set functions for short/long press and hold at the same time.

Functions assigned to a button:

– switch to a display,

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– change the value of a variable.

7.8 Auto-formatting mode

The auto-formatting mode displays a variable with maximum accuracy depending on the number of reserved characters. The auto-formatting mode is applied only for real variables. The mode can be enabled by selecting **Auto** in the "Decimal digits" field in akYtec ALP.

7.9 Modes of operation

As soon as the device is powered (either by main power or over USB), it reads the set position of the RUN/STOP. Then device runs self-testing.
Power over USB is sufficient for programming the device.

NOTE
When the device is powered over USB, the inputs, outputs and the remaining interfaces are disabled.

Once the main power is applied to the power terminals 13 and 14, the device starts the user's program if it has been loaded into the device memory.
The device operation modes are presented in the diagram below.

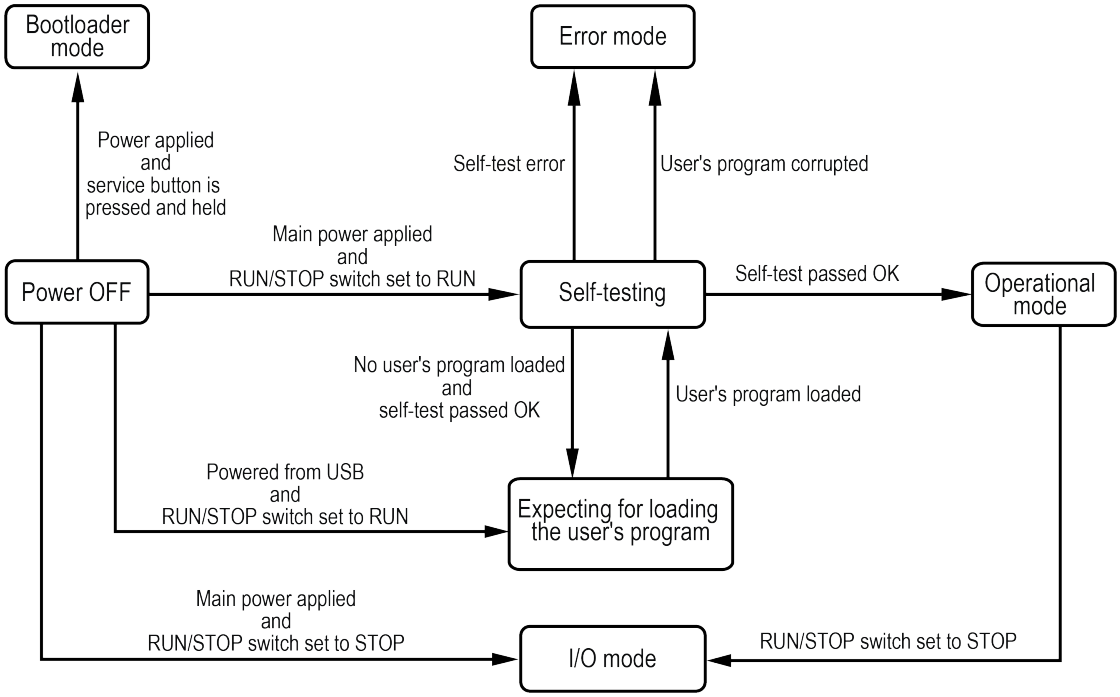


Fig. 7.4 Operation modes diagram

7.9.1 Operational mode

When the device enters the operational mode, it runs the operational cycle which includes the sequence of the steps as follows:

1. Starting the operational cycle
2. Reading the input states
3. Executing the user's program code
4. Writing the output states
5. Return to the Step 1 (starting the operational cycle)

Once the operational cycle is started, the device reads the input states and then copies the read data into an input data memory area. Next, the device executes the user's program code using the copy of the input data available in the memory area.

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7.9.2 Error mode

Device enters the error mode if any error occurred (see *Table 7.3* and *Table 7.4* for possible errors). Probable errors which cause device to enter error mode and related remedies are given in the table below.

Table 7.10 Errors and error remedies

LED ⚠	Cause	Remedy
ON	Device failure	Contact to the service center
Flashing	Flashing together with ⚠ — RTC battery discharged	Replace the RTC battery (see *Section 8.2*)

Type of an error occurred may be read from the Modbus status register if the Modbus connection is not failed and reading the status register is possible.
Status register bit assignment is given in the table below.

Table 7.11 Bit assignment of the status register 61620 (0xF0B4)

Bit No.	Assignment
Bit 0	Failure of digital inputs
Bit 1	Failure of digital outputs
Bit 2	Failure of analog inputs
Bit 3	Failure of analog outputs
Bit 4	Ethernet interface failure
Bit 5	Not used
Bit 6	USB interface failure
Bit 7	Not used
Bit 8	RS485 #1 failure
Bit 9	RS485 #2 failure
Bit 10	Not used
Bit 11	RTC failure
Bit 12	Power voltage is not available on power terminals 13 and 14
Bit 13	Firmware failure or cycle time exceeds 100 ms
Bit 14	Not used
Bit 15	Operation system error
Bit 16	File system failure
Bit 17	Built-in data storage has been formatted
Bit 18	No operational parameters
Bit 19	Firmware failure or firmware version does not match the user's program version
Bit 20	No user's program available, factory reset has been implemented
Bit 21	No archive available. Or archive recording failure. Or recording parameters to archive is disabled from ALP
Bit 22	RUN/STOP switch is set to STOP position
Bit 23	No user's program available
Bit 24	Execution of the user's program is terminated

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Bit No.	Assignment
Bit 25	Not used
Bit 26	Not used
Bit 27	Not used
Bit 28	Not used
Bit 29	Not used
Bit 30	Not used
Bit 31	User's program failure in retain memory

7.9.3 I/O mode

Once the RUN/STOP switch is set to STOP position, the user's program execution is terminated and the device enters I/O mode.
In I/O mode it is possible to read inputs and to control outputs, but there is no access to network variables.

7.9.4 Bootloader mode

NOTE
For the device in normal operation, firmware update should be performed according to *Section 7.13*.

When the device enters the bootloader mode, it is ready for updating its firmware over USB with no other device functionality supported.
The device enters the bootloader mode when:

– it is impossible to run the device firmware in the operational mode (see *Section 7.9.1*).
– the bootloader mode is forced by user.

The following steps must be implemented to force the bootloader mode:

1. Power down the device and disconnect the USB cable (if it was connected to the device earlier).
2. Press and hold the service button.
3. Apply power to the terminals 13 and 14 or connect USB cable to the device.

7.10 User program parameters

User variables can be assigned to the user program parameters in ALP.

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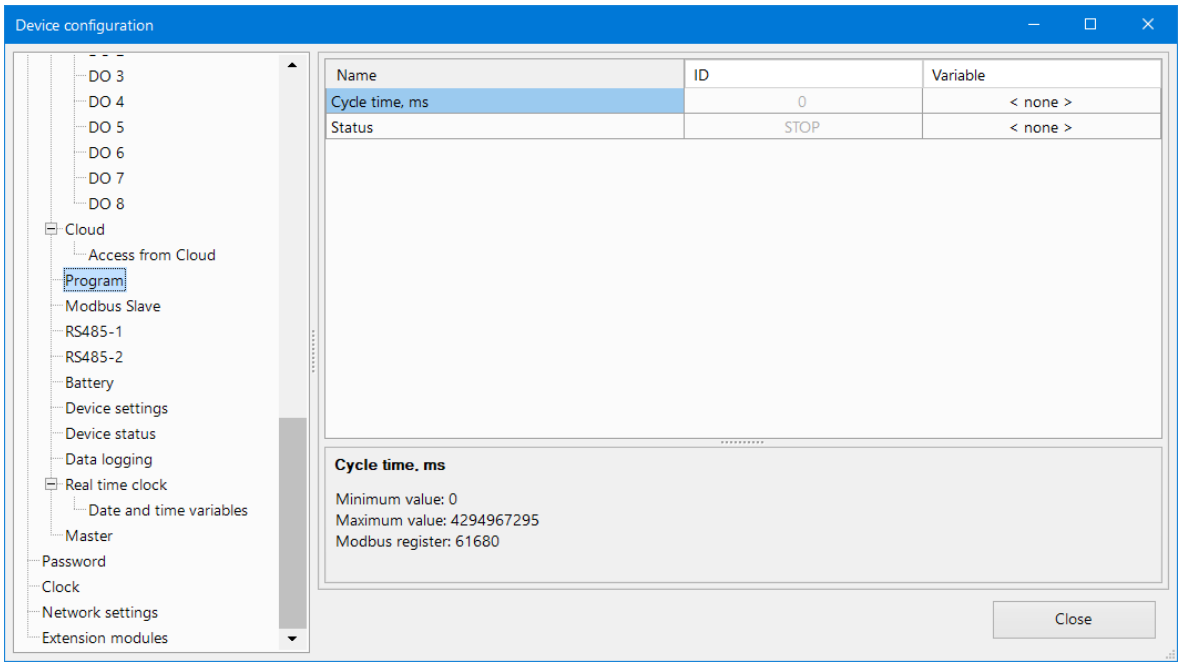


Fig. 7.5 Assignment of variables to the user program parameters

7.11 Real-time clock and retain memory

The device is equipped with the RTC and the retain memory.
The RTC is used for data logging. The retain memory is used for storing all settings of the device
The RTC and the retain memory are powered from the main supply voltage (applied to the terminals 13 and 14) when the device is powered on. Otherwise, the RTC and the retain memory are powered by the replaceable CR2032 battery.
A fully charged battery can supply RTC and retain memory continuously for 5 years. At the temperatures near the limits of the operating range (see *Table 3.9*), the operating time of the RTC and the retain memory is reduced.
Please refer to *Section 7.9.2* for RTC and retain memory related errors.
At the discharged battery, the following settings will be reset when the main supply voltage is removed from the device:

– RTC settings
– The device settings which have been changed over Modbus or by the user program during device operation with the battery discharged

If the discharged battery causes the reset of the settings, replace the battery. Please refer to *Section 8.2* for the battery replacement.
The battery level can be checked in akYtec ToolPro and ALP.

7.12 Setting Date and Time from the front panel

To set date and time using buttons on the front panel:

1. Press and hold button OK. The system menu will appear on the screen.
2. Select **Real-time clock** by pressing button OK.
3. Press button SEL.
4. The cursor will start flashing in the **Time and Date (UTC)** parameter at seconds. You can use buttons ⌃ and ⌄ to increase or decrease the value. To switch to the next level, press button ⟨. To save the changed values, press OK.

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5. To change the Time zone parameter, use buttons  and  to select the required item and confirm the value by pressing .

To exit the system menu, press and hold button .

7.13 Firmware update

NOTE
To update the firmware, disconnect the device from akYtec Cloud.

NOTE
The user program is erased from the device on updating the device firmware with ALP.

The firmware update is carried out with the programming and configuration interfaces.
Before starting the firmware update, perform the preparation steps as follows:

1. Prepare the PC with Windows 7 (SP1+)/8.1/10/11, akYtec ToolPro or ALP installed, and connect the PC to the Internet.
2. Install the device USB driver on the PC.

Firmware update in ALP

NOTE
During the user program transfer to the device in ALP, the firmware is updated automatically.

If the firmware update during user program transfer was unsuccessful, then **the forced firmware update** can be implemented. **The forced firmware update** can be made if the device is not detected in ALP, but the device connection is correctly displayed in the **Windows Device Manager**.
Follow the steps below for **the forced firmware update**:

1. Connect the device to the PC using a microUSB — USB cable or an Ethernet cable.
2. Then:
   – In the Windows Device Manager, check which COM port the device is using if it is connected over USB.
   – Check network settings in akYtec ToolPro if the device is connected over Ethernet.
3. In ALP, click the menu item ***Device > Port settings*** and enter the read COM port in the open dialog.
4. In ALP, select menu item ***Device > Firmware update***.
5. The currently connected device modification will be displayed and proposed to confirm the firmware update.

   NOTE
   If the device modification is not displayed or the displayed modification does not match the connected device, please contact technical support to resolve the problem.

6. Confirm to start the firmware update procedure.

When the firmware update is in progress, the loss of communication between the device and PC will cause damage of the device firmware. As result, the device will fail to operate. If this happened, repeat the forced firmware update to resolve the problem. If the above actions do not help, switch over to the Bootloader mode (see *Section 7.9.4*) and repeat the forced firmware update.

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8 Maintenance

8.1 Maintenance

The safety requirements (see *Section 1.4*) must be observed when the maintenance is carried out.

WARNING
Cut off all power before maintenance.

The maintenance includes:
– cleaning of the housing and terminal blocks from dust, dirt and derbis;
– checking the device fastening;
– checking the wiring (connecting wires, terminal connections, absence of mechanical damages).

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

8.2 Battery replacement

NOTE
The supply voltage may remain on when replacing the battery. This will prevent resetting the real-time clock and the device settings stored in the retain memory.

Follow the steps below to replace the RTC battery:

1. Pull out the holder with the battery.
2. Replace the battery in the holder.
3. Insert the new battery in its holder into the device. Observe polarity: plus should be on the surface opposite the device screen.

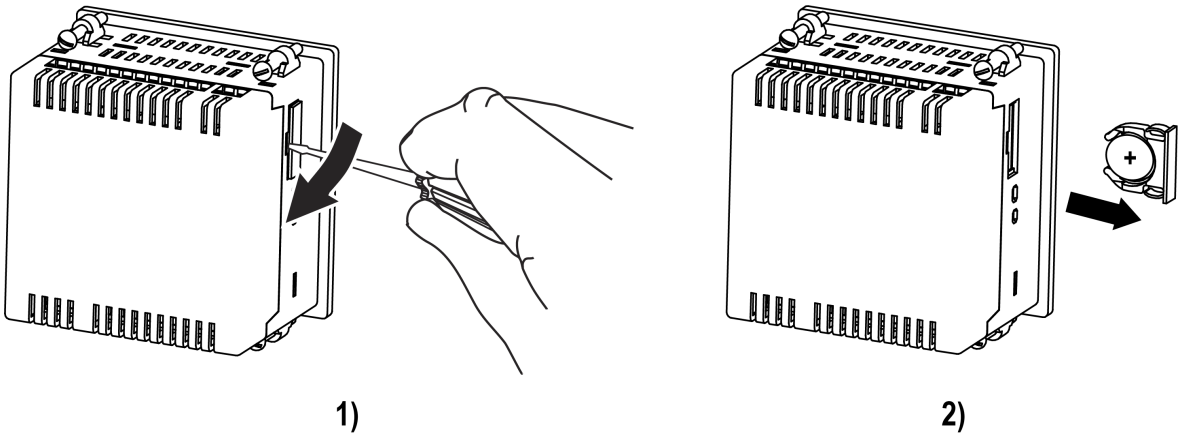


Fig. 8.1 Battery replacement

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9 Transportation and storage

Pack the device in such a way as to protect it reliably against impact for storage and transportation. The original packaging provides optimum protection.
If the device is not taken immediately after delivery into operation, it must be carefully stored at a protected location. The device should not be stored in an atmosphere with chemically active substances.
The environmental conditions must be taken into account during transportation and storage.

NOTICE
The device may have been damaged during transportation.
Check the device for transport damage and completeness!
Report the transport damage immediately to the shipper and akYtec GmbH!

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10 Scope of delivery

PR225	1
Short guide	1
Terminal blocks (set)	1
Mounting brackets (set)	1

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Appendix A. Terminal block layout

The terminal blocks are located on three surfaces of the device (see the figure below).

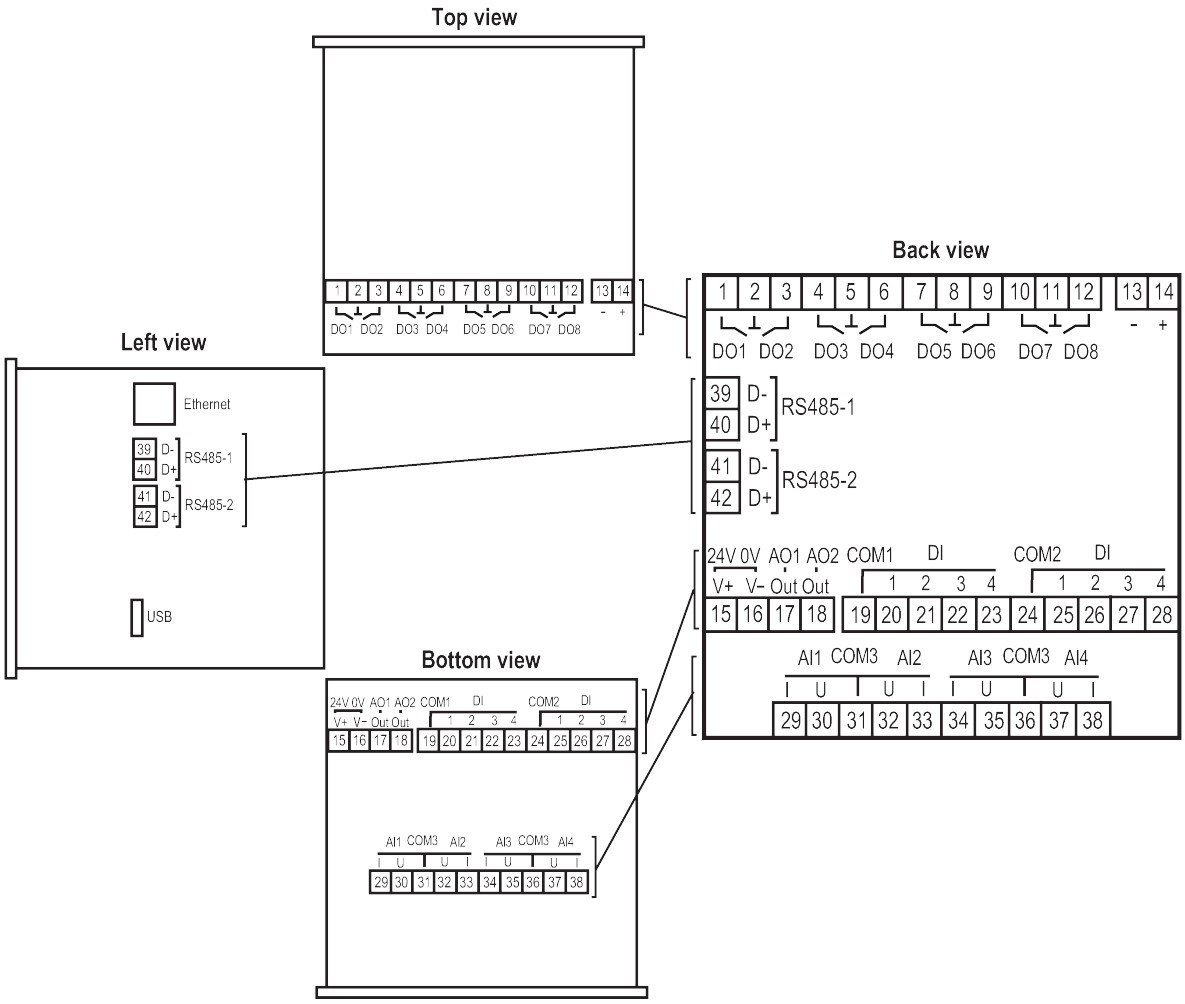


Fig. A.1 Terminal blocks on device surfaces

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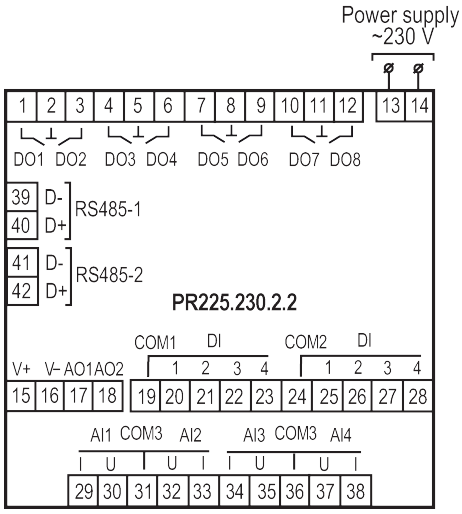


Fig. A.2 PR225.230.2.2 terminal block layout

Table A.1 PR225.230.2.2 terminal assignment

No.	Description	No.	Description
1	Digital output 1	15	Power supply V+ of analog outputs 1...2
2	Common contact of digital outputs 1 and 2	16	Power supply V- of analog outputs 1...2
3	Digital output 2	17	Analog output 1
4	Digital output 3	18	Analog output 2
5	Common contact of digital outputs 3 and 4	19	Common contact of digital inputs 1...4
6	Digital output 4	20	Digital input 1 (230 V)
7	Digital output 5	21	Digital input 2 (230 V)
8	Common contact of digital outputs 5 and 6	22	Digital input 3 (230 V)
9	Digital output 6	23	Digital input 4 (230 V)
10	Digital output 7	24	Common contact of digital inputs 5...8
11	Common contact of digital outputs 7 and 8	25	Digital input 5 (230 V)
12	Digital output 8	26	Digital input 6 (230 V)
13	Supply voltage (230 V)	27	Digital input 7 (230 V)
14	Supply voltage (230 V)	28	Digital input 8 (230 V)
39	Terminal D- of interface RS485 1	29	Current input I of AI1
40	Terminal D+ of interface RS485 1	30	Voltage input U of AI1
41	Terminal D- of interface RS485 2	31	Common contact of analog inputs 1 and 2
42	Terminal D+ of interface RS485 2	32	Voltage input U of AI2
		33	Current input I of AI2

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No.	Description	No.	Description
		34	Current input I of AI3
		35	Voltage input U of AI3
		36	Common contact of analog inputs 3 and 4
		37	Voltage input U of AI4
		38	Current input I of AI4

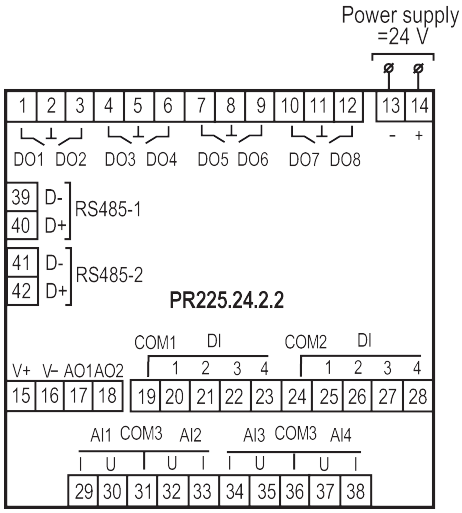


Fig. A.3 PR225.24.2.2 terminal block layout

Table A.2 PR225.24.2.2 terminal assignment

No.	Description	No.	Description
1	Digital output 1	15	Power supply V+ of analog outputs 1...2
2	Common contact of digital outputs 1 and 2	16	Power supply V- of analog outputs 1...2
3	Digital output 2	17	Analog output 1
4	Digital output 3	18	Analog output 2
5	Common contact of digital outputs 3 and 4	19	Common contact of digital inputs 1...4
6	Digital output 4	20	Digital input 1 (24 V)
7	Digital output 5	21	Digital input 2 (24 V)
8	Common contact of digital outputs 5 and 6	22	Digital input 3 (24 V)
9	Digital output 6	23	Digital input 4 (24 V)
10	Digital output 7	24	Common contact of digital inputs 5...8
11	Common contact of digital outputs 7 and 8	25	Digital input 5 (24 V)
12	Digital output 8	26	Digital input 6 (24 V)

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No.	Description	No.	Description
13	Terminal “–”	27	Digital input 7 (24 V)
14	Terminal “+”	28	Digital input 8 (24 V)
39	Terminal D- of interface RS485 1	29	Current input I of AI1
40	Terminal D+ of interface RS485 1	30	Voltage input U of AI1
41	Terminal D- of interface RS485 2	31	Common contact of analog inputs 1 and 2
42	Terminal D+ of interface RS485 2	32	Voltage input U of AI2
		33	Current input I of AI2
		34	Current input I of AI3
		35	Voltage input U of AI3
		36	Common contact of analog inputs 3 and 4
		37	Voltage input U of AI4
		38	Current input I of AI4

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Appendix B. Modbus register map

The addresses of Modbus registers presented in the tables below are available for download from akYtec ToolPro.

Table B.1 PR225.230.2.2 Modbus registers

Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Time (ms)	Real time clock	61563	0xF07B	2	3	-	Unsigned 32
Time (UTC)	Real time clock	61553	0xF071	2	3	16	Date time 32
Time zone	Real time clock	61555	0xF073	1	3	16	Enum 38
Seconds	Date and time variables	61557	0xF075	1	3	-	Unsigned 8
Minutes	Date and time variables	61558	0xF076	1	3	-	Unsigned 8
Hours	Date and time variables	61559	0xF077	1	3	-	Unsigned 8
Days	Date and time variables	61560	0xF078	1	3	-	Unsigned 8
Months	Date and time variables	61561	0xF079	1	3	-	Unsigned 8
Years	Date and time variables	61562	0xF07A	1	3	-	Unsigned 16
Day of the week	Date and time variables	61556	0xF074	1	3	-	Enum 8
MAC address	Network	61712	0xF110	9	3	-	String 144
IP address	Network	20	0x0014	2	3	16	Unsigned 32
Subnet mask	Network	22	0x0016	2	3	16	Unsigned 32
Gateway	Network	24	0x0018	2	3	16	Unsigned 32
DNS server 1	Network	12	0x000C	2	3	16	Unsigned 32

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
DNS server 2	Network	14	0x000E	2	3	16	Unsigned 32
DHCP	Network	32	0x0020	1	3	16	Enum 2
Apply now	Network	33	0x0021	1	3	16	Enum 2
Connection status	Network	34	0x0022	1	3	-	Enum 4
Voltage	Battery	801	0x0321	1	3	-	Unsigned 16
Low limit	Battery	800	0x0320	1	3	-	Unsigned 16
Status	Battery	802	0x0322	1	3	-	Enum 2
Update period	Device status	61624	0xF0B8	1	3	16	Unsigned 8
Status	Device status	61620	0xF0B4	2	3	-	Unsigned 32
Errors	Device status	61626	0xF0BA	1	3	-	Unsigned 16
Warnings	Device status	61627	0xF0BB	1	3	-	Unsigned 16
Logging interval	Data logging	900	0x0384	1	3	16	Unsigned 16
Number of files	Data logging	901	0x0385	1	3	16	Unsigned 16
File size	Data logging	902	0x0386	1	3	16	Unsigned 16
Last log file ID	Data logging	903	0x0387	1	3	-	Unsigned 16
Input bitmask	Digital inputs	51	0x0033	1	3	-	Unsigned 8
Inversion bitmask	Digital inputs	57	0x0039	1	3	16	Unsigned 8

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Debounce filter	DI 1	96	0x0060	1	3	16	Unsigned 8
Debounce filter	DI 2	97	0x0061	1	3	16	Unsigned 8
Debounce filter	DI 3	98	0x0062	1	3	16	Unsigned 8
Debounce filter	DI 4	99	0x0063	1	3	16	Unsigned 8
Debounce filter	DI 5	100	0x0064	1	3	16	Unsigned 8
Debounce filter	DI 6	101	0x0065	1	3	16	Unsigned 8
Debounce filter	DI 7	102	0x0066	1	3	16	Unsigned 8
Debounce filter	DI 8	103	0x0067	1	3	16	Unsigned 8
Input bitmask	Analog inputs	4000	0x0FA0	1	3	-	Unsigned 8
Inversion bitmask	Analog inputs	4357	0x1105	1	3	16	Unsigned 8
Input mode	AI 1	4100	0x1004	1	3	16	Enum 2
Debounce filter	Digital mode	4108	0x100C	1	3	16	Unsigned 8
LOW	Digital mode	4111	0x100F	2	3	16	Float 32
HIGH	Digital mode	4109	0x100D	2	3	16	Float 32
Input signal	Analog mode	4101	0x1005	1	3	16	Enum 28
Analog filter	Analog mode	4106	0x100A	2	3	16	Float 32
Lower measuring limit	Analog mode	4104	0x1008	2	3	16	Float 32
Upper measuring limit	Analog mode	4102	0x1006	2	3	16	Float 32

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Input mode	AI 2	4116	0x1014	1	3	16	Enum 2
Debounce filter	Digital mode	4124	0x101C	1	3	16	Unsigned 8
LOW	Digital mode	4127	0x101F	2	3	16	Float 32
HIGH	Digital mode	4125	0x101D	2	3	16	Float 32
Input signal	Analog mode	4117	0x1015	1	3	16	Enum 28
Analog filter	Analog mode	4122	0x101A	2	3	16	Float 32
Lower measuring limit	Analog mode	4120	0x1018	2	3	16	Float 32
Upper measuring limit	Analog mode	4118	0x1016	2	3	16	Float 32
Input mode	AI 3	4132	0x1024	1	3	16	Enum 2
Debounce filter	Digital mode	4140	0x102C	1	3	16	Unsigned 8
LOW	Digital mode	4143	0x102F	2	3	16	Float 32
HIGH	Digital mode	4141	0x102D	2	3	16	Float 32
Input signal	Analog mode	4133	0x1025	1	3	16	Enum 28
Analog filter	Analog mode	4138	0x102A	2	3	16	Float 32
Lower measuring limit	Analog mode	4136	0x1028	2	3	16	Float 32
Upper measuring limit	Analog mode	4134	0x1026	2	3	16	Float 32
Input mode	AI 4	4148	0x1034	1	3	16	Enum 2
Debounce filter	Digital mode	4156	0x103C	1	3	16	Unsigned 8
LOW	Digital mode	4159	0x103F	2	3	16	Float 32
HIGH	Digital mode	4157	0x103D	2	3	16	Float 32
Input signal	Analog mode	4149	0x1035	1	3	16	Enum 28

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Analog filter	Analog mode	4154	0x103A	2	3	16	Float 32
Lower measuring limit	Analog mode	4152	0x1038	2	3	16	Float 32
Upper measuring limit	Analog mode	4150	0x1036	2	3	16	Float 32
AI 1	Measured values	4002	0x0FA2	2	3	-	Float 32
AI 2	Measured values	4004	0x0FA4	2	3	-	Float 32
AI 3	Measured values	4006	0x0FA6	2	3	-	Float 32
AI 4	Measured values	4008	0x0FA8	2	3	-	Float 32
AI 1	Input statuses	4014	0x0FAE	1	3	-	Enum 11
AI 2	Input statuses	4015	0x0FAF	1	3	-	Enum 11
AI 3	Input statuses	4016	0x0FB0	1	3	-	Enum 11
AI 4	Input statuses	4017	0x0FB1	1	3	-	Enum 11
New output bitmask	Digital outputs	470	0x01D6	1	3	16	Unsigned 8
Output bitmask	Digital outputs	468	0x01D4	1	3	-	Unsigned 8
Safe state	DO 1	474	0x01DA	1	3	16	Enum 3
Safe state	DO 2	475	0x01DB	1	3	16	Enum 3
Safe state	DO 3	476	0x01DC	1	3	16	Enum 3
Safe state	DO 4	477	0x01DD	1	3	16	Enum 3
Safe state	DO 5	478	0x01DE	1	3	16	Enum 3
Safe state	DO 6	479	0x01DF	1	3	16	Enum 3
Safe state	DO 7	480	0x01E0	1	3	16	Enum 3
Safe state	DO 8	481	0x01E1	1	3	16	Enum 3
Output mode	AO 1	3160	0x0C58	1	3	16	Enum 3

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Output status	AO 1	3128	0x0C38	1	3	-	Enum 6
Safe state	AO 1	3032	0x0BD8	2	3	16	Float 32
Output mode	AO 2	3161	0x0C59	1	3	16	Enum 3
Output status	AO 2	3129	0x0C39	1	3	-	Enum 6
Safe state	AO 2	3034	0x0BDA	2	3	16	Float 32
AO 1	Output signal	3000	0x0BB8	2	3	16	Float 32
AO 2	Output signal	3002	0x0BBA	2	3	16	Float 32
LED bitmask	Programmable LEDs (Fn)	601	0x0259	1	3	-	Unsigned 8
New LED bitmask	Programmable LEDs (Fn)	600	0x0258	1	3	16	Unsigned 8
Safe state timeout	Modbus Slave	700	0x02BC	1	3	16	Unsigned 8
Baudrate	RS485-1	750	0x02EE	1	3	16	Enum 6
Data bits	RS485-1	751	0x02EF	1	3	16	Enum 2
Parity	RS485-1	752	0x02F0	1	3	16	Enum 3
Stop bits	RS485-1	753	0x02F1	1	3	16	Enum 2
Slave address	RS485-1	754	0x02F2	1	3	16	Unsigned 8
Baudrate	RS485-2	760	0x02F8	1	3	16	Enum 6
Data bits	RS485-2	761	0x02F9	1	3	16	Enum 2
Parity	RS485-2	762	0x02FA	1	3	16	Enum 3
Stop bits	RS485-2	763	0x02FB	1	3	16	Enum 2
Slave address	RS485-2	764	0x02FC	1	3	16	Unsigned 8
Cloud connection	Cloud	35	0x0023	1	3	16	Enum 2

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Connection status	Cloud	36	0x0024	1	3	-	Enum 5
Configuration	Access from Cloud	701	0x02BD	1	3	16	Enum 2
Output control	Access from Cloud	702	0x02BE	1	3	16	Enum 2
Modbus registers access	Access from Cloud	703	0x02BF	1	3	16	Enum 4
Availability of exchange	Sharing with devices	2008	0x07D8	2	3	-	Unsigned 32
Enable sharing	Sharing with devices	2010	0x07DA	2	3	16	Unsigned 32
Cycle time	Program	61680	0xF0F0	2	3	-	Unsigned 32
Status	Program	61682	0xF0F2	1	3	-	Enum 2
Screen backlight	Device settings	768	0x0300	1	3	16	Enum 5
Brightness	Device settings	769	0x0301	1	3	16	Unsigned 8

Table B.2 PR225.24.2.2 Modbus registers

Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Time (ms)	Real time clock	61563	0xF07B	2	3	-	Unsigned 32
Time (UTC)	Real time clock	61553	0xF071	2	3	16	Date time 32
Time zone	Real time clock	61555	0xF073	1	3	16	Enum 38
Seconds	Date and time variables	61557	0xF075	1	3	-	Unsigned 8
Minutes	Date and time variables	61558	0xF076	1	3	-	Unsigned 8
Hours	Date and time variables	61559	0xF077	1	3	-	Unsigned 8

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Days	Date and time variables	61560	0xF078	1	3	-	Unsigned 8
Months	Date and time variables	61561	0xF079	1	3	-	Unsigned 8
Years	Date and time variables	61562	0xF07A	1	3	-	Unsigned 16
Day of the week	Date and time variables	61556	0xF074	1	3	-	Enum 8
MAC address	Network	61712	0xF110	9	3	-	String 144
IP address	Network	20	0x0014	2	3	16	Unsigned 32
Subnet mask	Network	22	0x0016	2	3	16	Unsigned 32
Gateway	Network	24	0x0018	2	3	16	Unsigned 32
DNS server 1	Network	12	0x000C	2	3	16	Unsigned 32
DNS server 2	Network	14	0x000E	2	3	16	Unsigned 32
DHCP	Network	32	0x0020	1	3	16	Enum 2
Apply now	Network	33	0x0021	1	3	16	Enum 2
Connection status	Network	34	0x0022	1	3	-	Enum 4
Voltage	Battery	801	0x0321	1	3	-	Unsigned 16
Low limit	Battery	800	0x0320	1	3	-	Unsigned 16
Status	Battery	802	0x0322	1	3	-	Enum 2
Update period	Device status	61624	0xF0B8	1	3	16	Unsigned 8
Status	Device status	61620	0xF0B4	2	3	-	Unsigned 32

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Errors	Device status	61626	0xF0BA	1	3	-	Unsigned 16
Warnings	Device status	61627	0xF0BB	1	3	-	Unsigned 16
Logging interval	Data logging	900	0x0384	1	3	16	Unsigned 16
Number of files	Data logging	901	0x0385	1	3	16	Unsigned 16
File size	Data logging	902	0x0386	1	3	16	Unsigned 16
Last log file ID	Data logging	903	0x0387	1	3	-	Unsigned 16
Input bitmask	Digital inputs	51	0x0033	1	3	-	Unsigned 8
Inversion bitmask	Digital inputs	57	0x0039	1	3	16	Unsigned 8
Debounce filter	DI 1	96	0x0060	1	3	16	Unsigned 8
Debounce filter	DI 2	97	0x0061	1	3	16	Unsigned 8
Debounce filter	DI 3	98	0x0062	1	3	16	Unsigned 8
Debounce filter	DI 4	99	0x0063	1	3	16	Unsigned 8
Debounce filter	DI 5	100	0x0064	1	3	16	Unsigned 8
Debounce filter	DI 6	101	0x0065	1	3	16	Unsigned 8
Debounce filter	DI 7	102	0x0066	1	3	16	Unsigned 8
Debounce filter	DI 8	103	0x0067	1	3	16	Unsigned 8

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Input bitmask	Analog inputs	4000	0x0FA0	1	3	-	Unsigned 8
Inversion bitmask	Analog inputs	4357	0x1105	1	3	16	Unsigned 8
Input mode	AI 1	4100	0x1004	1	3	16	Enum 2
Debounce filter	Digital mode	4108	0x100C	1	3	16	Unsigned 8
LOW	Digital mode	4111	0x100F	2	3	16	Float 32
HIGH	Digital mode	4109	0x100D	2	3	16	Float 32
Input signal	Analog mode	4101	0x1005	1	3	16	Enum 28
Analog filter	Analog mode	4106	0x100A	2	3	16	Float 32
Lower measuring limit	Analog mode	4104	0x1008	2	3	16	Float 32
Upper measuring limit	Analog mode	4102	0x1006	2	3	16	Float 32
Input mode	AI 2	4116	0x1014	1	3	16	Enum 2
Debounce filter	Digital mode	4124	0x101C	1	3	16	Unsigned 8
LOW	Digital mode	4127	0x101F	2	3	16	Float 32
HIGH	Digital mode	4125	0x101D	2	3	16	Float 32
Input signal	Analog mode	4117	0x1015	1	3	16	Enum 28
Analog filter	Analog mode	4122	0x101A	2	3	16	Float 32
Lower measuring limit	Analog mode	4120	0x1018	2	3	16	Float 32
Upper measuring limit	Analog mode	4118	0x1016	2	3	16	Float 32
Input mode	AI 3	4132	0x1024	1	3	16	Enum 2
Debounce filter	Digital mode	4140	0x102C	1	3	16	Unsigned 8
LOW	Digital mode	4143	0x102F	2	3	16	Float 32

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
HIGH	Digital mode	4141	0x102D	2	3	16	Float 32
Input signal	Analog mode	4133	0x1025	1	3	16	Enum 28
Analog filter	Analog mode	4138	0x102A	2	3	16	Float 32
Lower measuring limit	Analog mode	4136	0x1028	2	3	16	Float 32
Upper measuring limit	Analog mode	4134	0x1026	2	3	16	Float 32
Input mode	AI 4	4148	0x1034	1	3	16	Enum 2
Debounce filter	Digital mode	4156	0x103C	1	3	16	Unsigned 8
LOW	Digital mode	4159	0x103F	2	3	16	Float 32
HIGH	Digital mode	4157	0x103D	2	3	16	Float 32
Input signal	Analog mode	4149	0x1035	1	3	16	Enum 28
Analog filter	Analog mode	4154	0x103A	2	3	16	Float 32
Lower measuring limit	Analog mode	4152	0x1038	2	3	16	Float 32
Upper measuring limit	Analog mode	4150	0x1036	2	3	16	Float 32
AI 1	Measured values	4002	0x0FA2	2	3	-	Float 32
AI 2	Measured values	4004	0x0FA4	2	3	-	Float 32
AI 3	Measured values	4006	0x0FA6	2	3	-	Float 32
AI 4	Measured values	4008	0x0FA8	2	3	-	Float 32
AI 1	Input statuses	4014	0x0FAE	1	3	-	Enum 11
AI 2	Input statuses	4015	0x0FAF	1	3	-	Enum 11
AI 3	Input statuses	4016	0x0FB0	1	3	-	Enum 11
AI 4	Input statuses	4017	0x0FB1	1	3	-	Enum 11
New output bitmask	Digital outputs	470	0x01D6	1	3	16	Unsigned 8

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Output bitmask	Digital outputs	468	0x01D4	1	3	-	Unsigned 8
Safe state	DO 1	474	0x01DA	1	3	16	Enum 3
Safe state	DO 2	475	0x01DB	1	3	16	Enum 3
Safe state	DO 3	476	0x01DC	1	3	16	Enum 3
Safe state	DO 4	477	0x01DD	1	3	16	Enum 3
Safe state	DO 5	478	0x01DE	1	3	16	Enum 3
Safe state	DO 6	479	0x01DF	1	3	16	Enum 3
Safe state	DO 7	480	0x01E0	1	3	16	Enum 3
Safe state	DO 8	481	0x01E1	1	3	16	Enum 3
Output mode	AO 1	3160	0x0C58	1	3	16	Enum 3
Output status	AO 1	3128	0x0C38	1	3	-	Enum 6
Safe state	AO 1	3032	0x0BD8	2	3	16	Float 32
Output mode	AO 2	3161	0x0C59	1	3	16	Enum 3
Output status	AO 2	3129	0x0C39	1	3	-	Enum 6
Safe state	AO 2	3034	0x0BDA	2	3	16	Float 32
AO 1	Output signal	3000	0x0BB8	2	3	16	Float 32
AO 2	Output signal	3002	0x0BBA	2	3	16	Float 32
LED bitmask	Programmable LEDs (Fn)	601	0x0259	1	3	-	Unsigned 8
New LED bitmask	Programmable LEDs (Fn)	600	0x0258	1	3	16	Unsigned 8
Safe state timeout	Modbus Slave	700	0x02BC	1	3	16	Unsigned 8
Baudrate	RS485-1	750	0x02EE	1	3	16	Enum 6

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Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function	Write function	Data type
Data bits	RS485-1	751	0x02EF	1	3	16	Enum 2
Parity	RS485-1	752	0x02F0	1	3	16	Enum 3
Stop bits	RS485-1	753	0x02F1	1	3	16	Enum 2
Slave address	RS485-1	754	0x02F2	1	3	16	Unsigned 8
Baudrate	RS485-2	760	0x02F8	1	3	16	Enum 6
Data bits	RS485-2	761	0x02F9	1	3	16	Enum 2
Parity	RS485-2	762	0x02FA	1	3	16	Enum 3
Stop bits	RS485-2	763	0x02FB	1	3	16	Enum 2
Slave address	RS485-2	764	0x02FC	1	3	16	Unsigned 8
Cloud connection	Cloud	35	0x0023	1	3	16	Enum 2
Connection status	Cloud	36	0x0024	1	3	-	Enum 5
Configuration	Access from Cloud	701	0x02BD	1	3	16	Enum 2
Output control	Access from Cloud	702	0x02BE	1	3	16	Enum 2
Modbus registers access	Access from Cloud	703	0x02BF	1	3	16	Enum 4
Availability of exchange	Sharing with devices	2008	0x07D8	2	3	-	Unsigned 32
Enable sharing	Sharing with devices	2010	0x07DA	2	3	16	Unsigned 32
Cycle time	Program	61680	0xF0F0	2	3	-	Unsigned 32
Status	Program	61682	0xF0F2	1	3	-	Enum 2
Screen backlight	Device settings	768	0x0300	1	3	16	Enum 5
Brightness	Device settings	769	0x0301	1	3	16	Unsigned 8

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Appendix C. Initialization vector for the archive file encryption

A cryptographic hash function should be used as an initialization vector for the archive file decryption. The hash function must return 8 bytes (LONG LONG type variable).
Please refer to the example of the hash function implemented in the C programming language given below.

```
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;
}
```

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