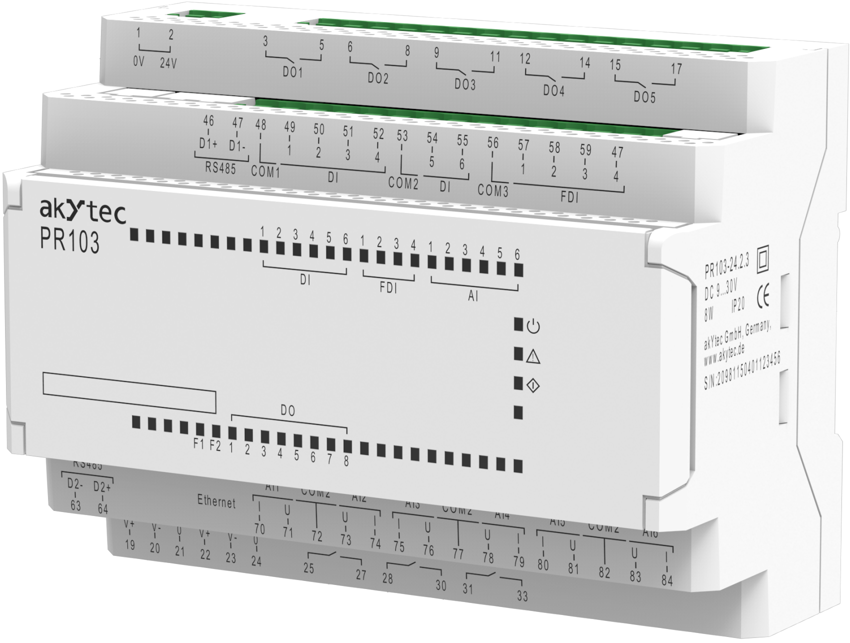
EN CE



PR103

Programmable relay

User guide

PR103_3-EN-90340-1.16

Contents

1 Introduction

This manual describes the functions, configuration, operating instructions, programming and troubleshooting of the multifunctional programmable relay PR103 (hereinafter referred to as PR103, 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.

1.3 Intended use

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

Improper use

Any other use is considered improper. Especially to note:

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

1.4 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.

2 Overview

The programmable relay PR103 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

The two modifications of the programmable relay PR103 are available:
- PR103.24.3.2
- PR103.24.6.2

The basic features of both PR103.24.3.2 and PR103.24.6.2 modifications are described below:

PR103.24.3.2	PR103.24.6.2
– 10 passive digital inputs (including 4 fast digital inputs up to 100 kHz) – 6 analog inputs (can be used as digital) – 10 relay outputs – 2 programmable LEDs F1, F2 – Slave in Modbus network over RS485 interface – Slave in Modbus network over Ethernet interface – real-time clock – data logging and archiving – possibility to connect up to 2 PRM series extension modules – configuration and programming with ALP software (free) – DIN rail or wall mounting – 3-level stepped form for installation in switchboards – quick and easy device replacement with plug-in terminal blocks	– 10 passive digital inputs (including 4 fast digital inputs up to 100 kHz) – 6 analog inputs (can be used as digital) – 8 relay outputs – 2 analog outputs (4-20 mA, 0-10 V) – 2 programmable LEDs F1, F2 – Slave in Modbus network over RS485 interface – Slave in Modbus network over Ethernet interface – real-time clock – data logging and archiving – possibility to connect up to 2 PRM series extension modules – configuration and programming with ALP software (free) – DIN rail or wall mounting – 3-level stepped form for installation in switchboards – quick and easy device replacement with plug-in terminal blocks

The number of the PR103 I/O points can be increased by using appropriate PRM extension modules:
- PRM-X.1 — for digital inputs/outputs extension
- PRM-X.2 — for analog inputs/digital outputs extension
- PRM-X.3 — for analog inputs/outputs extension

Please refer to the *section 7.3* for details as to PRM modules connection.

2.2 Design

PR103 front cover with the LED indication is shown in the *Fig 2.1*.

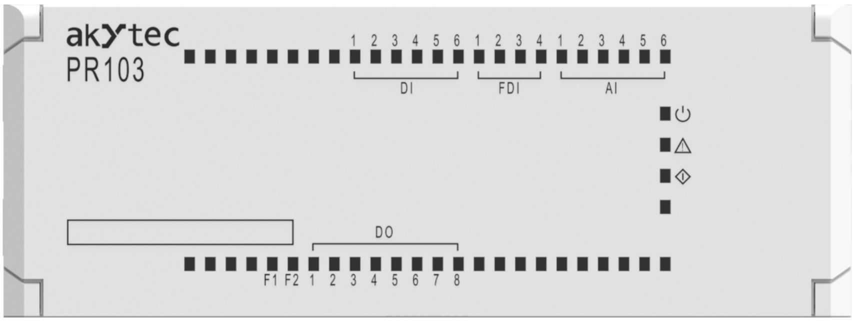


Fig. 2.1 Front cover

The controls and service interfaces are located under the PR103 front cover. PR103 with the front cover open is shown in the *Fig 2.2*.

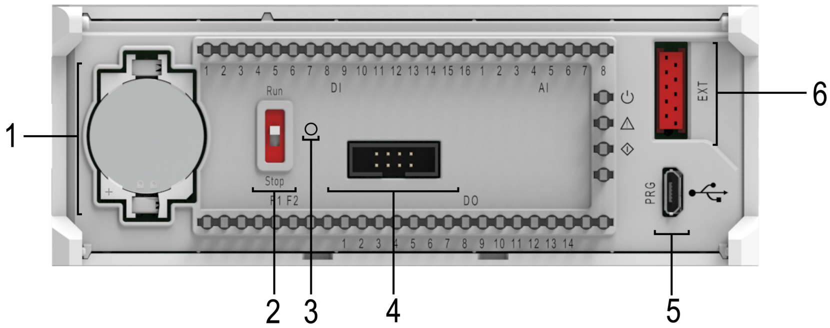


Fig. 2.2 Open front cover

Ethernet and RS485 interfaces are underneath the PR103 as shown in the *Fig 2.3*.

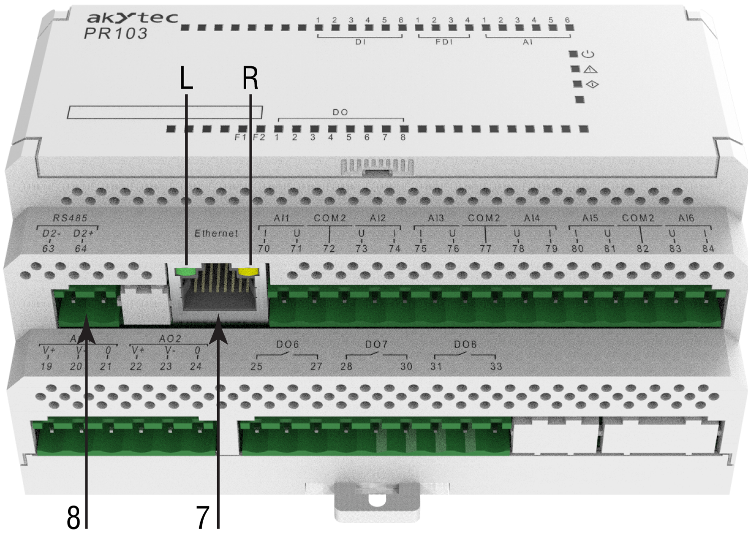


Fig. 2.3 Ethernet and RS485 interfaces

Controls and interfaces:

1. RTC battery
2. RUN/STOP switch
3. Service button

4. Service connector
5. microUSB programming connector
6. Extension module connector
7. Ethernet connector with “L” and “R” LEDs
8. RS485 interface

For detailed description of the PR103 indication, controls and interfaces please refer to the *section 7.1*.

3 Specifications

3.1 Specification tables

Table 3.1 Power supply specifications

Parameter	Value
Power supply	24 (9…30) V DC
Power consumption, max.	8 W
Reverse polarity protection	yes

Table 3.2 General specifications

Parameter	Value
Computing capabilities, extension modules and auxiliaries	
Minimum program execution cycle (may depend on user's program complexity)	1 ms
Network variables' memory size: Slave mode Master mode	 2040 Bytes 128 Bytes
Extension modules	up to 2 PRM
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	10 s
Programming and configuration	
Programming and configuration interfaces	USB, Ethernet, RS485
Programming software	akYtec ALP
Configuration software	akYtec ALP
Retain memory size	2040 Bytes
Memory size: Retain ROM RAM	 2040 Bytes 219136 Bytes 51200 Bytes
Communication interfaces	
Types of network interfaces	RS485 and Ethernet
Ethernet	
Number of Ethernet ports	1
Communication protocol	Modbus TCP
Operation modes	Master / Slave
Data transfer rate	10/100 Mbit/s
Galvanic isolation (between Ethernet port and other circuitry parts)	510 V
RS485	
Number of RS485 ports	2
Communication protocol	Modbus RTU, Modbus-ASCII
Operation modes	Master / Slave
Data transfer rate	9600, 14400, 19200, 38400, 57600, 115200 bit/s

Parameter	Value
Galvanic isolation (between RS485 ports and other circuitry parts)	1500 V
General	
Mounting	DIN-rail (35 mm)
Dimensions (with terminal blocks)	123 × 108 × 58 mm
IP code	IP20
Weight, max.	0.6 kg
Average service life	8 years

Table 3.3 Digital inputs

Parameter	Value
HIGH level	8.8…30 V / 2…15 mA
LOW level	-3…+5 V / 0…15 mA
Pulse length, min.	2 ms
Response time, max.	30 ms
Pulse frequency, max.	500 Hz
Galvanic isolation (between the two input groups: DI1…DI4 and DI5…DI6)	510 V
Galvanic isolation (between each input group and other circuitry parts)	510 V
Reverse polarity protection	yes

NOTE
In order to avoid false positives, set the debouncing filter to the value of not less than 2 ms.

Table 3.4 Fast digital inputs

Parameter	Value
HIGH level	15…30 V / 2…15 mA
LOW level	-3…+5 V / 0…15 mA
Pulse length, min.	5 μs
Pulse frequency, max.	100 kHz
Galvanic isolation (between the input group FDI1…FDI4 and other circuitry parts)	510 V
Reverse polarity protection	yes

Table 3.5 Analog inputs

<table>
<tr><th colspan="2">Parameter</th><th>Value</th></tr>
<tr><td colspan="2">Input voltage range</td><td>0...30 V DC</td></tr>
<tr><td colspan="2">ADC resolution</td><td>12 bit</td></tr>
<tr><td colspan="2">Sampling time, max.</td><td>1 ms</td></tr>
<tr><td colspan="2">Galvanic isolation</td><td>no</td></tr>
<tr><td colspan="3">Analog mode 1 (Linear input)</td></tr>
<tr><td rowspan="2">Input signal types</td><td>Voltage (unipolar)</td><td>0...10 V</td></tr>
<tr><td>Current (unipolar)</td><td>4...20 mA</td></tr>
<tr><td colspan="2">Input resistance for 0-10 V input</td><td>10 kΩ</td></tr>
<tr><td colspan="2">Full-scale accuracy</td><td>±0.5 %</td></tr>
<tr><td colspan="2">Temperature influence</td><td>±0.5 % of full-scale accuracy per each 10 °C</td></tr>
<tr><td colspan="2">Input resistance (at measuring voltage signal 0...10 V), min.</td><td>1 kΩ</td></tr>
<tr><td colspan="3">Analog mode 2 (Temperature sensors)</td></tr>
<tr><td colspan="2">Input signal range</td><td>0...300 kΩ</td></tr>
<tr><td colspan="2">Types of temperature sensors supported</td><td>see table 3.6</td></tr>
<tr><td colspan="2">Least significant bit value, max.</td><td>1 °C</td></tr>
</table>

Parameter		Value
Full-scale accuracy	for the resistance range 0...150 kΩ	±1.0 %
	for the resistance range 0...150 kΩ	±2.0 %
	for RTD and thermistors (NTC and PTC)	±1.5 %
Temperature influence		±0.5 % of full-scale accuracy 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 (at debouncing filter set to the values from 0 to 2), min.		2 ms
Signal frequency, max.		250 Hz

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	

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.***

Table 3.7 Digital outputs

Parameter		Value
Type of digital outputs		relay (NO)
Galvanic isolation (between individual outputs)		2300 V
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 (PR103.24.6.2 only)

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.	300 Ω
	R_U (0...10 V), min.	1 kΩ
Full-scale accuracy, max.		±0.5%
Temperature influence		±0.5 % of full-scale accuracy per each 10 °C
Galvanic isolation (between individual outputs)		510 V

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

4 Configuration and programming

4.1 Putting into operation

It 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 microUSB programming connector of the device to PC over a USB-to-microUSB connection cable (not included). Please refer to *Fig. 2.2* (see position 5) for location of the microUSB programming connector on the device.
2. Unplug the removable 2-terminal block from the device power connector and then connect the removable 2-terminal block to the external power supply.

> **NOTICE**
> ***Check the supply voltage level and polarity before connecting the power supply:***
> – ***the device fails to operate properly with no risk of damage if the supply voltage is below 9 V.***
> – ***there is a high risk of the device damage if the supply voltage is above 30 V.***
> – ***the device does not turn on if the supply voltage polarity is reversed.***

3. Plug the removable 2-terminal block into the device mating 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 7.1* and *section 7.2.2*).
6. Start ***ALP*** and make sure that the device is detected correctly. Using ***ALP***, set the date and the time required (please refer to *section 4.9*).
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* 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 using the menu item ***Device > Transfer application to device***. 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.

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).

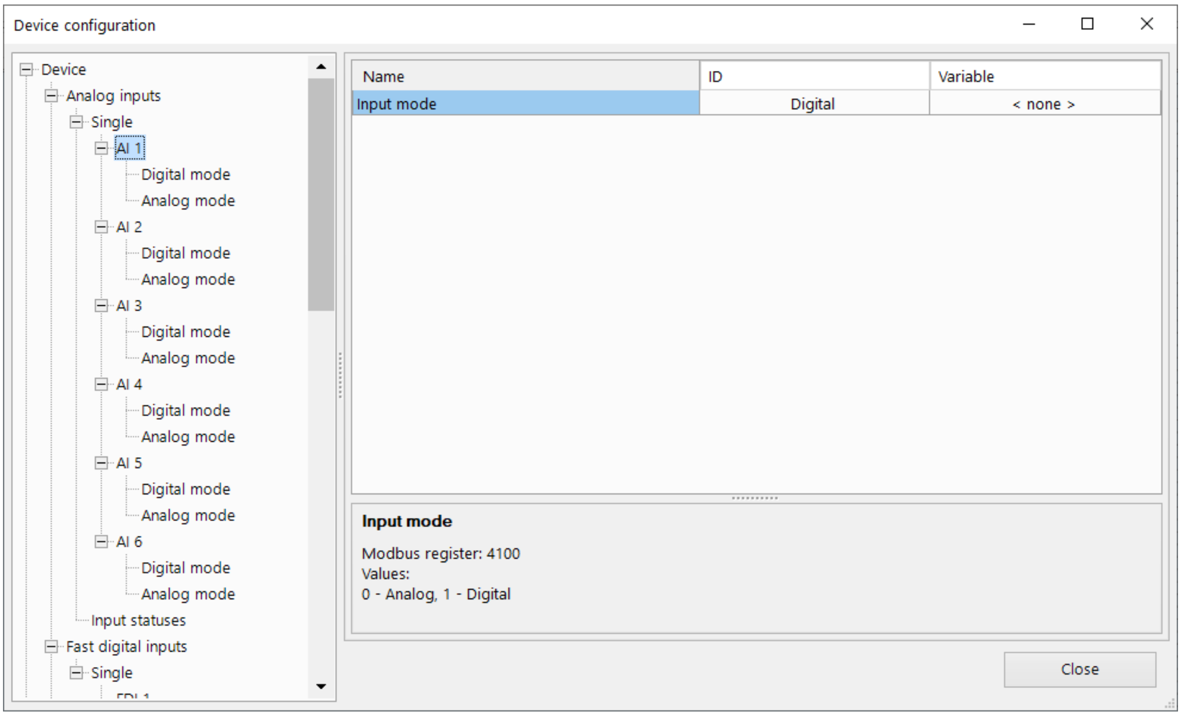


Fig. 4.1 Analog input, mode selection in ALP

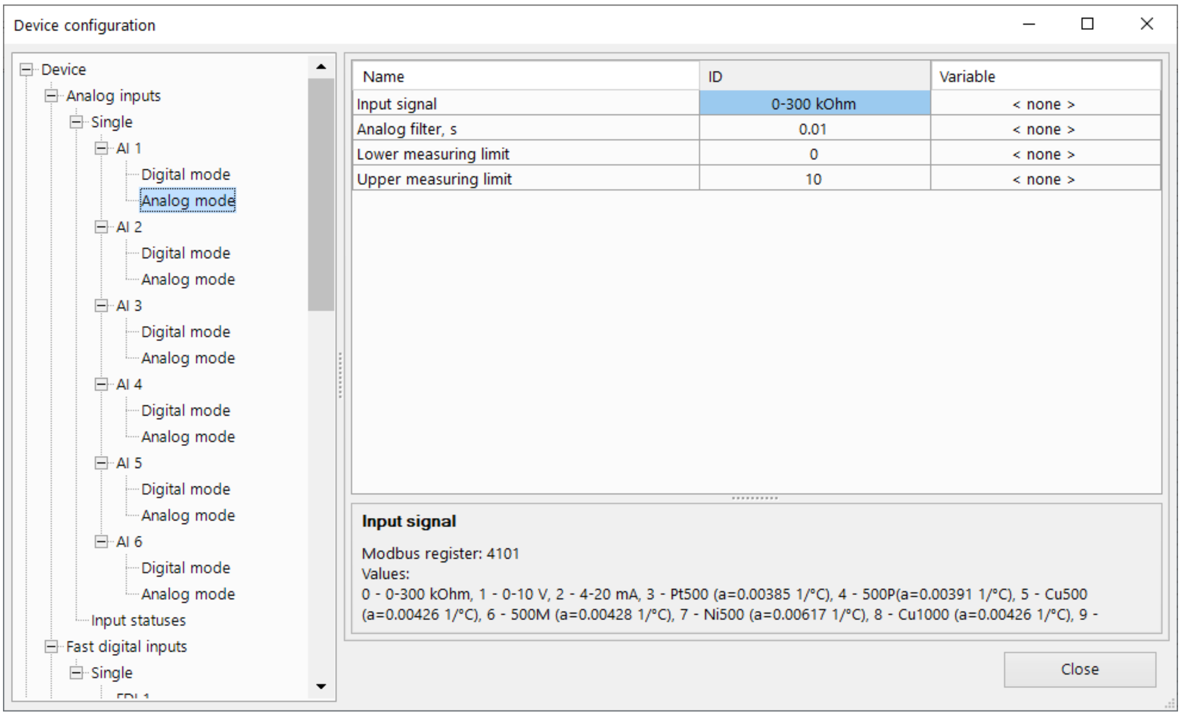


Fig. 4.2 AI analog mode parameters in ALP

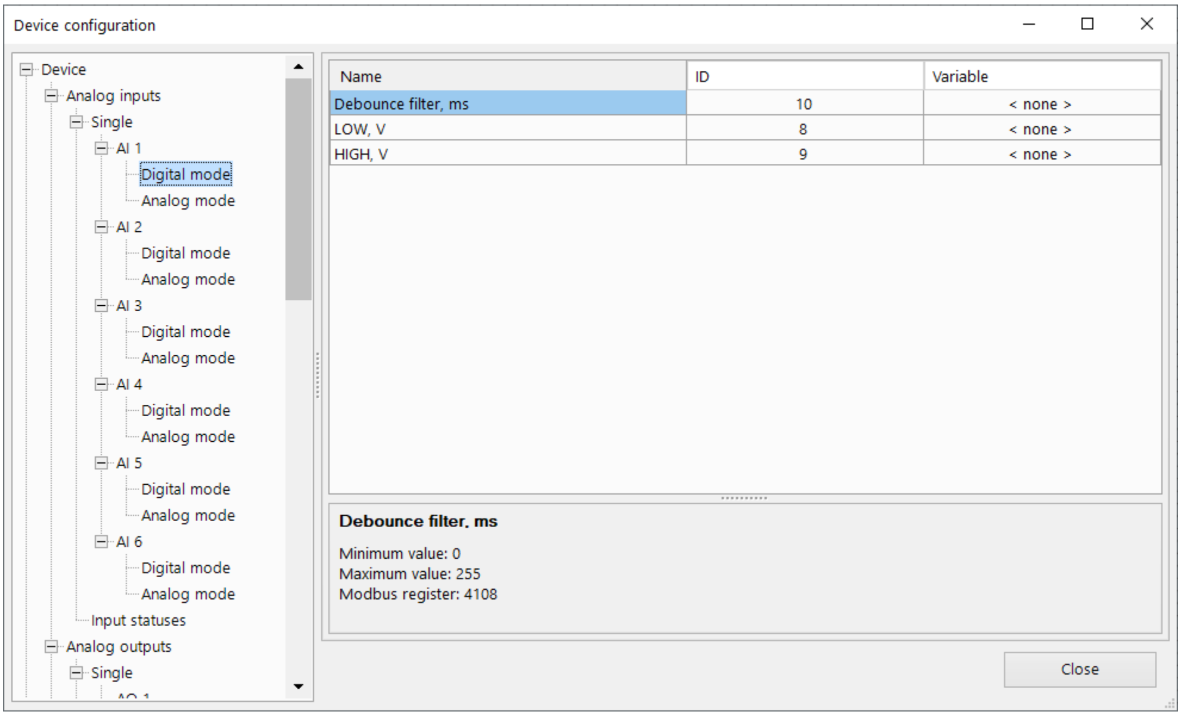


Fig. 4.3 AI digital mode parameters in ALP

Table 4.1 AI configuration parameters

Parameter	Description
Input mode	AI mode selection. The following values are available: 0 – Analog mode 1 – Digital mode
Analog mode configuration parameters	
Input signal	Selection of the input signal type from sensors. The following values are available: 0 – 0...300 kΩ 1 – 0...10 V 2 – 4...20 mA 3 – Pt500 (α = 0.00385) 4 - 500P (α = 0.00391) 5 – Cu500 (α = 0.00426) 6 – 500M (α = 0.00428) 7 – Ni 500 (α = 0.00617) 8 – Cu1000 (α = 0.00426) 9 – 1000M (α = 0.00428) 10 – Pt1000 (α = 0.00385) 11 – 1000P (α = 0.00391) 12 – Ni 1000 (α = 0.00617) 13 – NTC1008, R25 = 2 kΩ, B25/100 = 3560 14 – NTC8016, R25 = 3 kΩ, B25/100 = 3988 15 - NTC8016, R25 = 5 kΩ, B25/100 = 3988 16 - NTC8016, R25 = 10 kΩ, B25/100 = 3988 17 - NTC8018, R25 = 30 kΩ, B25/100 = 3964 18 – NTC2901, R25 = 50 kΩ, B25/100 = 3760 19 – NTC3435, R25 = 10 kΩ, B25/85 = 3435 20 – NTC3977, R25 = 10 kΩ, B25/85 = 3977 21 – KTY82-110 22 – KTY82-120 23 – KTY82-121 24 – KTY82-122 25 – KTY82-150

Parameter	Description
	26 – KTY82-151 27 – KTY82-152
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.
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/cm^2), 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 Fig.).

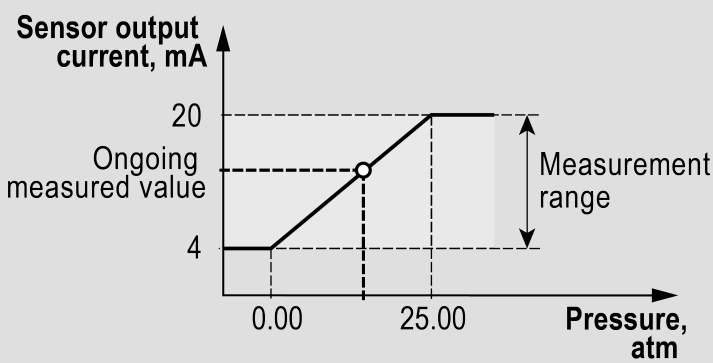


Fig. 4.4 Example of the input signal scaling

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 *Fig.*).

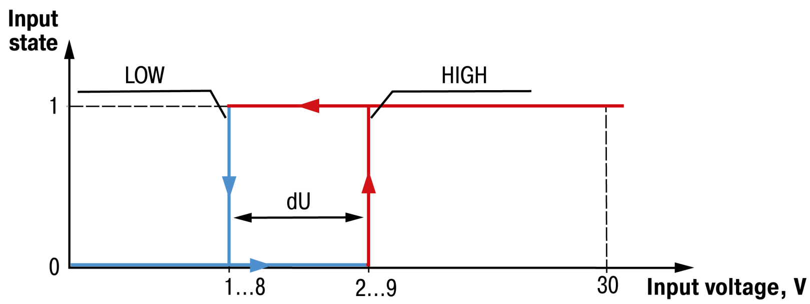


Fig. 4.5 Analog input, digital mode diagram

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.

4.2.1.3 Connected sensor error detection

In the analog mode, the device analog inputs ensure the detection of errors caused by sensors connected to the device. The sensor detection error codes are given in the *table 4.2*.

Table 4.2 Sensor error detection codes

Code	Meaning
5	Computed value is too large
6	Computed value is too small
7	Short circuit
8	Broken circuit

Description of the available error codes depending on the input signal types are given in the *table 4.3*.

Table 4.3 Available error codes depending on the signal types

Type of signal / Sensor	Error code			
	5	6	7	8
Resistive signal	—	—	—	—
Voltage 0...10 V Current 4...20 mA	+ +	— +	— —	— —
RTD	+	+	+	+
NTC thermistors	+	+	+	+
PTC thermistors (KTY-series)	+	+	+	+

4.2.2 Digital inputs

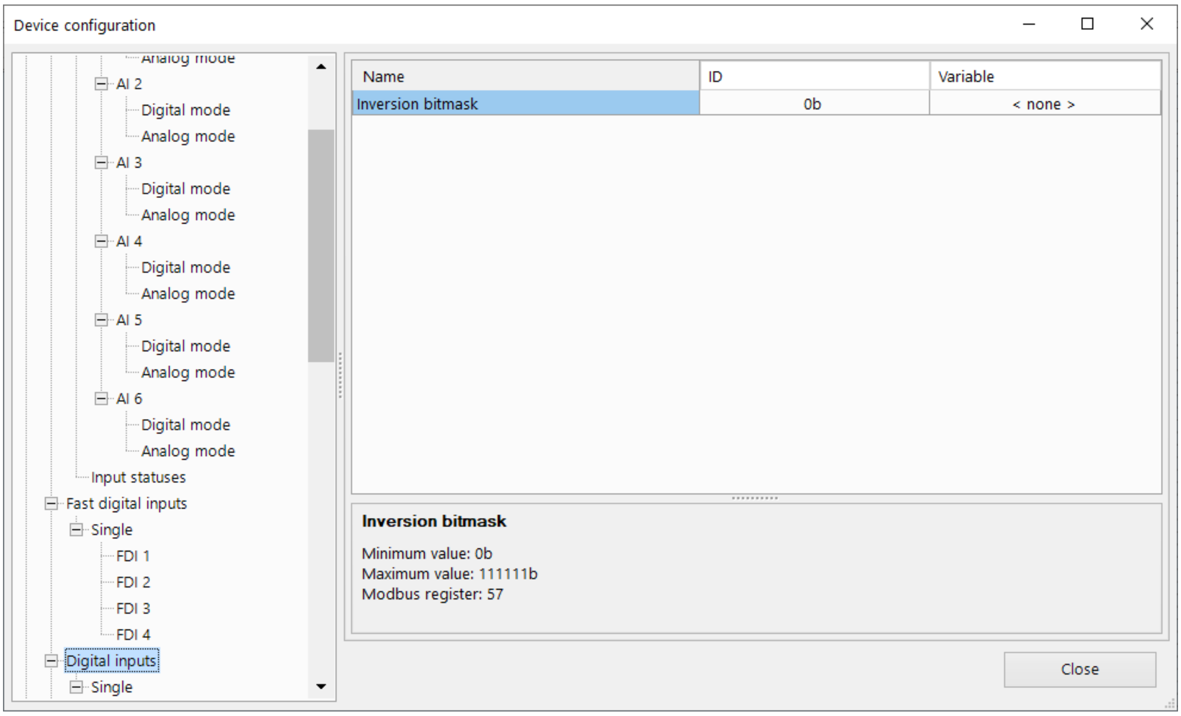


Fig. 4.6 DI inversion configuration parameter

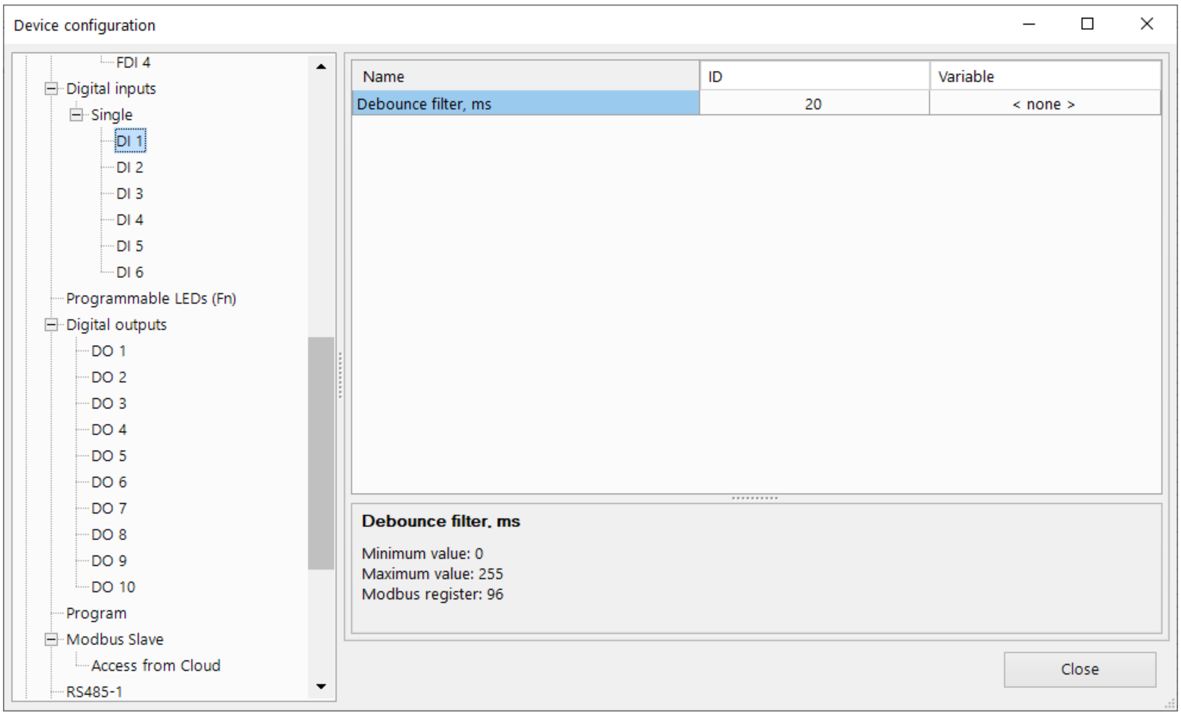


Fig. 4.7 DI debounce filter configuration parameter

Table 4.4 DI configuration parameters

Parameter	Description
Inversion bitmask	Inversion bitmask is to invert single or multiple digital inputs by setting the bitmask variable value.
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.

4.2.3 Fast digital inputs

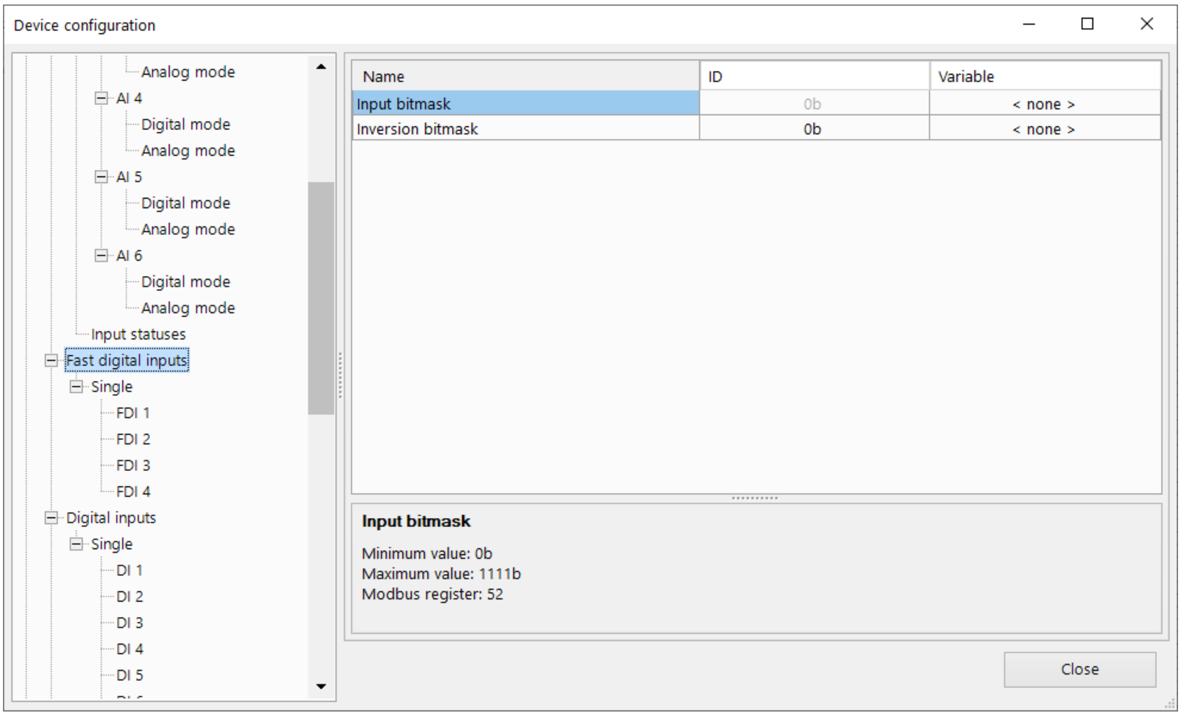


Fig. 4.8 FDI configuration parameters

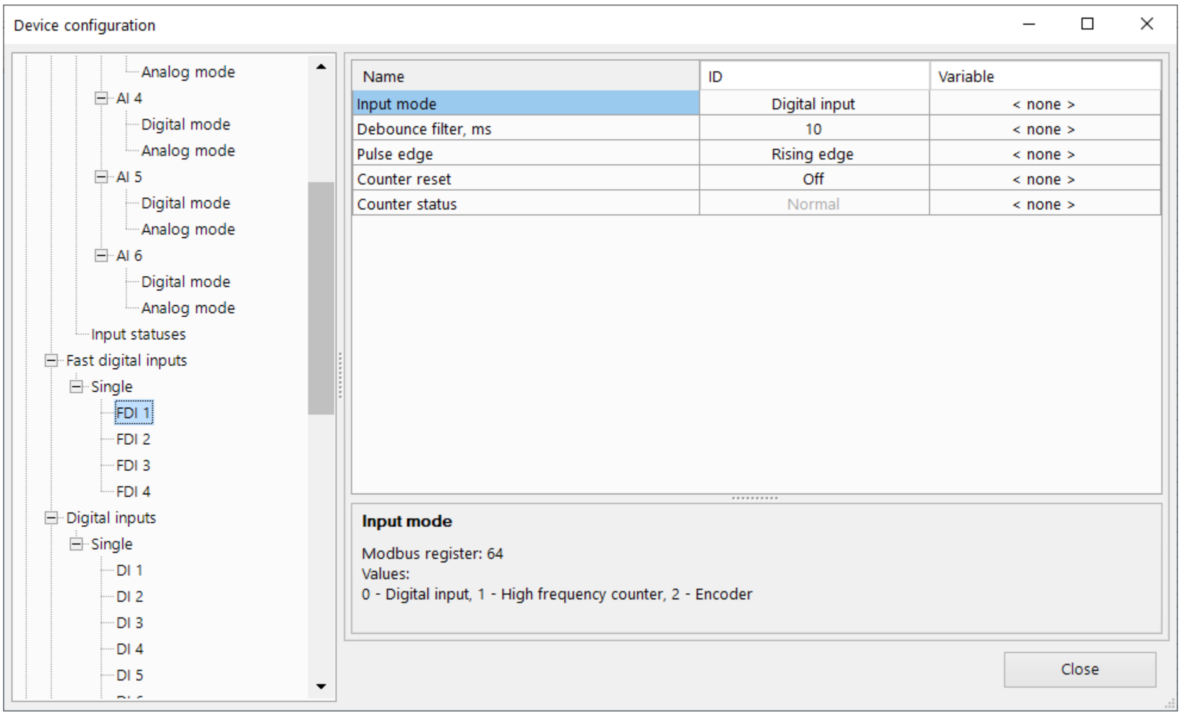


Fig. 4.9 FDI modes configuration

Table 4.5 FDI modes configuration parameters

Parameter	Value	Description
Input mode	0 – Digital input	The input is configured for the detection of the input logic level
	1 – High frequency counter	The input is configured for the input pulses counting
	2 – Encoder	The input is configured for the encoder signals processing
Debounce filter*	from 0 to 255 ms	The parameter is applicable only when the input is configured as digital input. The parameter is to set debouncing time of the built-in digital debouncing filter. The default value is 10 ms.
Pulse edge	0 – Rising edge	Pulses are triggered by their rising edge
	1 – Falling edge	Pulses are triggered by their falling edge
Counter reset	On	Counter forced reset every 10 ms NOTE ***The counter register is resetting itself if overflowed.***
	Off	No counter forced reset

NOTE
**** It is not recommended to use debounce filter for input signals with a frequency above 40 Hz and a duty cycle of 50 % or less. A useful signal can be missed.***

NOTE
The input counters retain their values after the device restart.

Two-channel encoders (without Z channel) with the maximum signal frequency of 100 kHz can be connected to the fast digital inputs.
The total number of pulses is stored in a 32-bit register, taking into account the direction of rotation after a zero crossing. When the direction of rotation changes (e.g. from positive to negative), pulses are counted with the opposite sign (in this case, subtracted).

4.3 Outputs

4.3.1 Digital outputs

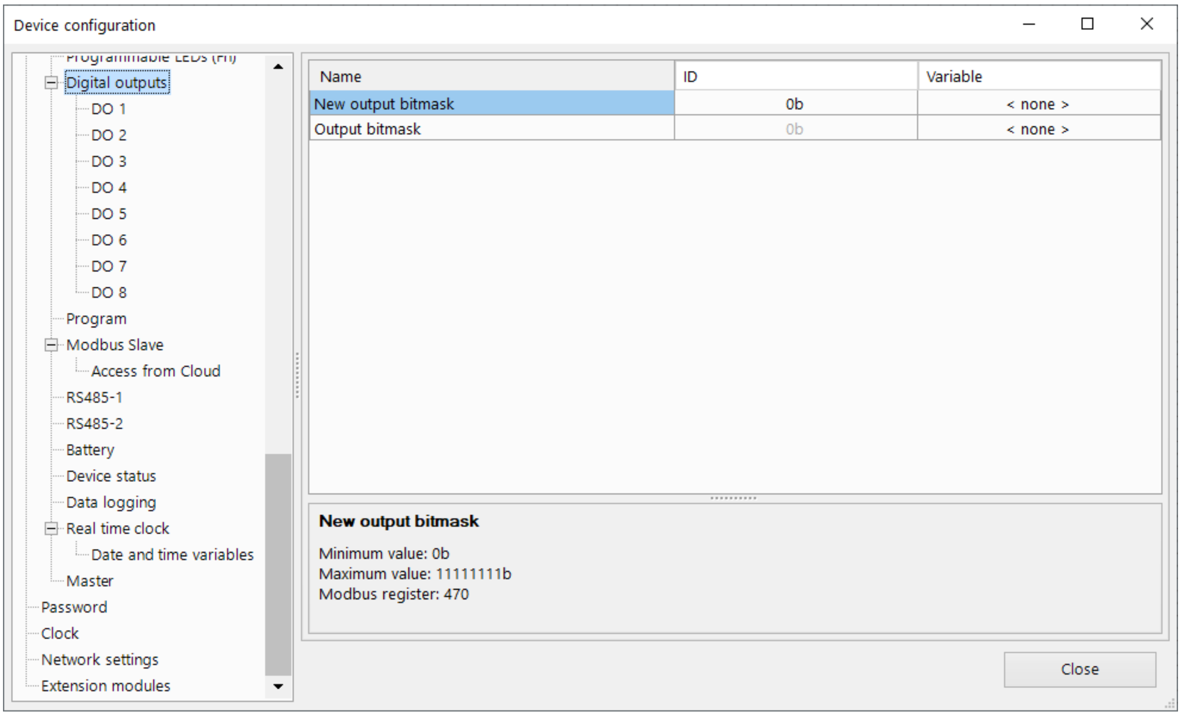


Fig. 4.10 DO configuration parameters

The safe state can be assigned for each of the device digital outputs as well as for each of the PRM extension module digital outputs (if used).

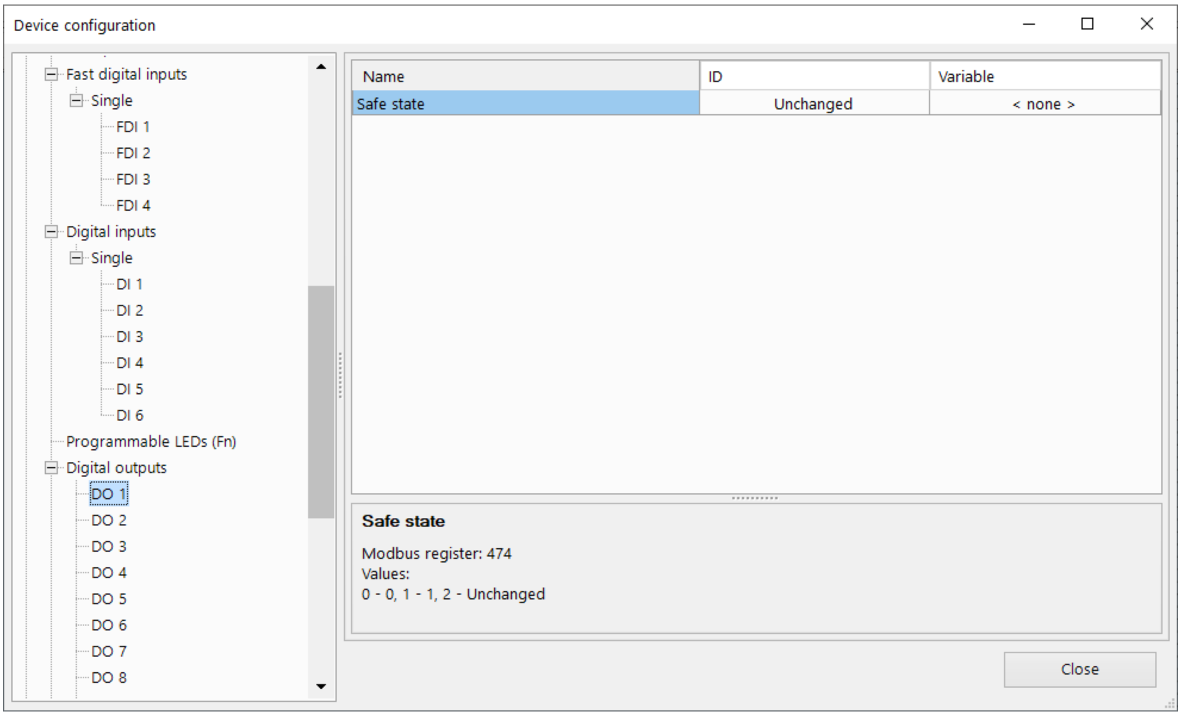


Fig. 4.11 DO safe state configuration parameters

Table 4.6 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 set to 0). value “1” – 1 (digital output is set to 1). value “2” – unchanged (digital output stays unchanged).

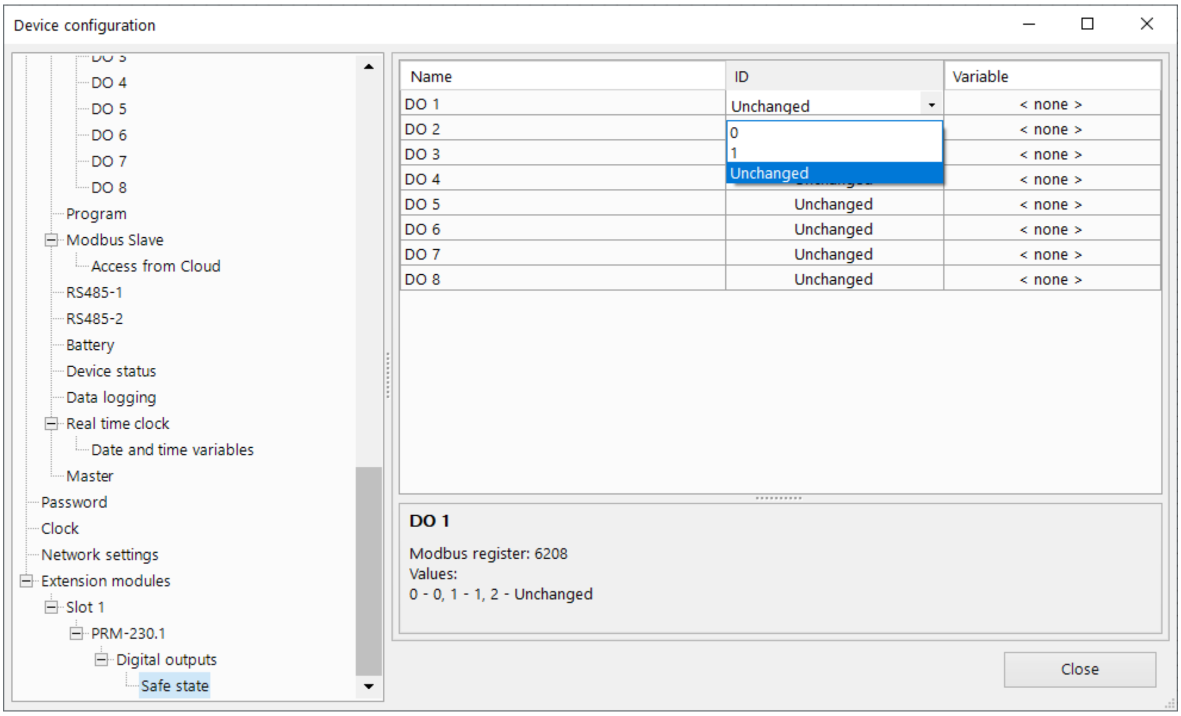


Fig. 4.12 PRM extension module DO safe state configuration parameters

Table 4.7 PRM extension module DO safe state configuration parameters

Parameter	Description
Safe state	The parameter is to assign an output state for the PRM extension module digital outputs when communication lost. The following values are to be set to assign appropriate output states: value “0” – 0 (PRM digital output is set to 0). value “1” – 1 (PRM digital output is set to 1). value “2” – unchanged (PRM digital output stays unchanged).

4.3.2 Analog outputs

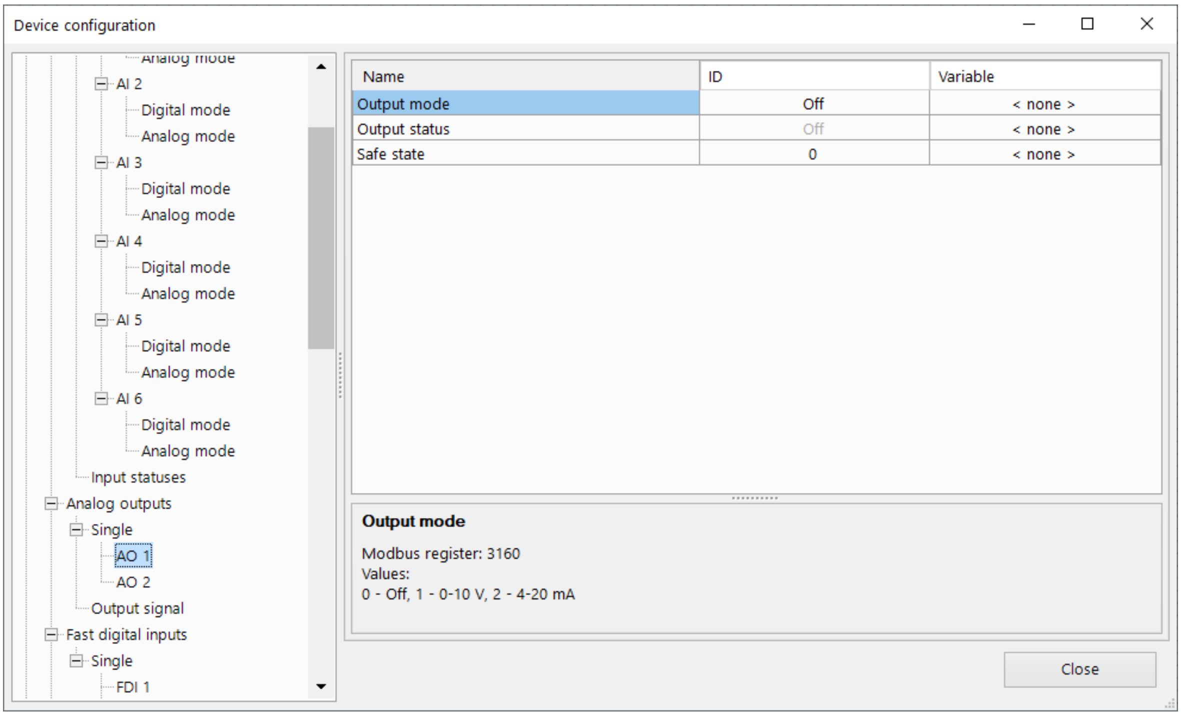


Fig. 4.13 AO parameters in ALP

Table 4.8 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
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

PR103 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.

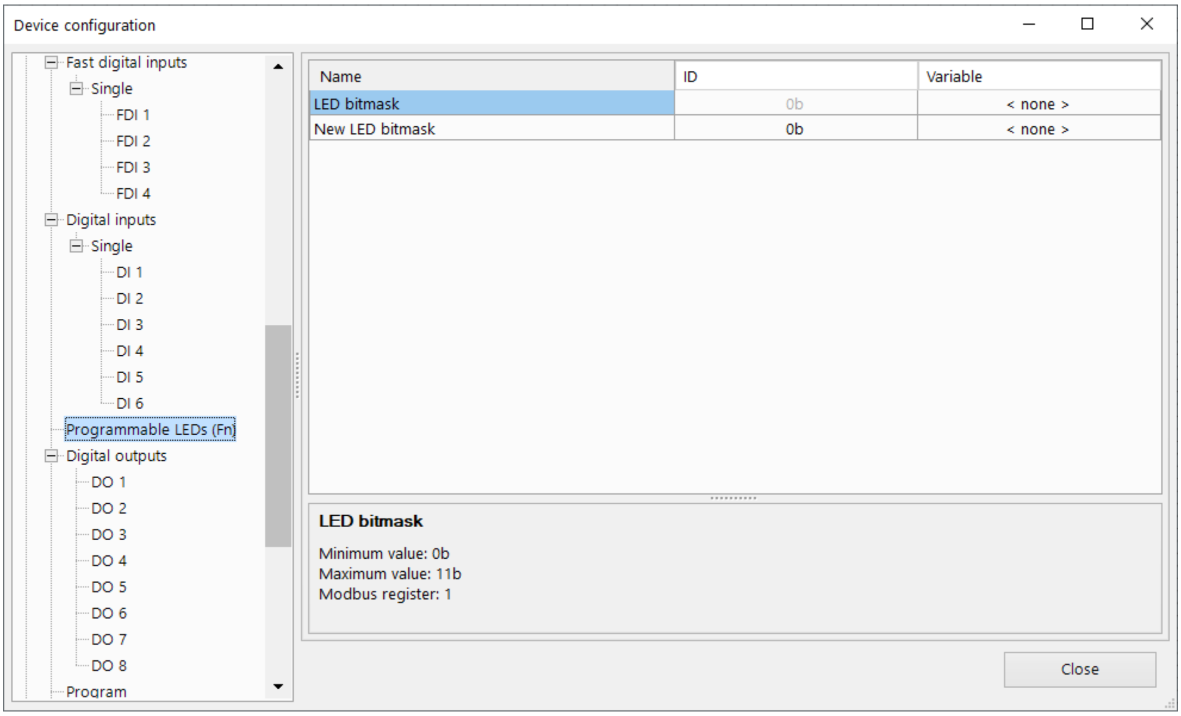


Fig. 4.14 LED parameters in ALP

4.5 Data logging

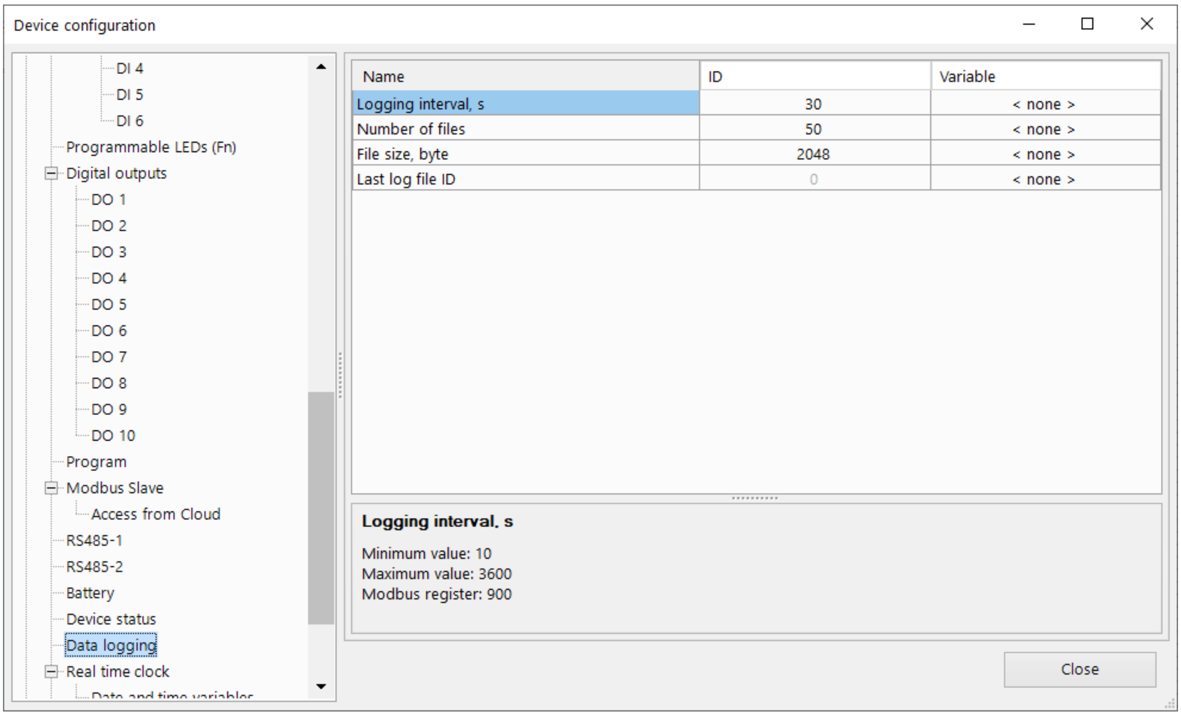


Fig. 4.15 Data logging parameters in ALP

Table 4.9 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
Last log file ID	ID of the last written file

4.6 Password and archives

4.6.1 Password

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

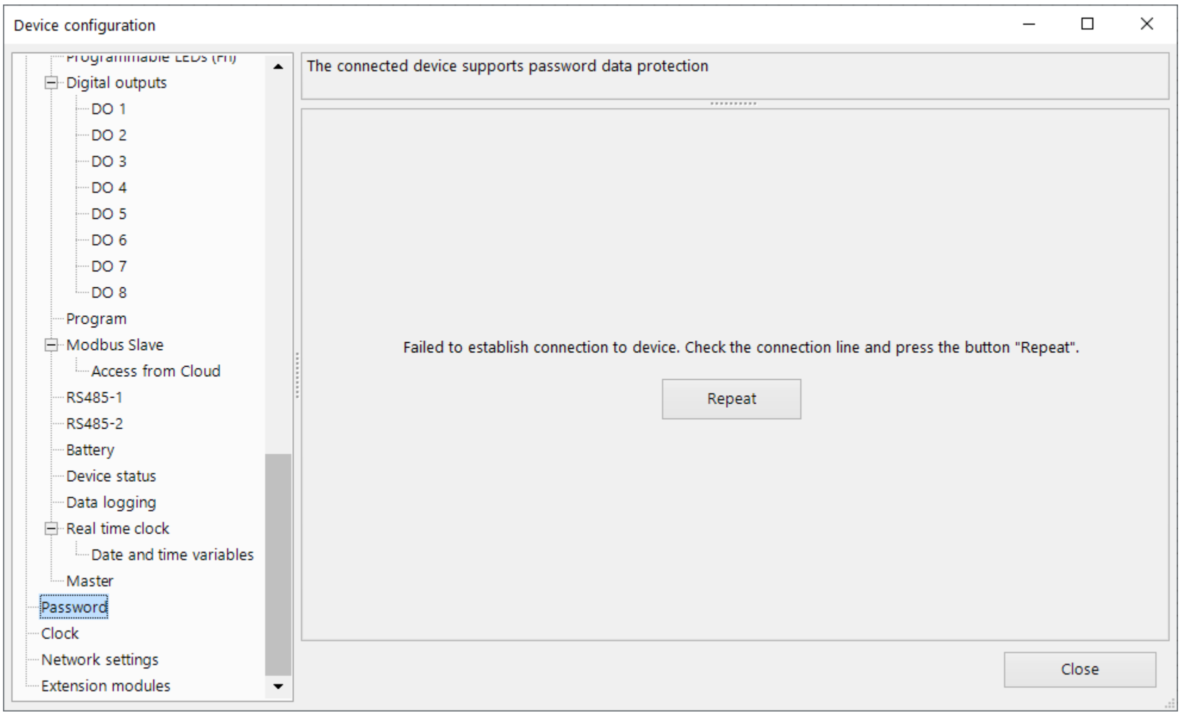


Fig. 4.16 Password setting in ALP

If you forgot the password, restore the factory setting (*section 4.10*).

4.6.2 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 4.10 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.
The data logging parameters (the logging interval, the number of files and the maximum file size) can be set by user 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 ***ALP***.
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.

4.7 Network

4.7.1 General

Network parameters can be set with ***ALP***.
The device operates:

– under the Modbus TCP protocol (Slave / Master) over the Ethernet interface (see *section 4.7.4* and *section 4.7.5*).

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 4.7.3* and *section 4.7.5*).

The device is equipped with the switchable built-in RS485 termination resistors which can be manually connected to the +D and –D lines of the RS485 interface.
RS485 termination resistors are used to ensure the communication integrity when there is no data transmission activity over the RS485 lines.
The termination resistors are placed at one end of the RS485 network, as a rule, on the Master side.
It is recommended to turn on the termination resistors if the device is operating in the Master mode.
The termination resistors should be turned off if the device is operating in the Slave mode.

4.7.2 Network parameters

4.7.2.1 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.

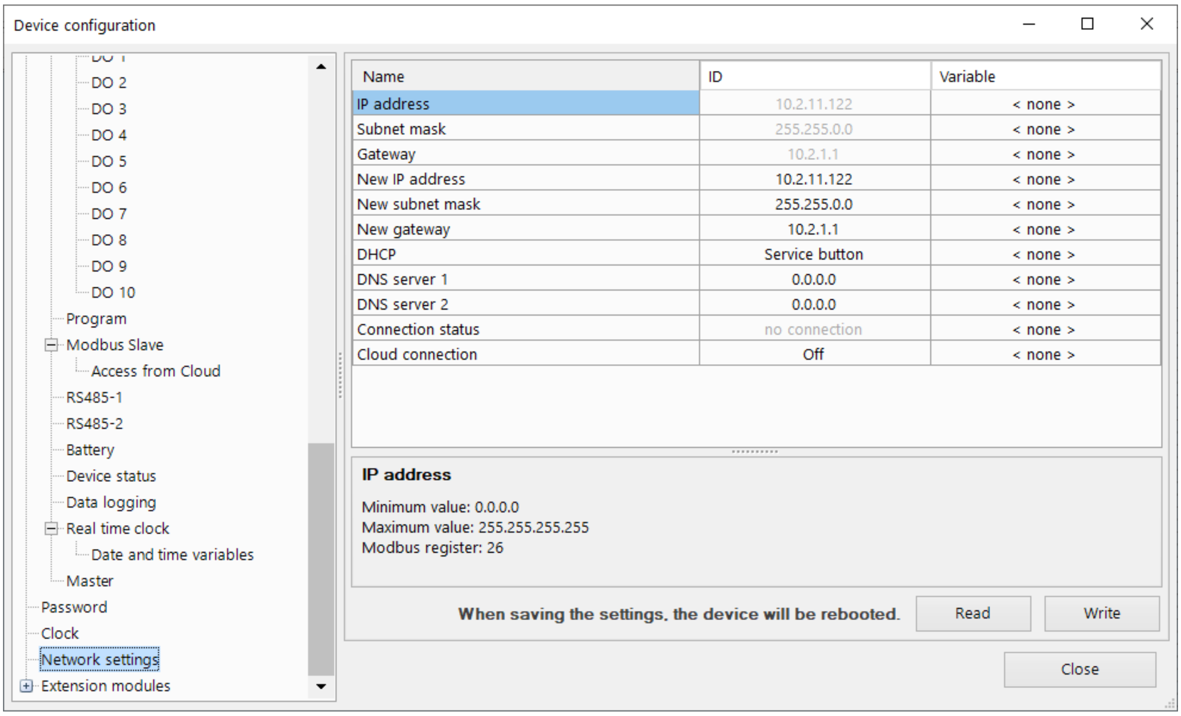


Fig. 4.17 Ethernet parameters in ALP

There are the two types of the IP address: a static IP address and a dynamic IP address. The static IP address can be also set by using the service button (in this case set the ***DHCP*** parameter value to ***Service button***).
The network parameters listed in the table below must be set to ensure communication over the Ethernet.

Table 4.11 Ethernet parameters

Parameter	Description
IP address	IP address: it can be static IP or dynamic IP. The IP address default factory setting is **192.168.1.99**
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 **192.168.1.80**
DNS server 1	Used to translate the host name to the numerical IP addresses. Set the parameter to the value: **8.8.8.8**
DNS server 2	
New IP address	Enter new value if required
New subnet mask	
New gateway	
DHCP	DHCP mode settings. The following values are available for setting: 0 – On (DHCP mode is on). 1 – Off (DHCP mode is off). 2 – Service button (DHCP mode is one-time set by the service button).

To configure the Ethernet interface, proceed as follows:

1. open the node ***Network settings*** in ***ALP*** configuration dialog.
2. set the parameters ***New IP address***, ***New subnet mask***, ***New gateway***.

DHCP mode parameter must be set to “Off”.

4.7.2.2 RS485

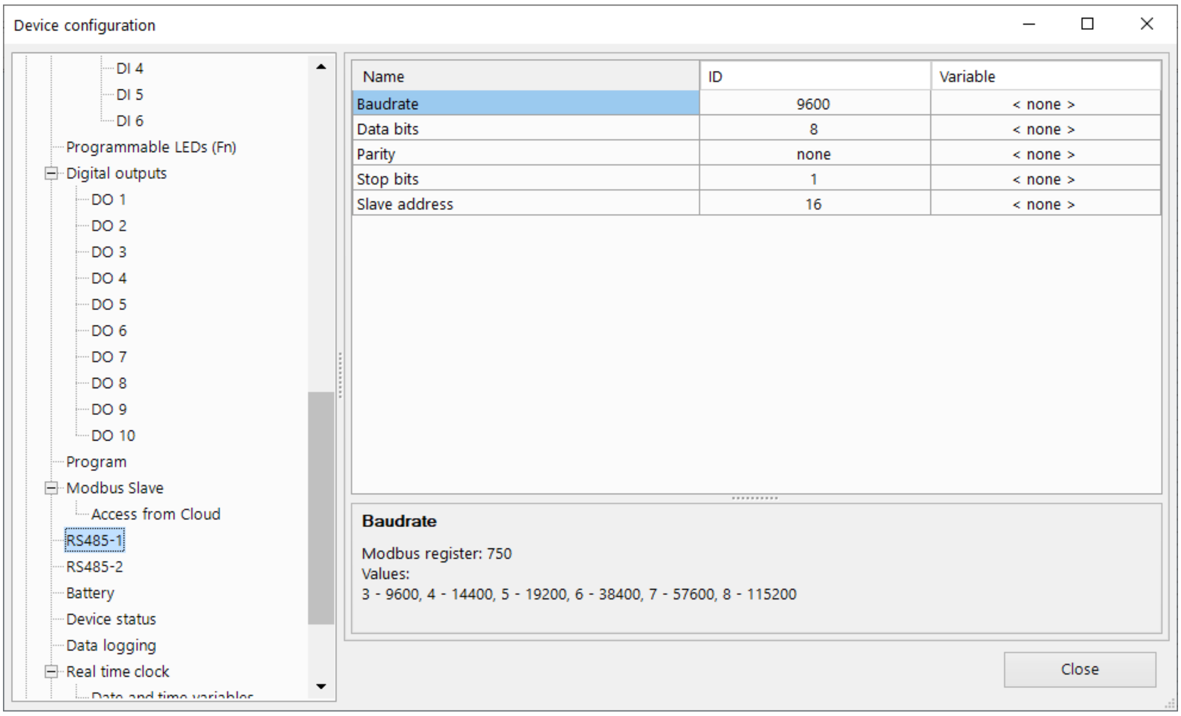


Fig. 4.18 RS485 configuration parameters

Table 4.12 RS485 parameters

Parameter	Description
Baud rate	The parameter is to set the COM port baudrate. 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: 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

4.7.3 Modbus RTU and Modbus ASCII

Depending on 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 4.7.5* for configuration parameters.
When necessary, the device built-in RS485 termination resistors can be connected to the interface +D and –D lines. The termination resistors are connected to the interface +D and –D lines by setting appropriate jumpers on the internal RS485 board which are accessible under the removable housing cover of the device.

RS485 termination resistors are used to ensure the communication integrity when there is no data transmission activity over the RS485 lines.
The termination resistors are placed at one end of the RS485 network, as a rule, on the Master side.

4.7.4 Modbus TCP

Modbus TCP protocol is used only for communication over the device Ethernet port . Please refer to *section 4.7.2.1* 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.***

4.7.5 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 128 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.

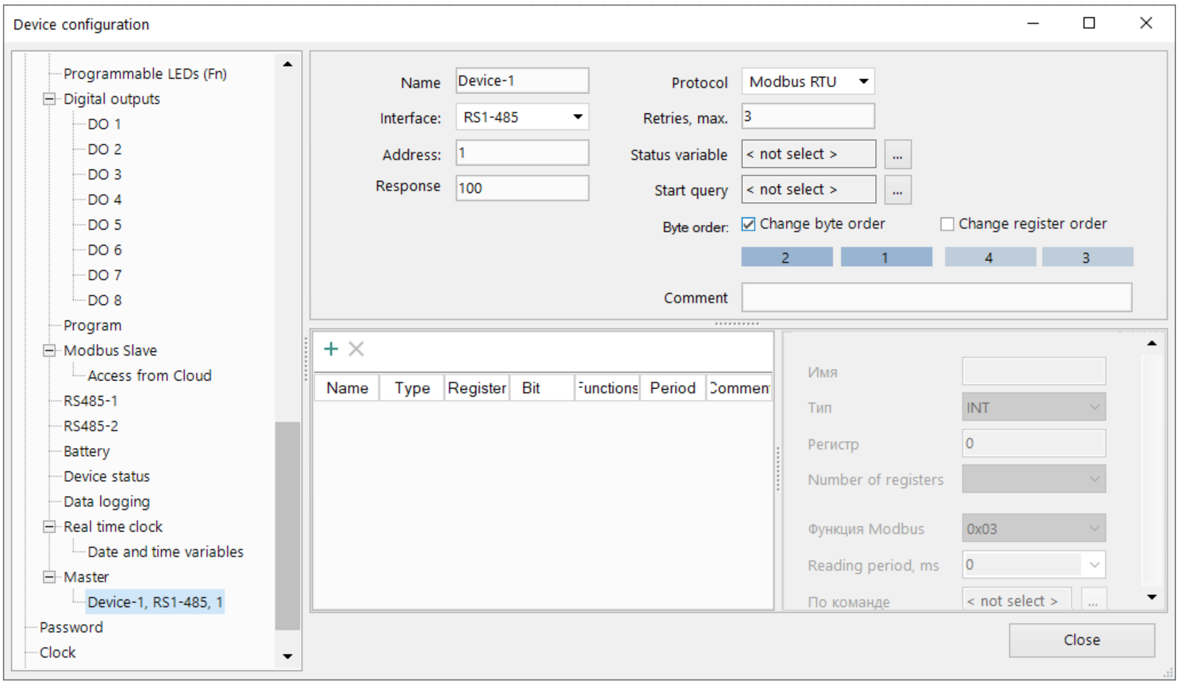


Fig. 4.19 Modbus Master configuration parameters

Table 4.13 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		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 request retries 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.*
Network variables' memory size for the device Slave mode is 2040 Bytes.

4.7.6 Safe mode timeout

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

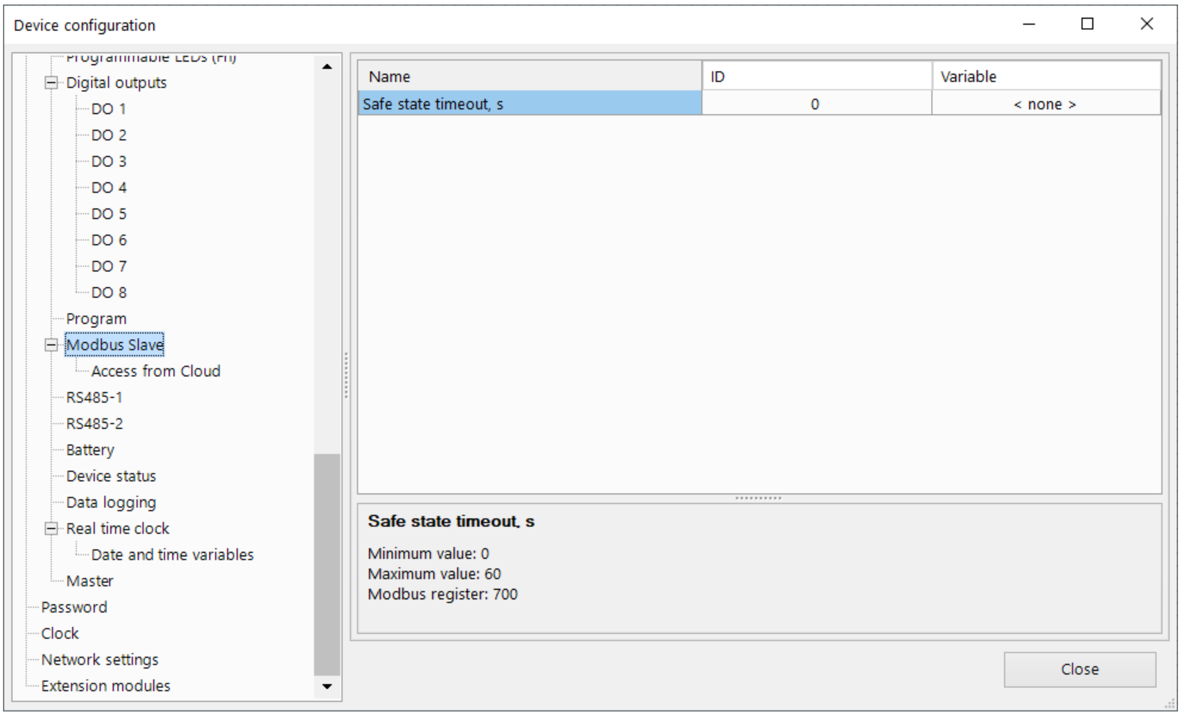


Fig. 4.20 Safe mode timeout configuration parameters

Table 4.14 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.

4.7.7 Modbus application

Table 4.15 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.
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 4.16 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 4.17 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 4.18 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.

4.7.8 Modbus error codes

Table 4.19 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.

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 4.15* 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 4.20 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).

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 4.21 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_READ_FILE_RECORD	MODBUS_ILLEGAL_DATA_ADDRESS	Reference type does not meet the specification. The file to be read failed to open or does not exist.
MODBUS_READ_FILE_RECORD	MODBUS_ILLEGAL_DATA_VALUE	Failed to move to the file offset required.
MODBUS_READ_FILE_RECORD	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_WRITE_FILE_RECORD	MODBUS_ILLEGAL_DATA_ADDRESS	Reference type does not meet the specification. The file to be written failed to open.
MODBUS_WRITE_FILE_RECORD	MODBUS_SLAVE_DEVICE_FAILURE	The requested file does not exist. The requested file is read-only. Failed to write the required number of bytes.

4.8 Device status

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

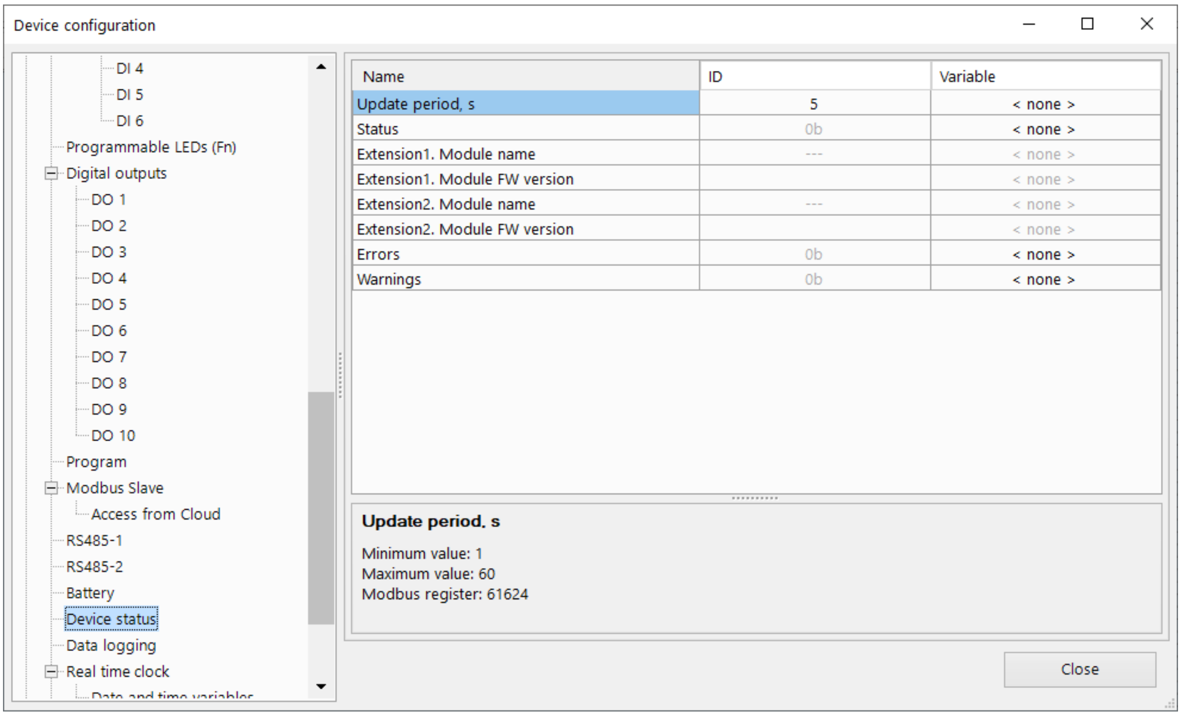


Fig. 4.21 Device status parameters in ALP

Table 4.22 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 4.23 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	

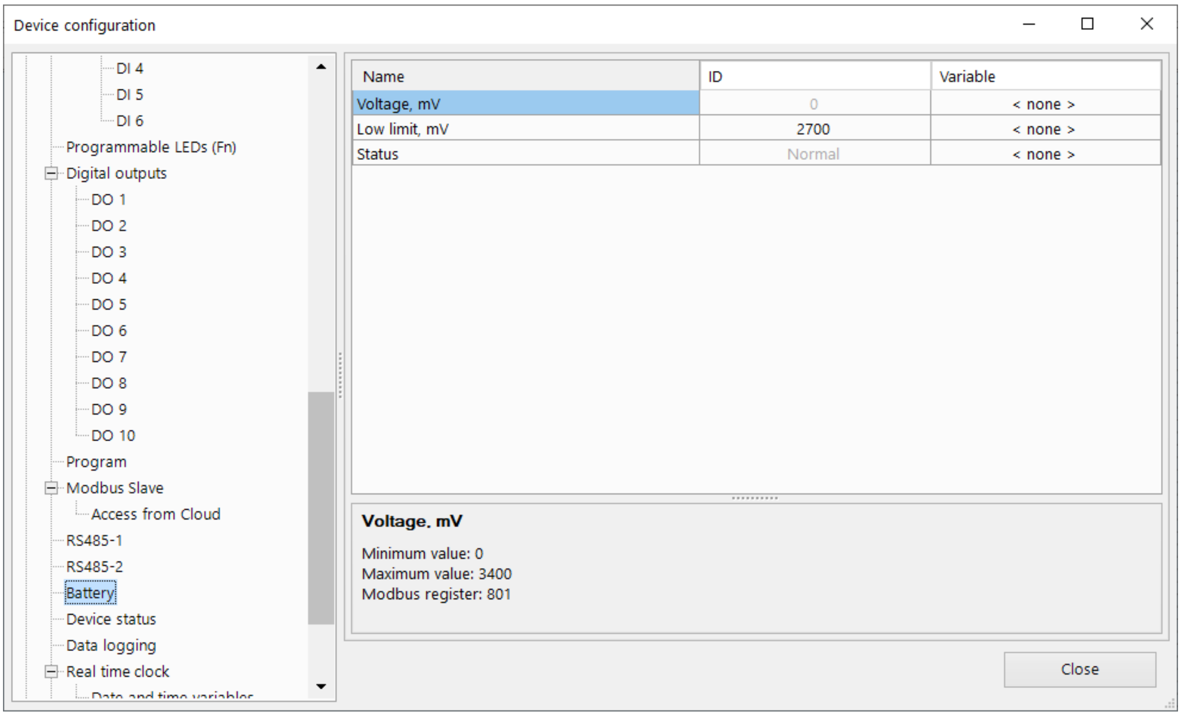


Fig. 4.22 Battery status parameters

Table 4.24 Possible states of the battery parameter Status

Value	Description
0	Battery is OK
1	Battery is discharged

The status parameters of the connected PRM extension modules are available in ALP.

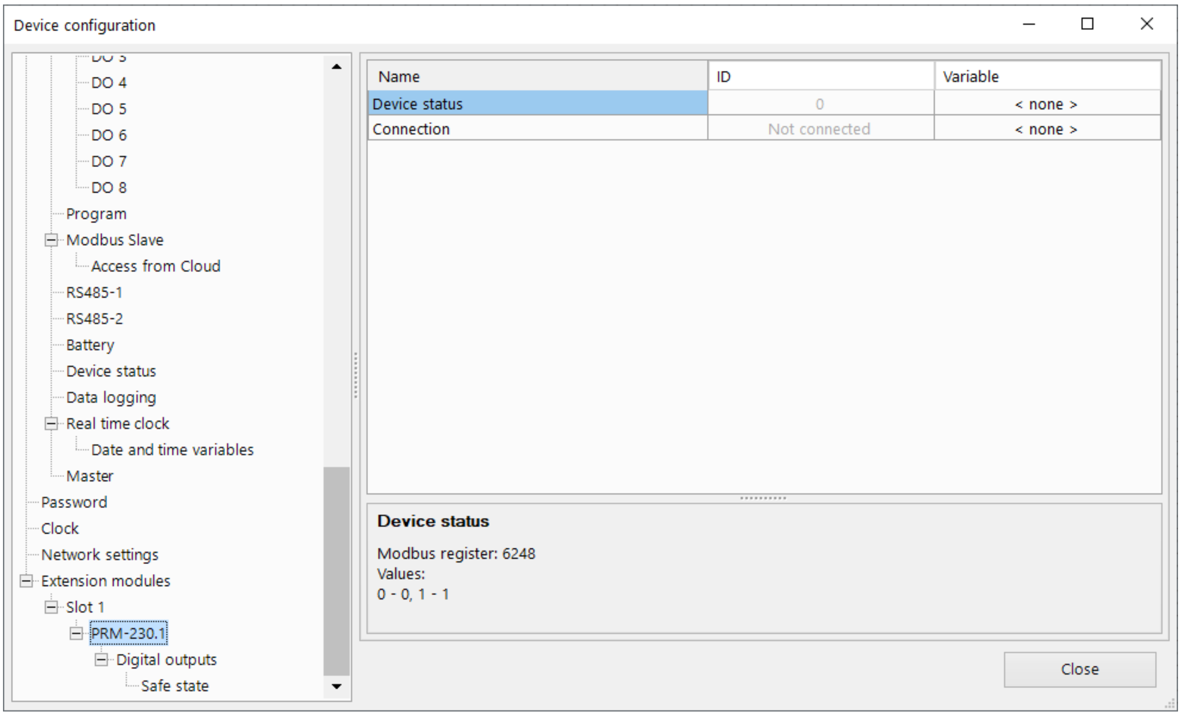


Fig. 4.23 Status parameters of the PRM extension modules

The value of the parameter ***Device status*** can be read over Modbus. Also a variable can be assigned in the user program to read the parameter value. Description of the parameter possible values is given in the table below.

Table 4.25 Possible values of the PRM extension module parameter Device status

Value	Description
0	No data exchange with the extension module
1	Data exchange with the extension module is in process

The value of the parameter ***Connection*** can be read over Modbus. Also a variable can be assigned in the user program to read the parameter value. Description of the parameter possible values is given in the table below.

Table 4.26 Possible values of the PRM extension module parameter Connection

Status	Value	Description
Not connected	0	No data exchange, the extension module is not connected.
Initialization	1	Connecting the extension module is in process.
Found	2	The extension module is found. The type of the extension module installed and the firmware version are not verified. No settings applied.
Inappropriate module type	3	Communication with the extension module is established but the type of the extension module installed is not appropriate for using with the device.
Invalid firmware version	4	Communication with the extension module is established but the firmware version of the extension module installed is invalid (out of date).
Operation	5	Communication with the extension module is established. The type and the firmware version of the extension module installed are correct. The extension module installed is ready for operation with the user software.

4.9 Real-time clock

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

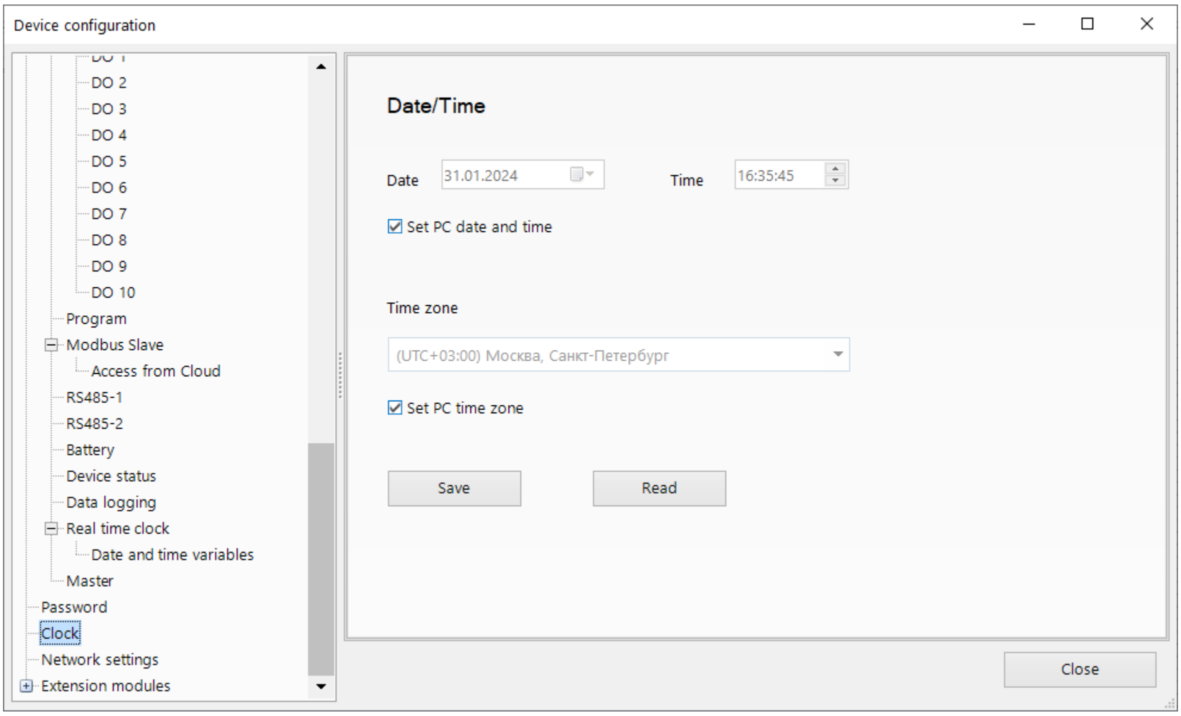


Fig. 4.24 Date and time settings

Table 4.27 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.

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 tree ***Real time clock*** to assign the user program variables.

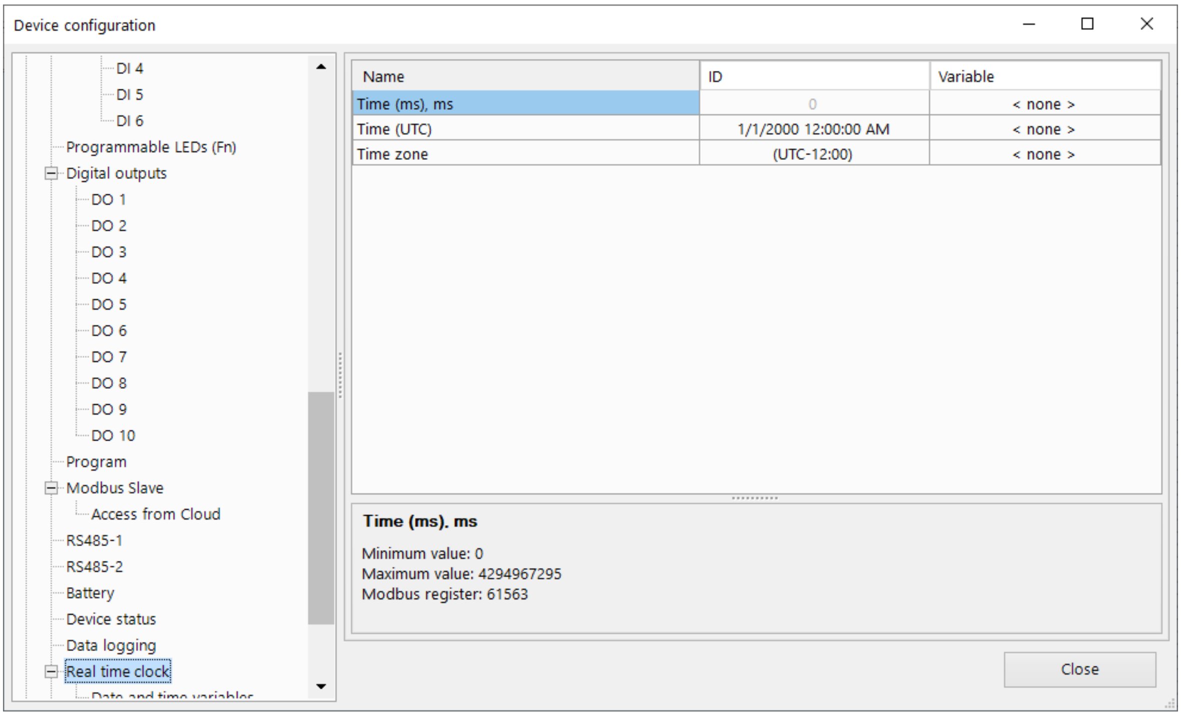


Fig. 4.25 Assignment of variables to the RTC settings

Table 4.28 RTC setting parameters

Parameter	Description
Time (ms), 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 the node***Date and time variables*** to assign the user program variables.

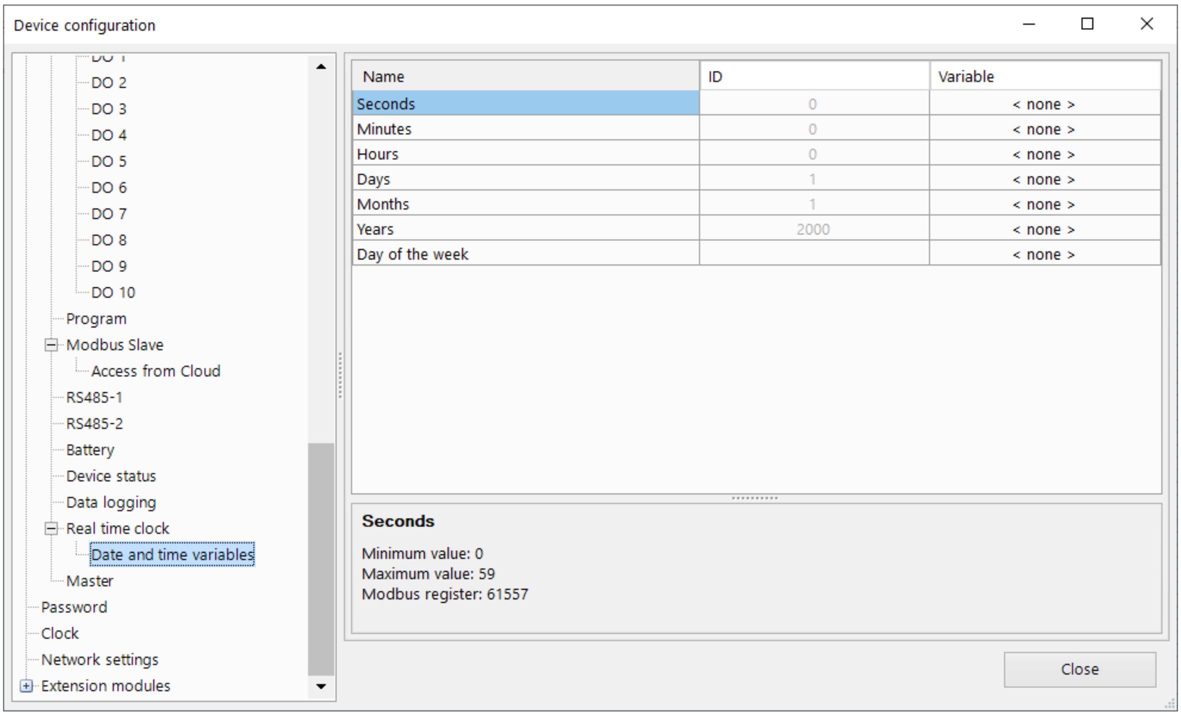


Fig. 4.26 Assignment of variables to the RTC date and time setting values

4.10 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 PR103.
2. Holding on to the ribbed area (see *Fig. 4.27*, 1, arrow 1), open the front cover (arrow 2).
3. Using a thin tool, press and hold the service button for at least 12 seconds (see *Fig. 4.27*, 2).
4. Release the button. The device will restart and all parameters will be reset to factory values.
5. Close the front cover.

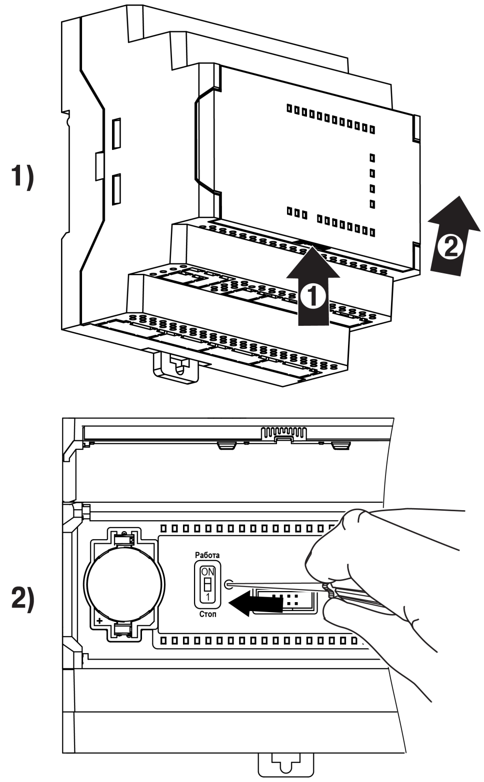


Fig. 4.27 Factory settings restoration

5 Installation

5.1 Montage

The safety measures specified in the *section 1.4* must be observed during the device montage
The device is to be mounted in enclosures, cabinets, e. t. c. with protection of the device from dust, moisture, and foreign objects.

NOTICE
Configure and program the device prior to montage and wiring.

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

The relay is designed for DIN rail mounting. The operating conditions (see *section 3.2*) should be taken into account when choosing the installation site.
Follow the steps below for mounting the device on the DIN rail:

1. Prepare the place on the DIN rail where the device should be mounted. Take into account the device overall dimensions (see *Fig. 5.1*).

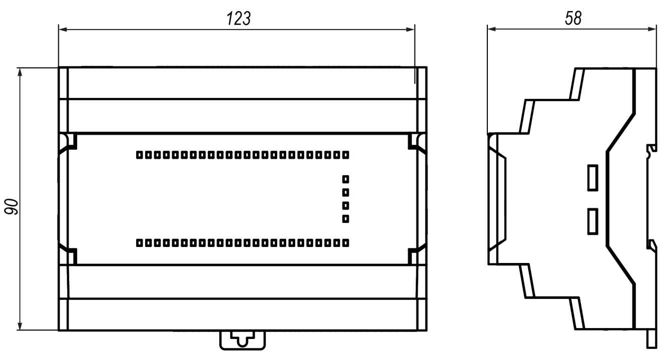


Fig. 5.1 Dimensions

2. Insert a screwdriver into the eyelet of the slide interlock and then pull it down to loosen the slide interlock (see *Fig. 5.2*, 1). Position the device onto the DIN rail.
3. Press the device firmly against the DIN rail in the direction of arrows 1 and 2 (see *Fig. 5.2*, 2). Using a screwdriver, pull up the slide interlock to lock it.
4. Connect the device to the external equipment using the removable terminal blocks (supplied with the device).

In order to remove the device from the DIN rail, follow the steps below:

1. Unplug the removable terminal blocks from the device mating connectors (see *section 5.2*).
2. Insert a screwdriver into the eyelet of the slide interlock.
3. Pull the slide interlock down to unlock it, then remove the device from the DIN rail.

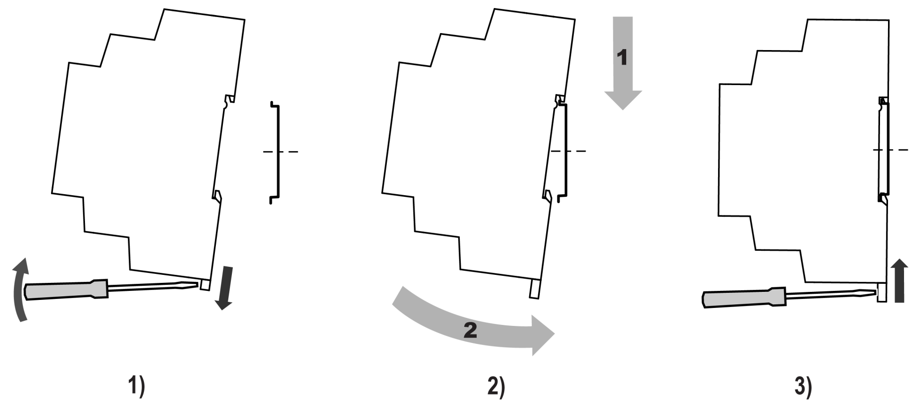


Fig. 5.2 DIN rail mounting

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. Remove the device from the DIN rail and install another PR103 of the same modification (with the terminal blocks unplugged).
4. Plug the terminal blocks with existing wiring into mating connectors of the PR103 installed.

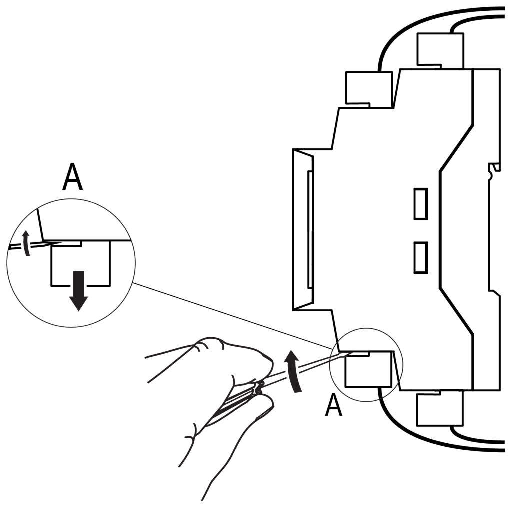


Fig. 5.3 Quick replacement

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 microUSB 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.

The analog inputs 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 the analog inputs and the USB interface of the device. If it is not possible, do not connect the external equipment to the analog inputs and the USB interface simultaneously. Disconnect external cables from the analog inputs when programming the device over the USB interface or use galvanic isolators (e. g. USB isolators, a battery-powered laptop, e. t. c.).

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 to appear 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.

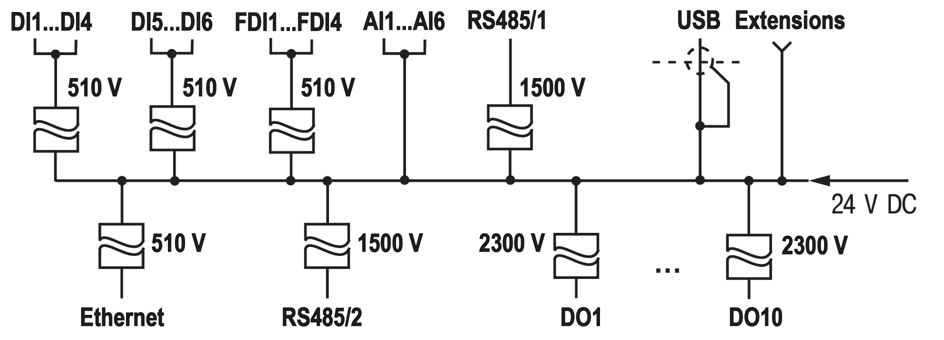
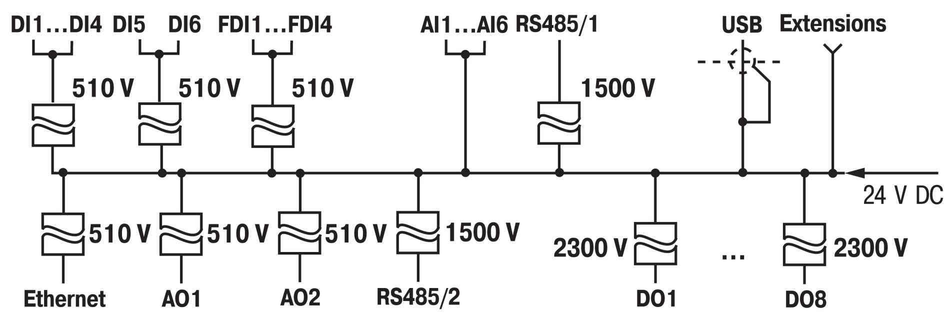
In order to reduce the interference effect, use the program debouncing filters which can be set individually for each of the device inputs. The program debouncing filters are available for the following device inputs:

- Analog inputs.
- 24 V digital inputs.

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

6.3 Galvanic isolation

Table 6.1 PR103 galvanic isolation

<table>
<tr><th>PR103 modification</th><th>Galvanic isolation diagram</th></tr>
<tr><td>PR103.24.3.2</td><td>
</td></tr>
<tr><td>PR103.24.6.2</td><td>
</td></tr>
</table>

6.4 Sensors wiring

6.4.1 Digital inputs – switch contacts wiring

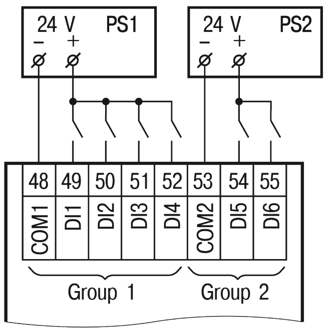


Fig. 6.1 DI – 24 V switch contacts wiring

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

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.

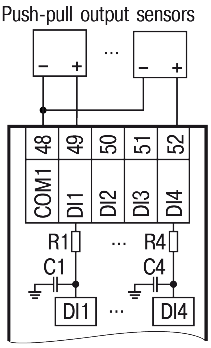


Fig. 6.2 DI – push-pull output sensor wiring

NPN output sensor

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

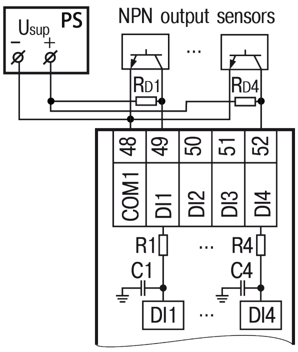


Fig. 6.3 DI – NPN output sensor wiring

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

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

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 – the device internal series input resistor.

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

Example:
Given the 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, the resistance R_D , calculated by the *formula* , must not exceed the value of 4.253 kΩ.

PNP output sensor

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

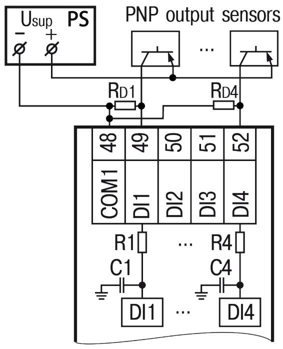


Fig. 6.4 DI – PNP output sensor wiring

Table 6.2 The applicable additional resistor R_D values

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

6.4.3 Fast digital inputs

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

Push-pull output sensor

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

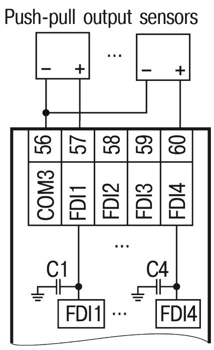


Fig. 6.5 DI – push-pull output sensor wiring

NPN output sensor

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

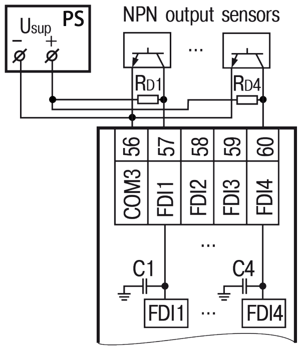


Fig. 6.6 DI – NPN output sensor wiring

The criterion for the R_D selection is described below.
As the fast digital input is set HIGH, the R_D value must allow the internal input capacitance to charge from zero to the HIGH threshold voltage, and keep the voltage above the HIGH threshold level for at least 5 µs.
In order to determine if the R_D value meet the criterion above, the value must be substituted into the formula:

$$U_{c.in} = (U_{p.min} - (R_D + R_{in}) \cdot I_{in.max}) \cdot \left(1 - e^{\frac{5\mu s - t_{hi}}{(R_D + R_{in}) \cdot C_{in}}}\right)$$

with meeting the condition as follows:

$$U_{c.in} > U_{in.h.max}$$

where
$U_{p.min}$ – minimum possible power voltage applied to the resistor R_D.
t_{hi} – duration of the HIGH input state
$I_{in.max}$ = 8.3 mA – maximum input current of the fast digital input.
$U_{in.h.max}$ = 13 V – LOW to HIGH threshold maximum voltage.
The input capacitance is represented by the internal protection diode capacitance only:
C_{in} = *400 pF*.
R_{in} = 0 Ω – as there is no input series resistor inside the device.

Example:
Given the 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.*
Assuming the duration of the HIGH input state t_{hi} = 10 µs and having the additional resistor R_D = 860 Ω,
substitute the R_D value into the formula to determine if it meets the selection criterion.
The result is $U_{c.in}$ = 13.262 which is more than 13 V. Therefore, the selected resistor R_D value meets the selection criterion and may be applied.

NOTE
12 V input signals are not supported by the fast digital inputs.

PNP output sensor

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

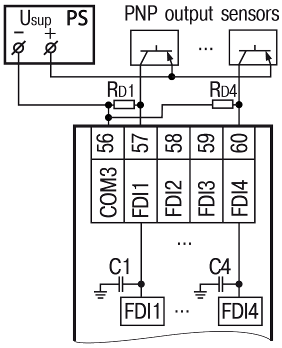


Fig. 6.7 DI – PNP output sensor wiring

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

$$R_D = \frac{5\mu s - t_{low}}{C_{in} \cdot ln\left(\frac{U_{in.l.min}}{U_{p.max}}\right)} - R_{in}$$

where
$U_{in.l.min}$ = 5 V – HIGH to LOW threshold minimum voltage.
$U_{p.max}$ = 30 V – maximum power supply voltage of the sensor.
t_{low} – duration of the LOW input state.
R_{in} = 0 Ω – as there is no input series resistor inside the device.
The input capacitance is represented by the internal protection diode capacitance only:
C_{in} = 400 pF.
Assuming the t_{low} = 10 µs, the calculated R_D maximum permissible value is 6976 Ω.

*Table 6.3 The applicable additional resistor R_D values**

Type of the sensor output	Power supply voltage (U_{sup})	R_D maximum permissible value
NPN transistor	24 V	860 Ω
PNP transistor		6976 Ω

NOTE
At the duration of the LOW/HIGH input signal state equal to 10 µs.

Encoders

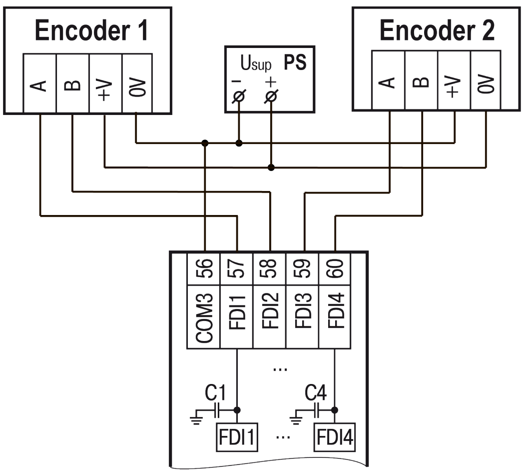


Fig. 6.8 AB Encoders wiring

6.4.4 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.

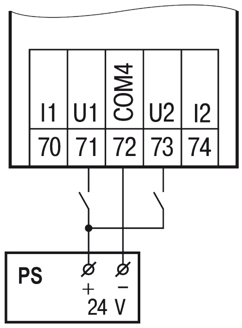


Fig. 6.9 AI (digital mode) – 24 V switch contacts wiring

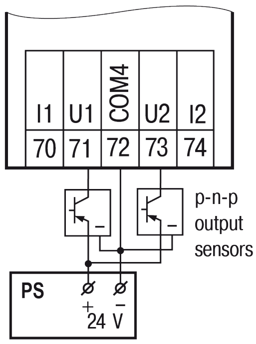


Fig. 6.10 AI (digital mode) – 3−wire PNP open collector output sensor wiring

NOTE
The COM4 terminals are internally connected.

6.4.5 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 6.4 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.

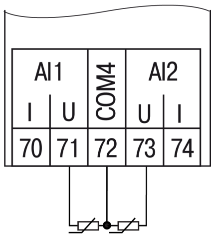


Fig. 6.11 RTD sensors wiring

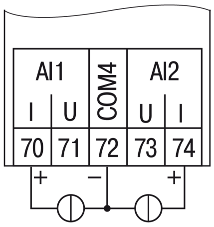


Fig. 6.12 Current sensors wiring

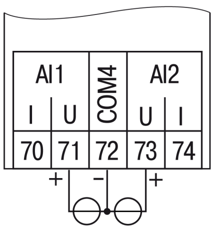


Fig. 6.13 Voltage sensors wiring

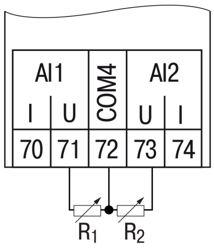


Fig. 6.14 Resistance sensors wiring

6.5 Output wiring

6.5.1 Digital outputs

The wiring of the digital outputs depending on the device modification is shown in the figures below.

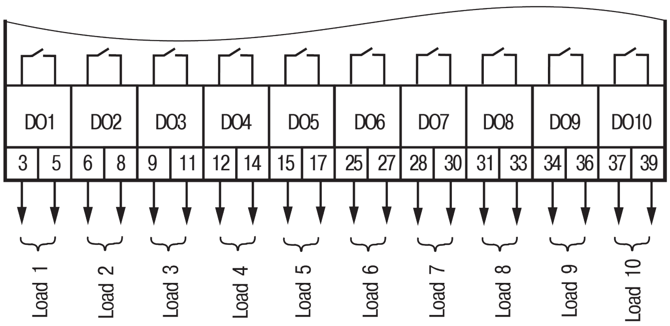


Fig. 6.15 PR103.24.3.2 – digital outputs wiring

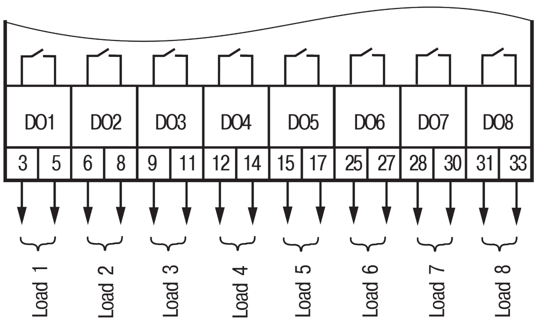


Fig. 6.16 PR103.24.6.2 – digital outputs wiring

6.5.2 Analog outputs

NOTE
Analog outputs require external voltage supply.

The analog outputs are galvanically isolated from each other and may be powered individually, if necessary.

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

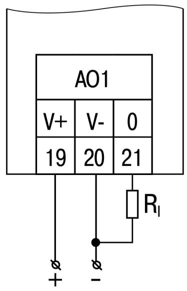


Fig. 6.17 PR103.24.6.2 – analog outputs wiring (4-20 mA output mode)

Load resistance for 4-20 mA output signal must not exceed 300 Ω.

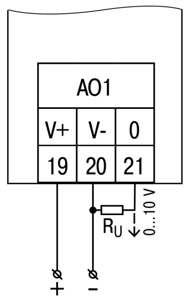


Fig. 6.18 PR103.24.6.2 – analog outputs wiring (0-10 V output mode)

Load resistance for 0-10 V output signal must not be lower than 1 kΩ.
For the 0-10 V output mode, an additional resistor of 20 kΩ should be connected to the analog outputs if necessary to ensure the guaranteed output control signal accuracy of 0.5% and guaranteed high input resistance of the unit being controlled.

6.6 Extension modules connection

NOTICE
The device must be powered off before connecting extension modules.
The device and all external equipment must be powered off before connecting the external equipment to the extension modules.

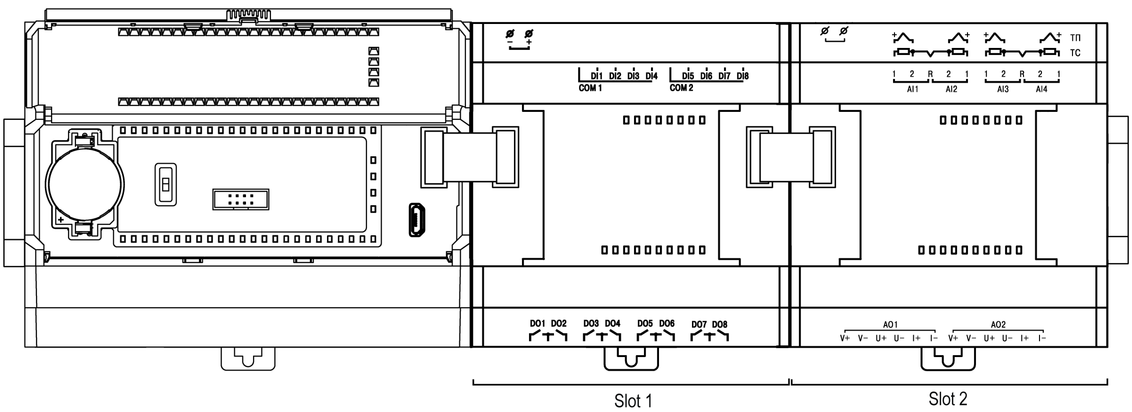


Fig. 6.19 Extension modules connection

Maximum two PRM modules can be connected to PR103 in series.
Mount the modules on the DIN rail to the right of the PR103 and connect them using the supplied 4.5 cm flat cable.
PRM has two EXT connectors located under the right and left front covers. The connector under the left cover is used to connect the 1st PRM to the PR103.
When connected, the flat cable should be placed in a special recess under the cover (see *Fig. 6.20*, arrow 1) to enable the PRM to be pushed close to the PR103 (see *Fig. 6.20*, arrow 2).

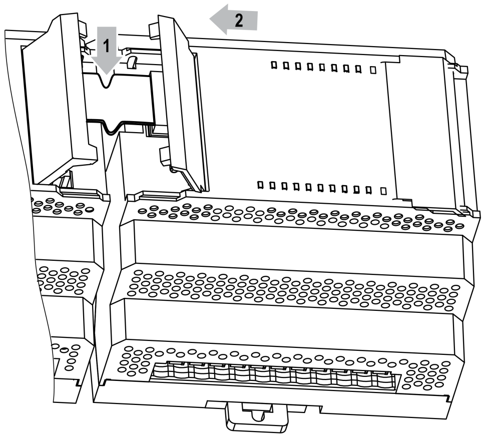


Fig. 6.20 Extension module flat cable

Each module has an independent power supply. It is possible to combine the basic device and modules with different supply voltages.
After the first connection to the basic device, the ERROR LED on the module blinks, since there is no data exchange between the module and the basic device. Only when the module is added to the basic device configuration and the project is transferred to the device, the ERROR LED on the module goes out. If that doesn't happen, update the module firmware.

6.7 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.

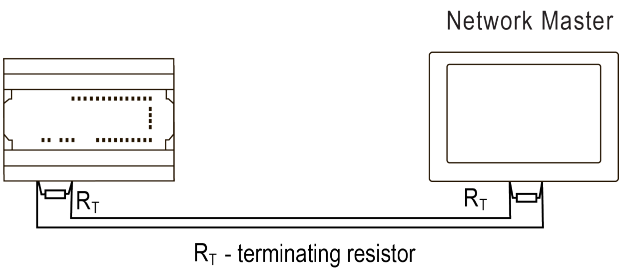


Fig. 6.21 Typical RS485 connection – PR103 as Slave

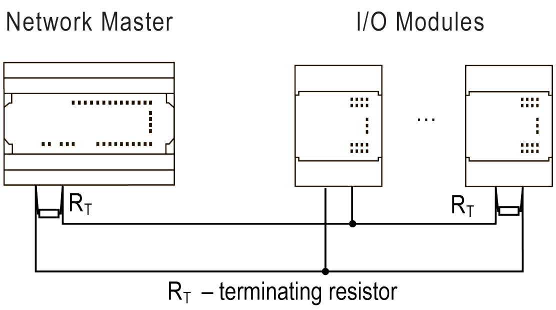


Fig. 6.22 Typical RS485 connection – PR103 as Master

6.8 RS485 termination resistors

The device is equipped with the built-in switchable termination resistors. If necessary, the built-in termination resistors may be connected to or disconnected from the RS485 bus using jumpers.

In order to connect or disconnect the built-in RS485 termination resistors, proceed as follows:

1. Remove the device housing cover (see *section 8.3* for details).
2. Set the jumpers on the device board in position as shown in *Fig. 6.23* below.
3. Install the device housing cover.

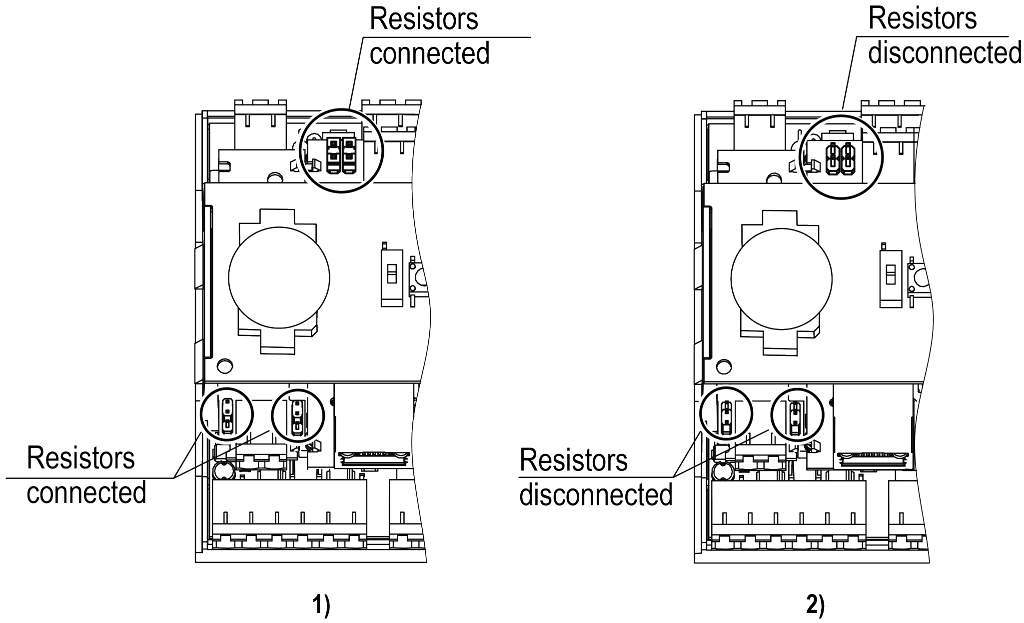


Fig. 6.23 RS485 termination resistors jumpers setting: 1 – RS485 termination resistors connected, 2 – RS485 termination resistors disconnected

6.9 Ethernet connection

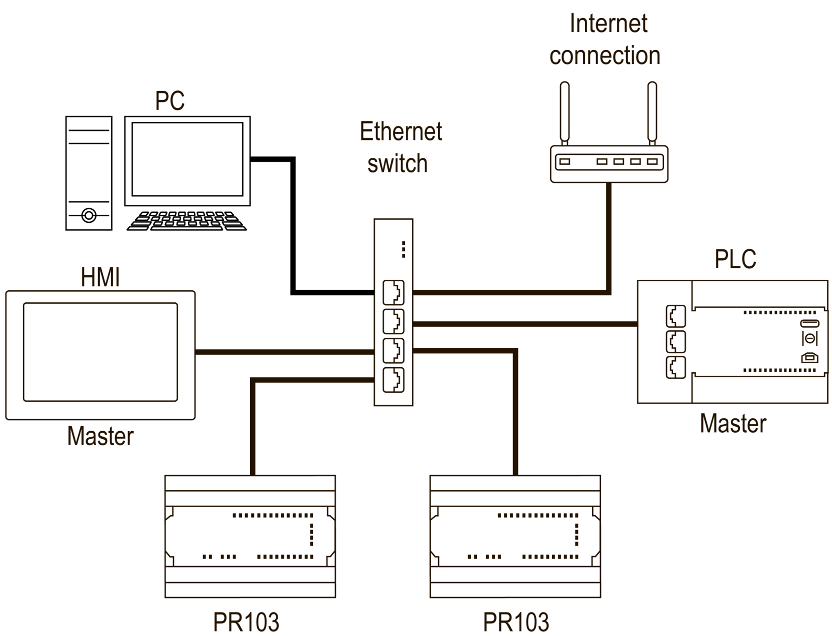


Fig. 6.24 Star topology

6.10 PC connection

Use the microUSB to USB cable for connecting the device to PC over USB interface or use the Ethernet cable for connecting the device to PC over Ethernet.

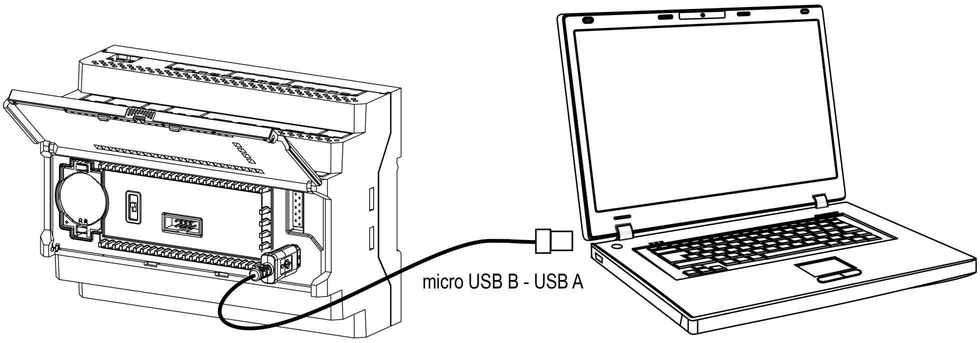


Fig. 6.25   Connecting PR103 to PC over USB

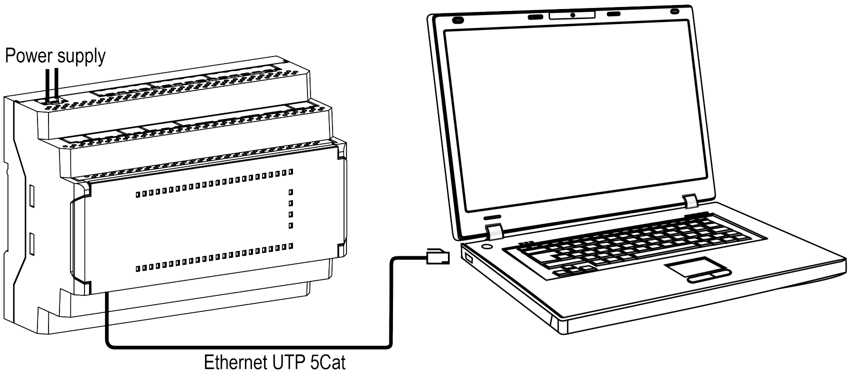


Fig. 6.26   Connecting PR103 to PC over Ethernet

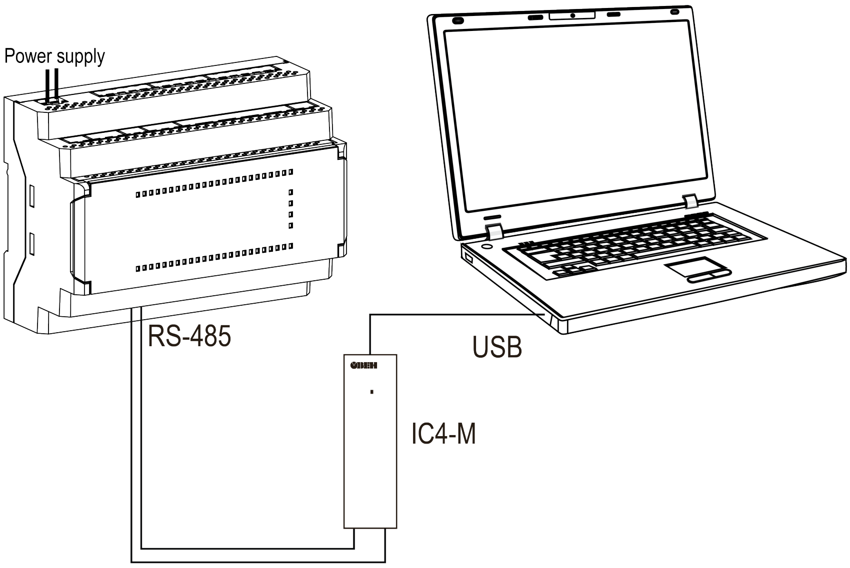


Fig. 6.27   Connecting PR103 to PC over RS485

7 Operation

7.1 Indication, controls and interfaces

The functional assignment of the LED indicators on the PR103 front cover is given in the table below.

Table 7.1 Functional assignment of the LED indicators

LED	Color	State	Description
⏻	green	ON	Power supply voltage applied to the power terminals 1 and 2
⚠	red	ON	Fatal error if ◇ LED simultaneously flashing (see *table 7.2*)
		flashing	Firmware update is in progress
		flashing with delay (see *Fig. 7.1*)	Non-fatal error (see *table 7.3*)
F1	green	—	To be assigned by user's program
F2	red	—	
DI1...DI6	green	ON	Logic HIGH on input
FDI1...FDI4	green	ON	When the digital input mode is set: logic HIGH on input When the encoder or the pulse counter modes are set: input detected pulses during polling cycle
AI1...AI6	green	ON	Logic HIGH on input (only when the digital input mode is set)
DO1... DO10*	green	ON	Output is on (relay output is closed)
◇	red green	OFF flashing	The RUN/STOP switch is in the STOP position. PR103 operates in the I/O mode (see *section 7.2.3*)
	red green	OFF OFF	User's program is not loaded. PR103 is not configured
	red green	ON OFF	No supply voltage applied to the power terminals 1 and 2. PR103 is powered from USB port
	red green	OFF ON	The RUN/STOP switch is in the RUN position. User's program is running
	red green	flashing OFF	Firmware update is in progress
	red green	flashing OFF	PR103 is not configured. RTC battery discharged if ⚠ LED simultaneously flashing.
	red green	flashing with delay ON (see *Fig. 7.1*)	Fatal error if ⚠ LED is simultaneously ON.
	red green	ON ON	Expecting for the start of the firmware boot
	red green	flashing flashing	Firmware boot is in progress

NOTICE
**** Number of digital outputs depends on PR103 modification.***

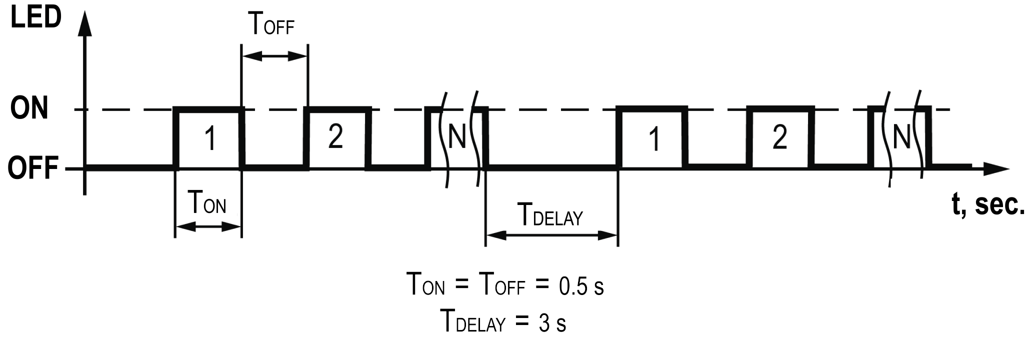


Fig. 7.1 Fatal and non-fatal errors indication diagram

Table 7.2 Fatal errors indication

Number of LED pulses (N)	Description
1	PR103 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 7.3 Non-fatal errors indication

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

For detailed information as to PR103 errors please refer to the *section 7.2.2*.

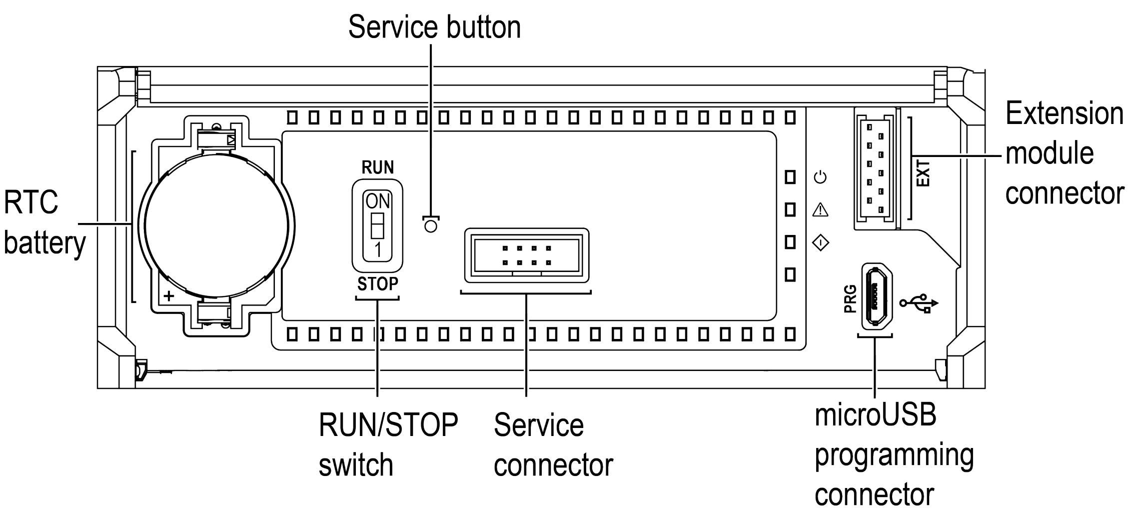


Fig. 7.2 PR103 with the front cover open

Table 7.4 RUN/STOP switch

RUN/STOP switch position	Function
RUN	Runs the user's program
STOP	Stops the user's program. As the user's program is stopped it is possible to update the PR103 firmware (see *section 7.6*) or replace the user's program if it causes incorrect operation
	PR103 operates in the I/O mode (see *section 7.2.3*)

Table 7.5 Service button

Duration of pressing	Function
2 s	IP address assignment (see *section 4.7.2.1*)
12 s	Restoration of the PR103 factory settings (see *section 4.10*)

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

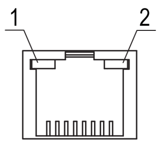


Fig. 7.3 Location of the Ethernet port LEDs: 1 – Green, 2 – Amber

Table 7.6 Ethernet port LEDs functional assignment

LED	State	Description
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 the Ethernet port is powered.***		
Green	OFF	No connection established
	ON	Connection established
	Flashing	Data transfer is in process

7.2 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-resting.
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 1 and 2, the device starts the user's program if it has been loaded into device memory.
The device operation modes are represented by the diagram given below.

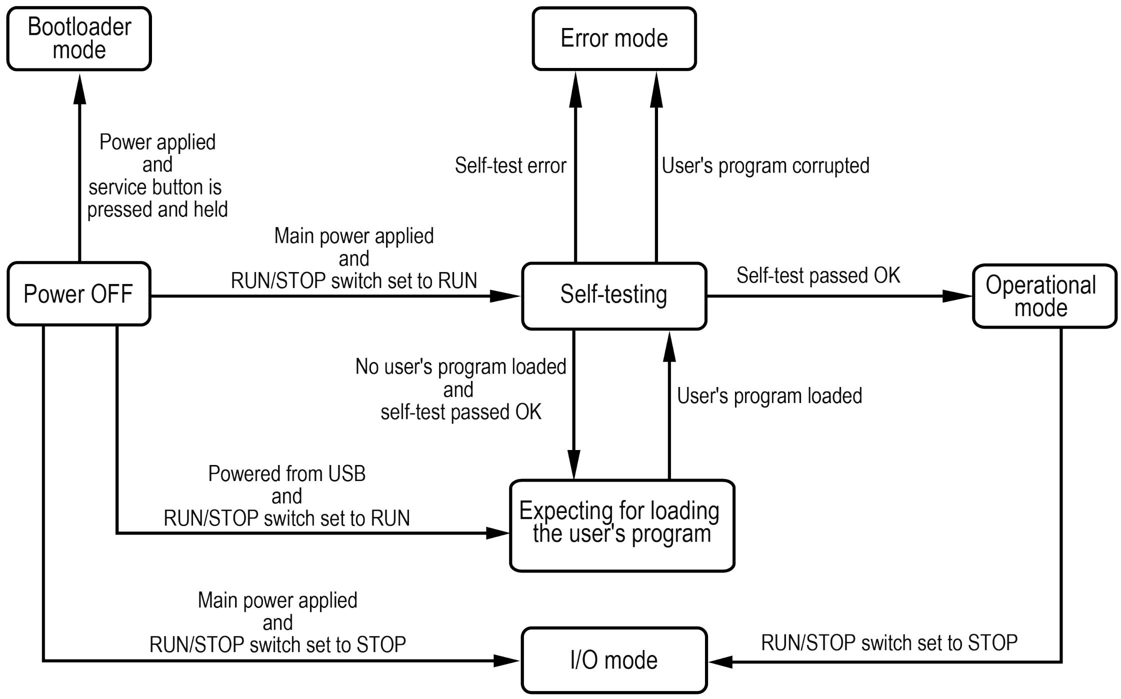


Fig. 7.4 Operation modes diagram

7.2.1 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.

7.2.2 Error mode

Device enters the error mode if any error occurred (see *table 7.2* and *table 7.3* for possible errors). Probable errors which cause device to enter error mode and related remedies are given in the table below.

Table 7.7 Probable error causes and related remedies

Cause	Remedy
Built-in microcontroller error	Please contact to the service center for elimination of the cause
Internal bus initialization failure	
Built-in RTC pulse generator failure	
Watchdog timer error	
Retain error	
Memory size is not sufficient for the logic program	
Ethernet interface failure	
RTC battery discharged	Replace RTC battery (see *section*)

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 7.8 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 (only for PR103.24.6.2)
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 the power terminals 1 and 2
Bit 13	Firmware failure or logic 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
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

7.2.3 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.

7.2.4 Bootloader mode

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 when it is in the operational mode (see *section 7.2.1*).
– 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 1 and 2 or connect USB cable to the device.

7.3 Extension modules

PRM extension modules are used to increase the number of I/O points. Please refer to the *section 6.6* for connection and installation of the extension modules. The operation of the extension modules is determined by user program in PR103.
The input polling time and the output state recording time of the extension modules are determined by complexity of the user program and they are the same as of PR103 inputs/outputs.

7.4 User program parameters

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

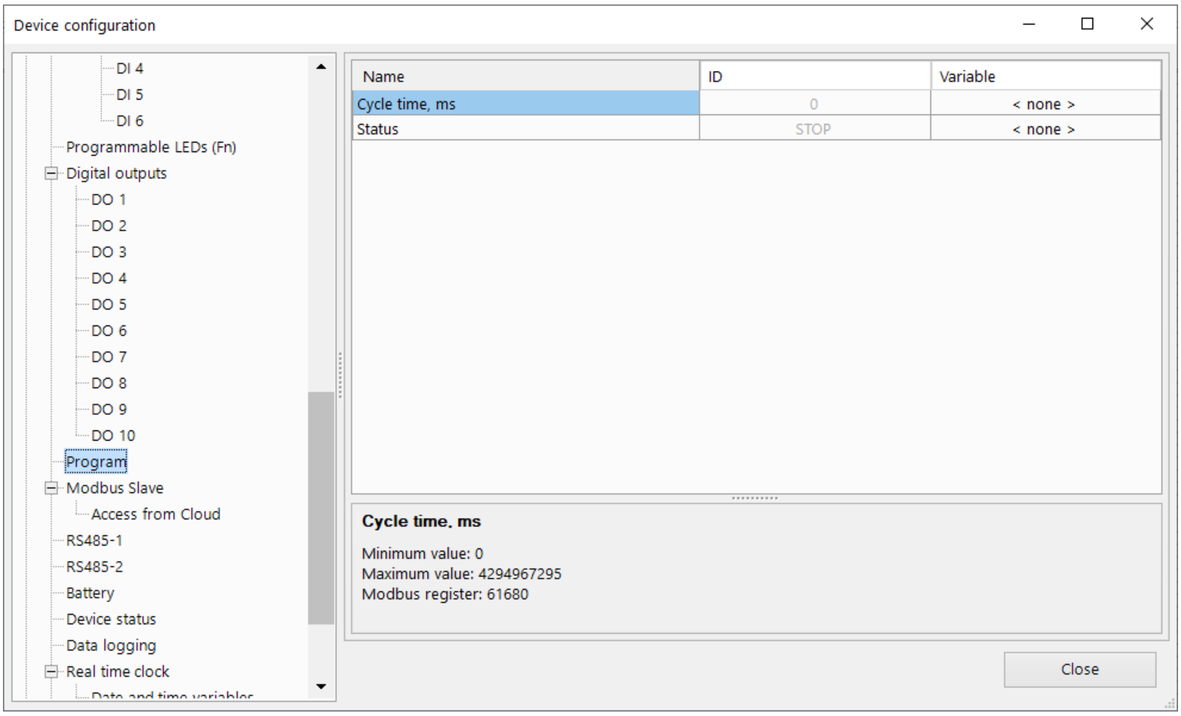


Fig. 7.5 Assignment of variables to the user program parameters

7.5 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 1 and 2) 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 7.2.2* 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* for the battery replacement.
The battery level can be checked in ALP.

7.6 Firmware update

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

The firmware update is carried out with ***ALP***, over USB.
Before starting the firmware update, perform the preparation steps as follows:

1. Prepare the PC with Windows Vista/7/8/10/11 and ALP installed, and connect the PC to the Internet.
2. Install the device USB driver on the PC.

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 PC over USB interface using microUSB – USB cable.
2. In the Windows Device Manager, check which COM port the device is using and read it.
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 process.

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.

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. Holding on to the ribbed area (see *Fig. 8.1*, 1, arrow 1), open the front cover (arrow 2).
2.

   NOTICE
   Remove any static charge from your hands and the used tools before replacement of the battery.

   Pick up the battery on the right side with a screwdriver and, while holding it, pull the battery out of its holder (see *Fig. 8.1*, 2).
3. Insert a new battery observing polarity.
4. Close the front cover.

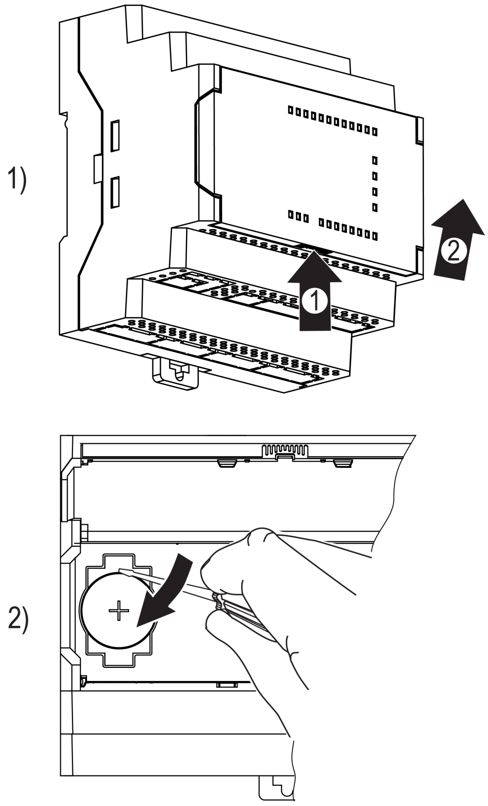


Fig. 8.1 Battery replacement

8.3 Housing cover removal

Remove the device housing cover only when it is necessary to access the RS485 termination resistors' jumpers located on the device board.

> **NOTICE**
> ***In order to prevent damage of the device, its disassembling must be performed only by a qualified technician***.

Follow the steps below to remove the housing cover:

1. Power off all connected lines including power supply. Unplug the removable terminal blocks.
2. On both sides of the device, unlock the housing cover. Using a screwdriver, release the locking pins from the mating apertures to unlock the housing cover (see *Fig. 8.2*, 1) , and then slightly lift up the cover in order to hold it in the unlocked position.
3. On both sides of the device, release the housing cover from under the terminal connectors . Carefully using a screwdriver as a lever, slightly bend the edge of the upper opening away from the edge of the upper connector (see *Fig. 8.2*, 2) while slightly pushing the lower connector inside to release the housing cover.
4. Remove the housing cover.

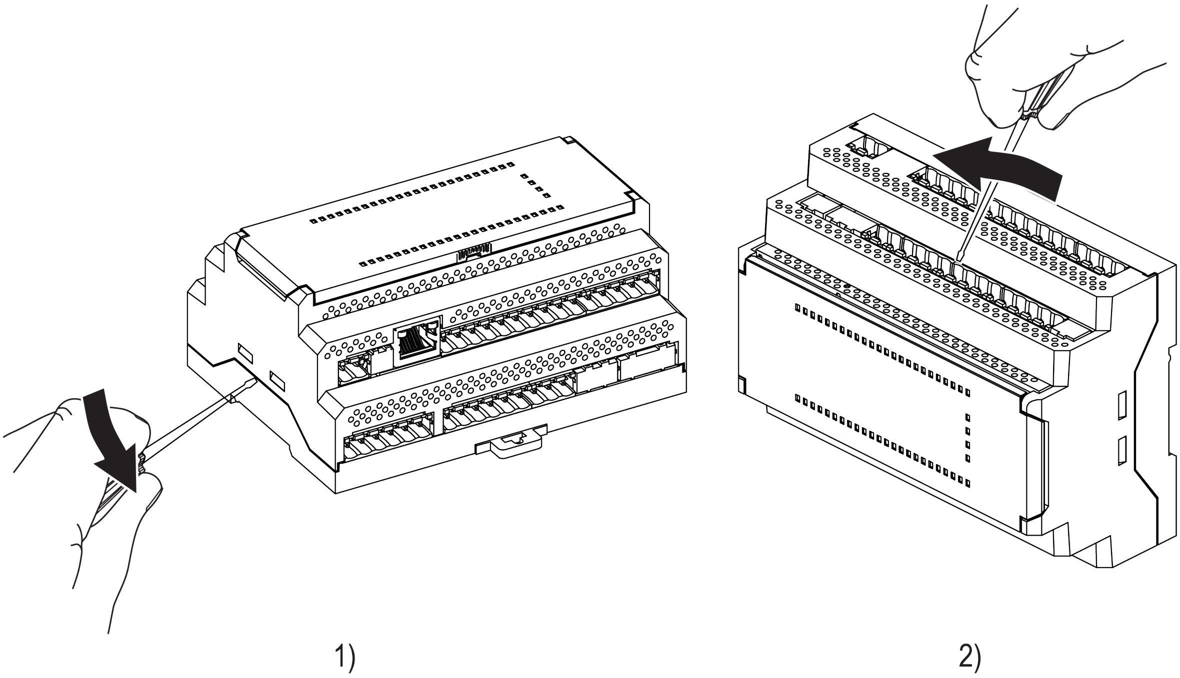


Fig. 8.2   Housing cover removal

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!

10 Scope of delivery

PR103	1
Short guide	1
Terminal blocks (set)	1

Appendix A. Terminal block layout

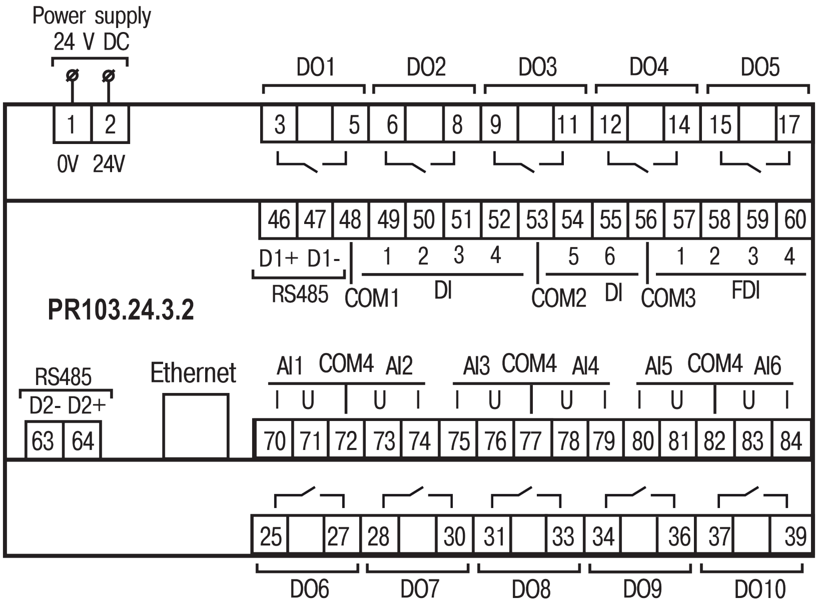


Fig. A.1 PR103.24.3.2 terminal block layout

Table A.1 PR103.24.3.2 terminal assignment

No.	Mark-ing	Description	No.	Mark-ing	Description
1	0 V	Power supply	46	D1+	RS485 interface 1
2	24 V	Power supply	47	D1-	RS485 interface 1
3	DO1	DO1 digital output	48	COM1	DI1…DI4 common contact
4	—	Not connected	49	DI1	DI1 digital input
5	DO1	DO1 digital output	50	DI2	DI2 digital input
6	DO2	DO2 digital output	51	DI3	DI3 digital input
7	—	Not connected	52	DI4	DI4 digital input
8	DO2	DO2 digital output	53	COM2	DI5…DI6 common contact
9	DO3	DO3 digital output	54	DI5	DI5 digital input
10	—	Not connected	55	DI6	DI6 digital input
11	DO3	DO3 digital output	56	COM3	FDI1…FDI4 common contact
12	DO4	DO4 digital output	57	FDI1	FDI1 digital input
13	—	Not connected	58	FDI2	FDI2 digital input
14	DO4	DO4 digital output	59	FDI3	FDI3 digital input
15	DO5	DO5 digital output	60	FDI4	FDI4 digital input
16	—	Not connected	63	D2-	RS485 interface 2
17	DO5	DO5 digital output	64	D2+	RS485 interface 2
25	DO6	DO6 digital output	70	I	AI1 current input
24	—	Not connected	71	U	AI1 voltage input
27	DO6	DO6 digital output	72	COM4	AI1...AI6 common contact
28	DO7	DO7 digital output	73	U	AI2 voltage input
29	—	Not connected	74	I	AI2 current input
30	DO7	DO7 digital output	75	I	AI3 current input
31	DO8	DO8 digital output	76	U	AI3 voltage input
32	—	Not connected	77	COM4	AI1...AI6 common contact
33	DO8	DO8 digital output	78	U	AI4 voltage input
34	DO9	DO9 digital output	79	I	AI4 current input

No.	Marking	Description	No.	Marking	Description
35	—	Not connected	80	I	AI5 current input
36	DO9	DO9 digital output	81	U	AI5 voltage input
37	DO10	DO10 digital output	82	COM4	AI1...AI6 common contact
38	—	Not connected	83	U	AI6 voltage input
39	DO10	DO10 digital output	84	I	AI6 current input
Ethernet		Ethernet interface			

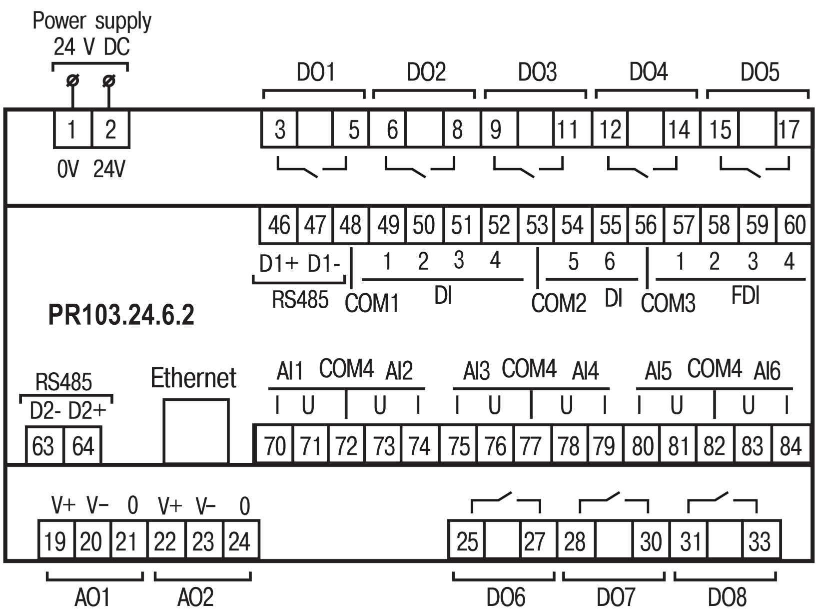


Fig. A.2 PR103.24.6.2 terminal block layout

Table A.2 PR103.24.6.2 terminal assignment

No.	Marking	Description	No.	Marking	Description
1	0 V	Power supply	Ethernet		Ethernet interface
2	24 V	Power supply			
3	DO1	DO1 digital output	70	I	AI1 current input
4	—	Not connected	71	U	AI1 voltage input
5	DO1	DO1 digital output	72	COM4	AI1...AI6 common contact
6	DO2	DO2 digital output	73	U	AI2 voltage input
7	—	Not connected	74	I	AI2 current input
8	DO2	DO2 digital output	75	I	AI3 current input
9	DO3	DO3 digital output	76	U	AI3 voltage input
10	—	Not connected	77	COM4	AI1...AI6 common contact
11	DO3	DO3 digital output	78	U	AI4 voltage input
12	DO4	DO4 digital output	79	I	AI4 current input
13	—	Not connected	80	I	AI5 current input
14	DO4	DO4 digital output	81	U	AI5 voltage input
15	DO5	DO5 digital output	82	COM4	AI1...AI6 common contact
16	—	Not connected	83	U	AI6 voltage input
17	DO5	DO5 digital output	84	I	AI6 current input
46	D+	RS485 interface 1	19	V+	AO1 +24 VDC
47	D-	RS485 interface 1	20	V-	AO1 -24 VDC
48	COM1	DI1…DI4 common contact	21	0	AO1 analog output

No.	Marking	Description	No.	Marking	Description
49	DI1	DI1 digital input	22	V+	AO2 +24 VDC
50	DI2	DI2 digital input	23	V-	AO2 -24 VDC
51	DI3	DI3 digital input	24	0	AO2 analog output
52	DI4	DI4 digital input	25	DO6	DO6 digital output
53	COM2	DI5…DI6 common contact	24	—	Not connected
54	DI5	DI5 digital input	27	DO6	DO6 digital output
55	DI6	DI6 digital input	28	DO7	DO7 digital output
56	COM3	FDI1…FDI4 common contact	29	—	Not connected
57	FDI1	FDI1 digital input	30	DO7	DO7 digital output
58	FDI2	FDI2 digital input	31	DO8	DO8 digital output
59	FDI3	FDI3 digital input	32	—	Not connected
60	FDI4	FDI4 digital input	33	DO8	DO8 digital output
63	D-	RS485 interface 2	—	—	—
64	D+	RS485 interface 2	—	—	—

Appendix B. Modbus register map

The addresses of the Modbus registers, depending on the device modifications, are given in the tables below.

NOTE
Possible values of the Enum data type parameters can be found in the sections related to the settings of the parameters concerned. For example, the possible values for the selection of the input signal type from analog sensors are listed in section 4.2.1 (see table 4.1).

B.1 PR103.24.3.2 Modbus register map

Table B.1 PR103.24.3.2 Modbus register map

Parameter	Group	Ad-dress (dec)	Ad-dress (hex)	Number of regis-ters	Read function code	Write function code	Data type
Date and time (UTC)	Real time clock	61568	0xF080	2	3	-	Date time 32
Time zone	Real time clock	61570	0xF082	1	3	16	Signed 16
Time in milliseconds	Real time clock	61563	0xF07B	2	3	-	Unsigned 32
IP address	Ethernet settings	26	0x001A	2	3	-	Unsigned 32
Subnet mask	Ethernet settings	28	0x001C	2	3	-	Unsigned 32
Gateway	Ethernet settings	30	0x001E	2	3	-	Unsigned 32
DNS server 1	Ethernet settings	12	0x000C	2	3	16	Unsigned 32
DNS server 2	Ethernet settings	14	0x000E	2	3	16	Unsigned 32
New IP address	Ethernet settings	20	0x0014	2	3	16	Unsigned 32
New subnet mask	Ethernet settings	22	0x0016	2	3	16	Unsigned 32
New gateway	Ethernet settings	24	0x0018	2	3	16	Unsigned 32
DHCP	Ethernet settings	32	0x0020	1	3	16	Enum 3
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

Parameter	Group	Ad-dress (dec)	Ad-dress (hex)	Number of regis-ters	Read function code	Write function code	Data type
Extension 1. Module name	Device status	6000	0x1770	8	3	-	String 128
Extension 1. Module FW version	Device status	6016	0x1780	4	3	-	String 64
Extension 2. Module name	Device status	6032	0x1790	8	3	-	String 128
Extension 2. Module FW version	Device status	6048	0x17A0	4	3	-	String 64
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
Input bitmask	Fast digital inputs	52	0x0034	1	3	-	Unsigned 8
Inversion bitmask	Fast digital inputs	58	0x003A	1	3	16	Unsigned 8
Input mode	FDI 1	64	0x0040	1	3	16	Enum 3
Debounce filter	FDI 1	104	0x0068	1	3	16	Unsigned 8

Parameter	Group	Ad-dress (dec)	Ad-dress (hex)	Number of regis-ters	Read function code	Write function code	Data type
Pulse edge	FDI 1	80	0x0050	1	3	16	Enum 2
Counter reset	FDI 1	224	0x00E0	1	3	16	Enum 2
Counter status	FDI 1	256	0x0100	1	3	-	Enum 2
Input mode	FDI 2	65	0x0041	1	3	16	Enum 2
Debounce filter	FDI 2	105	0x0069	1	3	16	Unsigned 8
Pulse edge	FDI 2	81	0x0051	1	3	16	Enum 2
Counter reset	FDI 2	225	0x00E1	1	3	16	Enum 2
Counter status	FDI 2	257	0x0101	1	3	-	Enum 2
Input mode	FDI 3	66	0x0042	1	3	16	Enum 3
Debounce filter	FDI 3	106	0x006A	1	3	16	Unsigned 8
Pulse edge	FDI 3	82	0x0052	1	3	16	Enum 2
Counter reset	FDI 3	226	0x00E2	1	3	16	Enum 2
Counter status	FDI 3	258	0x0102	1	3	-	Enum 2
Input mode	FDI 4	67	0x0043	1	3	16	Enum 2
Debounce filter	FDI 4	107	0x006B	1	3	16	Unsigned 8
Pulse edge	FDI 4	83	0x0053	1	3	16	Enum 2
Counter reset	FDI 4	227	0x00E3	1	3	16	Enum 2
Counter status	FDI 4	259	0x0103	1	3	-	Enum 2
FDI 1	Meas-ured values	160	0x00A0	2	3	-	Unsigned 32
FDI 2	Meas-ured values	162	0x00A2	2	3	-	Unsigned 32
FDI 3	Meas-ured values	164	0x00A4	2	3	-	Unsigned 32
FDI 4	Meas-ured values	166	0x00A6	2	3	-	Unsigned 32
Input bitmask	Analog inputs	4000	0x0FA0	1	3	-	Unsigned 8

Parameter	Group	Ad-dress (dec)	Ad-dress (hex)	Number of regis-ters	Read function code	Write function code	Data type
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
HIGH	Digital mode	4141	0x102D	2	3	16	Float 32
Input signal	Analog mode	4133	0x1025	1	3	16	Enum 28

Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function code	Write function code	Data type
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
Input mode	AI 5	4164	0x1044	1	3	16	Enum 2
Debounce filter	Digital mode	4172	0x104C	1	3	16	Unsigned 8
LOW	Digital mode	4175	0x104F	2	3	16	Float 32
HIGH	Digital mode	4173	0x104D	2	3	16	Float 32
Input signal	Analog mode	4165	0x1045	1	3	16	Enum 28
Analog filter	Analog mode	4170	0x104A	2	3	16	Float 32
Lower measuring limit	Analog mode	4168	0x1048	2	3	16	Float 32
Upper measuring limit	Analog mode	4166	0x1046	2	3	16	Float 32
Input mode	AI 6	4180	0x1054	1	3	16	Enum 2
Debounce filter	Digital mode	4188	0x105C	1	3	16	Unsigned 8

Parameter	Group	Address (dec)	Address (hex)	Number of registers	Read function code	Write function code	Data type
LOW	Digital mode	4191	0x105F	2	3	16	Float 32
HIGH	Digital mode	4189	0x105D	2	3	16	Float 32
Input signal	Analog mode	4181	0x1055	1	3	16	Enum 28
Analog filter	Analog mode	4186	0x105A	2	3	16	Float 32
Lower measuring limit	Analog mode	4184	0x1058	2	3	16	Float 32
Upper measuring limit	Analog mode	4182	0x1056	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 5	Measured values	4010	0x0FAA	2	3	-	Float 32
AI 6	Measured values	4012	0x0FAC	2	3	-	Float 32
AI 1	Analog input states	4014	0x0FAE	1	3	-	Enum 11
AI 2	Analog input states	4015	0x0FAF	1	3	-	Enum 11
AI 3	Analog input states	4016	0x0FB0	1	3	-	Enum 11
AI 4	Analog input states	4017	0x0FB1	1	3	-	Enum 11
AI 5	Analog input states	4018	0x0FB2	1	3	-	Enum 11

Parameter	Group	Ad-dress (dec)	Ad-dress (hex)	Number of regis-ters	Read function code	Write function code	Data type
AI 6	Analog input states	4019	0x0FB3	1	3	-	Enum 11
New output bitmask	Digital outputs	470	0x01D6	1	3	16	Unsigned 16
Output bitmask	Digital outputs	468	0x01D4	1	3	-	Unsigned 16
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
Safe state	DO 9	482	0x01E2	1	3	16	Enum 3
Safe state	DO 10	483	0x01E3	1	3	16	Enum 3
LED bitmask	Program-mable LEDs (Fn)	601	0x0259	1	3	-	Unsigned 8
New LED bitmask	Program-mable 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
Status	Input/ Output	2008	0x07D8	2	3	-	Unsigned 32

Parameter	Group	Ad-dress (dec)	Ad-dress (hex)	Number of regis-ters	Read function code	Write function code	Data type
Input/Output enable	Input/ Output	2010	0x07DA	2	3	16	Unsigned 32
Cycle time	Program	61680	0xF0F0	2	3	-	Unsigned 32
Status	Program	61682	0xF0F2	1	3	-	Enum 2

B.2 PR103.24.6.2 Modbus register map

Table B.2 PR103.24.6.2 Modbus register map

Parameter	Group	Ad-dress (dec)	Ad-dress (hex)	Number of regis-ters 3	Read func-tion code	Write function code	Data type
Date and time (UTC)	Real time clock	61568	0xF080	2	3	-	Date time 32
Time zone	Real time clock	61570	0xF082	1	3	16	Signed 16
Time in milliseconds	Real time clock	61563	0xF07B	2	3	-	Unsigned 32
IP address	Ethernet settings	26	0x001A	2	3	-	Unsigned 32
Subnet mask	Ethernet settings	28	0x001C	2	3	-	Unsigned 32
Gateway	Ethernet settings	30	0x001E	2	3	-	Unsigned 32
DNS server 1	Ethernet settings	12	0x000C	2	3	16	Unsigned 32
DNS server 2	Ethernet settings	14	0x000E	2	3	16	Unsigned 32
New IP address	Ethernet settings	20	0x0014	2	3	16	Unsigned 32
New subnet mask	Ethernet settings	22	0x0016	2	3	16	Unsigned 32
New gateway	Ethernet settings	24	0x0018	2	3	16	Unsigned 32
DHCP	Ethernet settings	32	0x0020	1	3	16	Enum 3
Voltage	Battery	801	0x0321	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

Parameter	Group	Address (dec)	Address (hex)	Number of registers 3	Read function code	Write function code	Data type
Extension 1. Module name	Device status	6000	0x1770	8	3	-	String 128
Extension 1. Module FW version	Device status	6016	0x1780	4	3	-	String 64
Extension 1. Module FW version	Device status	6032	0x1790	8	3	-	String 128
Extension 2. Module name	Device status	6048	0x17A0	4	3	-	String 64
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
Input bitmask	Fast digital inputs	52	0x0034	1	3	-	Unsigned 8
Configuration	Fast digital inputs	56	0x0038	1	3	-	Unsigned 8
Inversion bitmask	Fast digital inputs	58	0x003A	1	3	16	Unsigned 8
Input mode	FDI 1	64	0x0040	1	3	16	Enum 3

Parameter	Group	Address (dec)	Address (hex)	Number of registers 3	Read function code	Write function code	Data type
Debounce filter	FDI 1	104	0x0068	1	3	16	Unsigned 8
Pulse edge	FDI 1	80	0x0050	1	3	16	Enum 2
Counter reset	FDI 1	224	0x00E0	1	3	16	Enum 2
Counter status	FDI 1	256	0x0100	1	3	-	Enum 2
Input mode	FDI 2	65	0x0041	1	3	16	Enum 2
Debounce filter	FDI 2	105	0x0069	1	3	16	Unsigned 8
Pulse edge	FDI 2	81	0x0051	1	3	16	Enum 2
Counter reset	FDI 2	225	0x00E1	1	3	16	Enum 2
Counter status	FDI 2	257	0x0101	1	3	-	Enum 2
Input mode	FDI 3	66	0x0042	1	3	16	Enum 3
Debounce filter	FDI 3	106	0x006A	1	3	16	Unsigned 8
Pulse edge	FDI 3	82	0x0052	1	3	16	Enum 2
Counter reset	FDI 3	226	0x00E2	1	3	16	Enum 2
Counter status	FDI 3	258	0x0102	1	3	-	Enum 2
Input mode	FDI 4	67	0x0043	1	3	16	Enum 2
Debounce filter	FDI 4	107	0x006B	1	3	16	Unsigned 8
Pulse edge	FDI 4	83	0x0053	1	3	16	Enum 2
Counter reset	FDI 4	227	0x00E3	1	3	16	Enum 2
Counter status	FDI 4	259	0x0103	1	3	-	Enum 2
FDI 1	Measured values	160	0x00A0	2	3	-	Unsigned 32
FDI 2	Measured values	162	0x00A2	2	3	-	Unsigned 32
FDI 3	Measured values	164	0x00A4	2	3	-	Unsigned 32
FDI 4	Measured values	166	0x00A6	2	3	-	Unsigned 32
Input bitmask	Analog inputs	4000	0x0FA0	1	3	-	Unsigned 8

Parameter	Group	Address (dec)	Address (hex)	Number of registers 3	Read function code	Write function code	Data type
Configuration	Analog inputs	4356	0x1104	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
HIGH	Digital mode	4141	0x102D	2	3	16	Float 32

Parameter	Group	Ad-dress (dec)	Ad-dress (hex)	Number of regis-ters 3	Read func-tion code	Write function code	Data type
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
Input mode	AI 5	4164	0x1044	1	3	16	Enum 2
Debounce filter	Digital mode	4172	0x104C	1	3	16	Unsigned 8
LOW	Digital mode	4175	0x104F	2	3	16	Float 32
HIGH	Digital mode	4173	0x104D	2	3	16	Float 32
Input signal	Analog mode	4165	0x1045	1	3	16	Enum 28
Analog filter	Analog mode	4170	0x104A	2	3	16	Float 32
Lower measuring limit	Analog mode	4168	0x1048	2	3	16	Float 32
Upper measuring limit	Analog mode	4166	0x1046	2	3	16	Float 32
Input mode	AI 6	4180	0x1054	1	3	16	Enum 2

Parameter	Group	Address (dec)	Address (hex)	Number of registers 3	Read function code	Write function code	Data type
Debounce filter	Digital mode	4188	0x105C	1	3	16	Unsigned 8
LOW	Digital mode	4191	0x105F	2	3	16	Float 32
HIGH	Digital mode	4189	0x105D	2	3	16	Float 32
Input signal	Analog mode	4181	0x1055	1	3	16	Enum 28
Analog filter	Analog mode	4186	0x105A	2	3	16	Float 32
Lower measuring limit	Analog mode	4184	0x1058	2	3	16	Float 32
Upper measuring limit	Analog mode	4182	0x1056	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 5	Measured values	4010	0x0FAA	2	3	-	Float 32
AI 6	Measured values	4012	0x0FAC	2	3	-	Float 32
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
Output status	AO 1	3128	0x0C38	1	3	-	Enum 6

Parameter	Group	Ad-dress (dec)	Ad-dress (hex)	Number of regis-ters 3	Read func-tion code	Write function code	Data type
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
New LED bitmask	Program-mable LEDs (Fn)	600	0x0258	1	3	16	Unsigned 8
LED bitmask	Program-mable LEDs (Fn)	601	0x0259	1	3	-	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
Status	Input/ Output	2008	0x07D8	2	3	-	Unsigned 32
Input/Output enable	Input/ Output	2010	0x07DA	2	3	16	Unsigned 32
Cycle time	Program	61680	0xF0F0	2	3	-	Unsigned 32
Status	Program	61682	0xF0F2	1	3	-	Enum 2

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;
}
```