USER MANUAL		
Bellow Valves with Pneumatic Actuators and Positioners	**Fig. 236**	

CONTENTS

1. General information

1.1 Indications used in the Manual

Safety instructions which failure to obey can result in personal injury or damage to the equipment

Safety instructions, which failure to obey can cause a risk of electric shock

Safety instructions, which failure to obey can cause thermal hazard (burn)

ATTENTION Safety instructions which failure to obey can result in damage to the valves or their operation.

1.2 General remarks

The manual contains information, guideline and warnings ensuring the safe handling and operation of the stop and control valves and with electric and pneumatic actuators.


Failure to follow the manual by the user exempts the manufacturer from any liability and warranty

ATTENTION Valves can be used only for their intended purpose.
The intended use of valves and their pressure and temperature limits are described in the data sheet and in this manual.

ATTENTION Staff approved for installation and operation of the valve must have the necessary qualifications.

ATTENTION In the case of valves with actuators the instruction manual for the actuator supplied with the actuator by the actuator manufacturer must be observed.

2. Safety

This Manual contains basic instructions on installation and operation that should be followed.
The user must also comply with national rules on health and safety and the internal regulations on the working conditions, operation of equipment and safety issued by the user.


Before performing the work, the user and personnel hired to assembly, operate and maintain must read the Manual. The personnel must be trained and have the appropriate qualifications.


In addition to standard safety rules, instructions for additional valve equipment, i.e. electric and pneumatic actuators, must be complied with. These instructions are supplied with the actuators by manufacturers of these actuators.


Operational safety valves with actuators can be guaranteed, provided that they are used for their intended purpose and their pressure and temperature values specified in the data sheet and in this Manual are satisfied.


Introduction of alterations and use of non-original parts is unacceptable; it can cause damage to the reworked valve and the installation and cause health hazards to personnel. This will also result in loss of warranty and the user will be responsible for any resulting damage.


Electrical installation of the valve actuator must be performed in accordance with the requirements of regulations and standards for electrical installations and instructions of the actuator by electricians with appropriate permissions.


The person installing the valve with actuator in the place of operation is responsible for the compliance of the power and control installation with the applicable regulations and directives.

3. Transport and storage

The valves with actuators are delivered to the user in operational readiness condition.

ATTENTION During transport the valve with actuator cannot be hanged by the actuator elements.
For transportation, use the appropriate transport slings and ropes.

ATTENTION When transporting valves with actuators, pay attention to the risks resulting from their large mass.


Loading and unloading can be performed only by authorized by qualified personnel using appropriate equipment and slings used for such purposes.

Transport and storage should be carried out at the temperature of –20° to 65°C, and valves with actuators should be protected against external forces influence and destruction of painting layer. The aim of painting layer is to protect the valves against rust during transport and storage. Valves with actuators should be kept at unpolluted rooms and they should be also protected against influence of atmospheric conditions. There should be applied drying agent or heating at damp rooms in order to prevent condensate formation.

4. Operational data and technical documentation

4.1. Marking

The valves with actuators are provided with marking according to requirements of PN-EN19 standard. The marking facilitates technical identification and contains:

- nominal diameter DN (mm),
- nominal pressure PN (bar),
- body and bonnet material marking,
- arrow indicating medium flow direction,
- manufacturer marking,
- heat number,
- CE marking, for valves subjected 2014/68/EC directive. CE marking starts from DN32.

Marking relating to actuators is located on the bodies of these actuators, and detailed information in the manuals supplied with the actuators by manufacturers of these actuators.

4.2. Application and technical data

4.2.1. Stop valve Fig. 236 with SP pneumatic actuator is used to shut off the flow of medium in the system, on which it was mounted.

SP pneumatic actuator has a safety feature that in case of loss of air supply redirects the actuator to open the valve.

Application:

- industrial installations of cold and hot water,
- steam installations,
- district heating systems and central heating,
- refrigeration and air conditioning systems,

Body material	Nominal pressure	Diameter range	Max. temperature
Grey cast iron	16 bar	DN15-DN150	300°C
Ductile iron	16 bar 25 bar	DN15-DN150	350°C
Cast Steel	40 bar	DN15-DN150	400°C

Working pressure should be adapted to maximum medium temperature according to the table below

Acc. to EN 1092-2		Temperature[°C]				
Material	PN	-10 to 120	150	200	250	300
EN-GJL250	16	16 bar	14.4 bar	12.8 bar	11.2 bar	9.6 bar

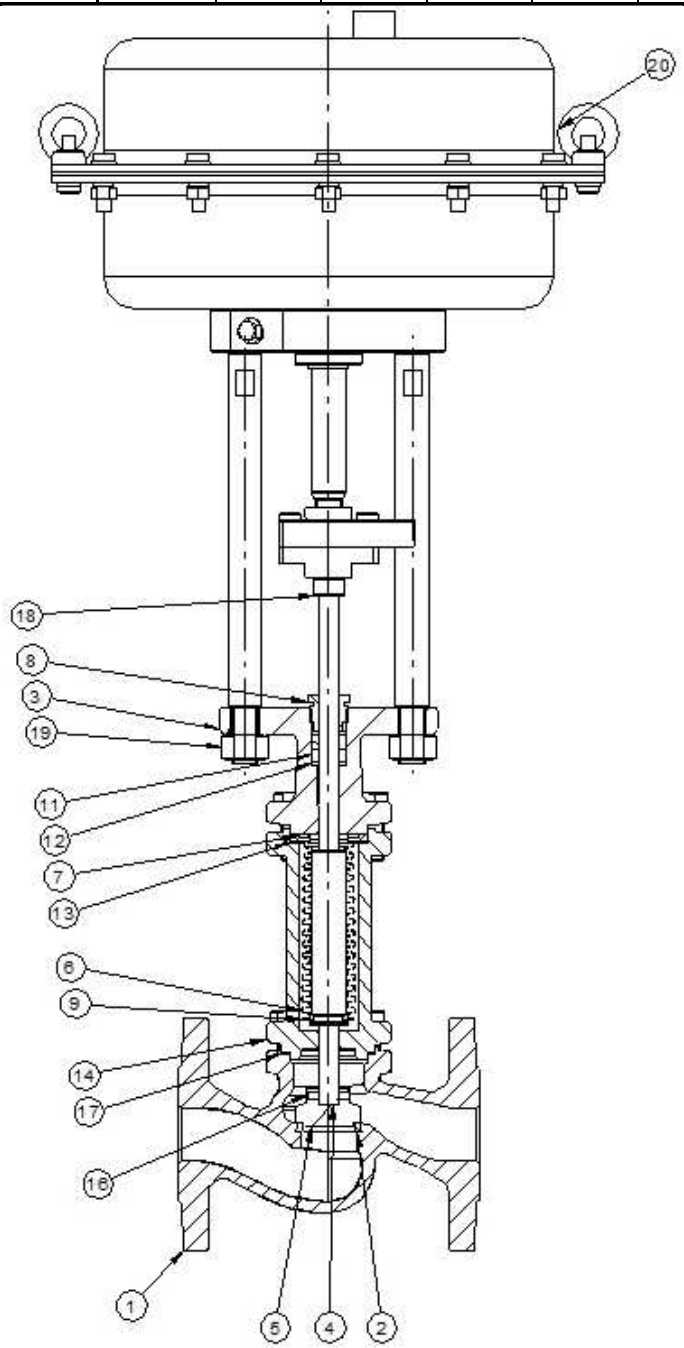
Acc. to EN 1092-2		Temperature[°C]					
Material	PN	-10 to 120	150	200	250	300	350
EN-GJS-400-18-LT	16	16 bar	15.5 bar	14.7 bar	13.9 bar	12.8 bar	11.2 bar

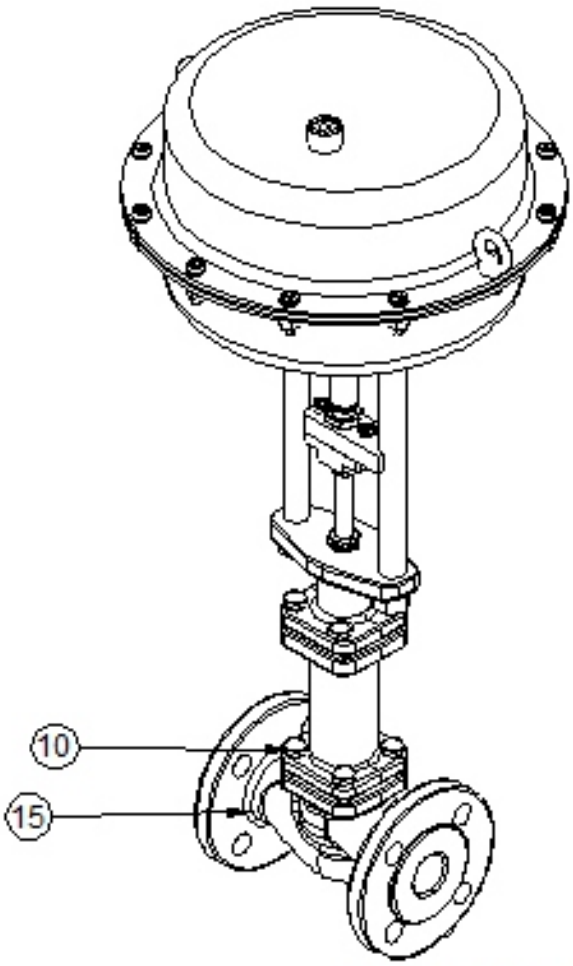
Acc. to EN 1092-2		Temperature[°C]					
Material	PN	-10 to 120	150	200	250	300	350
EN-GJS-400-18-LT	25	25 bar	24.3 bar	23 bar	21.8 bar	20 bar	17.5 bar

Acc. to EN 1092-1		Temperature[°C]								
Material	PN	-60< to <10	10 to 100	100	150	200	250	300	350	400
GP240GH	40	30 bar	40 bar	37.3 bar	37.4 bar	30.2 bar	28.4 bar	25.8 bar	24 bar	23.1 bar

The maximum differential pressure at various supply pressures of pneumatic actuators SP.

The maximum differential pressure of closed valve												
Type of actuator	Supply pressure [kPa]	DN 15	DN 20	DN 25	DN 32	DN 40	DN 50	DN 65	DN 80	DN 100	DN 125	DN 150
Actuator P280	140	8.1	6.2	4.7	2.9	2.6	1.6	1.1	0.8	0.6	0.4	0.3
	250	24.4	18.7	14.3	8.9	7.8	4.8	3.4	2.5	1.8	1.1	0.8
	400	47.5	36.4	27.8	17.4	15.4	9.4	6.6	4.9	3.5	2.2	1.7
Actuator P530	140	-	7.9	6.3	3.9	3.2	2.1	1.5	1.1	0.8	0.5	0.4
	250	-	30.7	24.4	14.9	12.5	8.3	5.8	4.4	3.1	1.9	1.5
	400	-	62.4	49.6	30.3	25.3	16.9	11.9	8.9	6.4	4	3
Actuator P1000	140	-	-	-	-	7.4	4.9	3.5	2.6	1.9	1.1	0.9
	250	-	-	-	-	25.1	16.5	11.8	8.9	6.4	3.9	3.0
	400	-	-	-	-	49.2	32.3	23.2	17.4	12.5	7.7	5.9





No.	Part	Material/standard	Material/standard	Material/standard
1	Body	GJL-250	GJS-400-18-LT	GP240GH
2	Seat ring	X20Cr13	X20Cr13	X20Cr13
3	Top cover	GJL-250	GJS-400-18-LT	GP240GH
4	Stem	X20Cr13	X20Cr13	X20Cr13
5	Plug	X20Cr13	X20Cr13	X20Cr13
6	Bellow	X6CrNiMoTi17-12-2	X6CrNiMoTi17-12-2	X6CrNiMoTi17-12-2
7	Upper ring	X20Cr13	X20Cr13	X20Cr13
8	Choke	11SMnPb30	11SMnPb30	11SMnPb30
9	Lower ring	X5CrNi18-10	X5CrNi18-10	X5CrNi18-10
10	Screw	PN-EN ISO 4017	PN-EN ISO 4017	PN-EN ISO 4017
11	Sealant	Graphite	Graphite	Graphite
12	Sealant washer	X5CrNi18-10	X5CrNi18-10	X5CrNi18-10
13	Gasket	Graphite	Graphite	Graphite
14	Bottom cover	GJL-250	GJS-400-18-LT	GP240GH
15	Screw	PN-EN ISO 4017	PN-EN ISO 4017	PN-EN ISO 4017
16	Peg	PN-EN ISO 8750	PN-EN ISO 8750	PN-EN ISO 8750
17	Gasket	Graphite	Graphite	Graphite
18	Nut	PN-EN ISO 4032	PN-EN ISO 4032	PN-EN ISO 4032
19	Nut	PN-EN ISO 4032	PN-EN ISO 4032	PN-EN ISO 4032
20	Pneumatic actuator	SP	SP	SP

4.2.2. Control valve Fig. 236 with SP pneumatic actuator is used to control the flow of medium in the system, on which it was mounted.

SP pneumatic actuator has a safety feature that in case of loss of air supply redirects the actuator to open the valve.

Application:

- industrial installations of cold and hot water,
- steam installations,
- district heating systems and central heating,
- refrigeration and air conditioning systems,

Body material	Nominal pressure	Diameter range	Max. temperature
Grey cast iron	16 bar	DN15-DN150	300°C
Ductile iron	16 bar 25 bar	DN15-DN150	350°C
Cast Steel	40 bar	DN15-DN150	400°C

Working pressure should be adapted to maximum medium temperature according to the table below

Acc. to EN 1092-2		Temperature[°C]				
Material	PN	-10 to 120	150	200	250	300
EN-GJL250	16	16 bar	14.4 bar	12.8 bar	11.2 bar	9.6 bar

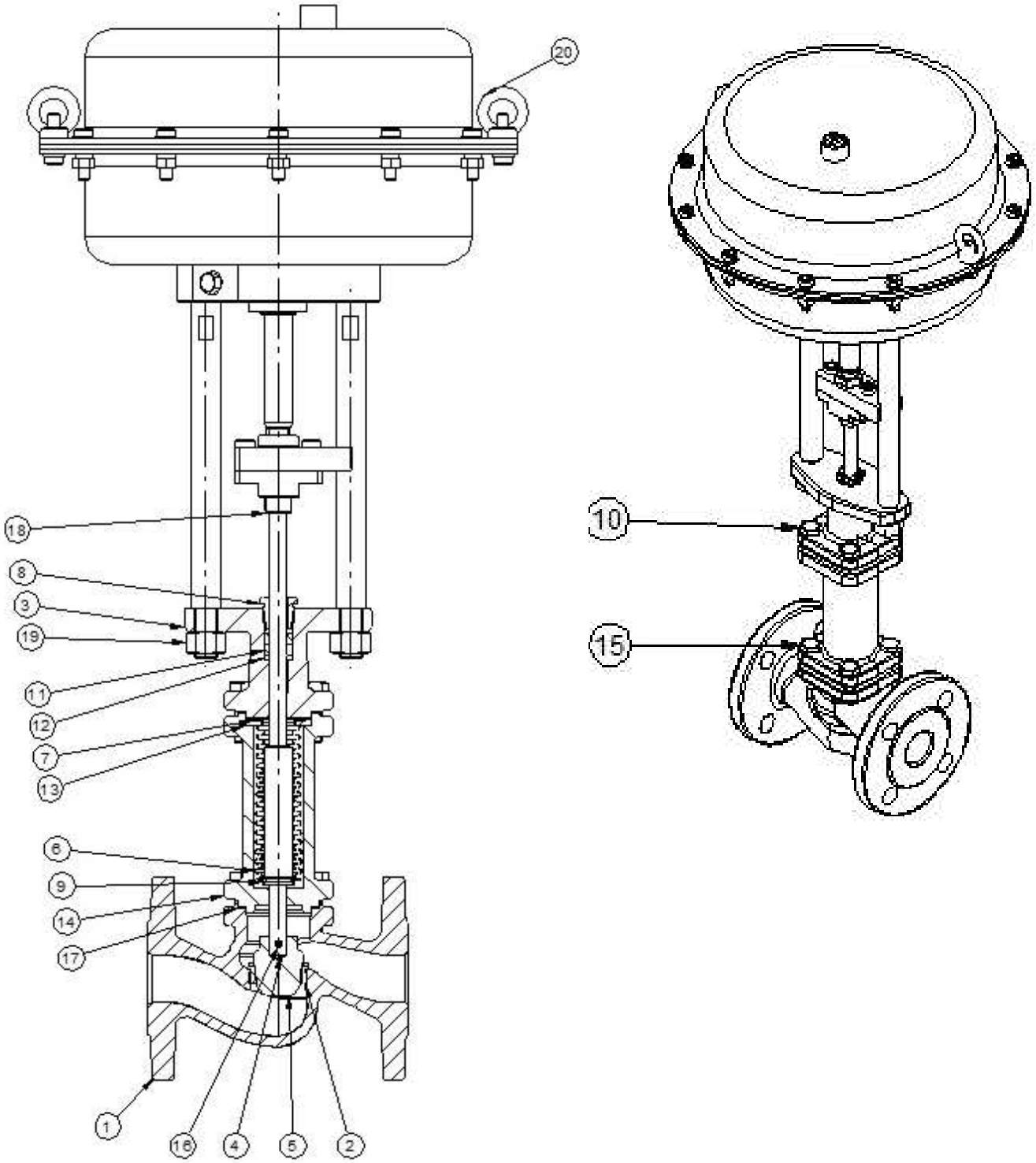
Acc. to EN 1092-2		Temperature[°C]					
Material	PN	-10 to 120	150	200	250	300	350
EN-GJS-400-18-LT	16	16 bar	15.5 bar	14.7 bar	13.9 bar	12.8 bar	11.2 bar

Acc. to EN 1092-2		Temperature[°C]					
Material	PN	-10 to 120	150	200	250	300	350
EN-GJS-400-18-LT	25	25 bar	24.3 bar	23 bar	21.8 bar	20 bar	17.5 bar

Acc. to EN 1092-1		Temperature[°C]								
Material	PN	-60< to <10	10 to 100	100	150	200	250	300	350	400
GP240GH	40	30 bar	40 bar	37.3 bar	37.4 bar	30.2 bar	28.4 bar	25.8 bar	24 bar	23.1 bar

The maximum differential pressure at various supply pressures of pneumatic actuators SP.

The maximum differential pressure of closed valve												
Type of actuator	Supply pressure [kPa]	DN 15	DN 20	DN 25	DN 32	DN 40	DN 50	DN 65	DN 80	DN 100	DN 125	DN 150
Actuator P280	140	21.5	16.8	11.7	7.9	5.8	3.6	2.1	1.5	1	0.6	0.4
	250	64.7	50.5	35.3	23.7	17.6	11	6.4	4.5	3	2	1.4
	400	125.8	98.2	68.7	46.1	34.2	21.5	12.6	8.7	5.8	3.8	2.7
Actuator P530	140	-	22.4	15.686	10.5	7.8	4.9	2.9	2	1.3	0.9	0.6
	250	-	86.9	60.784	40.8	30.3	19.0	11.1	7.7	5.1	3.4	2.4
	400	-	176.6	123.53	83.0	61.6	38.7	22.7	15.7	10.5	7	5
Actuator P1000	140	-	-	-	-	18.1	11.3	6.6	4.6	3.0	2.0	1.4
	250	-	-	-	-	61.1	38.2	22.5	15.6	10.4	6.9	4.9
	400	-	-	-	-	119.7	74.8	44.0	30.6	20.5	13.6	9.6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No.	Part	Material/standard	Material/standard	Material/standard
1	Body	GJL-250	GJS-400-18-LT	GP240GH
2	Seat ring	X20Cr13	X20Cr13	X20Cr13
3	Top cover	GJL-250	GJS-400-18-LT	GP240GH
4	Stem	X20Cr13	X20Cr13	X20Cr13
5	Plug	X20Cr13	X20Cr13	X20Cr13
6	Bellow	X6CrNiMoTi17-12-2	X6CrNiMoTi17-12-2	X6CrNiMoTi17-12-2
7	Upper ring	X20Cr13	X20Cr13	X20Cr13
8	Choke	11SMnPb30	11SMnPb30	11SMnPb30
9	Lower ring	X5CrNi18-10	X5CrNi18-10	X5CrNi18-10
10	Screw	PN-EN ISO 4017	PN-EN ISO 4017	PN-EN ISO 4017
11	Sealant	Graphite	Graphite	Graphite
12	Sealant washer	X5CrNi18-10	X5CrNi18-10	X5CrNi18-10
13	Gasket	Graphite	Graphite	Graphite
14	Bottom cover	GJL-250	GJS-400-18-LT	GP240GH
15	Screw	PN-EN ISO 4017	PN-EN ISO 4017	PN-EN ISO 4017
16	Peg	PN-EN ISO 8750	PN-EN ISO 8750	PN-EN ISO 8750
17	Gasket	Graphite	Graphite	Graphite
18	Nut	PN-EN ISO 4032	PN-EN ISO 4032	PN-EN ISO 4032
19	Nut	PN-EN ISO 4032	PN-EN ISO 4032	PN-EN ISO 4032
20	Pneumatic actuator	SP	SP	SP

5 Assembly

ATTENTION Installation of the valve can only be performed by trained personnel only.

The pipeline, on which valves are mounted, should be arranged and mounted so the valve body is not transmitting bending moment and is not extended.

Steam pipes must be routed in such a way as to prevent the accumulation of water

It is forbidden to use the valves in installations where the parameters of their work exceed the limit values.

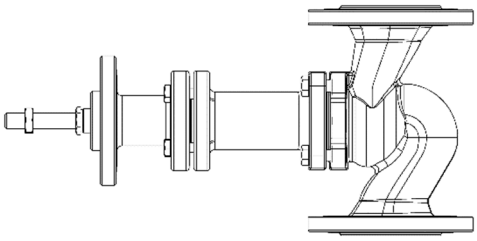
It is forbidden to use valves to other media than those provided in their application.

The direction of flow must match the direction of the arrow on the body.

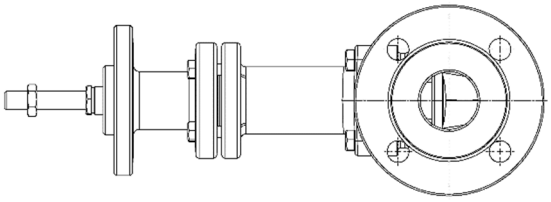
Control valves with actuators must be installed with the axis of the stem in the vertical position with the actuator located above the valve

It is allowed to install stop valves on the vertical and horizontal pipelines with valve in horizontal position, as shown on the following figures. Actuator weight cannot exceed the following limit values:

DN15-20 - 20kg
DN25-32 – 25kg
DN40-50 – 35kg
DN65-100 – 45kg
DN125-150 – 55kg



Installation on a vertical pipeline



Installation on a horizontal pipeline

It is forbidden to impose additional external forces on the valve with actuator.

When installing the valves, the following rules should be observed:

- prior to installation it should be checked whether the valves were not damaged during transport or storage,
- make sure that applied vent valves are suitable for working conditions and medium in the plant,
- attention should be paid to the flow direction, indicated by an arrow on the seat,
- immediately prior to installation remove the caps if the valves are provided with them,
- check pipe flanges, on which the valve is to be mounted; they should be smooth, coaxial and parallel to each other so that they do not cause excessive stress after fitting them with the valves,
- valves with actuators should be installed so that the axis of the spindle is set in a vertical position,
- screw connections on the pipeline cannot introduce additional stress resulted from excessive tightening, and connection materials must be adapted to the operating parameters of the installation,
- when painting, the pipeline the valve stem and actuator components should be protected,
- protect the valves during welding jobs against splinters and used plastics against excessive
- temperature,

6. Maintenance

During the first run, check valve connections and valve gland for leaking. If there is a leak on the flange connection, tighten the screws to eliminate leakage. In case of leakage through the gland of the gland valve tighten gland until the leakage is eliminated. The occurrence of leakage through the gland of the bellow valve indicates malfunction of the bellow; in this case, the upper part of the valve should be immediately replaced.

Take special care when handling the valve if it was mounted on a pipeline through that carries hot and/or aggressive media.

When operating, observe the following rules:

- initialization process - initialization should be conducted in a way that eliminates the occurrence of sudden changes
- in temperature and pressure,
- operation of mounted valves can be checked by repeated opening and closing,
- valve is closed by the spindle feed down, valve opening occurs with a spindle feed up,
- in order to ensure the safe operation of each valve, and especially one that is rarely used, it should be regularly monitored.

7. Service and repair


All service and repair jobs should be carried out by authorised staff using suitable tools and original spare parts.


Before disassembly of a complete valve from the pipeline or before service works, the particular part of the pipeline should be excluded from the operation and power source.


In the event of a leak of medium which is is not indifferent to the environment protective measures should be taken.

ATTENTION

In order to ensure the safe operation of each valve, and especially one that is rarely used, it should be regularly monitored and maintained. Maintenance intervals are defined by the user depending on the operating conditions, but not less frequently than once a month. Stem threads should be periodically lubricated.

During maintenance and repair:

- reduce the pressure and the temperature of the valve to a safe level,
- personal protection in pursuance of existing threat should be used,
- after valve disassembly it is necessary to replace gaskets between the valve and the pipeline,
- tightening of the screw connections of covers must be made with the valve opened,
- during valve re-assembly in the pipeline it is necessary to check valve operation and tightness of all connections before its restarting.

8. Reasons of operating disturbances and remedy


When seeking of valve malfunction reasons safety rules and guidelines contained in this manual should be strictly obeyed.

Fault	Possible cause	Remedy
No flow	Closed valve	Open the valve
	Flanges caps have not been removed	Remove the flanges caps
Low flow	Valve not fully opened	Open the valve
	Contaminated filter	Clean or replace the strainer
	Clogged pipeline system	Check the pipeline
Hard to control the actuator	Gland packing tighten too much	Slightly slacken nuts mounting the gland
Leakage on the stem	Leaky gland seal	Tighten the nuts that secure the gland to tightness
	Damage to the bellow	Tighten the gland to tightness Replace the upper part of the valve immediately.

Leakage on the seat	Improper closing	Check for proper operation of the torque switches of the actuator and the position of the actuator switches
	Damaged seat or plug	Replace the valve. Turn to the supplier or manufacturer
	Pressure difference too high	Select the appropriate actuator to the differential pressure
	Medium contaminated with solid objects	Clean the valve. Install the filter before the valve.
Broken connecting flange	Bolts tighten unevenly	Install a new valve.

9. Valve service discontinuity

After decommissioning and dismantling the proportioning valves must not be disposed of with household waste.
The proportioning valves are made of materials which can be re-used. For this purpose, they should be delivered to designated recycling centres.

10. Warranty terms.

ZETKAMA grants quality warranty with assurance for proper operation of its products, providing that assembly of them is done according to the user manual and they are operated according to technical conditions and parameters described in ZETKAMA's catalogue cards. The warranty period is 18 months from assembly date, however not longer than 24 months from sales date.
Warranty claim does not cover assembly of foreign parts and design changes done by user as well as natural wear.
Immediately after detection, the user should inform ZETKAMA about hidden defects of the product.
A claim should be prepared in written form.

1. Introduction

1.1 General part

Valve positioner PZ5000 is an intelligent electro-pneumatic positioner to control actuator of the control valve that converts the set value of the electrical signal to the appropriate valve plug position. The valve positioner PZ5000 is equipped with numerous communication interfaces, allowing the freedom to choose how to communicate with the device, maintaining full control and interaction with the positioner and the ease of carrying out all the diagnostic and maintenance. The positioner is modular, allowing for quick and easy functional development, depending on the possible needs.

Fig. 1: Valve positioner PZ5000 with pressure gauges connected

The valve positioner PZ5000, depending on the version, is equipped with a colour LCD touch screen 3.5"(version II) with a resolution of 320x240 or alphanumeric display 2x12 (version I). Additionally, the device is enriched with a control panel with 6 buttons and 3 LEDs - red, blue and green. Furthermore, the device has connectors for fitting the gauges that allow independent analog readout of air pressure. These elements allow for:

- full user interaction with the device,
- provide ease of use,
- easy control and diagnostics,
- transparency and unambiguous indications,
- minimization of the possibility of error.

The valve positioner PZ5000 is equipped with the following communication and service interfaces:

- Ethernet,
- RS485
- 2x current loop 4 ÷ 20mA,
- input 0-10V,
- USB device.

In addition, PZ5000 device is equipped with:

- 2 independent binary inputs AC/DC,
- 2 independent potential-free relay outputs (normally closed contact, shared, NC).

2. Technical data

Power supply	
DC voltage:	24V DC ±15%
DC current:	Max. 0.3A DC
Binary inputs	
Type of inputs	Binary
Power consumption by the input	Below 1.5mA at 24V
Voltage ranges of logic states.	
AC	Low <8,7VRM□; High> 13VRM□
DC	Low <12,4V; High> 16,6V
Rated voltage	24V AC or 24V DC
Binary outputs	
Type of outputs	Relay
Minimum switching current	10mA
Current carrying capacity contact constant	5A
Cross-section of connecting cables	0.14 – 1.5mm2
Nominal load current in category	
AC1	5A/250V AC
DC1	5A/30V DC
User Interface	
Alphanumeric display (version I)	2x12
Touch-screen display (version II)	TFT 3,5" 320x240
Keyboard	6 buttons
Signalling	3 LEDs
Communication interfaces	
USB B	2.0, device
Current loop	4 – 20mA
RS485	max.. 115.2kbit/s

LAN	Ethernet
Design parameters	
Operating temperature (version I)	-20ºC — 80ºC
Operating temperature (version II)	-20ºC — 70ºC
Operating pressure	1.5 — 7 bar
Weight	Max. 2.6 kg
Dimensions (height × width × depth)	130 × 230 × 150 [mm] without connectors
Level of security	IP66

3. Technical description of the valve positioner PZ5000

2.1 *General part*

The valve positioner PZ5000 is a modern adjustment device ensuring the correct position of the control valve actuator corresponding to the appropriate value of the control signal.

The valve positioner PZ5000 is characterized by the highest quality and attention to performance. The use of appropriate materials and design techniques makes it fully resistant to electromagnetic interference, vibration and climatic conditions according to the standards listed by the manufacturer. Declared IP66 degree of protection allows the use of equipment in industrial environments.

2.2 *Wiring*

All external signals are fed to the valve positioner PZ5000 through the cable glands, providing a proper tightness to the device in accordance with the stated degree of protection IP66. Connectors are located in the cable chamber of the positioner. Access is possible after unscrewing four screws. All work should be performed with due care by suitably qualified users.

Attention

Wiring and all assembly operations must be performed by trained personnel.

Fig. 2: Cable chamber of the valve positioner PZ5000

Fig. 3: Interior of the cable chamber of the valve positioner PZ5000

2.3 Description of connectors of the valve positioner PZ5000

External signals can be connected by connecting terminals placed in the cable chamber of the valve positioner PZ5000.

Attention

Pay special attention to ensure proper connection of signals in corresponding connector clamps and adequate level of signals.

Attention

Exceeding the permissible limits of signals can result in equipment damage.

Description of the signals on the connector Z300.

Clamp	Marking	Function
1	RVCC	+5V DC
2	A	R□485 signal A
3	B	R□485 signal B
4		
5		
6		
7		
8	RGND	Ground

Connector	Clamp	Marking	Function
Z2	1	24V	Power plus
	2	GND	Power minus

Connector	Clamp	Marking	Function
Z1	1	T2	Output T2 – normally closed contact
	2		Output T2 - common contact
	3		Output T2 - normally open contact
	4	T1	Output T1 – normally closed contact
	5		Output T1 - common contact
	6		Output T1 - normally open contact
	7	N1	Input N1
	8		Input N1
	9	N2	Input N2
	10		Input N2

Connector	Clamp	Marking	Function
Z3	1	WY_AN2_N	The mass of analog output (2)
	2	WY_AN2_P	Analog output 4-20mA (2)
	3	WY_AN1_N	The mass of analog output (1)
	4	WY_AN1_P	Analog output 4-20mA (1)
	5	WY_GND	Output 12V (-)
	6	WY_12V	Output 12V (+)
	7	WE_4-20mA	Analog input 4-20mA
	8	WE_0-10V	Analog input
	9	WE_4-20_N	Analog input 4-20mA (-)
	10	WE_4-20_P	Analog input 4-20mA (+)

4.Modes of control of the valve positioner PZ5000

Positioner PZ5000 provides a wide range of modes of valve control. The mode is set in the user interface after proper authentication. The following modes are available:

- Inactive
- Manual
- With analog input 0-10V
- With analog input 4-20mA
- Modbus
- Profibus
- HTTP

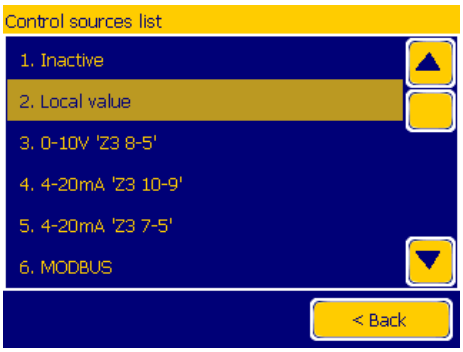


Fig. 4: Control mode selection of the valve positioner PZ5000

4.1 Inactive control

Valve positioner PZ5000 has a mode of operation with control switched off - then it can serve as a device measuring / monitoring the operation of the valve. This mode ensures that the actuator does not affect the operation of the valve.

This mode can also be used in emergency/maintenance situations where there is a need to check the communication interfaces and visibility of the device in the system, and in which the accidental activation of the valve could create hazardous situations for health or life of personnel removing the failure or performing maintenance work on the valve or positioner.

4.2 Manual

The simplest control mode of the positioner is manual control. It involves setting the desired position of the valve opening by means of the display and keyboard. Positioner automatically adjusts the valve to the desired position and it keeps this position until it receives a new setpoint position.

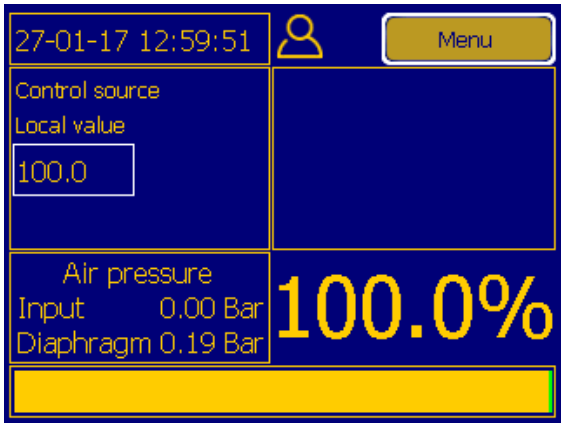


Fig. 5: The main screen in manual operation

4.3. With analog input

In valve position control mode with one of the analog inputs, there are 3 analog inputs available.

- Current loop 4-20mA on the connector Z3, clamps 5, 7;
- Input voltage 0-10V on the connector Z3, clamps 5, 8;
- Current loop 4-20mA on the connector Z3, clamps 9, 10.

Each of these inputs can be selected as the valve position control source. Additionally, logic control is configurable - straight or reverse. Straight logic indicates that the minimum value of analog range (0V or 4mA) corresponds to the complete closure of the valve (0%), and the maximum value of analog range (10V or 20mA) to valve fully open (100%). In this configuration, an increase in the analog value causes the valve to open, and the decline causes it to close. Reverse logic indicates that the minimum value of analog range (0V or 4mA) corresponds to the complete opening of the valve (100%), and the maximum value of analog range (10V or 20mA) to valve fully closed (0%). In this configuration, an increase in the analog value causes the valve to close, and the decline causes it to open.

4.4. Modbus

Valve positioner PZ5000 has a built-in Modbus RTU and TCP protocol support. The physical layer of protocol for RTU version is a serial interface RS485 on the connector Z300 and for the TCP version it is Ethernet.

Available speeds for Modbus RTU:

- 1200
- 2400
- 4800
- 9600
- 19200
- 38400
- 57600
- 115200

Supported Modbus commands:

- read coils (1) - current state of relay outputs
- read discrete inputs (2) - digital inputs read
- read holding registers (3)
- read input registers (4)
- write single coil (5)
- write single register(6)
- write multiple coils (15)
- write multiple registers (16)

Name of Holding type registry	Number
Valve position 0-1000 0.1%	100
PID proportional term 0-65000 0.0001	101
PID integral term 0-65000 0.0001	102
PID derivative term 0-65000 0.0001	103
Hysteresis 0-1000 0.1%	104
Loop current Z3 1-2 4000-20000 1uA	105
Loop current Z3 3-4 4000-20000 1uA	106
Operation Mode 0-7	107
Digital outputs Z1 1-3,4-6 0-3	200

Name of Input type registry	Number
Valve position 0-1000 0.1%	100
Pressure input 0-7000 1mBar	101
Pressure valve 0-7000 1mBar	102
Input 4-20mA Z3 5-7 4000-20000 1uA	103
Input 0-10V Z3 5-8 0-10000 1mV	104
Input 4-20mA Z3 9-10 4000-20000 1uA	105
Digital inputs Z1 7-8,9-10 0-3	200

4.5. Profibus

Valve positioner PZ5000 has a built-in Profibus DP V0 protocol support. The physical layer of the protocol is a serial interface RS485, available on the connector Z300. The transmission parameters are 19200 8E1. The positioner is defined according to the GSD file attached as a modular device, of which individual modules include input, output and records that are to participate in the exchange of data. In order to activate the control of valve position via the Profibus protocol, select the appropriate control mode and set the active protocol on the serial interface RS485 on Profibus and, in protocol, send the record: Operating Mode: 0-7 value 6, corresponding to the control from the Profibus, to the module CFG.

Module name	Number	Configuration string
AO Valve position 0-1000 0.1%	0x80	0x81,0x40,0x00
AO Loop current Z3 1-2 4000-20000 1uA	0x83	0x81,0x40,0x03
AO Loop current Z3 3-4 4000-20000 1uA	0x84	0x81,0x40,0x04
CFG record PID proportional term 0-65000 0.0001	0x88	0x81,0x40,0x08
CFG record PID integral term 0-65000 0.0001	0x89	0x81,0x40,0x09
CFG record PID derivative term 0-65000 0.0001	0x8A	0x81,0x40,0x0A
CFG record Hysteresis 0-1000 0.1%	0x8B	0x81,0x40,0x0B
DO Digital outputs Z1 1-3,4-6 0-3	0x90	0x81,0x00,0x00
CFG record Operation Mode 0-7	0x92	0x81,0x00,0x02
AI Valve position 0-1000 0.1%	0x40	0x41,0x40,0x00
AI Pressure valve 0-7000 1mBar	0x41	0x41,0x40,0x01
AI Pressure input 0-7000 1mBar	0x42	0x41,0x40,0x02
AI Loop current Z3 1-2 4000-20000 1uA	0x43	0x41,0x40,0x03
AI Loop current Z3 3-4 4000-20000 1uA	0x44	0x41,0x40,0x04
AI Input 4-20mA Z3 5-7 4000-20000 1uA	0x45	0x41,0x40,0x05
AI Input 0-10V Z3 5-8 0-10000 1mV	0x46	0x41,0x40,0x06
AI Input 4-20mA Z3 9-10 4000-20000 1uA	0x47	0x41,0x40,0x07
CFG record PID proportional term 0-65000 0.0001	0x48	0x41,0x40,0x08
CFG read PID integral term 0-65000 0.0001	0x49	0x41,0x40,0x09
CFG read PID derivative term 0-65000 0.0001	0x4A	0x41,0x40,0x0A
CFG reading Hysteresis 0-1000 0.1%	0x4B	0x41,0x40,0x0B
DI Digital outputs state Z1 1-3,4-6 0-3	0x50	0x41,0x00,0x00
DI Digital inputs Z1 7-8,9-10 0-3	0x51	0x41,0x00,0x01
CFG reading Operation Mode 0-7	0x52	0x41,0x00,0x02

4.6. HTTP

Valve positioner PZ5000 has a built-in HTTP server that allows to either control the positions of the valve or to modify the device configuration and view the event log through a website. The HTTP server runs on both an Ethernet connector and within a WiFi network. In order to start using website run any graphical web browser on a computer located in the same Ethernet or WiFi as the positioner, typing the IP address of the positioner in a browser. The website consists of three main tabs:

"Homepage" - shows the user the basic information on the state of the positioner (Fig. 6).

"Recorder" - displays a list of events (Fig. 7).

"Settings" - after logging in (Fig. 8) a full positioner menu is displayed. Menu appearance (Fig. 9) is not identical to that presented in the positioner display (Chapter 31). However, its structure and the available options are the same. This allows for better use of the computer screen space.

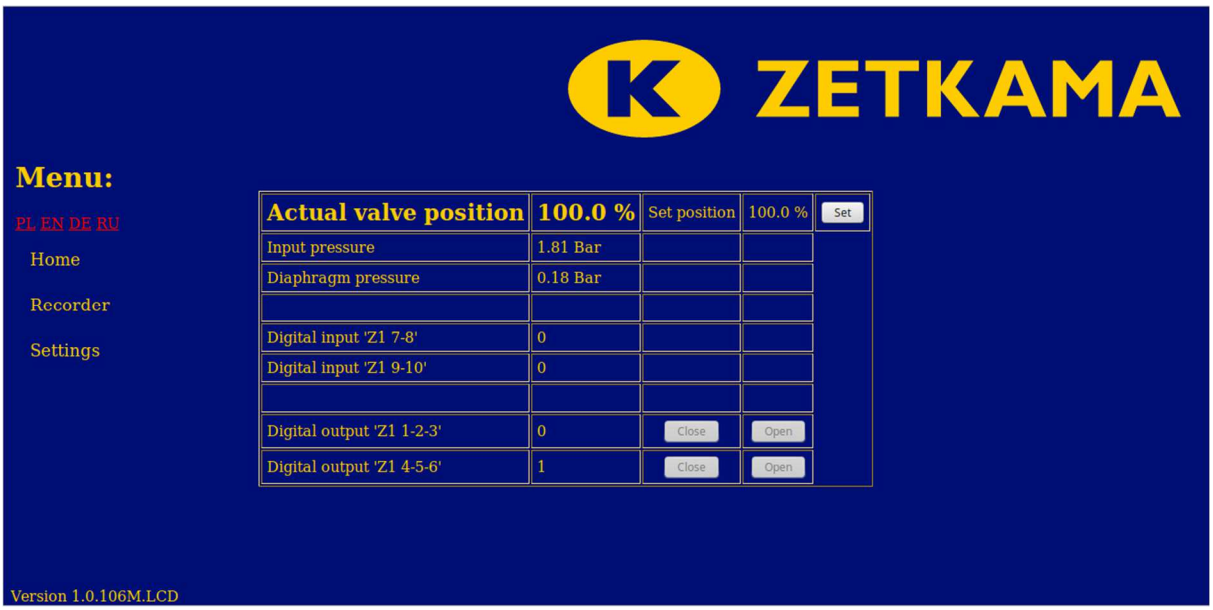


Fig. 6: HTTP - home page

Fig. 7: HTTP – overview of the event recorder

Fig. 8: HTTP – login

Fig. 9: HTTP – configuration of the positioner

4.6.1. Access via Ethernet

Access to the HTTP page via the Ethernet network is possible after the device is properly configured. After connecting the positioner with a network cable, it must be configured using the network settings menu (Fig. 10). Then check if the HTTP server is enabled on the cable (Fig. 11).

The website can be accessed using any web browser by entering a set IP device in the address bar. Current IP of the positioner is indicated in the menu shown in Fig. 10. The method of accessing the website using a browser is shown in Fig. 12.

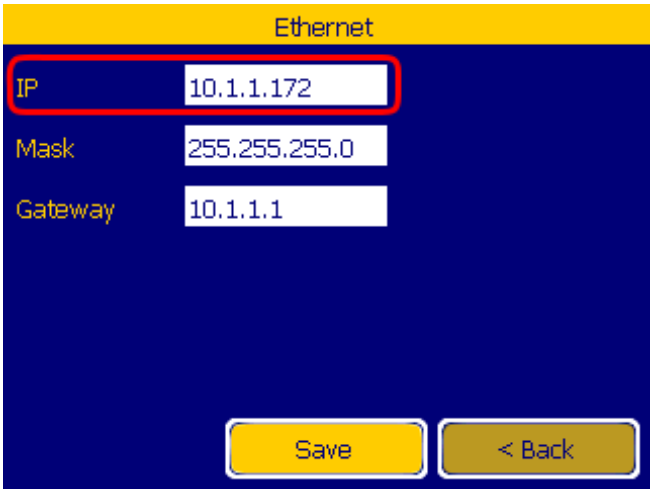


Fig. 10: Network settings (Menu> configuration> LAN> Ethernet).

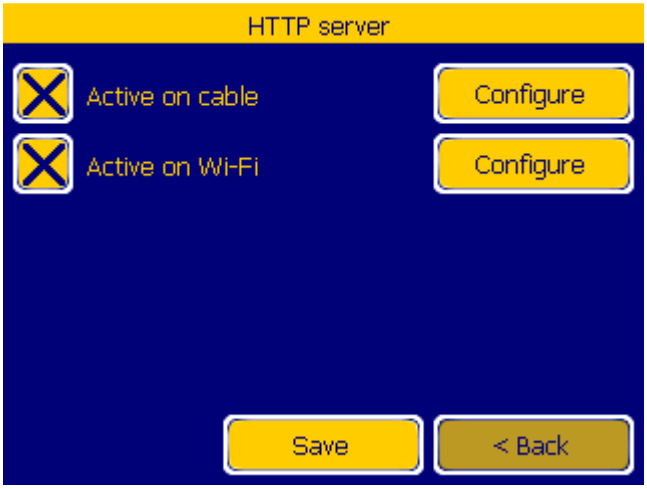


Fig.11: HTTP server active on the cable (Menu> configuration> LAN> HTTP server).

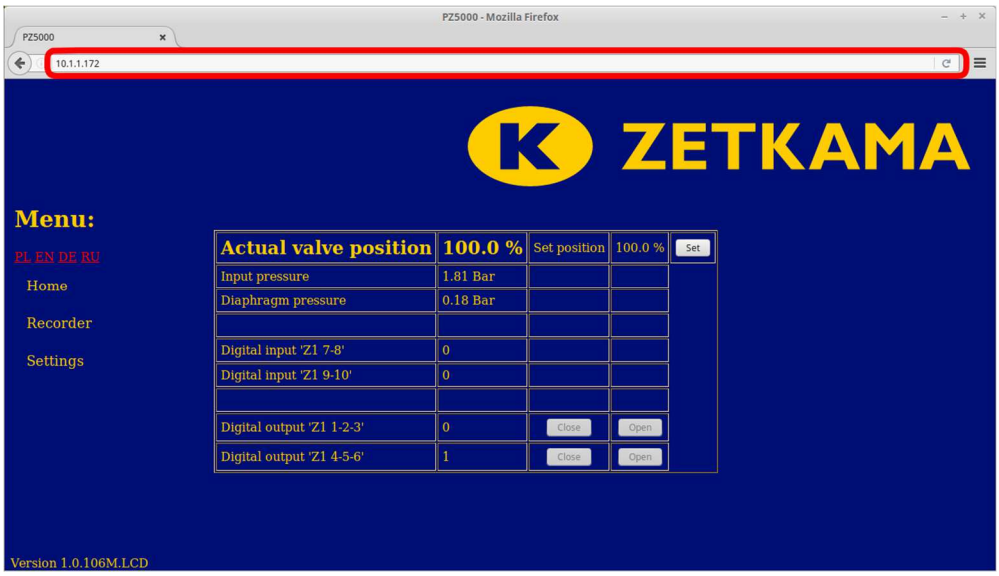


Fig.13:HTTP page - Ethernet

2.3.1 Access via WiFi

Access to HTTP using Wi-Fi requires configuration of settings. The positioner can create an access point, allowing other devices to connect to it. Using the Wi-Fi menu (Fig. 13) it is possible to configure network name, password and IP under which the site will be available. It is also necessary to check if the HTTP server is enabled on the cable (Fig. 14). The next step should be found and connecting to the network created by the positioner (Fig. 15 shows the connection using the laptop menu). This connection takes place after entering the password (Fig. 16) predetermined earlier in the Wi-Fi settings menu. The website should open under the IP address specified in the Wi-Fi settings. The method of accessing it using a browser is shown in Fig. 17.

Fig. 12: HTTP of the positioner - Ethernet.

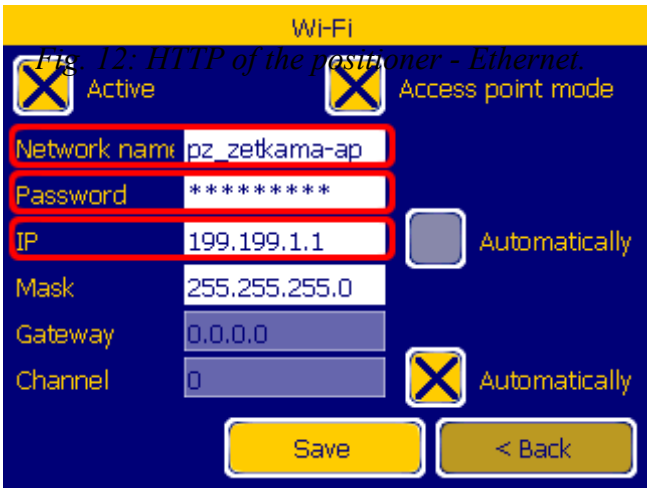


Fig. 13: Wi-Fi settings (Menu> configuration> LAN> Wi-Fi).

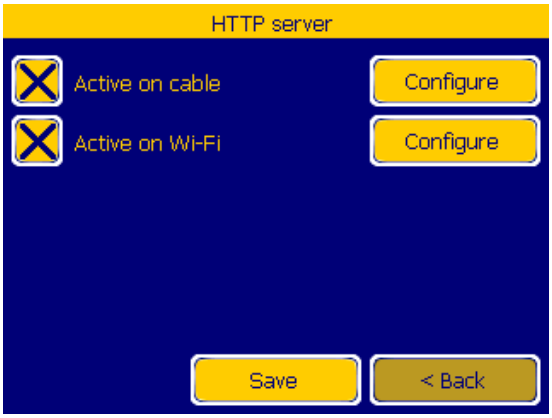


Fig. 14: HTTP server active on Wi-Fi (Menu> configuration> LAN> HTTP server).

Fig. 15: The choice of Wi-Fi networks.

Fig. 16: Log in positioner to a Wi-Fi.

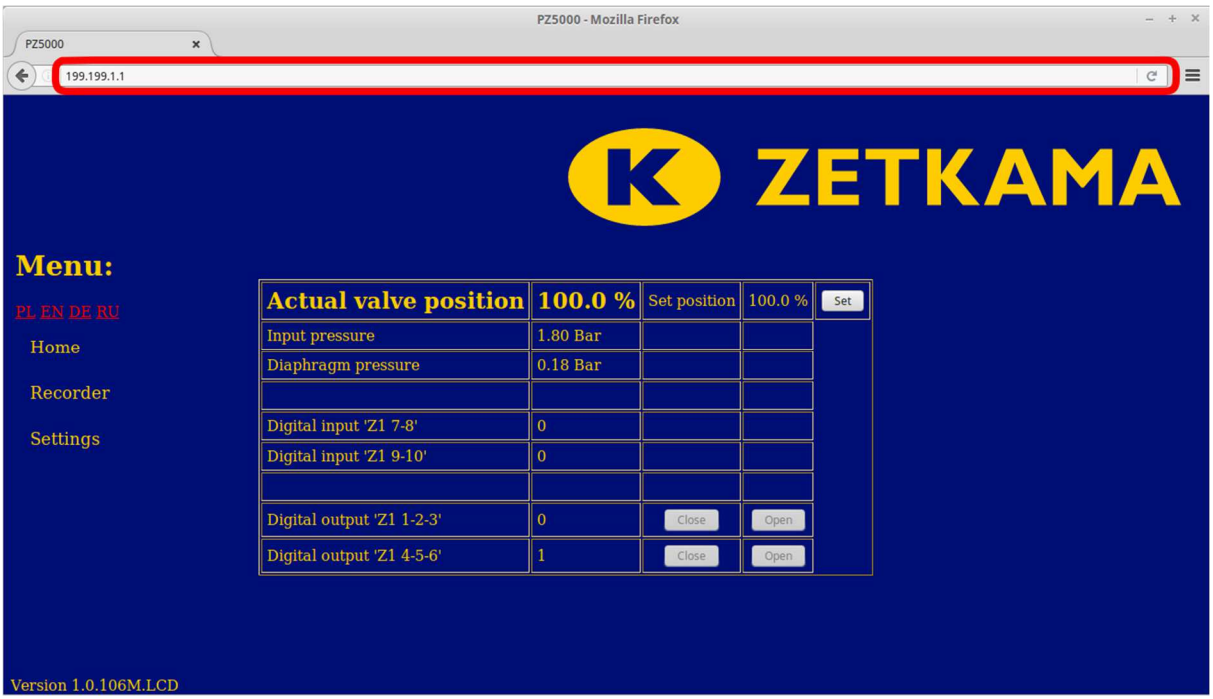


Fig. 17: HTTP of the positioner - Wi-Fi.

5. Menu structure

5.1. Navigation

Navigation is possible using the touch screen or using the keys on the keyboard. Exiting most menu screens is done by pressing a button in the lower right corner of the screen allowing the user to easily return to the main window. Changes in the editable windows are saved only after pressing **"Save"** button.

5.2. Main menu

The configuration and operation of the device is done from the main menu shown in Fig.18

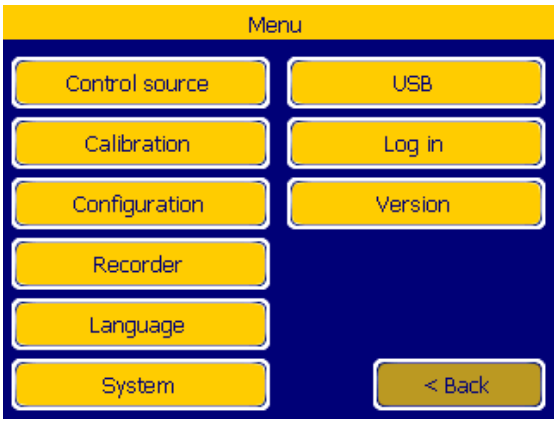


Fig. 18: Main menu.

Options included in the above menu allow to access all functions of the positioner. All configuration accessible from the touch screen menu is also possible to be changed from the level of HTTP server.

5.3. Control

The control menu allows the user to select the source of the valve operation control.

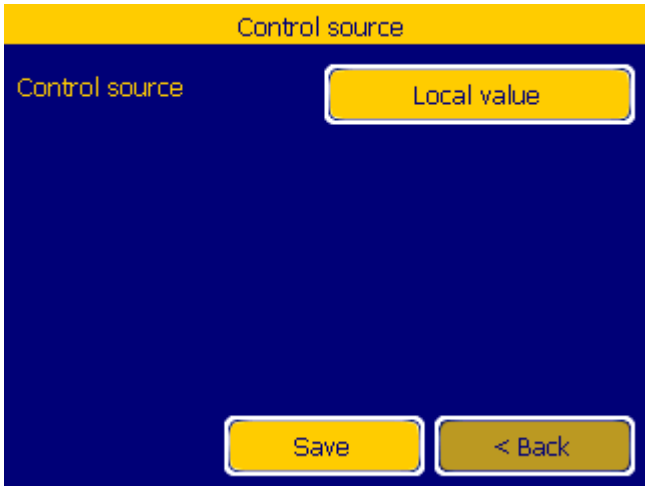


Fig. 19: Sources of Control (Menu> Control).

5.4. Calibration

The calibration menu allows the user to run valve calibration algorithm. In addition, the user can: edit parameters PID (Fig. 21), manually control the piezo-valves without PID controller (Fig. 22), edit calibration values (Fig. 23) and edit the distance from the shaft to propeller coupling, which is used to linearize the valve position.

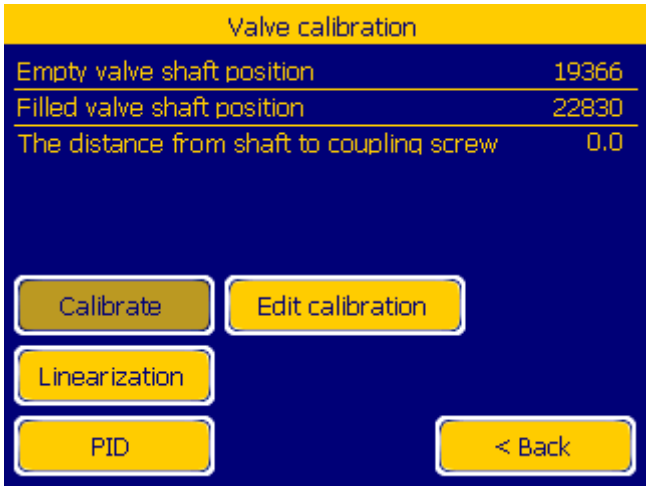


Fig. 20: Valve calibration menu (Menu> Calibration).

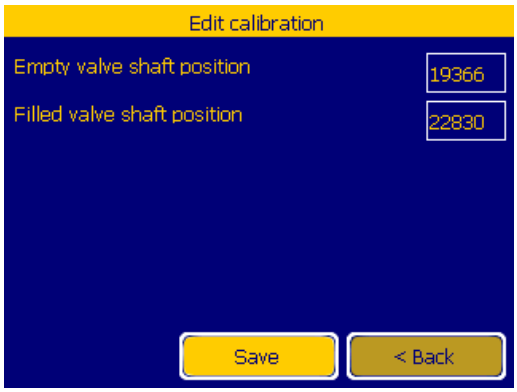


Fig.21: Edit calibration (Menu>Calibration>Edit calibration)

Selecting "PID" from the menu of Fig.20 will open the window for editing the parameters of the PID controller (Fig. 22). Used algorithm can be described by the following formula:

$$WY = K_p \cdot e(t) + \int \frac{K_i}{T} \cdot e(t)\, dt - K_d \cdot T \cdot \frac{d \cdot \text{poz\_we}}{dt}$$

where e = poz_zadana - poz_we.

The **"poz_we"** is read the value of angle while **"poz_zadana"** means the target position of the shaft. The value of **"T"**, expressed in ms specifies the time at which the algorithm is executed. Result of the work of the algorithm "OFF" sets the speed with which built piezovalve will fill the air or drop from the actuator.

The **"Maximum"** to limit the maximum power regulator. It sets a limit for the **"Out"**, which can generate a PID algorithm.

The **"Hist."** to limit the precision work of the algorithm. Supplementation value is a percentage of the full opening of the valve. The positioning of the valve will stop when the valve approaches of defined value to the desired open position. This is useful where for reasons of mechanical constraints the valve can not be accurately set in a given position.

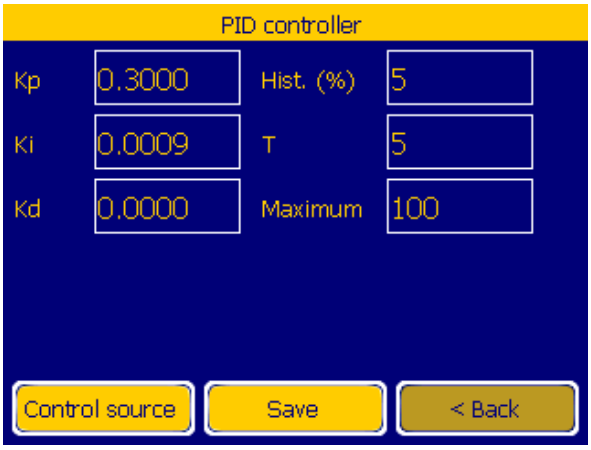


Fig. 22: Configuration of the PID (Menu> Calibration> PID).

Manual control window allows you to disconnect the PID and manual setting force regulator

Fig. 23: Manual defining (Menu> Calibration> PID> Control).

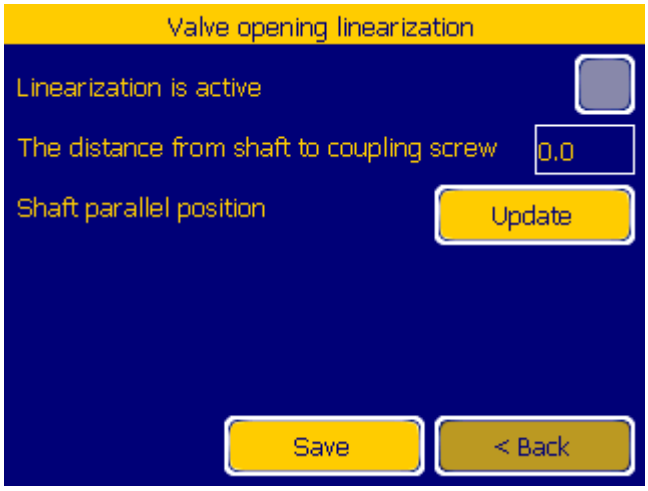


Fig. 24: Edit linearization (Menu> Calibration> Edit linearization).

Menu linearization valve opening (Fig. 24) allows to improve the precision positioner. This is especially important when mechanical reasons positioner could not be mounted so that 50% of the valve opening lever was placed along the axis. Editable field "Distance shaft to the screw coupling" means the distance between the shaft and the screw coupling of the positioner mounted on the valve. This distance is a shown in Fig. 25 by arrow

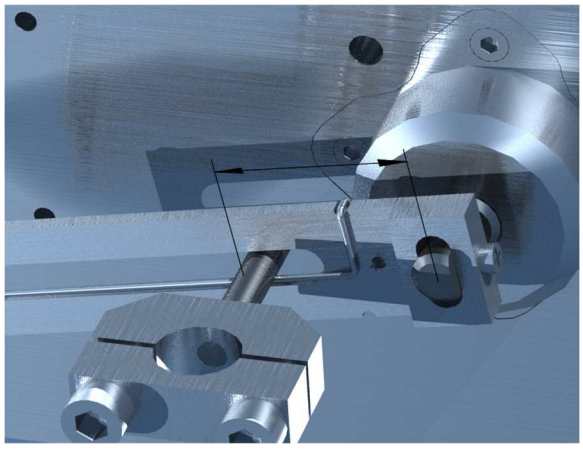


Fig. 25: Distance between the shaft and the screw coupling

Linearization valve opening (Fig. 26) is based on user-entered distance shaft screw-coupling and angle of which was twisted lever shaft (Kąt otw.). The reference point performing these calculations is pre-stored angle (Kąt fab.) For which arranged the lever shaft in parallel to the long side of the device (there is then in its axis as shown in Fig. 80). The "Shaft Parallel Position" (menu Fig. 24) allows you to update this value. However, it can be used only after the shaft when the lever is set in the previously described positions.

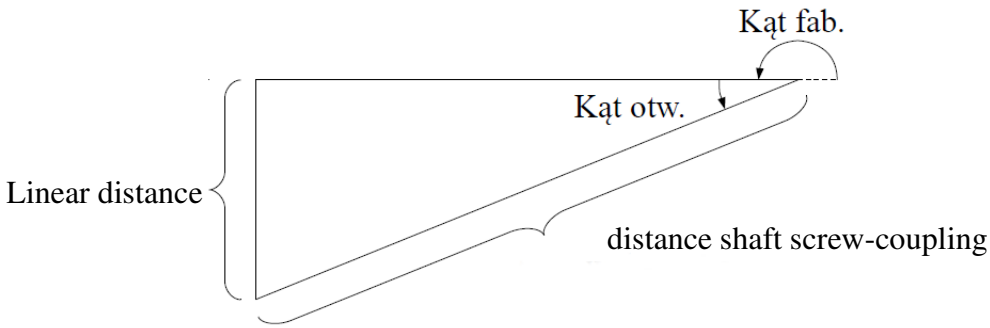


Fig. 26: Linearization valve opening

5.5 Configuration

The configuration menu is the main place where the user can make changes in the device settings.

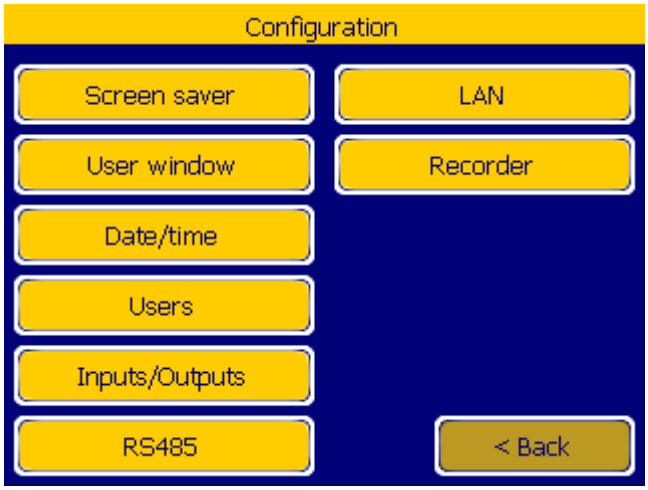


Fig. 25: Positioner configuration menu (Menu> configuration).

5.5.1. Screensaver

The positioner allows to turn off the LCD screen after a defined period of inactivity. Screensaving reduces the energy consumed by the positioner and extends its life. Restart can take place when the user touches the display, presses any button or activates the proximity sensor.

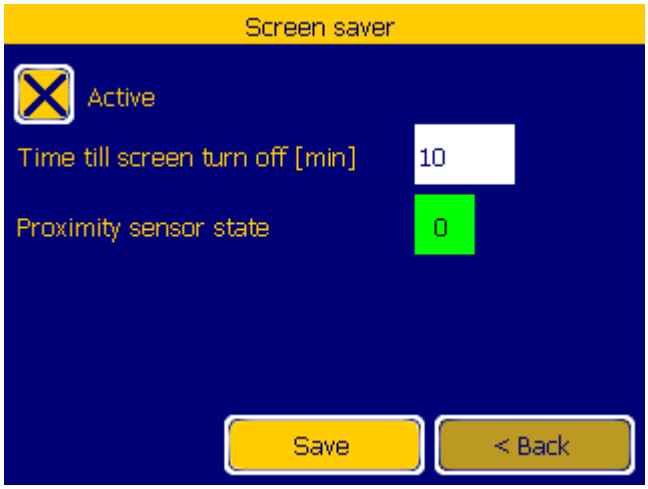


Fig. 28: Screen saver (Menu> configuration> Screen Saver).

The capacitive proximity sensor enables to turn on the screensaver without opening the housing. Fig. 27 shoes its approximate position. Touching or placing the hand in the immediate vicinity of the area is detected by the device.

Fig. 29: Position of the proximity sensor.

5.5.2. User window

The following menu allows the user to configure the main window of the positioner. The user can choose between two types of windows. The choice of the windows is done using the pull-down selection bar shown in Fig. 28. When the user chooses an extended window, additional options appear in the menu (Fig. 30).

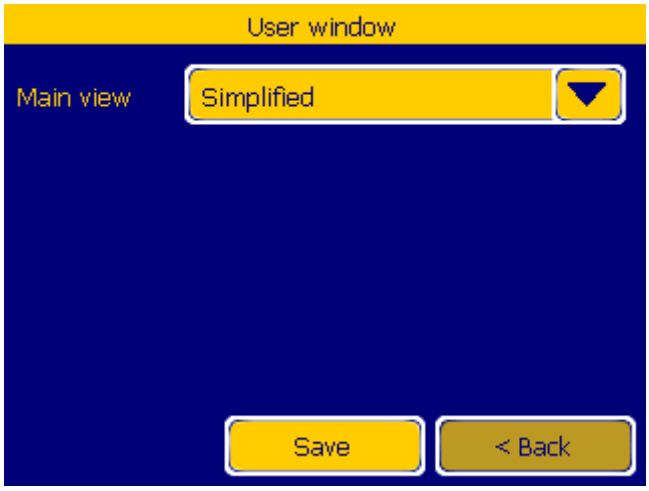


Fig. 30: Configuration menu of the main window (Menu> configuration> User window).

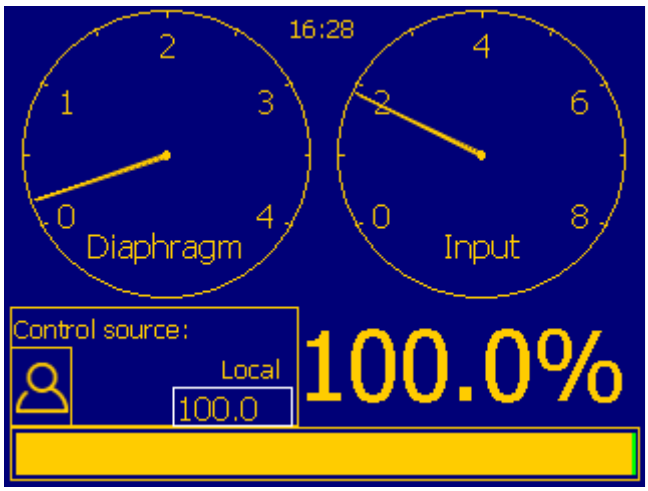


Fig. 31: Simplified window.

The simplified window(Fig. 31) shows the pressure in the actuator diaphragm and pressure input in the form of analog pressure gauges. The screen also shows: time, percentage of valve opening, control source, from which the positioner receives the target position, and valve opening bar. The access to the main menu (Fig. 18) is possible by touching the screen in the area of pressure gauges.

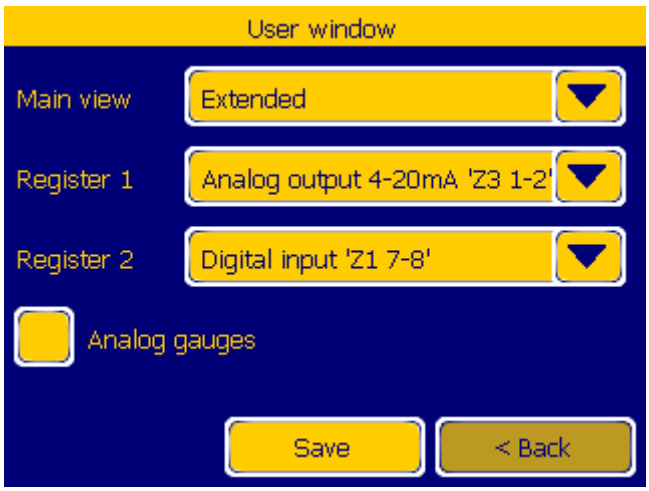


Fig. 32: Configuration menu of the main window (Menu> configuration> User window).

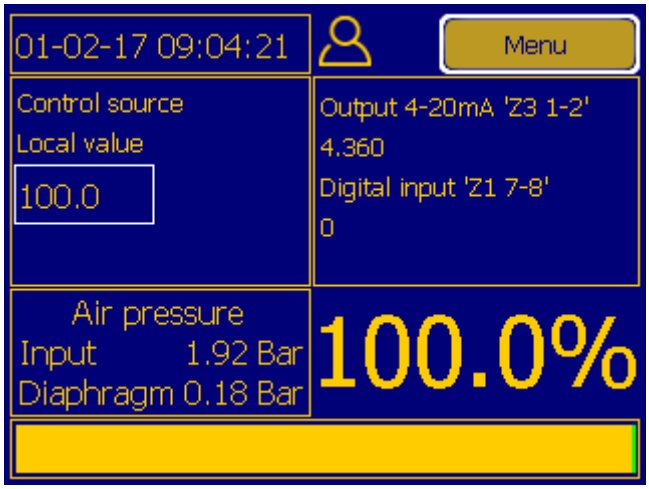


Fig. 33: Extended window.

Extended window (Fig. 33) allows the user to display two user-configurable parameters. As shown in example in Fig. 32, the user displayed the current of one of the current outputs and state of a digital input. The extended window shows also: full date and time, menu entrance button, source control from which the positioner receives the target position, percentage of valve opening, position bar and pressure read from the actuator diaphragm and input pressure. If in the menu shown in Fig. 32 the user selects the option **"Analog gauges"**, then the numerical value of air pressure in the extended window will be replaced by small analog gauges.

Fig. 34: Position bar.

Position bar is present in each window. It consists of two elements. Filled bar (marked in Fig. 34 as 1) with its length represents position of the valve stem. The maximum length indicates the full opening of the valve. The vertical green line (marked in Fig. 34 as 2) indicates the target position of the valve.

5.5.3. Date/time

Date and time setting window allows the user to correct dates of the internal clock of the RTC. Separate "**Save**" buttons update time or date.

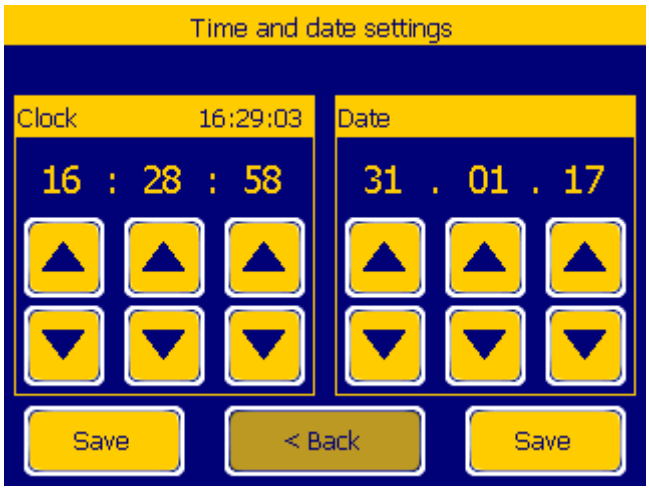


Fig. 35: Time and date settings window (Menu> configuration> Date / Time).

5.5.4. Users

Changing the configuration of the positioner requires the user to log into it. By default, the positioner has an administrator account with the following access pin: "**2846**". Adding, deleting and changing user permissions is done using the menu shown in Fig. 34. Entering the shown menu is possible only for users with a sufficiently high level of authorisation (level 15).

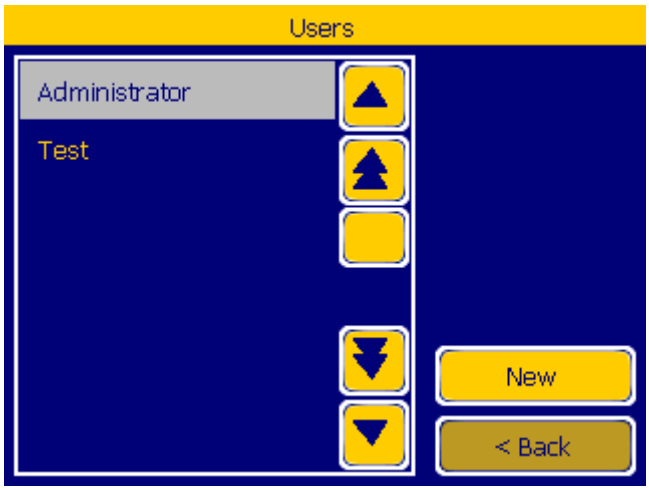


Fig. 36: Registered users (Menu>Configuration> Users).

Pressing the **"New"** button will display a window to create a new user (Fig. 37).

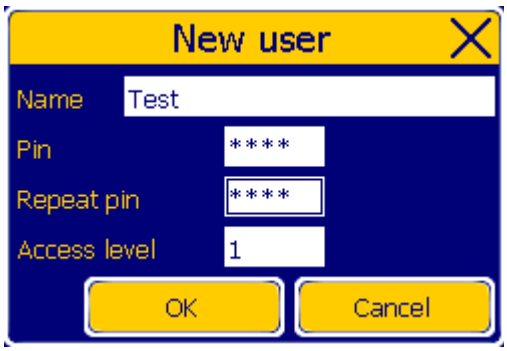


Fig. 37: New user account.

In order to create a new user the following fields need to be filled in:

"**Name**" - defining the user name. It is used, among others, by the event recorder to enable distinction of users introducing changes in the configuration of the positioner.

„**Pin**" - 4-digit pin

"**Repeat pin**" - enter the same value as in the "**Pin**"

"**Access Level**" - users with low-level access can change most settings of the positioner. In order to create and delete users, the access level must be 15.

After pressing the "**OK**" button, the new user you will be created.

Changing the settings for existing users is done by pressing a user name from the menu shown in Fig. 36. This opens the menu shown in Fig. 38.

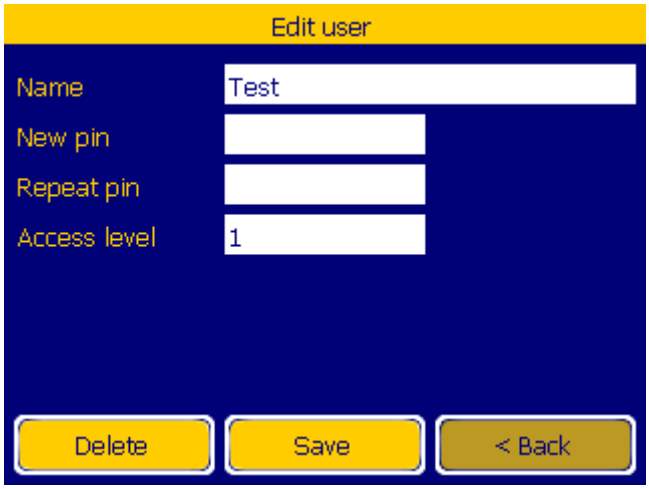


Fig. 36: User editing window (Menu>Configuration> Users> [Name]).

The menu allows the user to change all the user parameters and to delete it.

Deleting all users with access level 15 (such as administrator) will block access to the „5.5.4. Users**" menu!**

5.5.5. Inputs/Outputs

Inputs/Outputs submenu allows the user to configure current and voltage inputs, current outputs, digital inputs and outputs and the level of alarm.

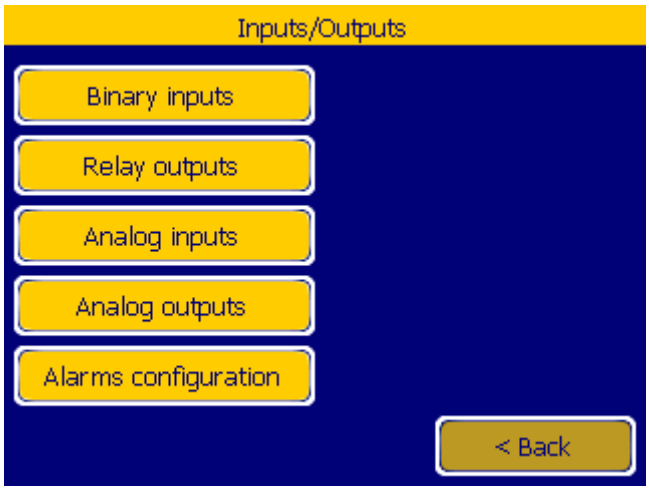


Fig. 39: Menu configuration of inputs and outputs (Menu> Configuration> Inputs / Outputs).

5.5.5.1 Binary inputs

The positioner has two digital inputs "**Z1 7-8**" and "**Z1 9-10"**; they may be used to limit movement of the valve and to stop its operation.

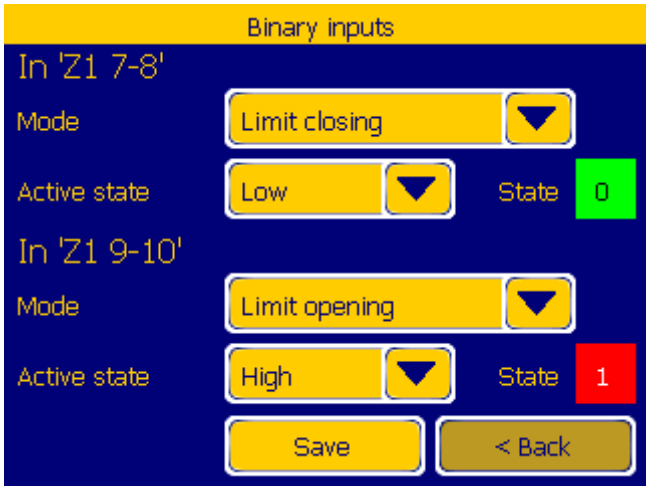


Fig. 40: Binary inputs (Menu> Configuration> Inputs / outputs> Binary inputs).

With the menu shown in Fig. 40, it is possible to configure each of the binary inputs in one of the 4 "**Operation modes**".

"**Inactive**" - inputs do not affect the positioner operation.

"**Limit opening**" - after modulating the input, the positioner ceases to drop out of the air from the valve.

"**Limit closing**" - after modulating the input, the positioner ceases to fill the valve with air.

"**Disable control**" - after modulating the input, the positioner stops the valve control.

In each mode, the status of the inputs is transmitted by digital protocols of the positioner.

The signals "Limit opening" and "Limit closing" are taken into account also during calibration of the positioner.

Each of the presented modes can be activated with low or high state. This is configurable using the “**Active state**” option.

The current state of each input is shown in the "**Status**" field where "**0**" means no modulation and the value "**1**" informs about modulation of a particular input.

For example, in case of using the settings shown in Fig. 40 it is possible to limit the degree of valve opening and closing with external limit switches that detect the movement of the stem. The outline of such a circuit is shown in Fig. 41.

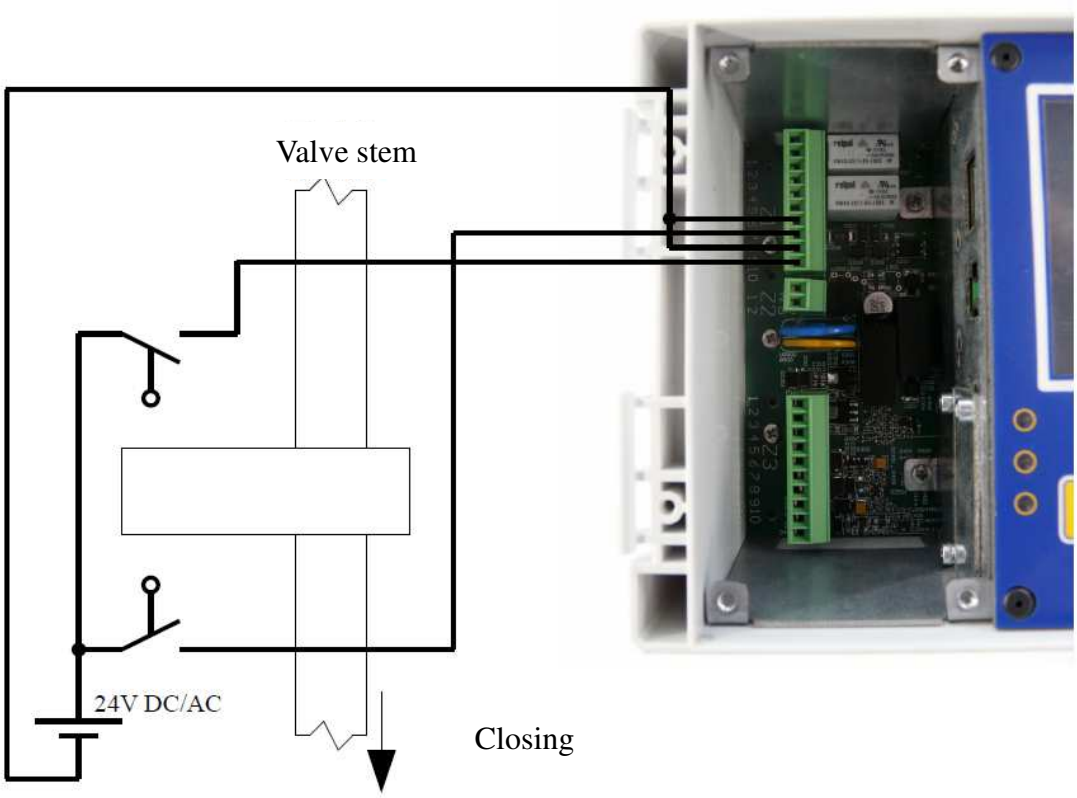


Fig. 41: Example of limit switches connection limiting the movement of the valve

5.5.5.2. Relay outputs

The positioner has two relay outputs “**Z1 1-2-3**” and “**Z1 4-5-6”**. The relays can be controlled via digital protocols or manually. In addition, with their status they may indicate selected device alarms.

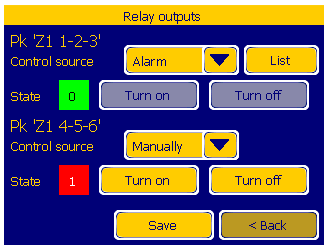


Fig. 42: Configuration menu of relay outputs (Menu> Configuration> Inputs / Outputs>Relay outputs).

Configuration menu of relays (Fig. 42) allows the user to specify the "Control source" from which the relays will receive state. The following options are available:

"**Off**" - relay control is inactive.

"**Manual**" - activates "**Turn on**" and "**Turn off**" buttons allowing to set a state of relays. Saved state of relay is restored each time the device is started.

"**Modbus**" - relays can be switched remotely using the protocol.

"**Website**" - relays can be controlled via the HTTP server.

"**Alarm**" - relay will be switched after the occurrence of the defined alarm. After selecting this option in the menu appears button "**List**" that allows switching to the list of available alarms (Fig. 43). In the example shown in Fig. 43 relay will be switched when the pressure at the input of the positioner drops below the minimum value ensuring its correct operation.

The configuration menu displays the status of the relays using the "**Status**” field. The value of "**0**" means the off state while tthe "**1**" - on state.

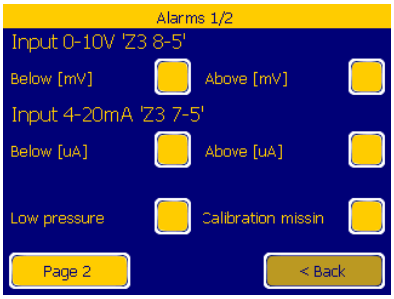


Fig. 43: List 1 of relay outputs alarms (Menu> Configuration> Inputs / Outputs>Relay outputs>List).

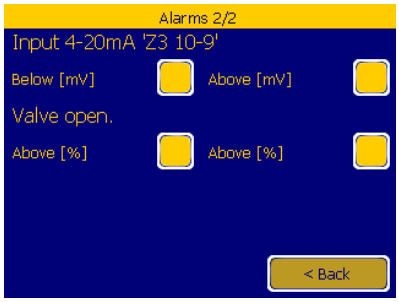


Fig. 44: List 2 of relay outputs alarms (Menu> Configuration> Inputs / Outputs>Relay outputs>List>Page 2).

5.5.5.3. Analog inputs

Menu allows the user to quickly read the state of all analog inputs and, if necessary, adjust their offset. It should be noted that the inputs '**Z3 8-5**' and '**Z3 7-5**' use the same transmitter. This means that the signal at input '**Z3 8-5**' will be visible at the input of '**Z3 7-5**', and vice versa.

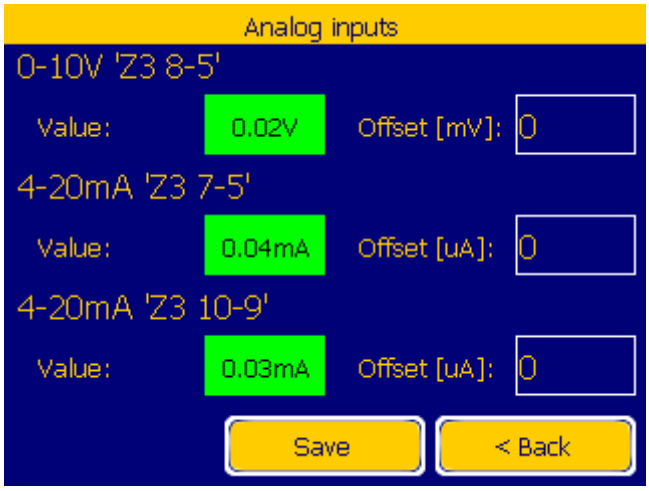


Fig. 45: Menu of readout and configuration of the analog inputs offset (Menu>Configuration>Inputs/Outputs>Analog inputs>

Setting the offset value of the output allows to eliminate the errors of the input signal. For example, when the current measured at the input of '**Z3 10-9**' varies in the range from 4.1mA to 20.1mA, it is possible to shift its level by -100uA. In this way, the positioner will be able to take full advantage of the range of 4-20 mA loop. Required offset must be entered in the appropriate field, which is shown in Fig. 46. The value of the read input will be updated after pressing "**Save**". Up to this point the word and the field "**Value**" will change colour to gray, thus indicating an unsaved change of settings.

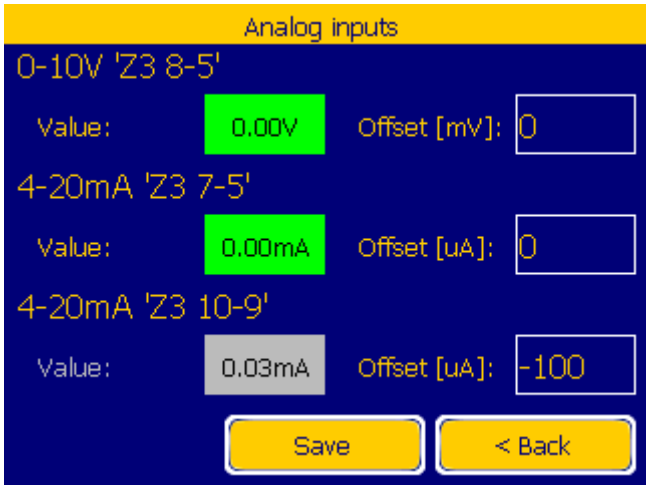


Fig. 46: Changing the offset of analog input (Menu> Configuration> Inputs/Outputs>Analog inputs>

5.5.5.4. Analog outputs

The positioner has two 4-20mA current loop outputs "**Z3 1-2**" and "**Z3 3-4"**. The configuration allows the user to specify the source that will force the particular output current. The adequate setting of outputs allows the device to transmit current information on the status of valve opening, about the pressures or enables to act as a repeater of analog inputs.

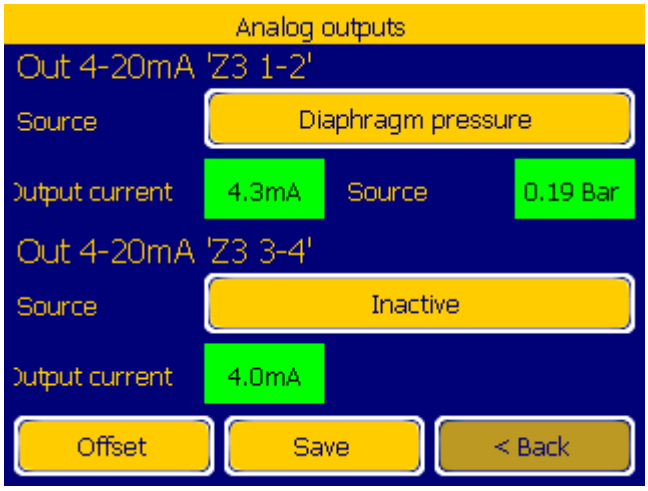


Fig. 47: Configuration of relay outputs (Menu> Configuration> Inputs /Outputs>Analog outputs)

"**Source**" button shown in Fig. 47 enables to select the source of force. After pressing it, a list of available sources opens (shown in Fig. 48). In addition to choosing the source of force it is also possible to reverse the current value. The relationship between the output current and the value of force at a given source is presented in Table 1. The menu also shows the current value of the current loop in the "**Output current**" field and the value forcing this current in the "**Force**" field.

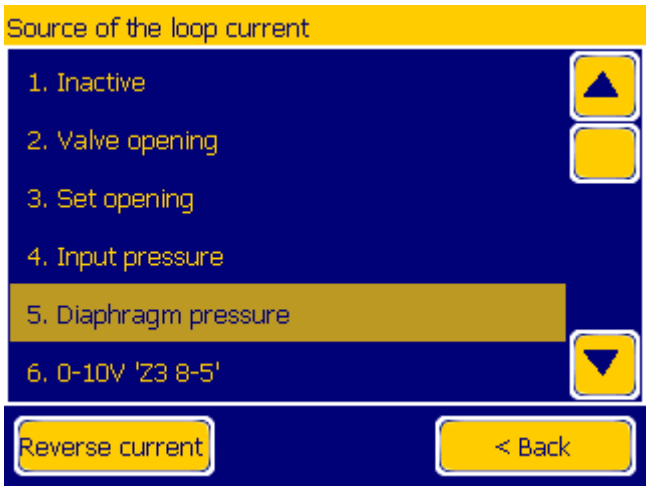


Fig. 48: The list of output current sources (Menu> Configuration> Inputs / Outputs> Analog outputs> Operating mode).

Source	Force [min] / [max]	Output current at forcing [min] / [max]	
		"Reverse the current" unselected	"Reverse the current" selected
1. Inactive	- / -	4mA / 4mA	20mA / 20mA
2. Valve opening	0% / 100.0%	4mA / 20mA	20mA / 4mA
3. Set opening	0% / 100.0%	4mA / 20mA	20mA / 4mA
4. Input pressure	0Bar / 8Bar	4mA / 20mA	20mA / 4mA
5. Valve pressure	0Bar / 8Bar	4mA / 20mA	20mA / 4mA
6. 0-10V 'Z3 8-5'	0V / 10V	4mA / 20mA	20mA / 4mA
7. 4-20mA 'Z3 10-9'	4mA / 20mA	4mA / 20mA	20mA / 4mA
8. 4-20mA 'Z3 7-5'	4mA / 20mA	4mA / 20mA	20mA / 4mA

Table 1: The relationship between the output current and the source of extortion.

The analog output configuration menu (Fig. 47) also allows the user to add an offset to each of the outputs. Pressing the "**Offset**" button will open the window shown in Fig. 49. For example, if it is required that the output current loop **'Z3 1-2**' varied in the range from 4.25mA to 20.25mA, then the user should enter a value of 250 into the "**Offset [uA]:"** field. Offset can have a positive or the negative sign. Note, however, that this option is limited by the scope of changes of the current loop transmitter. Therefore, it will work correctly only for small offset value. For most systems, the range of valid values will be between -500uA to 1000uA.

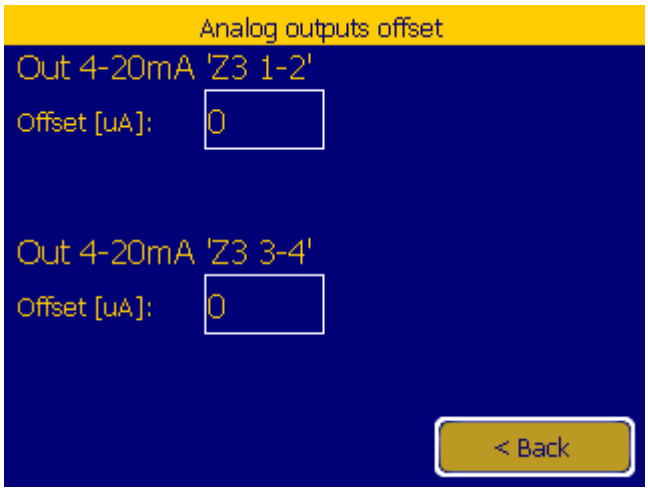


Fig. 49: Changing the offset of analog input (Menu> Configuration> Inputs/Outputs>Analog inputs>Offset).

If the parameters of the analog outputs are changed, until pressing the "**Save**" button the field "**Output current**" will be grey, thus indicating that the value is invalid because of an unsaved change of settings (eg Fig. 50).

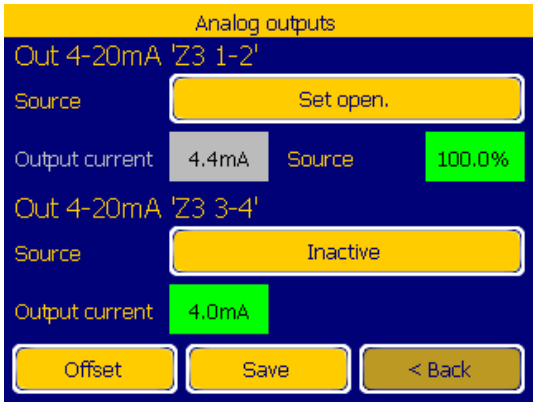


Fig. 50: Changing the configuration of inputs

(Menu> Configuration> Inputs/Outputs>Analog inputs>Offset).

The relationship between the input current and the value of force can be calculated based on Table 1. For the unselected option "**Reverse current**" the pattern is set to:

$$\text{Current\_loop[mA]} = \frac{\text{Force\_Value} - Force[min]}{Force[max] - Force[min]} * 16 + 4$$

While for the selected option "**Reverse current"**:

$$\text{Current\_loop[mA]} = 20 - \frac{\text{Force\_Value} - Force[min]}{Force[max] - Force[min]} * 16$$

For example, for the input pressure on the value of 2.5bar and the unselected option "**Reverse current**" output current will be set as follows: $\frac{2.5-0}{8-0} * 16 + 4 = 9mA$. While for the selected option "**Reverse current**" and the source of '**Z3 10-9**' with the value of 6.5mA, the output current will be set to $20 - (\frac{6.5-4}{20-4} * 16) = 17.5mA$.

The current outputs reach the target accuracy after warming up. Determining the temperature may take several minutes after the positioner is started.

5.5.5.5. Alarm configuration

Alarm signals can be configured using the following menu options (Fig. 51 and Fig. 52). Alarms they will turn on when the signal tested exceeds the value entered in the **"Above"**, or falls below the value of the "**Below"**. The alarm stops when the signal returns beyond the limit of a certain percentage of its maximum value. This is specified field **"Hysteresis** [%]" that affects how disable all alarms. For example, if the value of the "**Above [mV]**" for **"Input 0-10V 'Z3 8-5' 'of 5000 (5V) and" Hysteresis [%]** "is 10, the alarm will be activated at a voltage of 5.000V above but will be turned off below 4.000V voltage. Similarly, if **"The following [uA]"** for "**Input 4-20 '7-5 Z3' '10000 (10mA) and" Hysteresis [%] "**is 10, an alarm will be activated when the current drops below 10mA but will be turned off when the current rises above 12mA.

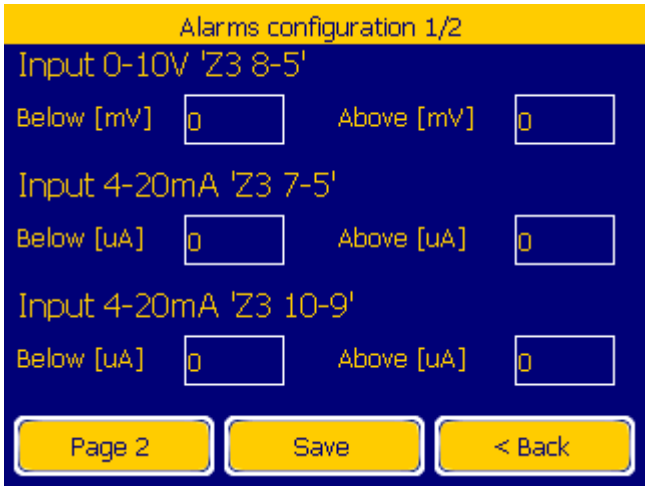


Fig. 51: Alarm configuration page 1 (Menu>Configuration> Inputs/Outputs>Page1).

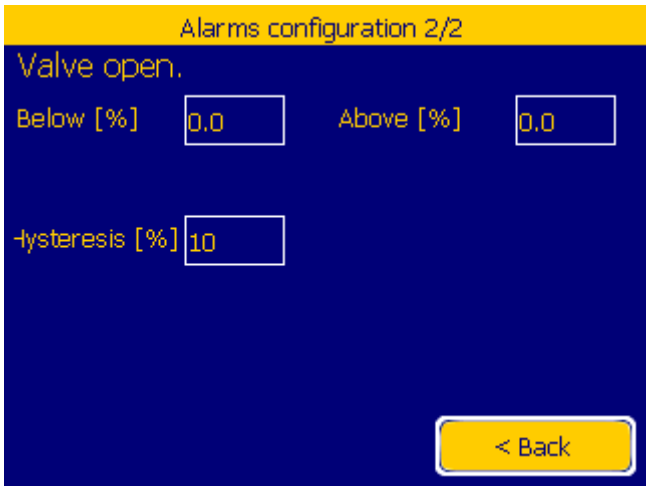


Fig. 52: Alarm configuration page 2 (Menu>Configuration> Inputs/Outputs>Page2).

5.5.6. RS485

The configuration menu of RS485 port allows the user to select the protocol by which communication is to take place. There are two protocols available: "**Modbus**" and "**Profibus**".

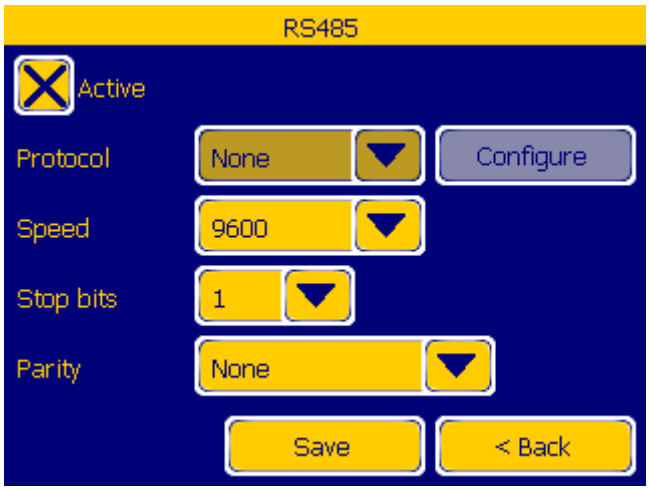


Fig. 53: Configuration window of protocols on the RS485 connection (Menu> Configuration>RS485).

Using the drop-down "**Protocol**" menu the user can choose between two protocols or turning off communication on the port. After selecting the protocol, the "**Configure**" button will display the menu allowing to set the device address. During configuration, it is also possible to define the speed ("**Speed**"), the amount of stop bits ("**Stop bits**") and parity ("**Parity**").

Changing the protocol requires a reboot of the device. When changing the configuration, pressing the "**Save**" button will display a message informing the user to restart the device. The message is shown in Fig. 54. Pressing "**OK**" will automatically reboot and load the new configuration settings.

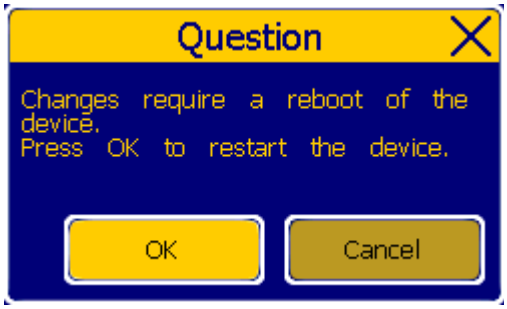


Fig. 54: Request to reboot the device.

5.5.7. LAN

The menu allows the user to configure the connection to the local network.

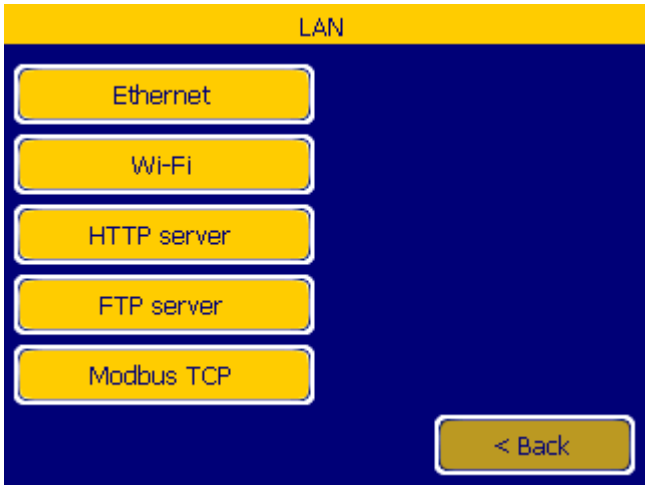


Fig. 55: LAN menu (Menu> Configuration> LAN).

5.5.7.1. Ethernet

Network settings window (Fig. 54) allows the user to assign the device with IP address, Mask, and Gateway. These changes require rebooting the device. The user is alerted about this via the window shown in Fig. 52. The connection with HTTP site via Ethernet is shown in section 5.6.1.

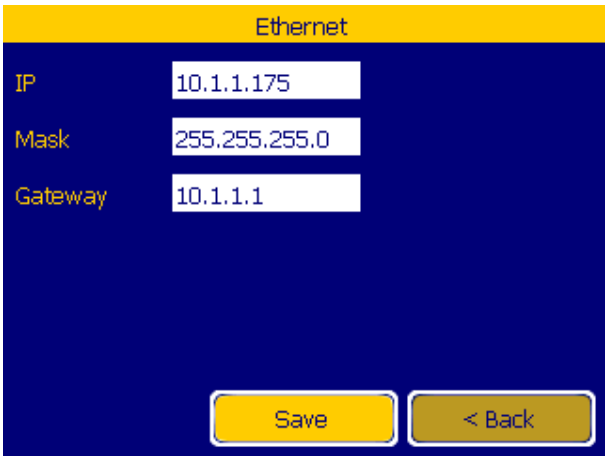


Fig. 56: Network settings (Menu> configuration> LAN> Ethernet).

5.5.7.2. Wi-Fi

Communication via Wi-Fi allows the user to use and configure the device using the HTTP page. The connection with the page via Wi-Fi is shown in section 4.6.2.

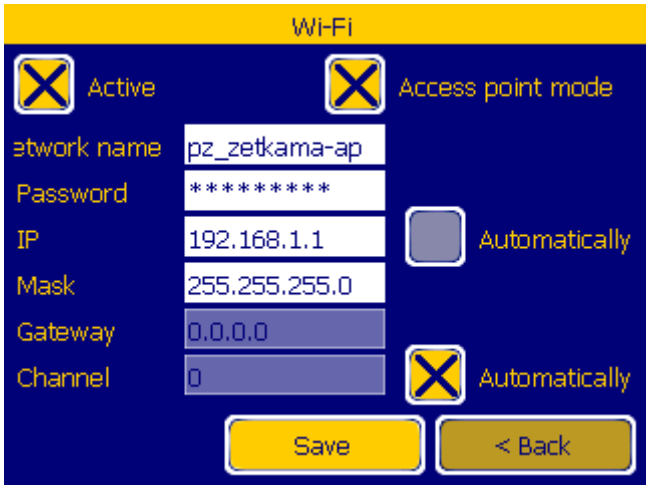


Fig. 57: Wi-Fi settings (Menu> configuration> LAN> Wi-Fi).

Fig. 57 shows the Wi-Fi configuration menu. The device can operate in two basic modes.

When the "**Access point mode**" selection button is selected Wi-Fi operates in the access point mode. This allows the user to connect to networks created using a phone or laptop. The created access point will be shown under the name entered into the "**Network name**" and access to it will be protected by a sequence of characters (minimum 8) entered into the field "**Password**". This mode is usually used when a single user is trying to change the configuration or read the events of the positioner.

When the "**Access point mode**" selection button is unselected the device will attempt to connect to an existing Wi-Fi network. In this mode, the "Network name" refers to the network, to which the device is to connect using the sequence of characters entered into the "**Password**" field. For the configuration presented an option becomes available to automatically assign an IP ("**Automatically**" selection button), and to define the gates used (the "**Gate**"). This mode is useful when there is a need to manage more positioners. In contrast to the previous mode, there is no need to connect to the created network each time to change the settings.

To activate communication through Wi-Fi, the "**Active**" selection button must be selected and the setting saved using the "**Save**" button.

5.5.7.3. HTTP Server

The HTTP server configuration menu allows the user to specify the protocol on which it is to be activated. The server can be accessed via the Ethernet (the "**Active on cable**" selection button) and Wi-Fi (the "**Active on Wi-Fi**" selection button). The "Configure" buttons allow respectively to jump to the Ethernet settings menu (Section 4.5.7.1), or Wi-Fi menu.

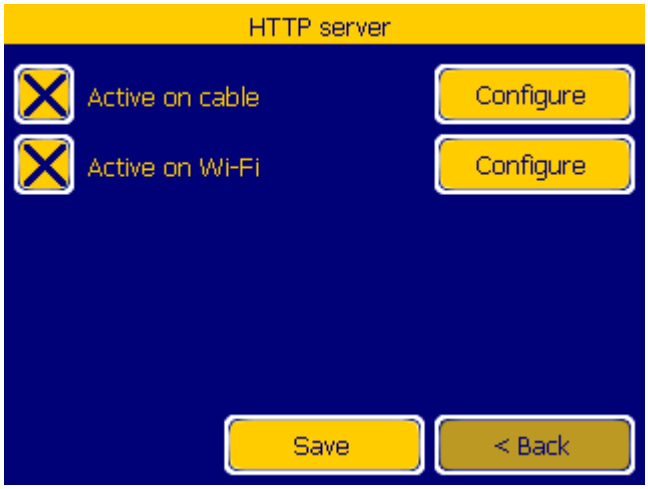


Fig. 58: HTTP server settings (Menu> configuration> LAN> HTTP server).

5.5.7.4. Modbus TCP

The positioner can controlled using the Modbus TCP protocol described in section 4.4. The following menu shows the option of its configuration. The protocol can be activated on the Ethernet level using the "**Active on cable**" selection button. Using the "**Configure**" button it is possible to jump to the Ethernet configuration menu (section 5.5.7.1). The "Address" field with the "**Use address**" selection button allow the user to set the protocol in such a way that the positioner does not respond to commands with a mismatched target address. The "**TCP port No**" field specifies the port, on which the communication will be carried out.

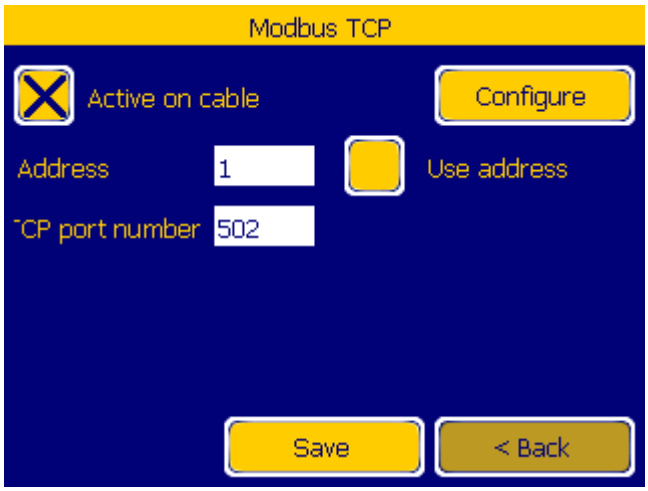


Fig. 59: Modbus TCP protocol configuration (Menu> Configuration> LAN> Modbus TCP).

5.5.8. Recorder

Counters and recorders described in section 5.11 have a configurable sensitivity which can be configured using the menu shown in Fig. 60.

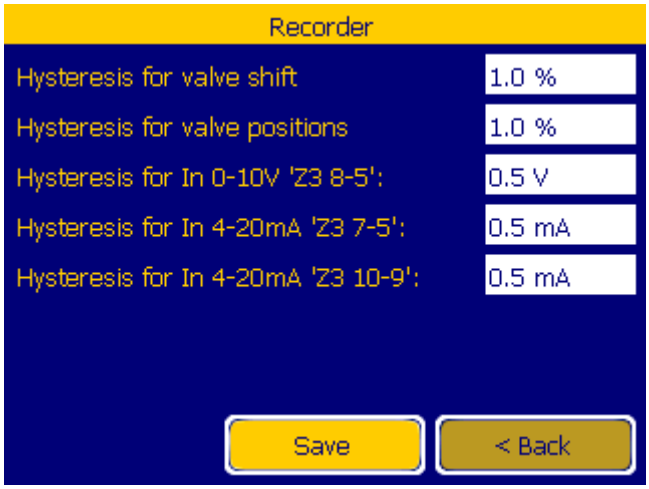


Fig. 60: Recorder configuration menu (Menu> configuration>recorder).

In the following fields, it is possible to determine the minimum value of change that will induce the recorder. Another options enable the following:

"Hysteresis for valve shift" - specifies the minimum change in the value of the valve opening before triggering the position recorder.

"Hysteresis for valve positions" - specifies the minimum change in the set value of the valve opening before triggering the position recorder and the modulation counter.

"Hysteresis for In 0-10V 'Z3 8-5'", "Hysteresis for In 4-20mA 'Z3 7-5'", "Hysteresis for In 4-20mA 'Z3 10-9'". - specify the minimum change in the input value before triggering the analog values recorder.

2.4 Language

The language is changed by pressing the flag of a country. The available languages of the positioner are: Polish, English, German and Russian. Once the language is changed the selection is automatically saved. It changes the language of the user menu, the language of events and the language of the default HTTP server site.

Fig. 61: Changing the language (Menu> Language).

5.7. System

System submenu allows the user to activate special modes, reset the device and configure the touch screen.

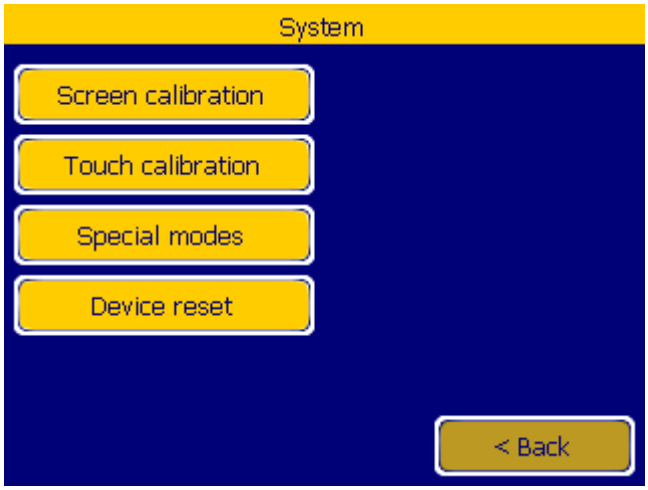


Fig. 62: System menu (Menu>System).

Special mode window shown in Fig. 63 allows the user to run the valve durability test program. In this mode, the positioner stops responding to external commands of valve modulation and further changes of opening are made locally. Changing the valve opening is carried out in two modes: by maximally modulating it from opening to closing, by every 10% of its calibrated way. Switching between programs takes place after a user-defined number of cycles. After performing the program cycle, data on the valve are recorded. They can be recorded on a USB drive by pressing the "Save to USB" button.

The mode is started by pressing the "On" button, after which the positioner will restart and automatically run in the regulation unit mode.

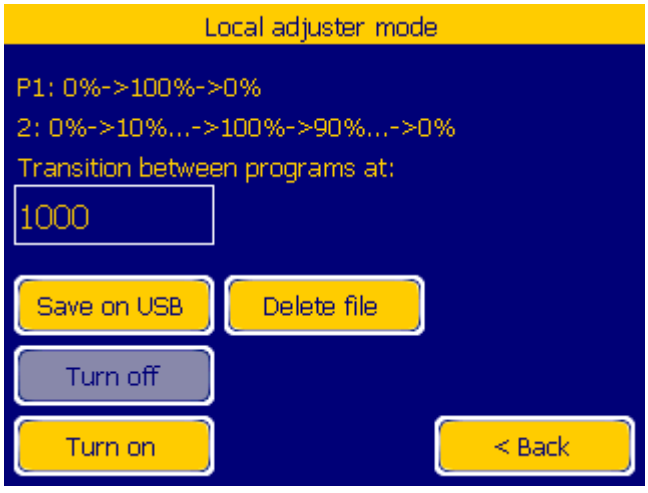


Fig. 63: Special mode (Menu> System> Special modes> Local regulation unit)

5.8. Log in

This option allows the user to log into account stored in the positioner's memory. By default, the positioner has an administrator account with the following access pin: **2846**.

Fig. 64: User login window.

If the user is logged, pressing the "**Login**" button will display the log out window. This screen is shown in Fig. 65.

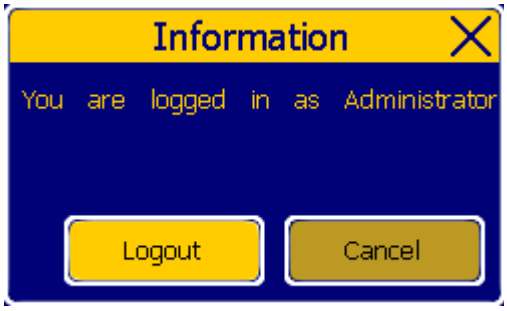


Fig. 65: User logout window.

5.9. Version

The window displays information about the program version, installed licenses and the number of the device. The line "ID Code" specifies the 24-digit number of the device, on the basis of which the license unlocking some of the software functions of the positioner may be generated.

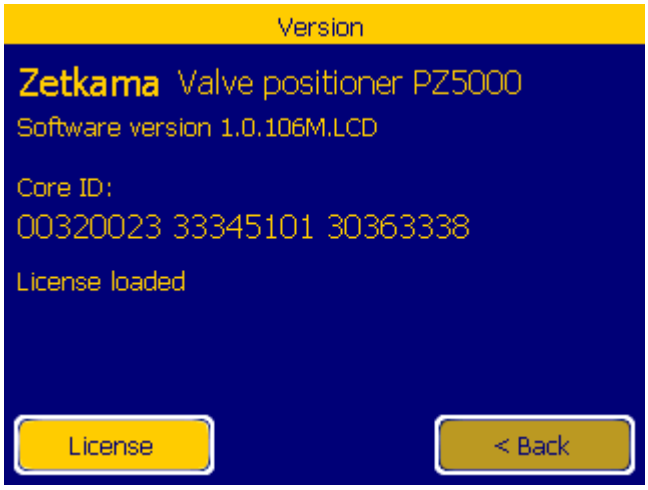


Fig. 66: Software version (Menu> Version).

After entering the '**License**' menu the user can check which elements of the positioner have been activated. Unavailable functionalities are grey. In the case of Fig. 67 all the available functions are active.

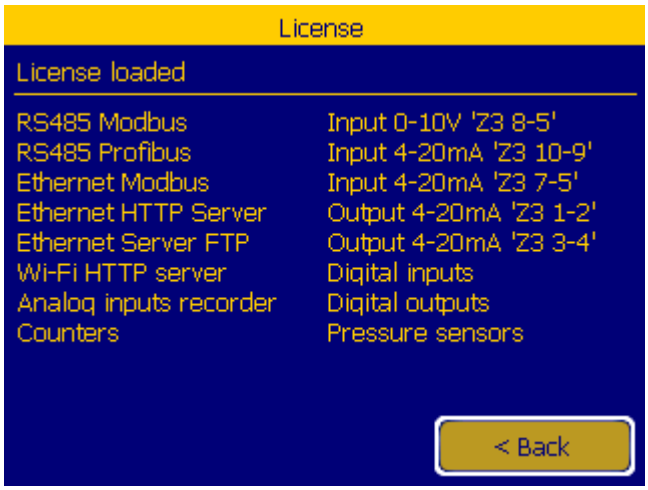


Fig. 65: Activated license elements (Menu> Version> License).

5.10 USB

The menu allows the user to interact with USB.

Fig. 68: USB options menu (Menu> USB).

Options shown in Fig. 66 allow the user to transfer data using the built-in USB port.

The user has access to the following options:

"**Load graphics**" - updates graphics files displayed by the positioner.

"Update WWW" - updates the content of the page being sent by the HTTP server.

"**Load configuration**" - allows to load new positioner settings. Only files with the correct format and the name "pz.cfg" will be accepted.

"**Archive configuration**" - saves the current configuration of the positioner in the form of a file named "pz_ [time UNIX].cfg" (for example, "pz_1469534164.cfg"). In combination with the option to load the configuration, this option allows to quickly copy configuration between different devices.

"**Save events**" - records events in the file named "events.csv." Events are stored in the currently selected language. For Polish, English and German ISO-8859-2 coding is used.

"Load license file" - loads a license for the device thus allowing the activation of additional software features.

If the reading or saving data is correct on the information screen will appear. Up to this point, do not remove the USB memory device.

5.10. Recorder

The positioner has a number of recorders that allow the acquisition of a range of information about its operation. The positioner in its basic functionality provides event logger and recorder of valve position. After installing additional license, counters of valve modulation and recorder of analog inputs become available.

Fig. 69: Recorders options (Menu> Recorder).

5.11.1 Events

The "Events" button jumps to the window shown in Fig.70. By using it, the user can scroll through the stored events, and by using the "**Save to USB**" he can archive them on an external flash memory (the same as for the "**Save Event**" option in section 5.10).

Fig. 70: Event recorder (Menu> Recorder> Events).

The positioner saves the series of events related to its operation and to the change of its parameters by the user. Recorded events are shown in the following tables. Each of the events has date and type of recorded event.

Event name
Power failure
Turning on the power
Manual reset
Reset watchdog
User login
User logout
Login error
Changing user parameters
Valve calibration
New Control Source
Change of date
Change of time
New user
User removed
Change of parameters

The change of parameters event always contains the location of their changes. The list of parameters is presented below.

Place of parameter change
PID
Screensaver
User window
Digital inputs
Relay outputs
RS485
Profibus
Ethernet
Wi-Fi
HTTP Server
FTP Server
Modbus TCP
Analog inputs
Analog outputs
Recorder

2.4.1 Counters

The counters implemented in the positioner allow to monitor the working time of the positioner and the valve connected to it.

Fig. 71: Counters selection menu (Menu> Recorder> Counters).

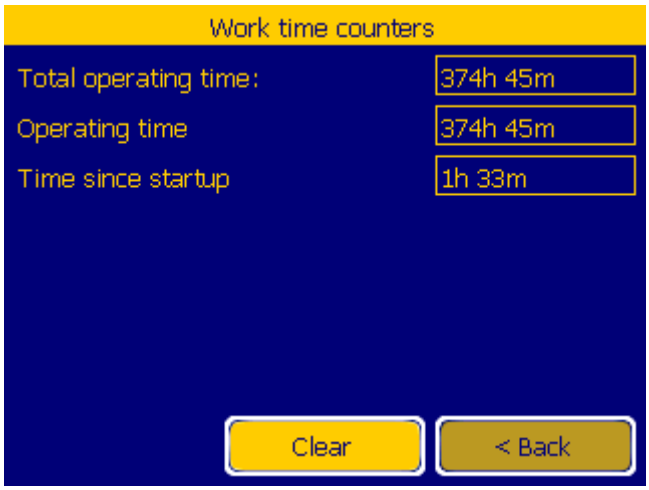


Fig. 72: Work time counters (Menu> Recorder> Counters> Work time counters).

Fig. 72 shows the work time counters window. The menu items show as follows:

"**Total operating time**" - the total time for which the positioner was running.

"**Operating time**" - the cumulative working time of the positioner with the possibility of its deletion. Counter reset is done by pressing the "Delete" button. The counter can be reset, for example, when the positioner is mounted on a new valve.

"**Time since statup**" - uptime of the positioner.

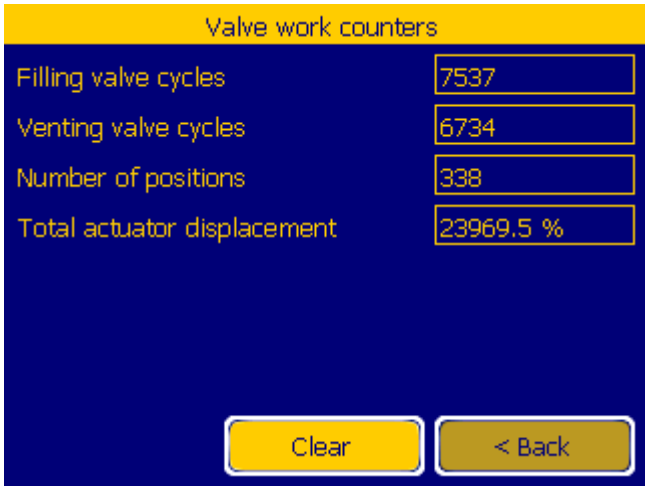


Fig. 73: Valve work counters (Menu> Recorder> Counters>Valves).

The valve work counter menu shown above displays the following information:

"**Filling valve cycles**" and "**Drain valve cycles**" - refer to the cycles performed through the piezo valves built in the positioner. Their lifespan is at least 25 million cycles.

"**Number of positions**" - the value is incremented each time the valve is set in the new position. This option has a configurable hysteresis, which allows for the exclusion of very small changes in position.

"**Total actuator displacement**"- determines the amount of displacement of the valve stem with respect to 100% of the path. This value can indicate the remaining life of the valve. The minimum movement of the valve, which increases this value is configurable.

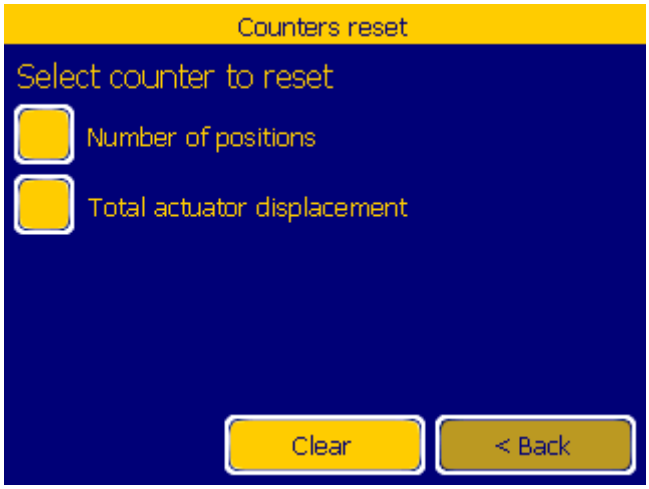


Fig. 74: Resetting valve work counters (Menu> Recorder> Counters>Valves>Delete).

Pressing "Cancel" button in the menu shown in Fig. 71 displays the option for resetting the counters. Possible to delete are only the counters: "**Number of positions**" and "**Total actuator displacement**". After selecting the desired counter pressing the "Delete" button will result in its reset. This option may be used after moving the positioner to another valve.

5.11.3 Valve position

The positioner has a recorder that allows tracking of changes in the valve position. The valve position is saved maximally every 1 second, when the valve changes its position by 0.5%, or when the reference value, which is to be pursued by the valve, changes by 0.5%. If the valve does not move, its position is saved every hour. The recorder has a capacity of 5,000 samples.

After inserting the flash drive and selecting "**Save to USB**" opition, the positioner creates the file "**positions.csv**" containing all stored samples.

Fig.75.Valve position recorder (Menu>Recorder>Valve position)

5.11.4. Analog inputs

The analog inputs recorder allows the user to store the value from the inputs: 0-10V 'Z3 8-5', 4-20mA 'Z3 7-5' and 4-20 'Z3 10-9'. The values are archived when any of the inputs change its reading by a value exceeding the value set in the hysteresis configuration. The recorder has a capacity of 5,000 samples.

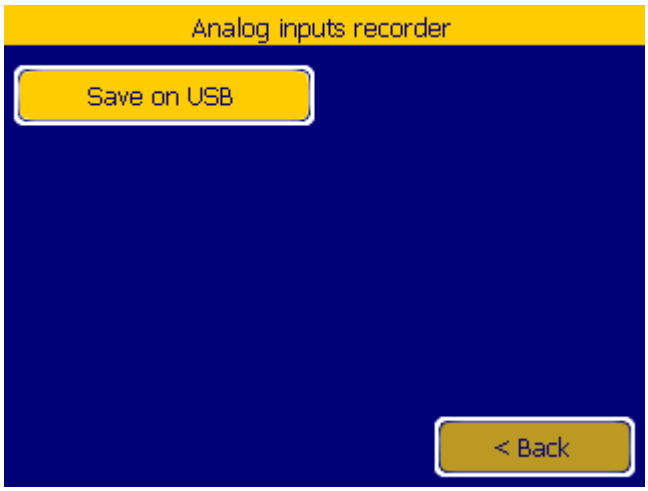


Fig. 76: Analog inputs recorder (Menu> Recorder> Analog inputs).

After inserting the flash drive and selecting "**Save to USB**" opition, the positioner creates the file "a**nalogs.csv**" containing all samples collected from analog inputs.

3. Mounting the positioner on the valve

The section presents an example order of mounting the positioner on the valve. Components used are shown in Fig. 76 and Fig. 75. When assembling the tools shown in Fig. 77 were used.

Fig. 77: From left: stem clamp with retaining screws, lever with spring and screw securing it to the positioner shaft, positioner mounting screws with handles.

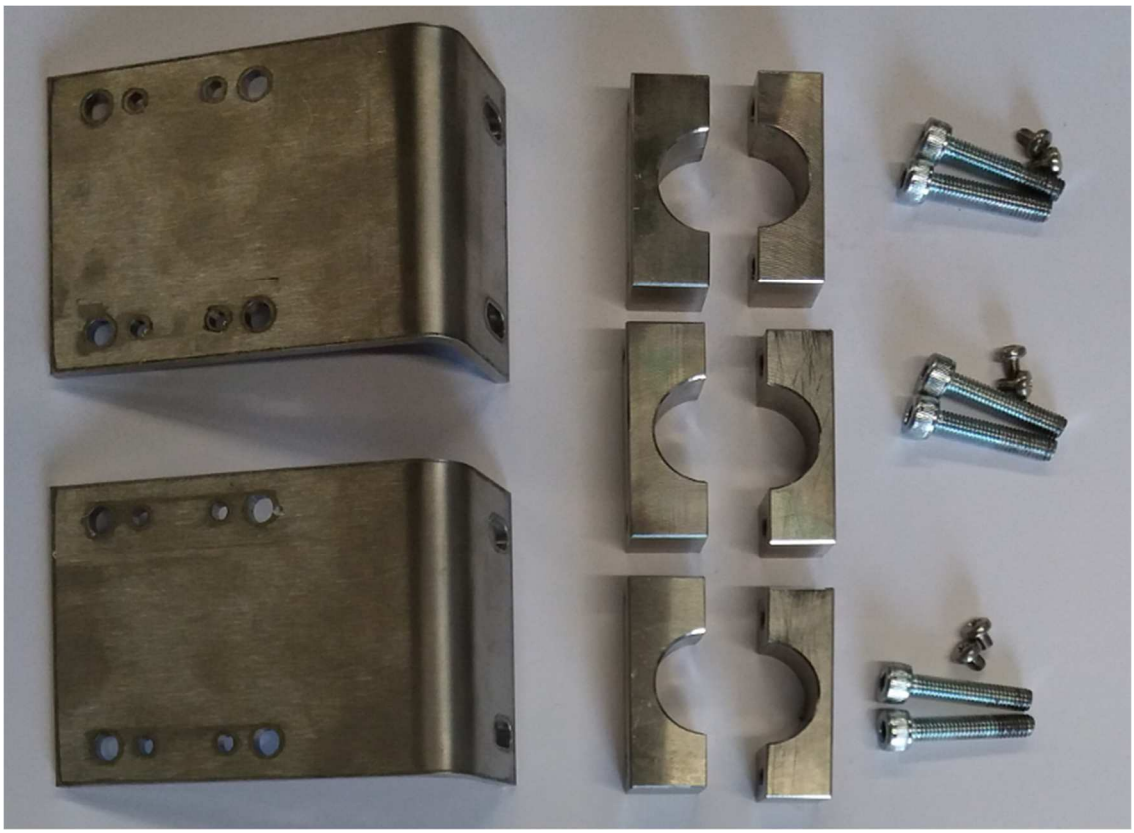


Fig. 78: From left: positioner handles, clamps of valve columns, mounting screws.

Fig. 79: The tools used in the assembly: Phillips screwdriver, bent Allen key M4, and wrench 8.

The assembly can be started with the connection of lever with positioner shaft. This is done using screw M3. Fig. 80 shows the connected elements. The lever will change a linear movement of the valve stem into the rotational movement of the positioner shaft.

Fig. 80: The connection of positioner shaft with lever.

The stem clamp has a thread allowing to screw partially threaded screws M5. After mounting on the positioner stem, this screw will connect with the shaft lever. After screwing, the screw should be slightly above the inner side of the stem clamp. The assembled elements are shown in Fig. 81.

Fig. 81: Clamp of the stem with tightened screw.

The positioner handle and the halves of column clamps can be connected before mounting the valve. This is not required, however, it improves the assembly. Fig. 82 shows a method of joining two elements using a screw M3. The kit includes three sets of column clamps and two positioner handles. They must be connected in such a way that they do not interfere with the movement of the valve, as will be explained later in this section.

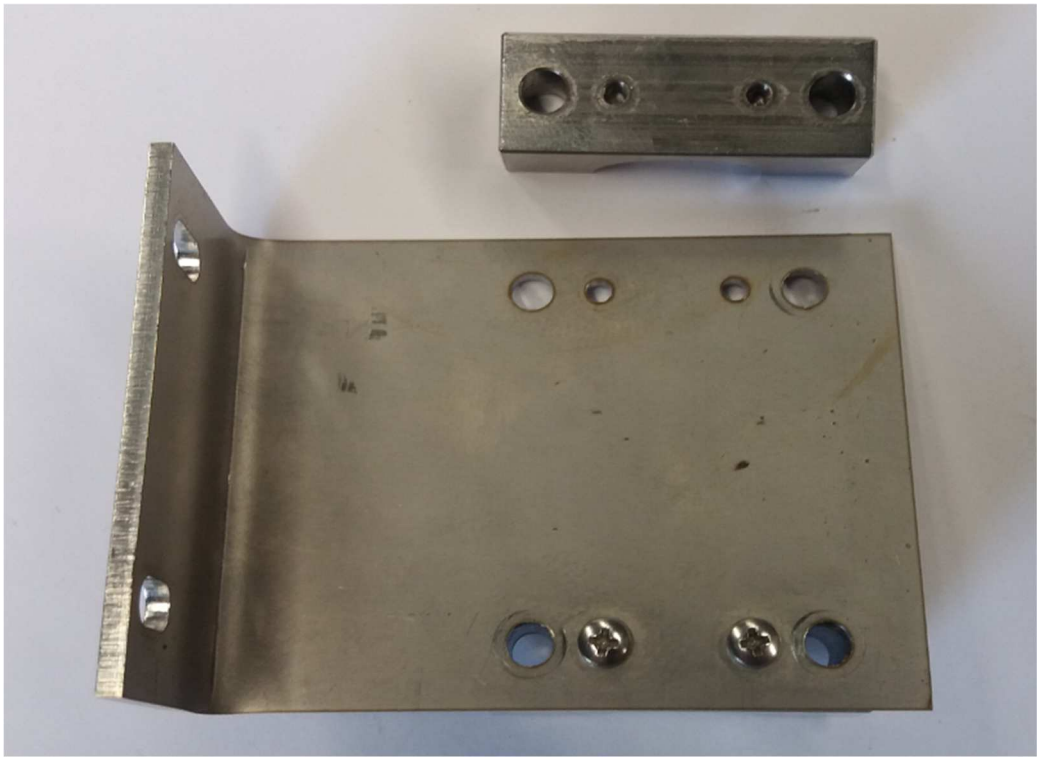


Fig. 82: Positioner handle with half of the clamp and screws M3x5.

Next, the handles of the positioner (Fig. 83) and stem clamp (Fig. 84) are mounted on the valve. The elements should be tightened only slightly to allow their further pushing.

Fig. 83: Mounting valve clamp on the valve columns (elements are not tightened).

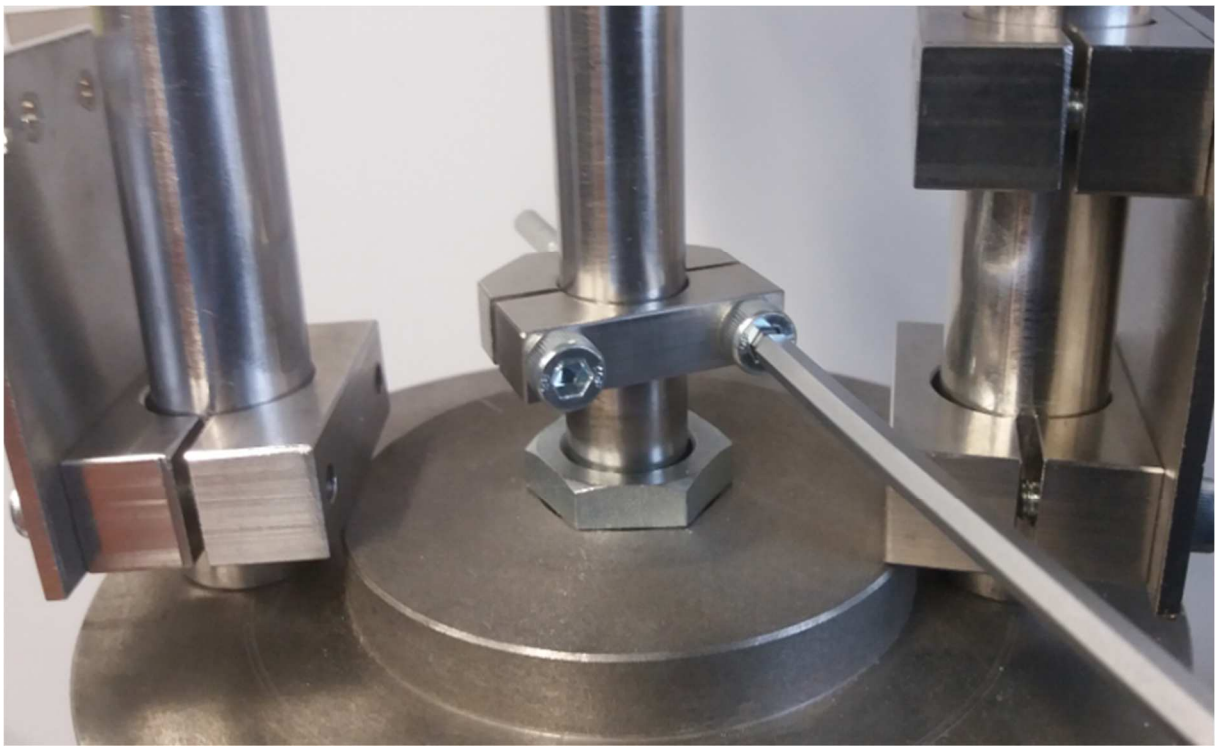


Fig. 84: Mounting valve clamp on the stem (elements are not tightened).

Pay attention not to block the valve movement with elements fastening the positioner. In the case of fastening shown in Fig. 85 the column clamps skip the stem guide.

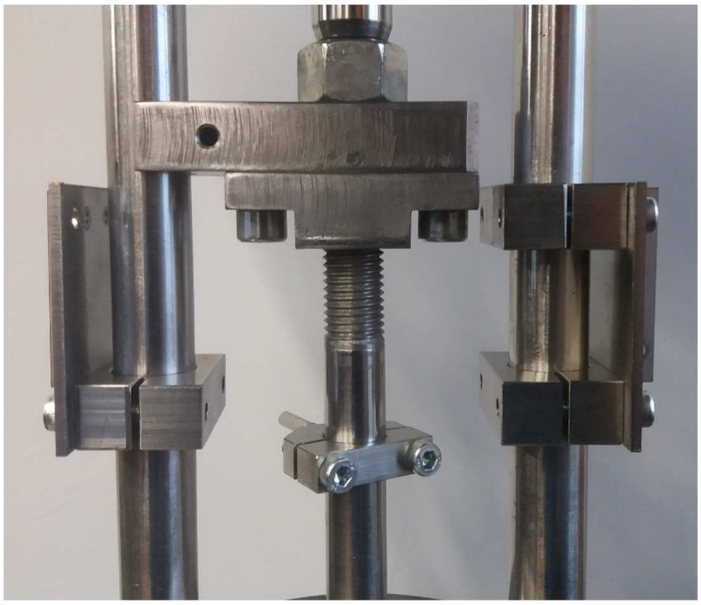


Fig. 85: Mounting elements of the handle on the valve, not blocking the valve stem

Fastening of postitioner to the mounted handles is performed using four M5 bolts and nuts (Fig. 84). If the elements are not tightened too much, the positioner with column clamps can now be lifted to the target position. Simultaneously, the clamp screws should be tightened strongly enough for the positioner not to move from that position (Fig. 85).

Then the positioner can be firmly tightened to its handles. This will determine the position of the column clamps that can now be tightened (Fig. 86).

Fig. 86: Fitting positioner to the handles.

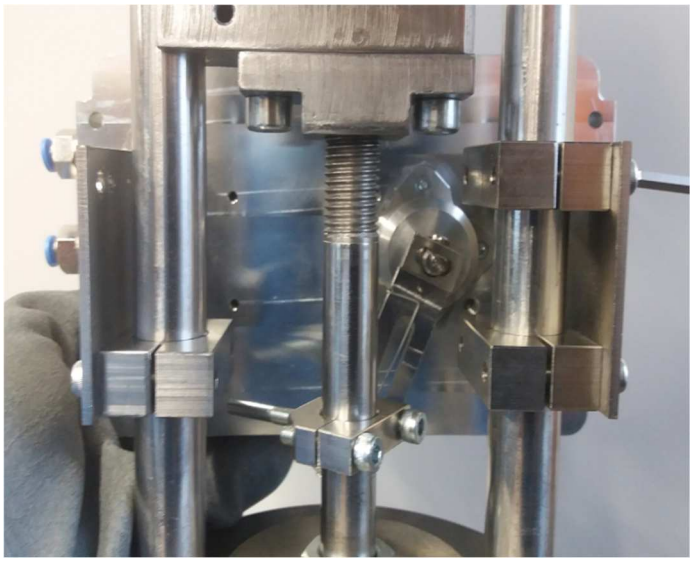


Fig. 87: Placing the positioner and tightening the clamps screws several times.

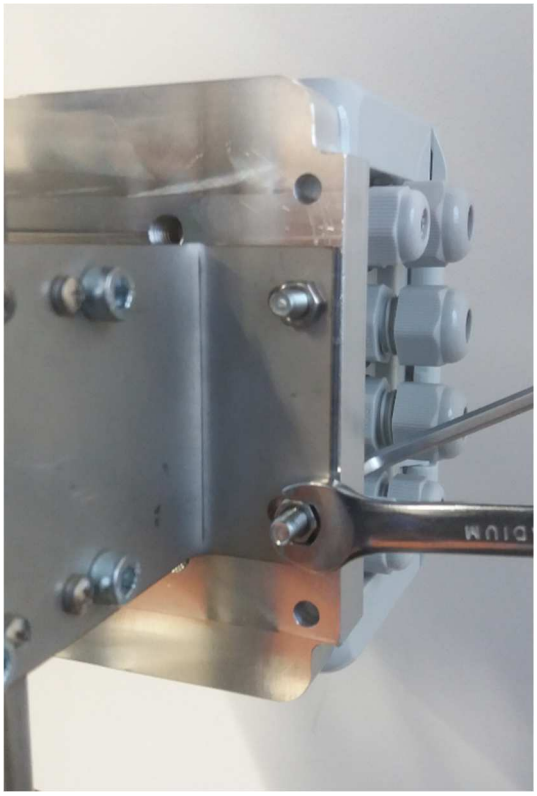


Fig. 88: Tightening positioner to the handles.

The screw screwed into the stem clamp must be placed in the shaft lever in such a way that presses by the spring. By manipulating the location of the clamp and the lever (Fig. 87), the coupling screw may be placed in the recess of the lever (Fig. 88). Next, the position of the clamp should be aligned and then it can be tightened. The level of mounting the clamp should be selected so that the shaft lever is in a horizontal position, when the valve stem has travelled 50% of its path. In the case shown in Fig. 89 the valve is fully open, and when closing the stem will move downwards. Therefore, the clamp was placed above the position of the positioner shaft.

Fig. 89: Placing the coupling screw on the lever.

Fig. 90: Correct insertion of a screw coupling to the spring

Fig. 91: Twisting clamps

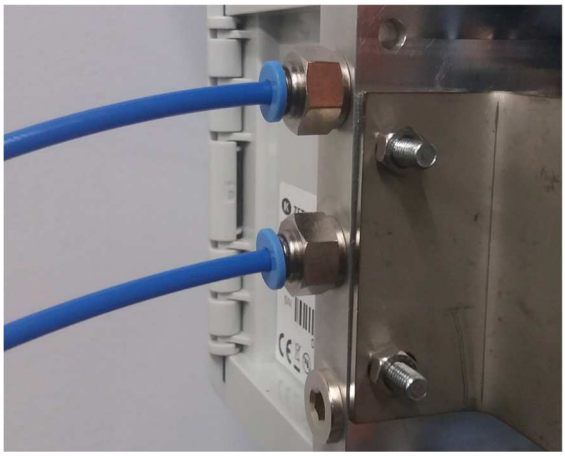


Fig. 92: Connecting the pneumatic valve (bottom) and the conductor of pressure (upper)

7 Examples of configuration

7.1 Valve calibration

After mounting and connecting pressure pipe (Fig. 92), the positioner should be calibrated in order to find the limit positions of the valve stem.

This is done by selecting the '**Calibration**' option from '**Menu> Calibration**' (the button marked in Fig. 93). After selecting this option, the window will appear asking the user to confirm the selection (Fig. 94, then the positioner will start

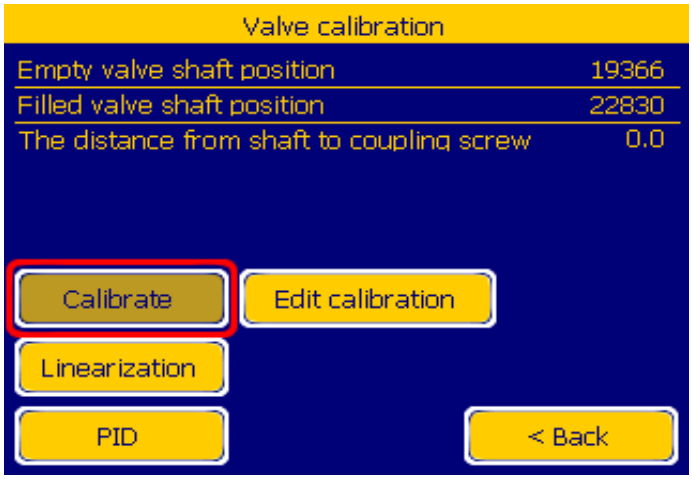


Fig. 93 Valve calibration (Menu>Calibration)

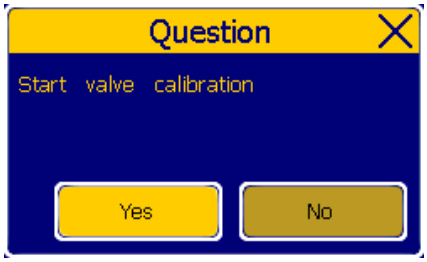


Fig. 94: Valve calibration (Menu> Calibration).

The calibration process can take up to one minute. Its progress will be currently displayed on the screen. The positioner is ready for operation, when the calibration is completed without errors.

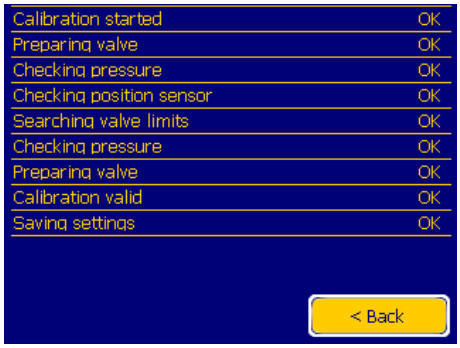


Fig. 95: Screen of properly carried out calibration.

7.2. Control via 4-20 mA loop

The positioner has two inputs of 4-20mA current loop through which it is possible to control the position of the valve. In the following example, the 'Z3 10-9' input will be used.

Fig. 96 shows the connection of wires to the connector Z3 shown on the right side of the photograph. Red positive wire is connected to pin Z3-10 and the black negative to pin Z3-9.

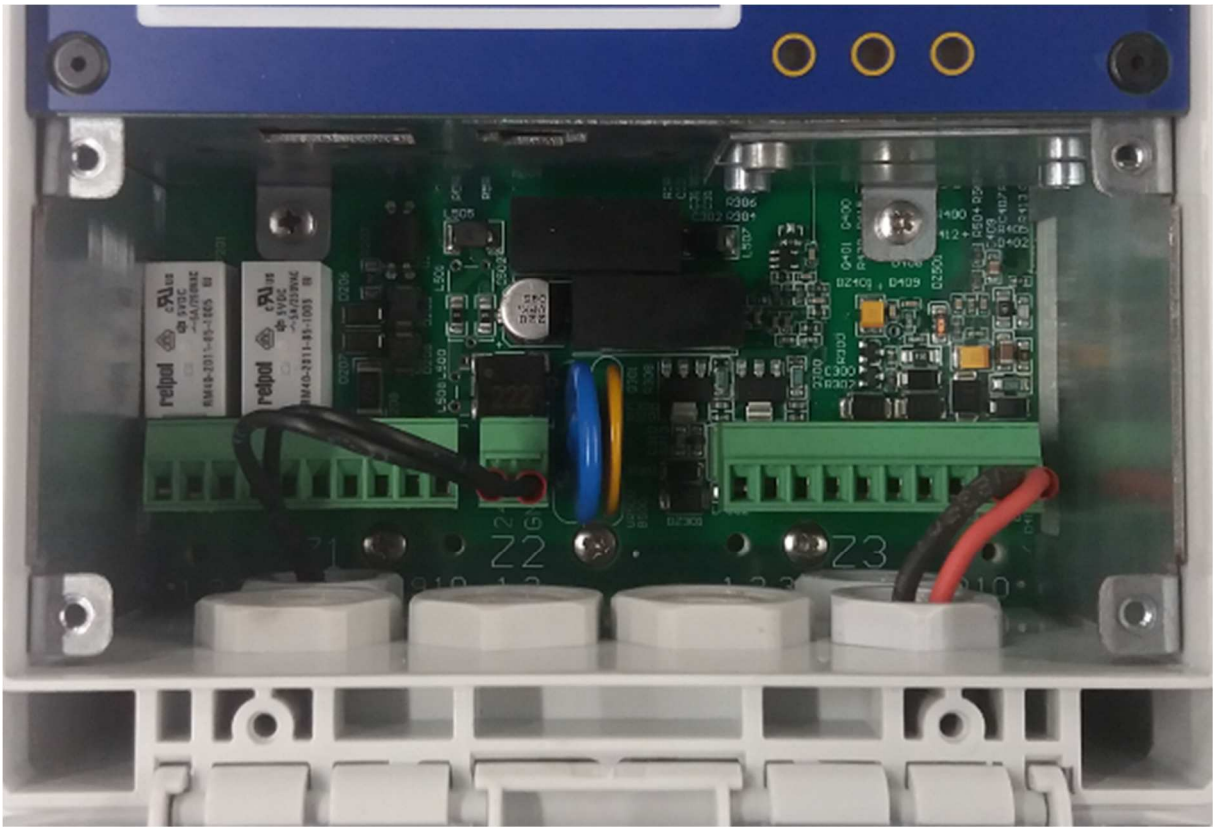


Fig. 96: Cable compartment: 4-20mA loop connection.

Using the menu "**Menu> Control**", select '**Z3 10-9**'as a reference source setting valve position (Fig. 95). After saving the settings, the positioner starts operation via the current loop.

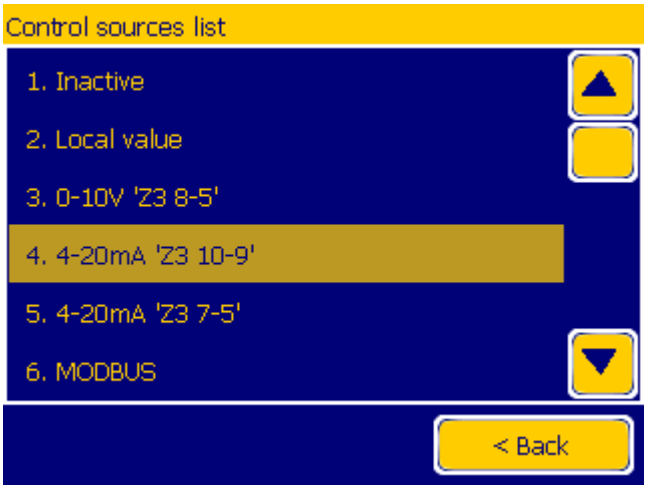


Fig. 97: List of control sources, mode 4-20mA (Menu> Control).

7.3. Control via 0-10V voltage

The position of the valve can also be set via 0-10V input '**Z3 8-5**'. In the following example, it is used to connect an external potentiometer allowing to manually adjust the position of the valve. Fig. 98 shows the connection of signals to the connector Z3 shown on the right side of the photograph. Black wire is connected to ground analog inputs on pin '**Z3-5**'. Blue wire with voltage signal is connected to the input on pin '**Z3-8**'. Red wire is connected to the pin '**Z3-6**' generating a current limited voltage of 12V DC.

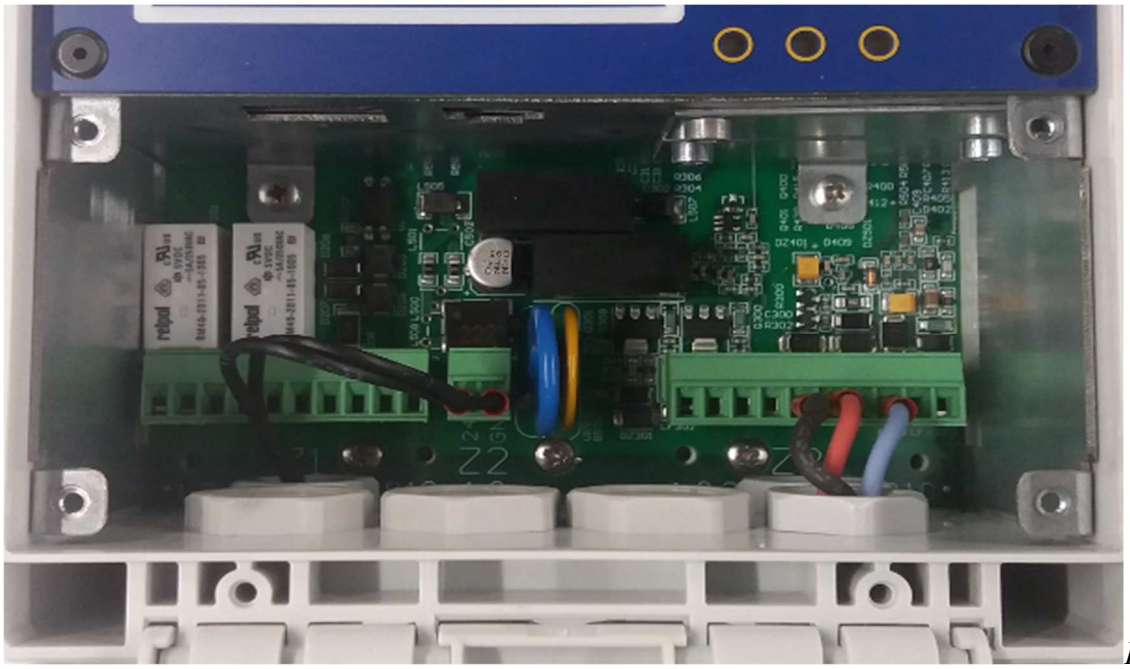


Fig. 98: Cable compartment: external potentiometer connection.

Using the menu "**Menu> Control**", select '**0-10VZ3 8-5**' as a reference source setting valve position (Fig. 97). After

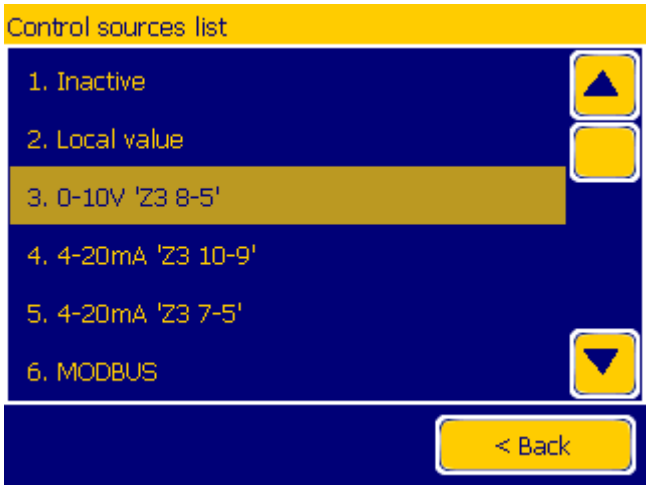


Fig. 99: List of control sources, mode 0-10V (Menu> Control).

saving the settings, the positioner starts operation via the voltage input.

7.4 Control via Modbus TCP

Control of the positioner via MODBU□TCP protocol requires connection of the local network cable to the Ethernet socket. Viewed from the glands, the socket is placed on the left side of the cable compartment. The connection is shown in Fig. 100.

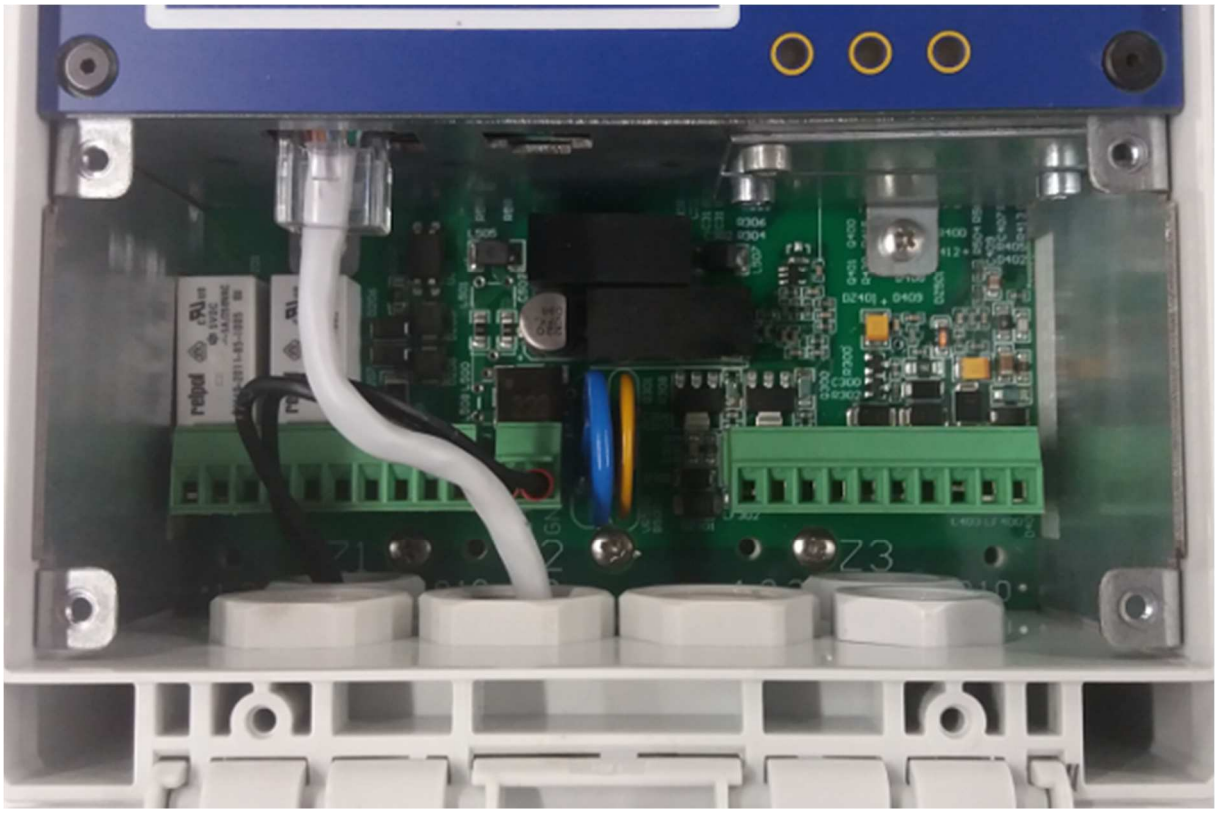


Fig. 100: Cable compartment: connection of the local network.

To run the protocol, the user must select the '**Menu> Configuration> LAN> Modbus TCP**' option, which is shown in Fig.101.

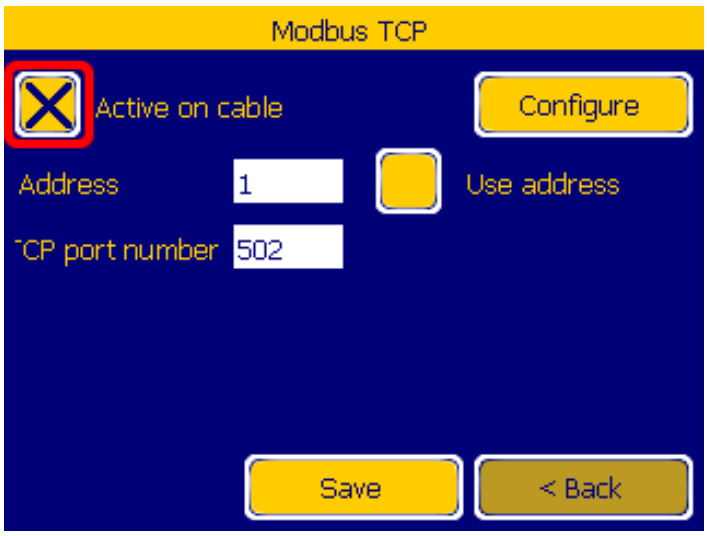


Fig. 101: Modbus TCP activation (Menu> Configuration> LAN> Modbus TCP).

The IP address of the device can be read or modified in **'Menu> Configuration> LAN> Ethernet'.** This field is shown in Fig. 102.

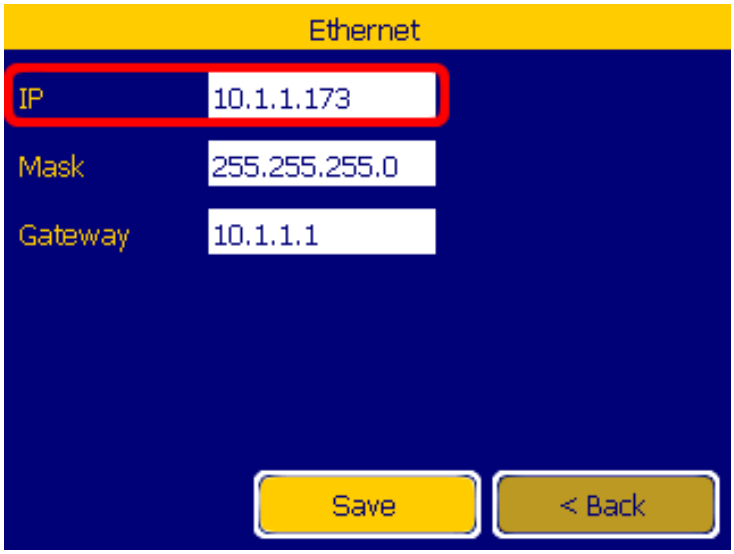


Fig. 102: IP address of the device (Menu>Configuration> LAN> Ethernet).

Using the menu "**Menu> Control**", select **MODBUS**' option as a reference source setting valve position (Fig. 103). After saving the settings, the positioner will start control according to the data received from the protocol.

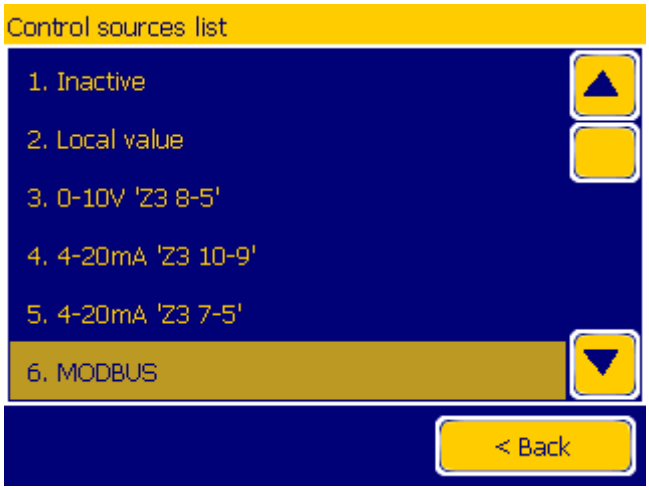


Fig. 103: List of control sources, mode Modbus (Menu> Control).

7.5 Control via Modbus RTU

Control of the positioner using the Modbus RTU protocol requires connection of the R□485 wire with the socket located closer to the centre of the cable compartment. The connection is shown in Fig. 104.

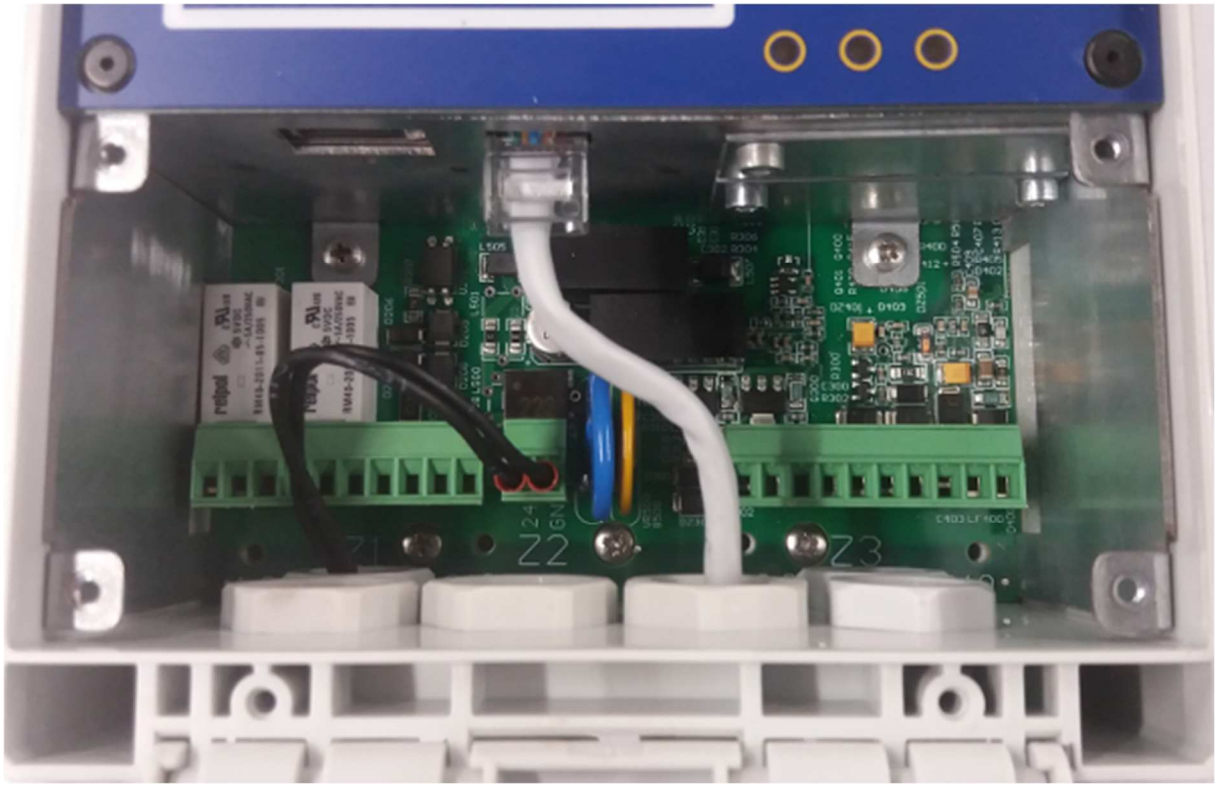


Fig. 104: Cable compartment: connection of the RS485 cord.

Activating the protocol is done from **‘Menu> Configuration> RS485’**. From the drop-down '**Protocol**' menu select '**Modbus**' and then configure the rest of the transmission parameters. The example configuration is shown in Fig. 105. If the protocol has not been activated after saving the settings, the device will require a restart.

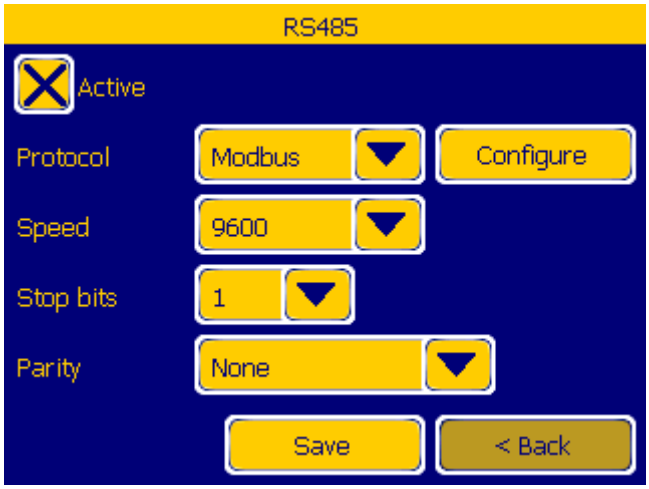


Fig. 105: Activating Modbus RTU protocol (Menu> Configuration> RS485).

Using the menu “**Menu> Control**”, select **MODBUS**’ option as a reference source setting valve position (Fig. 105). After saving the settings, the positioner will start control according to the data received from the protocol.

7.6 Downloading recorders from the FTP server

The built-in FTP server allows the comfortable reading and saving of files from the positioner. It enables to: read recorders, record license or configure reading and saving configurations. In the following example, the event files of the recorder will be read from the positioner.

The positioner must be connected to the local network as shown in Fig.100.

The IP address required to connect to the server is in '**Menu> Configuration>LAN> Ethernet**' (Fig. 102). Password and user login can be read or modified in the '**Menu> Configuration> LAN> FTP Server**'. The default user name is 'root' and the password is 'pzftp'. In the following example, the recorder file was downloaded from the positioner with the program called 'FileZilla'.

Fig. 106 shows the configuration program thet allows for communication with the positioner. After connecting, the main positioner catalogues are visible: ‘**recorder**’ that contains the recorder files and '**system**' that contains configuration files.

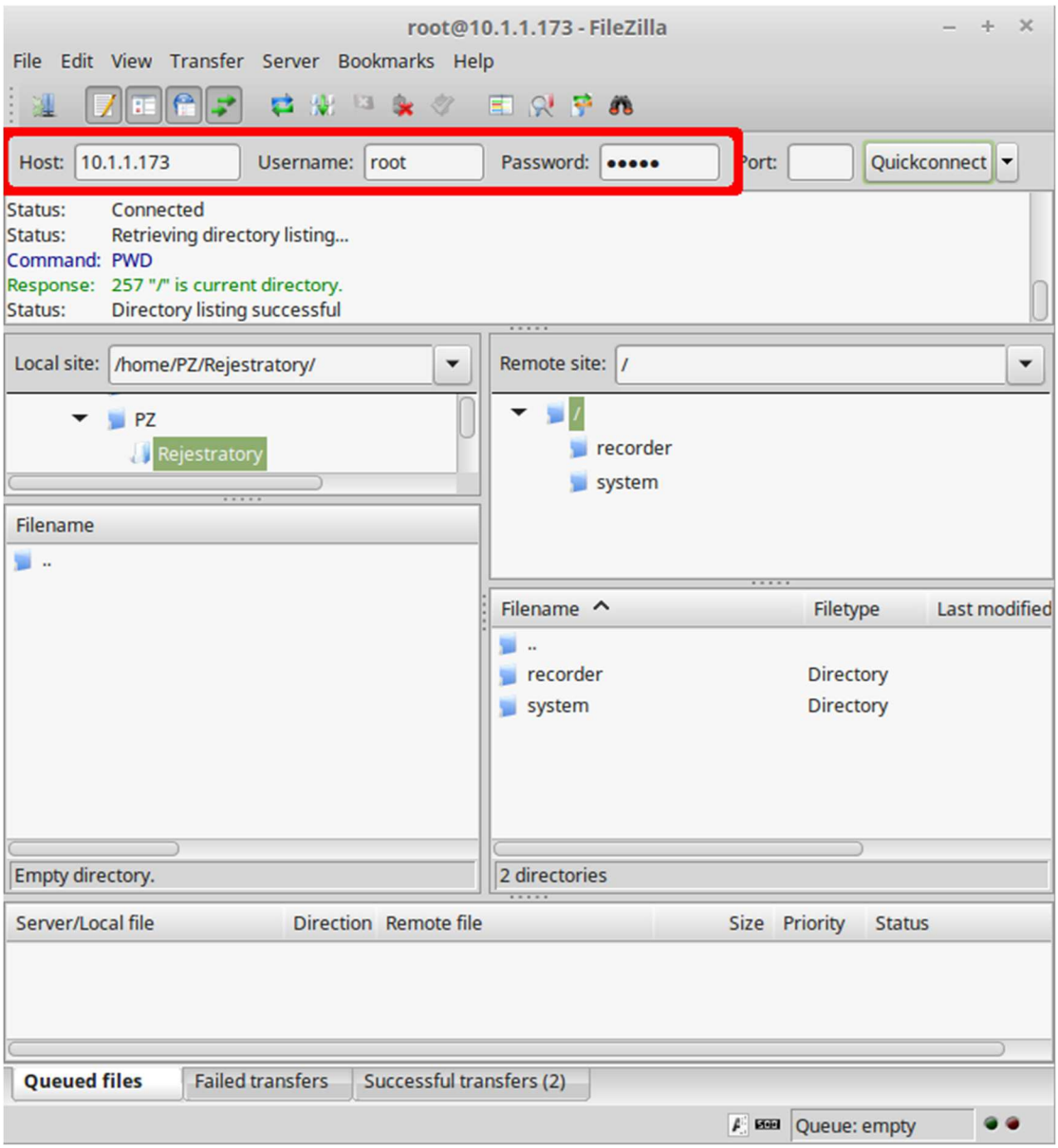


Fig. 106: FTP client window, connection with the positioner.

After entering the 'recorder' catalogue, it is possible to download the recorder event files - '**events.csv**' (Fig. 107). When the positioner is set into English, the file is saved with I□O-8859-2 coding. The downloaded recorder is stored in a format that allows the easy import and read using spreadsheets.

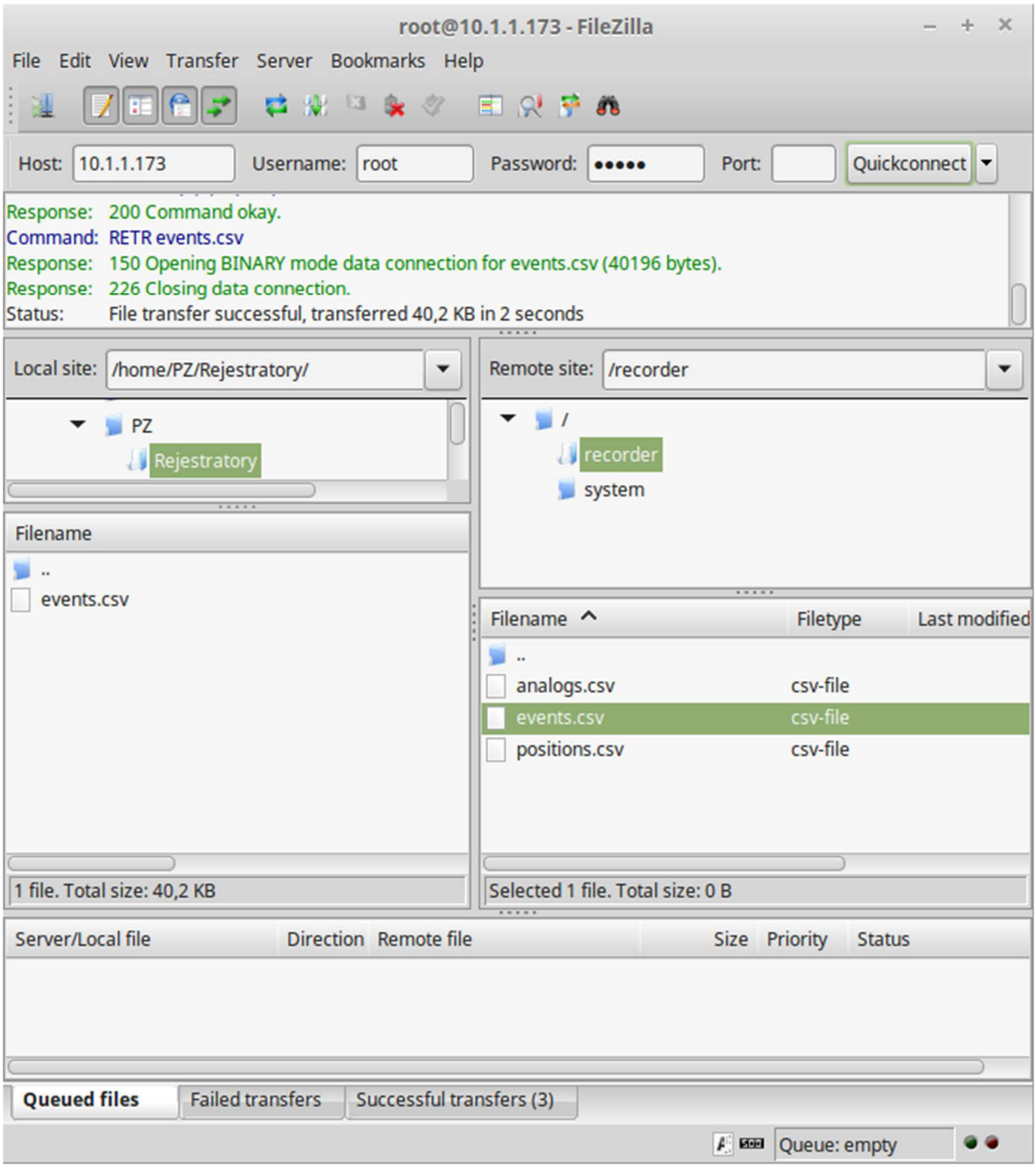


Fig. 107: FTP client window, downloads.

8. Software update

8.1 Bootloader mode.

This function is used to update the device software. The bootloader will run if at boot of the device, the pressing of the following keys is detected: "arrow left" and "right arrow".

To start the device in bootloader mode, the user should therefore:

I. Turn off the power.

II. Press and hold down: "arrow left" and "right arrow".

III. Turn on the power.

Bootloader should start.

If it is hard to disconnect the power of the positioner, it is possible to enter the bootloader mode by manually causing the device to reset. Then the user should:

I. From the main window, go to "**Menu**"> "**System**".

II. Press and hold down: "arrow left" and "right arrow".

III. elect "**Reset device**" option.

After a hardware reset, the bootloader should start.

After starting the bootloader, on the screen the window will appear enabling the user to calibrate the touchscreen (Fig. 106). This option should be used when the touchscreen lost the precision necessary for the smooth navigating through the menus. In order to calibrate the touchscreen, touch the places indicated by the appearing points. If the touchscreen did not create any problems, you can skip this step. To do this, wait a few seconds without touching the screen.

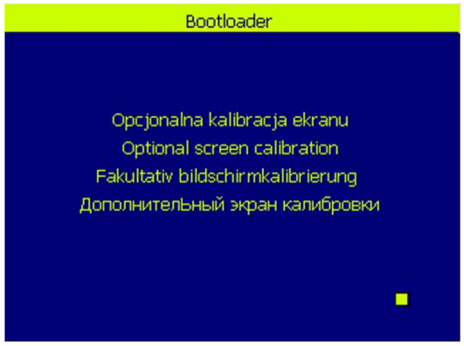


Fig. 108: Touch screen calibration window

When you close the calibration window, the bootloader will display the main menu screen (Fig. 109). It contains options allowing installation and commissioning the installed program. In addition, the buttons located in the lower part of the program allow the user to change the language.

Fig. 109: Main bootloader window.

8.2 Software update with USB memory

In order to update the device software, the user should:

I. Prepare a U□B memory formatted in the FAT32 file program located in the root directory.

II. Enter the device into bootloader mode.

III. Install previously prepared U□B memory.

IV. From the main bootloader menu select "Install from U□B".

V. The screen will display a list of available files found in the root directory of a U□B memory (Fig. 110). □elect the appropriate program.

VI. Confirm that you want to install the application in the newly opened window.

After several seconds, the selected program will be installed. You can now press the "□TART" button to exit the bootloader and start it.

Fig. 110: The list of files read from USB memory.

9. Operation

9.1 General remarks

Attention

Exceeding the permissible limits of signals can result in equipment damage.

Before connecting the power supply, check whether it fulfils the conditions set out in section 3, *Technical data* of this study.

Before connecting signals to the terminals, check whether they meet the levels of voltages and currents set out in section 3, *Technical data* of this study.

Before connecting circuits, digital inputs and outputs, check whether the signal values the levels set out in section 3, *Technical data* of this study.

3.1 *Battery replacement*

One of the consumables of the valve positioner PZ5000 are 3V lithium batteries CR2032. Battery replacement is performed only by the manufacturer's service.

Attention

Improper battery insertion creates the risk of fire. Hold the battery as indicated.

3.2 *Installation of the valve positioner PZ5000*

The valve positioner PZ5000 is adapted for mounting on control valves.

The compressed air in the system should be dry and of adequate quality; it is of particular importance in the case of operation in freezing temperatures.

Attention

The compressed air in the system should be dry and of adequate quality.

The maximum cross section of conductors used to connect external circuits is defined in section 3, *Technical data* of this study.
All ports and device resources can be fully utilized during normal operation of the controller.
The device requires no additional forced ventilation.

3.3 *Commissioning and maintenance of the device*

Before starting the unit, make sure of:

- proper compressed air quality in the system,
- proper connection of the signals to the respective terminals,
- proper supply voltage.

Any connection operations should be made with power supply disconnected.

Replacement of consumable items, e.g. battery is to be performed by the manufacturer's service.

Overview of the device involves cleaning it from dust and examination. Pay attention to any mechanical damage, raids or infiltrations. The user should also check the reliability of electrical connections.

9.5 Operation of the valve positioner PZ5000

It is the user’s responsibility to read and comply with all requirements of the manufacturer as to the proper application and use of the valve positioner type PZ5000, in accordance with its intended purpose. In the case of non-compliance with the recommendations of the manufacturer for use, installation or operation - the device functions cannot be carried out properly, and the full responsibility for this situation lies with the user.

Any connection operations should be made with power supply disconnected.

The valve positioner PZ5000 is equipped with elements ensuring full interaction with the user. Ease of use is provided by elements placed at the front of the device:

- colour touch 3.5” TFT display with a resolution of 320 × 240 (version II),
- alphanumeric display 2x12 (version I)
- 4 directional buttons,
- green accept button,
- red negation button (exit),
- 3 LEDs.

10. Packing, storage and transport guideline

Documentation and software for the device is delivered to the recipient without the packaging.

10.1 Packing

Packing should take place indoors, where the air temperature is not lower than 288K (+15°C), relative humidity less than 85%, and the degree of aggressiveness of the atmosphere reaching maximum a value of B PN-71/H-04651.

The packaging should contain a permanent and legible appropriate markings in accordance with drawings of packing method.

10.2 Storage

The device should be stored in unit packagings, in roofed areas free of vapours and reactive substances, with air temperature in the range from -20°C to 70°C and relative humidity not exceeding 80%. Packagings with devices should be stored in no more than two layers.

The storage time should not exceed one year.

10.3 Transport

Transport of the device should be carried in individual packages, with protection against moving during transport. On the transport packaging there should be additionally a note with the address of the recipient.

Means of transport must ensure the elimination of direct atmospheric effects.