# TX01-RS

**Tachometer**

⊚ EAC

User guide

# Contents

# Warning notice system

Explanation of the symbols and keywords used:

**DANGER**
DANGER indicates an **imminent dangerous situation** that will result in death or serious injuries if not prevented.

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

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

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

# Introduction

This document provides detailed information about the operation principle, design, configuration, installation and maintenance of the tachometer TX01-RS, hereinafter referred to as the Device.

Connection, setup and maintenance should be made only by qualified specialists after reading this manual.

The device is produced in various modifications, that are encrypted in code of full conventional designation.

**TX01-X.X.XP-RS**

| Power supply |
| Version |
| Analog output |
| Digital output:<br>**P** – electromagnetic relay |
| Communication interface:<br>**RS** – RS-485 interface |
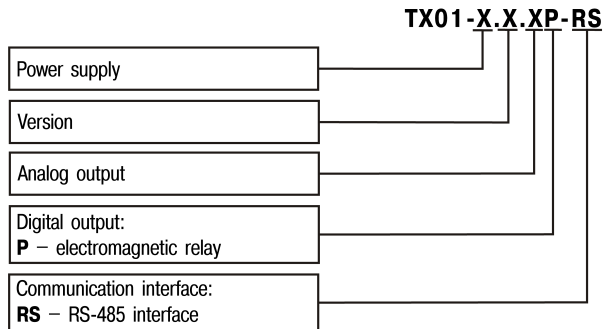
**Power supply:**

**224** – 90…264 V AC or 20…34 V;

**24** – 10,5...30 V DC.

**Construction type:**

    **H** – wall-mounting housing;

    **Щ2** – panel-mounting housing.

**Analog output:**

    **И** – DAC «parameter-4…20 mA»;

    **У** – DAC «parameter-0…10 V»;

    *not specified* – without analog output

Example of ordering key: **TX01-224.H.ИР-RS**. The device in case H is to be delivered, with a power supply of 224 V, an analog output of type И, a discrete output of type P and an RS-485 interface.

# Abbreviation

    **DAC** – digital-to-analog converter.

    **PC** – personal computer.

# Characters on display

| A | b | C | d | E | F | G | H | i | J | K | L | M | n | O | P | Q | r | S | t | U | V | W | X | Y | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

# 1 Purpose and functions

The device is designed for:

- measuring and automatically controlling the speed of shafts and parts of mechanisms, as well as other physical values, that can be converted into a value inversely proportional to the duration of the interval between the edges of the pulses coming from the primary transducer (sensor);
- measuring the operating time of the connected equipment or other quantities that can be converted into the duration of the interval during which a control signal is supplied to the input of the device;
- control of external equipment in accordance with the customizable logic of the device (if there is an output).

Device is used in control and regulation systems when performing various technological processes in industry, agriculture and other sectors of the national economy, in particular for the automation of diesel systems.

# 2 Specification

## 2.1 Technical data

The main technical data of the device are presented in *Table 2.1*.

**Table 2.1 – Device features**

| Description | | | Value |
|---|---|---|---|
| **Power supply** | | | |
| Power supply | from AC mains | TX01-224.X.XP-RS | 90 … 264 V AC, 47 … 63 Hz (nominal values: 110 V, 220 V or 240 V) |
| | from DC mains | TX01-224.X.XP-RS | 20 … 34 V DC (nominal value: 24 V) |
| | | TX01-24.X.XP-RS | 10.5 … 30 V DC (nominal values: 12 V, 24 V) |
| Power consumption, max. | TX01-24.X.XP-RS | | 8 W |
| | TX01-224.X.XP-RS | | 10 VA |
| Baud rate for RS-485 | | | 2400; 4800; 9600; 14400; 19200; 28800; 38800; 57600; 115200 bit/s |
| **Inputs** | | | |
| Number of inputs | | | 2 |
| Maximum input current | | | 10 mA |
| Voltage of Logical 1 | | | from 12 to 30 V |
| Voltage of Logical 0 | | | from 0 to 4 V |
| Current of Logical 1, min. | | | 3 mA |
| Current of Logical 0, max. | | | 1.5 mA |
| Maximum input voltage | | | 30 V |
| Pulse duration at counting input, min. | | | 10 µs |

**Table 2.1 (continued)**

| Description | Value |
|---|---|
| Duration of the signal at operating time counter, min. | 300 ms |
| Maximum pulse repetition rate at pulse counter, min. | 2500 Hz |
| Minimum pulse repetition rate at pulse counter, min. | 0.2 Hz |
| Filtering the input signal by the duration of the pulses (pauses) | 10…999999 µs |
| **Internal power supply** | |
| Nominal DC voltage | 24 V DC |
| Maximum output current | 50 mA |
| Instability of output supply voltage, max. | 12 % |
| Pulsation level, max. | 100 mV |
| **Outputs** | |
| *Electromagnetic relay (R)* | |
| Maximum load current (at 220 V, 50 Hz and cos φ > 0.4) | 8 A |
| Maximum DC load voltage | 30 V |
| *Analog output of type И* | |
| Output signal | from 4 to 20 mA |
| Load resistance | from 0 to 1300 Ω |
| DAC supply voltage | from 10 to 30 V |
| Accuracy, max. | 0.5 % |
| *Analog output of type У* | |
| Output signal | from 0 to 10 V |
| Load resistance, min. | 2 kΩ |

**Table 2.1 (continued)**

| Description | | Value |
|---|---|---|
| DAC supply voltage | | from 10 to 30 V |
| Accuracy, max. | | 0.5 % |
| **Housing** | | |
| Dimensions | wall-mounted (Н) | 105 × 130 × 65 mm |
| | panel-mounted (Щ2) | 96 × 48 × 100 mm |
| IP code | wall-mounted (Н) | IP44 |
| | panel-mounted (Щ2) | IP54 (front panel) |
| **Device features** | | |
| Speed value, **n** | rps | **n = f** |
| | rpm | **n = 60·f** |
| | rph | **n = 3,600·f** |
| | custom units (**USER** mode) | **n = F·10 -FdP** |
| Input frequency, **f** | | 0.2 … 2500 Hz |
| Multiplier, **F** | | from 0.0001 to 999 |
| Measurement ranges of time intervals | | from 0 s to 99 h 59 min 59 s<br>from 100 h 00 min to 9999 h 59 min<br>from 10000 h to 9999 days 23 h |
| Accuracy in «Tachometer» mode (rps, rpm, prh, specified units) | | $\Delta n = \pm\left(5 \times 10^{-3} n_{meas} + C\right)$<br><br>where **n_meas** is the measured value in the selected display dimension (rps, rpm, rph, **USER** mode); |

**Table 2.1 (continued)**

| Description | Value |
|---|---|
| | **C** is the unit of the smallest digit of display taking into account the position of the decimal point (rps, rpm, rph)<br>Depending on the position of the decimal point, **C** is:<br>• 1 (at **dP** = 0);<br>• 0.1 (at **dP** = 1);<br>• 0.01 (at **dP** = 2);<br>• 0.001 (at **dP** = 3);<br>• 0.0001 (at **dP** = 4) |
| The limit of permissible absolute error of measurement of time intervals (s, min, h) | $$\Delta\tau = \pm\left(5 \times 10^{-3}\tau_{meas} + C\right)$$<br>where $\tau_{meas}$ is the duration of the time interval measured by the device (s);<br>**C** is the unit of the least discharge of the measuring range.<br>Depending on the measuring range, **C** is equal to:<br>• 1 s (for range from 0 s to 99 h 59 min 59 s);<br>• 1 min (for the range from 100 h 00 min to 9999 h 59 min);<br>• 1 h (for the range from 10000 h 00 min to 9999 days 23 h) |
| Weight, max. | 0.5 kg |
| Average service life | 12 years |
| Mean time between failures | 75000 h |

By operational completeness, the device belongs to second-order products.

Isolation of live circuits of the device meets the requirements of GOST R 52931.

The electrical insulation resistance of the current-carrying circuits of the device among themselves in accordance with GOST R 52931 is as follows:

- 20 MΩ (under normal environmental conditions);
- 5 MΩ (at the upper temperature value of the operating conditions);
- 1 MΩ (at the upper value of the relative humidity of the operating conditions).

## 2.2 Operating conditions

The device is designed for operation in the following conditions:

- closed explosion-proof rooms without aggressive vapors and gases;
- ambient temperature: from -20 to +70 °C;
- relative humidity: max. 95 % (at ≤ 35 °C, non-condensing);
- atmospheric pressure: from 84 to 106.7 kPa.

In terms of resistance to mechanical influences during operation the device corresponds to group of performance N2 in GOST R 52931.

In terms of resistance to electromagnetic influences (interference resistant), the device corresponds to class A equipment according to GOST 51522.

By the level of radiation of radio interference (interference emissions), the device corresponds to class B equipment according to GOST 30804.6.4.

**NOTICE**
Requirements in terms of external influencing factors are mandatory as related to safety requirements.

# 3  Safety

⚠️ **CAUTION**
There is a life-threatening voltage of up to 250 V on the terminal block of TX01-224.X.XP-RS. Any connections to the device and maintenance work should be carried out only when the device power is turned off.

By the method of protection from electric shock the device corresponds to class II according to GOST12.2.007.0-75.

While operating, maintaining and checking, it is necessary to comply with GOST 12.3.019-80, Rules of technical operation of electric installations of consumers and Safety code for operation of electric installations of consumers.

Do not allow moisture to contact the output connector and the internal electrical elements of the device.

It is forbidden to use the device in corrosive environments containing in the atmosphere of acids, alkalis, oils, etc.

# 4 Installation

## 4.1 Installation of device in housing H

To connect Device:

1.  Fasten the bracket with three M4 × 20 screws on the surface intended for mounting the Device (see *Figure 4.2*).

    🛇 **NOTICE**
    Bracket mounting screws are not included.

2.  Hook the fixing bracket from the back panel of device to the upper edge of the wall bracket.
3.  Attach device to the bracket with the supplied screw.

Demount the device in the reverse order.

🛇 **NOTICE**
Remove the cover before wiring. Fasten the base of the device to the bracket with a supplied screw.
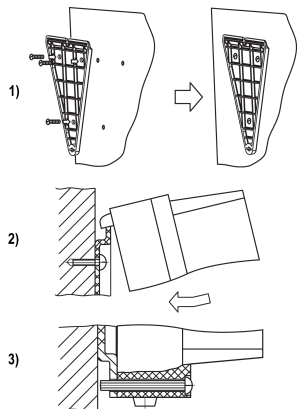


**Figure 4.1 – Installation of wall-mounting device**
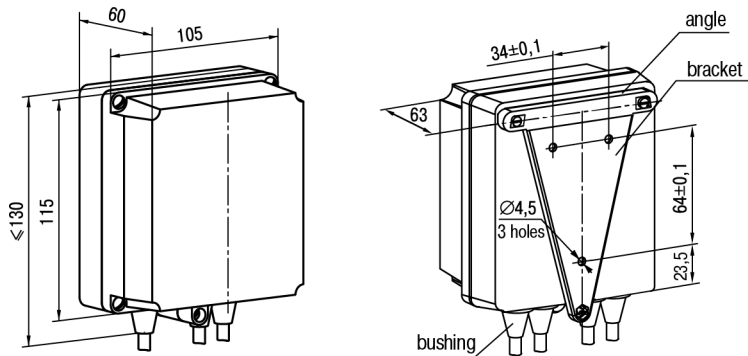
**Figure 4.2 – Dimensions of H housing**

**NOTICE**

The bushings need to be cut in accordance with the diameter of the lead-in cable.

## 4.2 Installation panel-mounting device in Щ2 housing

To connect Device:

1. Prepare a place for mounting on the control panel (see *Figure 4.4*).
2. Install the gasket on the frame of the device to ensure degree of protection IP54.
3. Insert the device into a specially prepared hole on the front of the control panel.
4. Insert the supplied retainers into holes on the sides of the device.
5. Tighten supplied screws M4 x 35 in the holes of each retainer so that the device is firmly pressed to the front of the control panel.

Demount the device in reverse order.
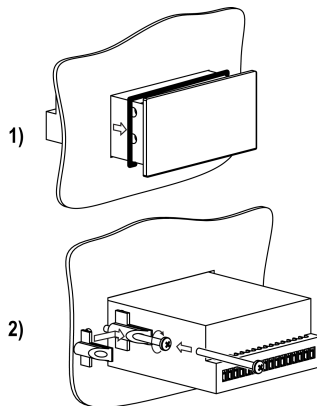


**Figure 4.3 – Installation of panel-mounting device**
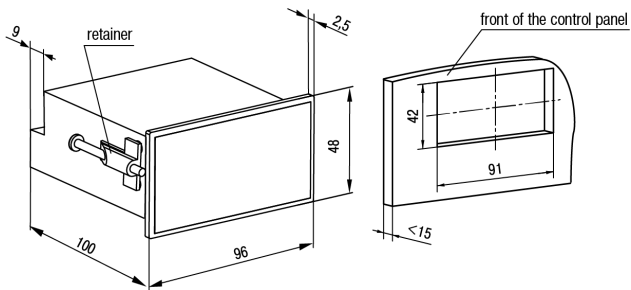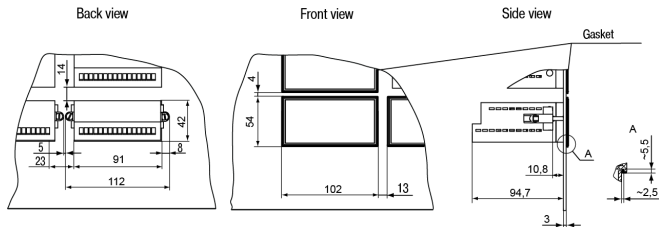
**Figure 4.4 – Dimensions of Щ2 housing**



**Figure 4.5 – The device in Щ2 housing mounted in the control panel thickness of 3 mm**

# 5 Connection

## 5.1 Wiring recommendations

To ensure the reliability of electrical connections it is recommended to use copper stranded cables, the ends of which should be carefully cleaned and tinned. Otherwise use cable lugs before connection. Cable conductors should be stripped so that their bare ends do not protrude beyond the terminal strip after connecting to the device. The cable cross section must be not more than 1 mm$^2$.

General requirements for connection lines:

- During the cabling, communication lines that connect the Device with sensors must be isolated to a separate circuit (or several circuits) and placed separately from power cables or other sources of high-frequency and impulse interferences;
- To protect the Device inputs from the effects of industrial electromagnetic interference, the communication lines between Device and sensors should be shielded. Special cables with shielding or grounded steel pipes of suitable diameter can be used. The cable shielding should be connected to the functional ground terminal (FE) in the control panel;
- Network interference filters should be installed in the power supply lines;
- Spark-fighting filters should be installed in the switching lines of power equipment.

When installing the system in which the Device operates, you should follow the rules for effective grounding:

- all grounding lines must be laid in Y-connected circuit, ensuring good contact with the grounding element;
- all earthing circuits must be made with wires of the largest possible cross-section;
- it is forbidden to connect the device terminal "Common" with grounding lines.

## 5.2 Getting Started

⚠️ **DANGER**
After unpacking the device, make sure that the device has not been damaged during transportation.

If the device was kept for a long time at a temperature below minus 20 °C, then before turning it on and starting work, it should be kept in a room with a temperature corresponding to the operating range for 30 minutes.

To connect the device:

1. Connect the Device to a power source.

⚠️ **CAUTION**
Before applying power to the Device, check that the supply voltage and its level are correct.

2. Connect primary transducers to the device inputs.
3. Apply power to the device.
4. Set up the device.
5. Make a test run of the device algorithm to verify that the settings are correct.
6. Power off the device.
7. Connect operating mechanisms to the device outputs.

## 5.3 Terminal block contacts assignments

Screw terminals are located on the back wall (panel-mounting) or inside the device (wall-mounting). The terminal block contacts assignment is shown in *Figure 5.1*.
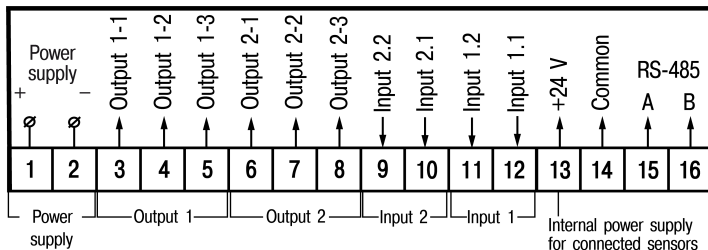


**Figure 5.1 – Terminal block contacts assignments**

## 5.4 Connection of switching devices and sensors

**CAUTION**
Do not apply voltage to the device inputs (pins 9 – 12 of the terminal block) that is outside the range from 0 to 24 V.

**NOTICE**
Pin 13 is an internal power supply, required for connecting of switching devices and sensors.
If the power consumption of the input devices exceeds the load capacity of the internal power source (24 V), an external source with an output voltage of 12 to 34 V (recommended 24 V) is required.

Scheme for connection of the switching devices to the inputs is shown in *Figure 5.2*.
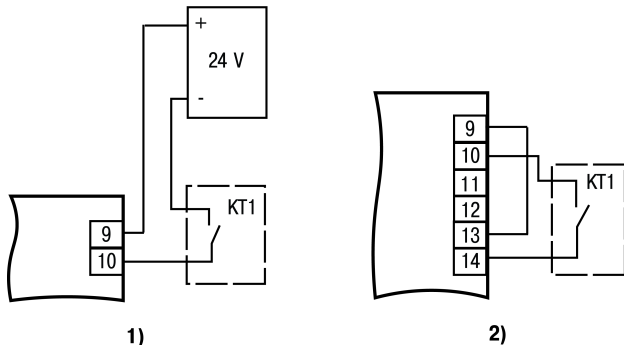


**Figure 5.2 – Connecting switching devices: 1) when the device is operating from an external power source; 2) when the device is operating from an internal power source**

The connection diagrams of passive sensors with an *n-p-n*-type transistor with an open collector output are shown in *Figure 5.3*.
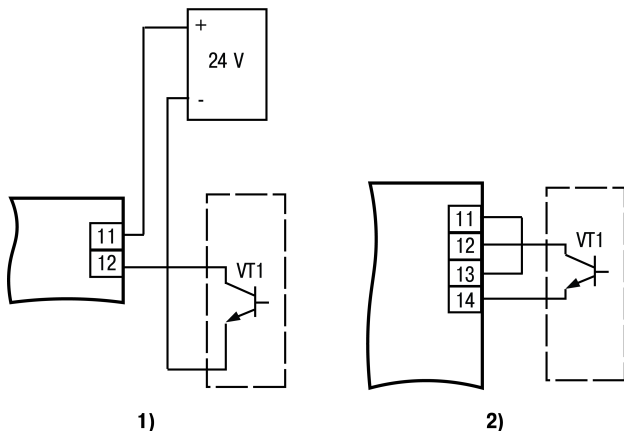
**Figure 5.3 – Connection of passive sensors with n-p-n-output: 1) when the sensor is operating from an external power source; 2) when the sensor is operating from an internal power source**

## 5.5 Connecting load to the outputs

The device may not have outputs, have one analog or digital output or two outputs, one of which is analog, and the second is digital.

 **CAUTION**
The outputs are galvanically isolated from the circuit of the device.

It is possible to use an internal 24 V power supply to power the output, which is used to power active sensors.

### 5.5.1 Analog outputs

The analog output can operate as a DAC in two modes: "parameter-current" (И) or "parameter-voltage" (У).

For normal operation of devices with an analog output of type И, the DAC must be powered from an independent DC source that provides galvanic isolation of the device's electrical circuit and "connected mechanisms". The voltage of the power source is calculated by the formulas:

$$U_{PSmin} \leq U_{PS} \leq U_{PSmax}$$

$$U_{PSmin} = 7.5 + I_{DACmax} \times R_{load}$$

$$U_{PSmax} = U_{PSmin} + 2.5$$

where **U$_{PS}$** is voltage of the power source, V;

**U$_{PS\ min}$** is the minimum allowable voltage of the power source, V;

**U$_{PS\ max}$** is the maximum allowable voltage of the power source, V;

**I$_{DAC\ max}$** is the maximum allowable current of DAC, mA;

**R$_{load}$** is load resistance of DAC, kΩ.

⚠️ **CAUTION**
The **U_SP** value must be included in the allowable range of the supply voltage (from 10 to 36 V).

If for any reason the voltage of the DAC power supply exceeds the calculated value **U_SP max**, then the limiting resistor should be connected in series with the load, the resistance of which is calculated by the formulas:

$$R_{limitmin} < R_{limitnominal} < R_{limitmax}$$

$$R_{limitmin} = \frac{U_{PS} - U_{PSmax}}{I_{DACmax}}$$

$$R_{limitmax} = \frac{U_{PS} - U_{PSmin}}{I_{DACmax}}$$

where **R_limit nominal** is nominal value of the limiting resistor, kΩ;

**R_limit min** is minimum permissible value of the limiting resistor, kΩ;

**R_limit max** is maximum permissible value of the limiting resistor, kΩ;

**I_DAC max** is the maximum allowable current of DAC, mA;

**U_PS** is voltage of the source used to power the DAC, V.

An example of the connection to the output of type И with a power source and load is presented in *Figure 5.4*.
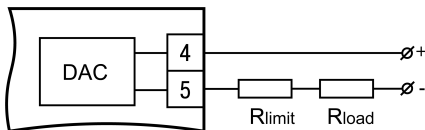
**Figure 5.4 – Wiring of output of type И**

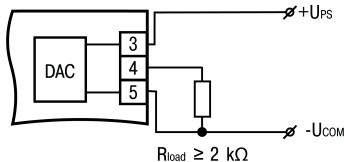An example of connection to the output of type У is shown in *Figure 5.5*.



**Figure 5.5 – Wiring of output of type У**

⚠ **CAUTION**
The load resistance $R_{load}$ connected to the DAC must be at least 2 kΩ.
The voltage of the output power source should be not more than 30 V.

### 5.5.2 Digital output

The digital output is an electromagnetic relay (type P) (see *Figure 5.6*). This output is used to control the load (on / off) directly or through more powerful control elements, such as starters, solid state relays.
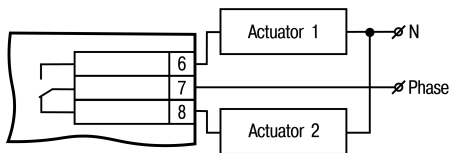


**Figure 5.6 – Output wiring**

# 6 Operation

## 6.1 Principle of operation

Functional diagram of the device is shown in *Figure 6.1*.
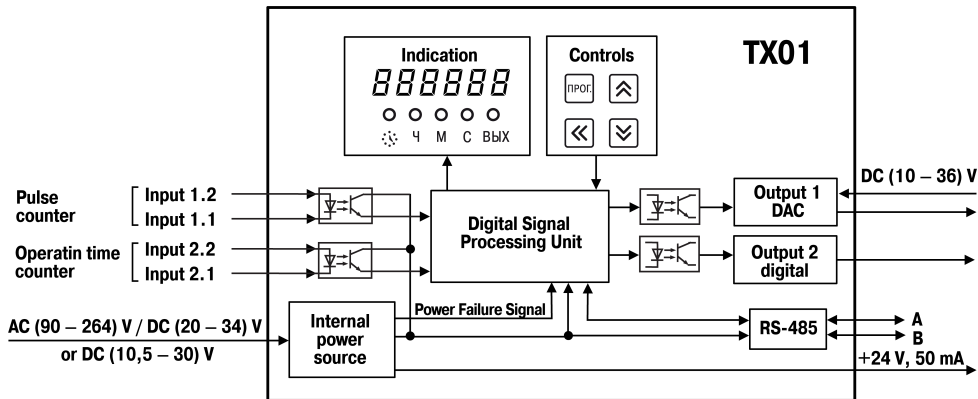


**Figure 6.1 – Device operation**

The device has two *digital* inputs for connecting sensors (pulse counter and operating time counter). To the inputs of the device can be connected:

• sensors with output *n-p-n*-transistor with an open collector;

• sensors with a dry contact type output (reed switches).

The counting input of the device receives pulses from a sensor that controls one or more marks on the motor shaft.

The levels of the input signals are converted and processed in the *matching unit*, after which they are sent to the *digital processing unit*, where it occurs:

• filtering of input signals;
• measuring the instantaneous value of the shaft speed;
• measurement of operating time at the operating time counter;
• conversion of measured values into real physical quantities;
• scaling of values before their output to the display;
• generation of signals for controlling the *outputs* according to a specified algorithm.

⚠ **NOTICE**
The parameter-current/voltage conversion is carried out using the built-in output of a ten-digit DAC. The signals obtained after the conversion can be used to register parameters.

*Control unit* includes buttons for entering parameters and controlling the operation of the device.

*Display unit* displays the measurement results or operating parameters on the indicators and shows the device status using LEDs.

*Internal power supply*, depending on the version of the device (with AC or DC power), converts the supply voltage for all units of the device and generates a signal indicating the loss of supply voltage. It also generates a DC voltage to power the sensors connected to the inputs of the device.

Using the *RS-485* interface, the device is connected to a PC, which makes it possible to set and edit the configuration of the device, to monitor its current status and readings.

## 6.2 Control and indication

Elements of indication and control are located on the front panel of the device (see *Figures 6.2 and 6.3*):
- seven-segment six-digit display;
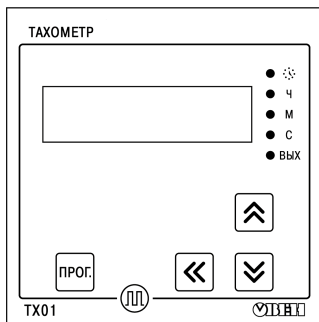- five LEDs;
- four buttons.



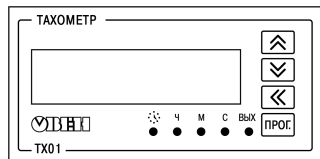**Figure 6.2 – Front panel of the device in housing for wall-mounting (H)**



**Figure 6.3 – Front panel of the device in housing for panel-mounting (Щ2)**

**Table 6.1 – Display function**

| Operating mode | Displayed information | Refresh rate |
|---|---|---|
| Tachometer | The current value of the pulse repetition rate obtained after filtering and averaging, taking into account scaling at the measuring input of the device | ≤ 6 s (equal to the duration of the time interval between the leading edges of the pulses at the measuring input of the device) |
| (!) | **NOTICE**<br>If the pulse repetition rate is less than 0.2 Hz or the pulse source disappears, then the last measured value is displayed on the digital clock for 6 seconds, after which 0 will be highlighted.<br>If the pulse repetition rate exceeds the maximum value with a positive tolerance of 2 % (**FrEQ** × 1.02), then the last measured value is displayed on the display for 6 seconds, after which the value recorded in the **FrEQ** parameter flashes. | |
| Operating time counter | Operating time | 1 s |
| Setup | Parameter name and value | — |

**Table 6.2 – Assigning LEDs**

| LED | State | Value | |
|---|---|---|---|
| | | **Tachometer mode** | **Operating time counter** |
| ⁙ | ON | Measurement of operating time is in progress | |
| Ч* | ON | Display scale – **rph** | Range of operating time (DDDD.HH) – **from 10000 h to 9999 days 23 h** |
| M* | ON | Display scale – **rpm** | Range of operating time (HHHH.MM) – **from 100 h to 9999 h 59 min** |

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**Table 6.2 (continued)**

| LED | State | Value | |
|---|---|---|---|
| | | **Tachometer mode** | **Operating time counter** |
| **C\*** | ON | Display scale – **rps** | Range of operating time (HH.MM.SS) – **from 0 to 99 h 59 min 59 s** |

(!) **NOTICE**
\* In **USER** mode, these LEDs are off.

| LED | State | Value |
|---|---|---|
| **ВЫХ** | ON | • The digital output is enabled according to the selected logic.<br>• A digital signal corresponding to the maximum current / voltage value is applied at the analog output |

(!) **NOTICE**
For devices with two outputs (discrete and analog), the LED glows in accordance with the logic of the digital output.

**Table 6.3 – Buttons Assignment**

| Button | Operating mode of the device | Function |
|---|---|---|
| прог | Operation | Switch to setup mode |
| | Setup | Switch to editing a parameter value after selecting it |
| ⌃ ⌄ | Operation | Switch to the display of operating hours counter values (hold ⌃) |
| | Setup | • Enter a password to change the settings (if it is not **0**).<br>• View parameter values and edit them |

**Table 6.3 (continued)**

| Button | Operating mode of the device | Function |
|--------|------------------------------|----------|
| $\ll$ | Setup | Selecting an editable digit when changing a parameter value and entering a password (used with the $\triangle$ and $\triangledown$ buttons) |

## 6.3 Switch on and operation

The device can perform following functions:

- tachometer;
- operating time counter.

The signals arriving at the counting input of the device are filtered. The filter is characterized by the minimum allowable pulse and pause lengths (**minImp** parameter, ms). All pulses and pauses less than the specified duration are perceived as bounce and ignored.

The recommended value for this parameter is calculated as follows:

$$minImp = (\frac{1}{4} \times \frac{1}{MaxFreqRele}) \times 10^6$$

where *MaxFreqRele* is the maximum frequency (up to 100 Hz) of switching a dry contact relay.

For input frequencies greater than 100 Hz, set **minImp = 10** μs.

The principle of operation of this parameter is shown in *Figure 6.4*:

- **1**: pulse duration and pause duration greater than **minImp** – the signal is passed through the bounce protection system;

- **2**: the pulse duration is less than **minImp** – the signal is not passed by the bounce protection system;
- **3**: the pulse duration is greater than **minImp**, but the pause duration is shorter than **minImp** – the signal is not skipped by the chatter protection system.
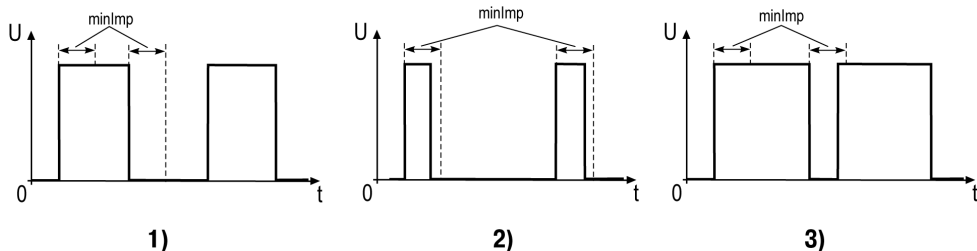


**Figure 6.4 – Parameter «minImp»**

#### 6.3.1 Tachometer mode

When performing the function of a tachometer:

- device measures the instantaneous value of the duration of the time intervals (T) between the leading or trailing edges (in s);
- device calculates the value of N / T, where N is the value determined by the dimension of the display of the measured value;
- device displays the obtained value taking into account the scaling factor.

The tachometer measurement interval is set by the **dttA** parameter in:

- rps (N = 1);
- rpm (N = 60);
- rph (N = 3600)
- custom values (N = F × 10<sup>-FdP</sup>, where F and FdP are variable parameters).

If F × 10$^{-FdP}$ < 1, the values dependent on **dttA** (**FrEQ**, **UdAC**, **dPro**, **LOR**, **HIR**, **UdO**, **dU**) can be less than 1 (for example, 0.25) and displayed on the display as 0. This occurs because fractional display is not supported. But in the operation of the device, values with a fractional part will be used.

The **dttA** value affects the upper and lower limits of the **FrEQ** parameter. That is, the limits are recalculated in accordance with the coefficient N. For example, the values of the **FrEQ** parameter lie in the range [1; 2500]. With the coefficient N = 60, the boundaries of the **FrEQ** parameter will be as follows:

- lower limit: 1 × 60 = 60;
- upper limit: 2500 × 60 = 150000.

Counting results are shown on the display. Calculation units are displayed in the form of highlighting of single LEDs (see *Table 6.2* for details).

**NOTICE**

1. Rounding of the measurement results is carried out in a standard mathematical way, in a big way. That is, if in a rounded digit a digit is more than or equal to 5, then one is transferred to the next digit. If the measured value lies within 0.2 ... 0.5 Hz inclusively, then a value of 1 is transmitted via Modbus to indicate the presence of a signal.

2. If the digit capacity is not enough to display the selected number of digits after the decimal point, the device automatically shifts the number to the right.

An eighth-order moving average filter is used to damp the signal in the device. The **MAV.L** parameter defines the minimum time (in seconds) for filling the filter buffer. Adding a new value to the buffer will be done not earlier than in (**MAV.L** / 8) seconds. At input frequencies less than or equal to (8 / $\bar{n}\mathcal{R}u.L$), the settling time of the input signal to the digital signal can be longer than **MAV.L**. By default, this filter is enabled.

### 6.3.2 Operating time counter

The device counts the operating time if the signal level on the operating time counter reaches a logical 1. When the device performs this function, the ⋰ LED lights up.

To see the current operating time on display, press and hold the button ⬆. If you release this button, the display returns to the tachometer reading.

The measured operating time is shown on the display (see *Table 6.1* for details). If the current range is exceeded, the device automatically sets the next display range of the measurement results. The maximum value of the operating time takes values from 1 s to 9999 days 23 hours.

For devices with discrete output, it is possible to set the limit values of the operating time, upon reaching which the output is switched on.

# 7 Configuration

## 7.1 Setup sequence

The Setup mode is intended for viewing and editing the device parameters. New parameters are saved to non-volatile memory of the device.

To enter the setup mode, press and hold the button $\boxed{\text{прог}}$ for at least 2 seconds.

Using $\boxed{\ll}$, $\boxed{\wedge}$ and $\boxed{\vee}$ enter the password, and then press $\boxed{\text{прог}}$ and $\boxed{\ll}$. If the password is **0** (default), press $\boxed{\ll}$.

> **NOTICE**
> If you forgot your password, you can enter the settings mode using the password **1098**!
> Further password changes are available only on the RS-485 network.

If no button operations are performed within 2 minutes:

- when editing a parameter, the device automatically restores its value and returns to the parameter viewing mode;
- when setting the parameter, the device automatically returns to tachometer mode.

Device settings and the possible values of each of the parameters are presented in *Figures 7.1– 7.4* and in *Appendix A*.

> **NOTICE**
> Upon entering the settings menu, the device does not stop functioning in the operating mode (it continues to measure the time interval between pulses, counts the operating time, controls the operation of the output).
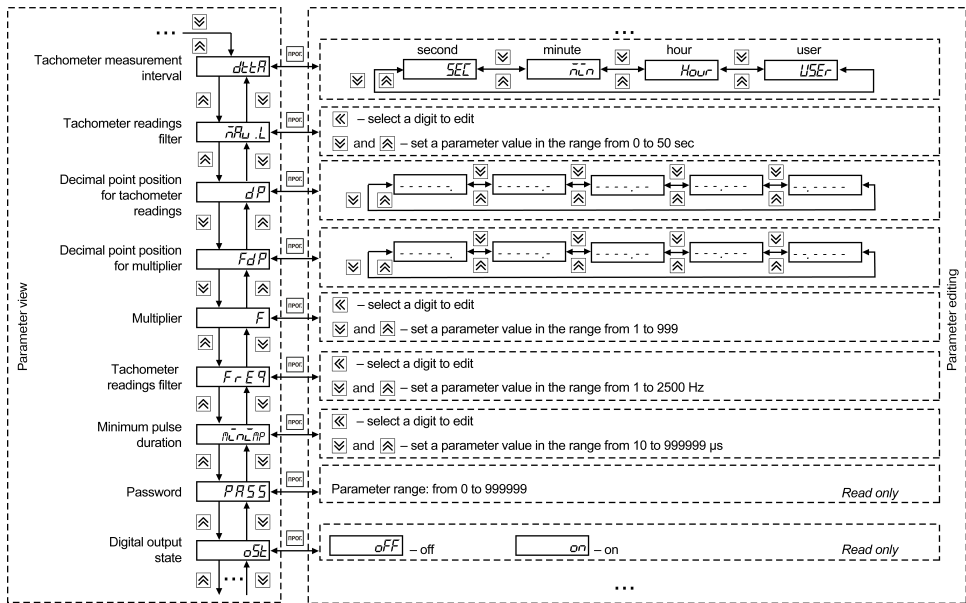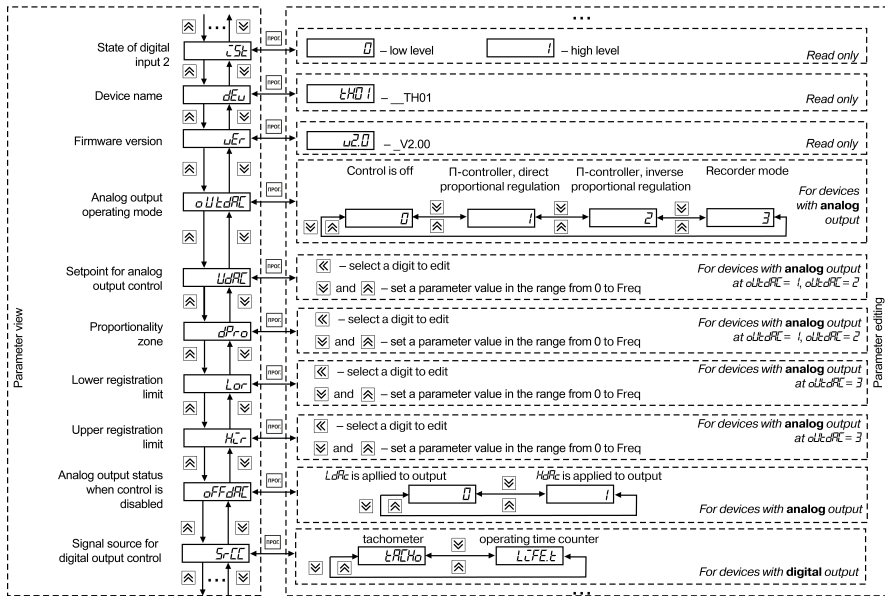
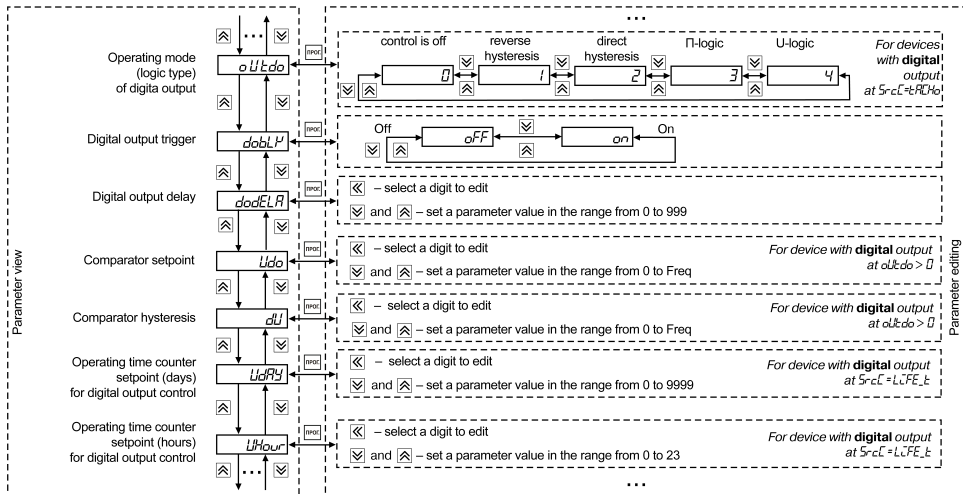**Figure 7.1 – Configuration menu**

**Figure 7.2 – Configuration menu (continued)**

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**Figure 7.3 – Configuration menu (continued)**
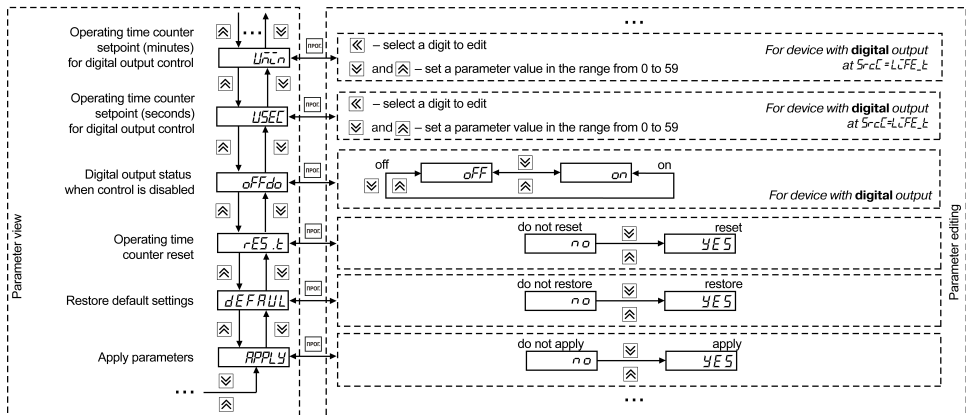
**Figure 7.4 – Configuration menu (end)**

## 7.2 Calibration mode setting

To enter the calibration mode, press and hold the [ПРОГ] and [◁] buttons for at least 2 seconds.

Using [◁], [⌃] and [⌄] buttons enter the password, and then press [ПРОГ] and [◁]. If the password is **0** (default), press [◁].

To exit the menu in the parameter viewing mode, press the button ◄.

The calibration parameters and the display of the possible values are shown in *Figure 7.5*.
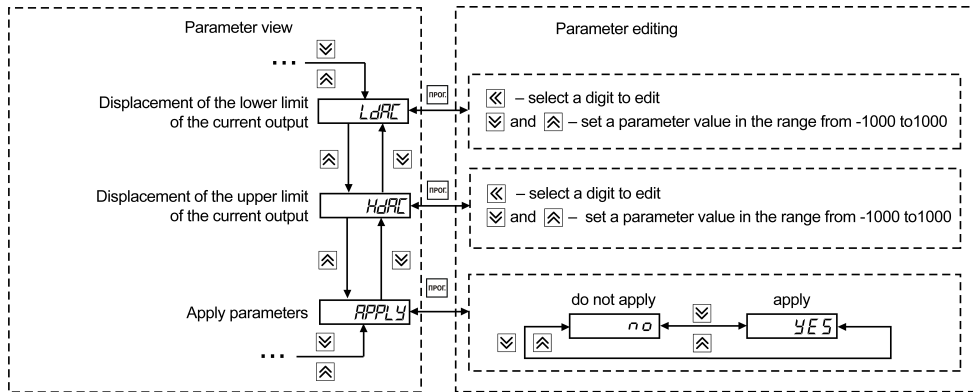


**Figure 7.5 – Calibration menu**

> **NOTICE**
> For calibration, the value of the **oUtdAC** parameter must be other than 0.

## 7.3 Output settings

Device **digital output** (type P) functions as a comparison device (comparator).

The input value of the comparison device:

- tachometer measurement result (**SrcC = tACHo**) – control mode is selected using the **oUtdo** parameter;
- measured value of the operating time (**SrcC = LiFE_T**) – the output is switched on when the setpoint is reached to control the digital output for the operating time **UdAY**, **UHour**, **UMin**, **USEc**.

When the output is turned on, the **ВЫХ** LED lights up.

It is possible to work according to one of the following types of logic (see *Figures 7.6 and 7.7*):

- reverse hysteresis (**oUtdo** = 1) – output turns on at values $F_{current} > (U+\Delta)$ and turns off at values $F_{current} < (U-\Delta)$;
- direct hysteresis (**oUtdo** = 2) – output turns on at values $F_{current} < (U-\Delta)$ and turns off at values $F_{current} > (U+\Delta)$;
- П-shaped logic (**oUtdo** = 3) – output is turned on at values $(U-\Delta) < F_{current} < (U+\Delta)$;
- U-shaped logic (**oUtdo** = 4) – output is turned on with the values $F_{current} < (U-\Delta)$ and $F_{current} > (U+\Delta)$.

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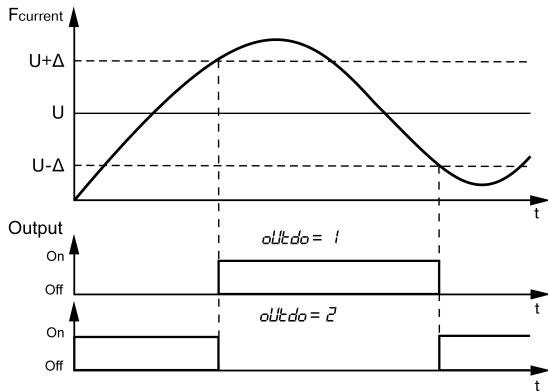
**Figure 7.6 – Types of logic (reverse and direct hysteresis) when the output operates as a comparator**
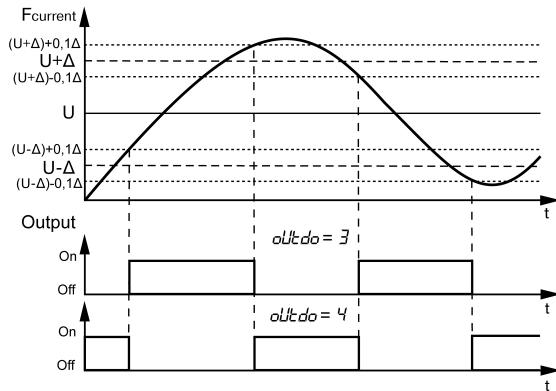
**Figure 7.7 – Types of logic (Π- and U-shaped) when the outputs operates as a comparator**

> **NOTICE**
> 1. With Π- or U-shaped logic, to suppress bounce during switching, there is an additional hysteresis of operation of 5 % of the range between the limits (2Δ) (see *Figure 7.7*).
> 2. When the pulse repetition rate at the counting input is more than **FrEQ**, the value equal to the value calculated for **FrEQ** is set at the output.

Recommendations for setting the output:
   • set **oFFdo** = 0 and **oUtdo** = 0;

- specify values in **Udo** and **dU**. It is recommended that **Udo**, **dU**, the upper and lower limits do not go beyond 0 and **FrEQ**;
- set the desired output logic (**oUtdo**).

Digital output control is disabled when **oUtdo** = 0. The output status is set using the **oFFdo** parameter.

**Analog output** of the device (types И, У) functions as a П-controller and a recorder. The operation mode of the analog output is set using the **oUtdAC** parameter.

When the output operates as a **П-controller**, the current value of the measured value is compared with the preset setpoint (**UdAC** parameter) and the output signal is from 4 to 20 mA (for type И) or 0 to 10 V (for type У) proportional to the deviation. The direct proportionality zone is set by the parameter Δ (**dPro**). The output signal is generated in accordance with the regulator characteristic set in the **oUtdAC** parameter, either in direct proportion (1) or inversely proportional (2) regulation law. Graphs explaining the principle of forming the control current and voltage of the П-controller for both characteristics are shown in the *Figures 7.8 and 7.9*.



a) inversely proportional control        b) direct proportional control
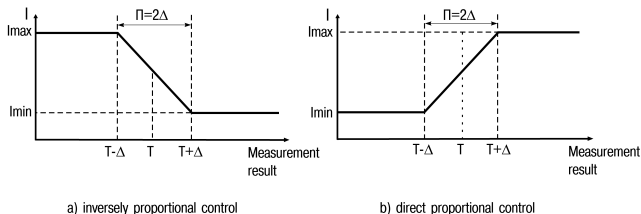
**Figure 7.8 – Generating of the output signal in the П-controller mode (output of type И)**

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a) inversely proportional control        b) direct proportional control
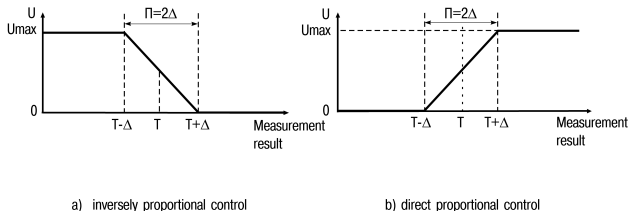
**Figure 7.9 – Generating of the output signal in the U-controller mode (output of type У)**

When the output works as a **recorder** (**oUtdAC** = 3), the following occurs:

- comparing the measured value with the set values of the lower limit of the recording range and the value of the entire recording range;
- issuing an analog signal to the corresponding output in the form of a current from 4 to 20 mA (for output type И) or voltage from 0 to 10 V (for output type У), which can be fed to a recorder or other recording device.

The principle of generating the output signal is shown in *Figures 7.10 and 7.11*. When the output is working as a recorder, the lower and upper limits of registration should be set in the **Lor** and **Hir** parameters.

> **NOTICE**
> When the measured value goes beyond the recording range, the error level is set at the output: 20.2 mA (for type И output), more than 10.5 V (for type У output).

When **oUtdAC** = 0, the operation control of the analog output is disabled. The output status is set by **oFFdAC** parameter.

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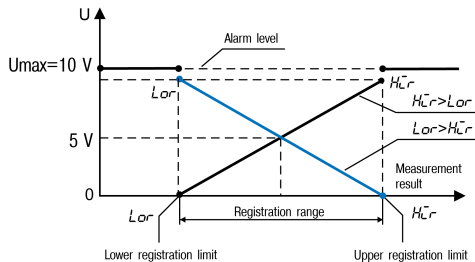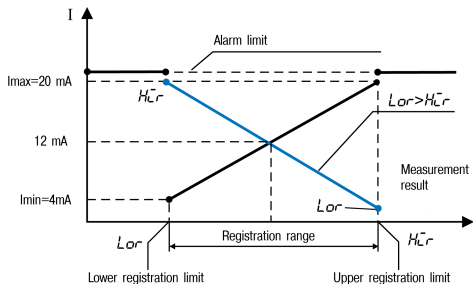
**Figure 7.10 – Principle of generating the output signal in the recorder mode (output of type И)**   **Figure 7.11 – Principle of generating the output signal in the recorder mode (output of type У)**

## 7.4 Configuring the device from a PC

To configure the device with a PC, communication interfaces RS-485 is used. The device supports two communication protocols: MODBUS RTU and MODBUS ASCII. Addresses, names and lengths of the device parameters are given in *Appendix A*.

To go to the device settings from a PC, press and hold the ⁿᵖᵒʳ and ⌃ buttons for at least 2 seconds.

Then use the ≪, ⌃ and ⌄ buttons to enter the password, and then press ⁿᵖᵒʳ and ≪. If the password is **0** (default), press ≪.

To exit the menu in the parameter viewing mode, press the button $\boxed{\ll}$.

Settings for communicating with a PC and displaying on the digital indicator the possible values of each of the parameters are presented in *Figure 7.12*.
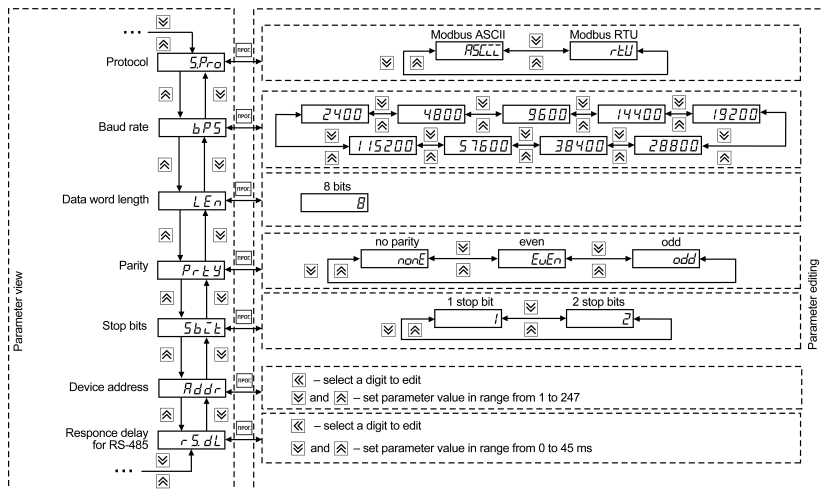


**Figure 7.12 – PC communication settings**

# 8 Maintenance

## 8.1 Maintenance

Safety measures (see *Section 3*) should be observed during the maintenance.

Maintenance of the device has to be carried out at least once in 6 months and includes the following procedures:

- checking the mounting of the device;
- checking the screw connections;
- removing dust and dirt from the terminal board of the device.

## 8.2 Calibration

Calibration is intended to restore the metrological characteristics of the device in case of their change after prolonged use or repair work and consists in selecting the minimum and maximum values of the output signal.

⚠️ **CAUTION**
Calibration of the device should be carried out only by qualified specialists of metrological services.

Calibration is carried out only for analog outputs. To do this:

- connect the load ($R_{load}$) and a voltmeter to the output according to *Figures 8.1*(for output of type У) *and 8.2* (for output of type И);
- apply power to the device.

0 is displayed – the device is in operating mode.
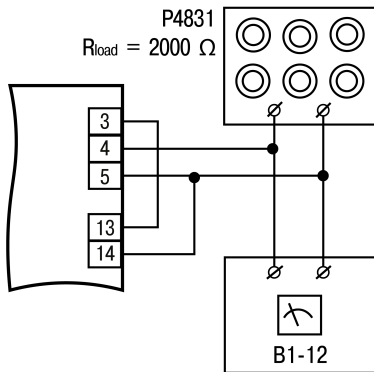


**Figure 8.1 – Calibration of output voltage values**
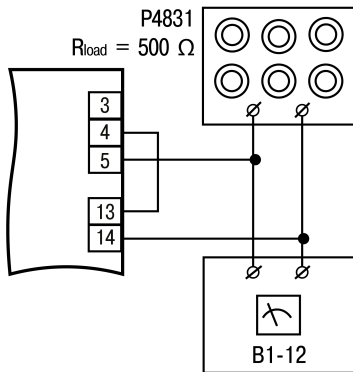
**Figure 8.2 – Calibration of output current values**

The calibration algorithm for analog output:

1. By changing the DAC code and controlling the current (voltage) at the output of the analog device, to achieve the value of the output signal corresponding to the **lower** limit of the output current or voltage (in general, 4 mA or 0 V).
2. Commit the current DAC code as the **lower** desired limit of the signal at the output of the analog device.
3. By changing the DAC code and controlling the current (voltage) at the output of the analog device, to achieve the value of the output signal corresponding to the **upper** desired limit of the output current or voltage (in the general case, 20 mA or 10 V).
4. Commit the current DAC code as the **upper** desired current limit at the output of the analog device.
5. Set **APPLY** parameter to **YES**.
6. Exit the calibration menu.

**NOTICE**

To apply the calibration parameters, you need to edit both **LdAC** and **HdAC**.

Calibration can be carried out using the service menu of the device or via the RS-485 network.

The commands used when calibration over the RS-485 network are given in *Appendix A* (section "Calibration").

Set the **LdAC** and **HdAC** parameters to achieve that the value of the output signal corresponds to a lower or upper desired limit of the output current (voltage). The first submission of these commands is considered the implementation of paragraphs 2 and 4 of the calibration algorithm, respectively.

# 9 Marking

The housing of the device is marked with:

- name of the device;
- protection class of the housing according to GOST 14254;
- voltage and frequency of supply;
- power consumption;
- class of protection against electric shock according to GOST 12.2.007.0;
- approval mark for measuring devices;
- EAC mark;
- country of origin;
- device serial number and year of manufacture.

Consumer packaging is marked with:

- name of the device;
- EAC mark;
- country of origin;
- device serial number and year of manufacture.

# 10 Packaging

Device should be packed according to GOST 23088-80 into consumer packaging, made of paperboard (according to GOST 7933-89).

Packaging of the device for mail delivery is performed according to GOST 9181-74.

# 11 Transportation and storage

The device must be transported in closed transport of any kind. The fastening of containers during transport should be carried out in accordance with the rules applicable to the respective modes of transport.

The transport conditions must be in accordance with IEC 61131-2-2012 at ambient temperature from – 40 to + 55 °C in compliance with the protection measures against impacts and vibrations.

Transportation should be carried out in a shipping container individually or in over-packs.

The storage conditions in the packaging at the manufacturer's and consumer's warehouse must comply with IEC 61131-2-2012. In the air no aggressive impurities must be present.

The device should be stored in the racks.

# 12 Scope of delivery

| Description | Quantity |
| --- | --- |
| Device | 1 pc. |
| Passport and warranty card | 1 pc. |
| User manual | 1 pc. |
| Mounting kit | 1 kit |

**NOTICE**
The manufacturer reserves the right to make additions to the slope of delivery.

# 13 Warranty

The manufacturer guarantees conformity of the Device to requirements of technical conditions (ТУ) under the conditions of operation, transportation, storage and installation.

Warranty period of operation: **24 months** from the date of sale.

In case of failure of the Device during the warranty period at observance of conditions of operation, transportation, storage and installation the manufacturer undertakes to provide free repair or replacement.

The procedure for transferring the Device to repair is described in the passport and in the warranty card.

# Appendix A. Device parameters

| Parameter | Modbus register, HEX | Allowed values | Data type | Notes |
|---|---|---|---|---|
| **Network parameters** | | | | |
| Protocol<br>5.Prō | 0x0008 | 0 – ASCII;<br>1 – rtU | unsigned char | Write / Read<br>Default – 1 |
| Baud rate, bps<br>bPS | 0x0009 | 0 – 2400;<br>1 – 4800;<br>2 – 9600;<br>3 – 14400;<br>4 – 19200;<br>5 – 28800;<br>6 – 38400;<br>7 – 57600;<br>8 – 115200 | unsigned char | Write / Read<br>Default – 8 |
| Data word length, bits<br>LEn | 0x000A | 1 – 8 | unsigned char | Read<br>Default – 1 |
| Parity<br>PrtY | 0x000C | 0 – no control (nōnE);<br>1 – parity (EuEn);<br>2 – parity (ōdd) | unsigned char | Write / Read<br>Default – 0 |
| Stop bits<br>Sbīt | 0x000B | 0 – 1 stop bit ( 1);<br>1 – 2 stop bits (2) | unsigned char | Write / Read<br>Default – 0 |
| Device address<br>Rddr | 0x0006 | from 1 to 247 | unsigned short | Write / Read<br>Default – 16 |
| Response delay, ms<br>r5.dL | 0x000D | from 0 to 45 | unsigned char | Write / Read<br>Default – 2 |

| Parameter | Modbus register, HEX | Allowed values | Data type | Notes |
|---|---|---|---|---|
| **Parameters for devices with analog output** | | | | |
| Analog output mode *oUtdAC* | 0x0031 | 0 – output is off (*0*)<br>1 – directly proportional (*1*);<br>2 – inversely proportional (*2*);<br>3 – recorder (*3*) | unsigned char | Write / Read<br>Default – 3 |
| Setting value U of the analog output *udAc* | 0x0032<br>0x0033 | from 0 to *FrEq* | Unsigned long | Write / Read<br>Only for directly proportional mode.<br>Default – 0 |
| Value of the direct proportionality zone *dPro* | 0x0034<br>0x0035 | from 1 to *FrEq* | Unsigned long | Write / Read<br>Only for directly proportional mode.<br>Default – 1 |
| Value of the lower registration limit (U-L) *Lor* | 0x0036<br>0x0037 | from 0 to *FrEq* | Unsigned long | Write / Read<br>Only in the recorder mode.<br>Default – 0 |
| Upper registration limit value (U-H) *Hir* | 0x0038<br>0x0039 | from 0 to *FrEq* | Unsigned long | Write / Read<br>Only in the recorder mode.<br>Default – 2500 |
| Analog output status when control is disabled *oFFdAC* | 0x003A | 0 – the value *LdAC(0)* is output;<br>1 – the value *HdAC(1)* is output | unsigned char | Write / Read<br>Default – 0 |

| Parameter | Modbus register, HEX | Allowed values | Data type | Notes |
|---|---|---|---|---|
| **Parameters for devices with digital output** | | | | |
| Signal source for digital output<br>$5rLL$ | 0x0013 | 0 – tachometer measurement result ($tRLHo$);<br>1 – the value $HdRL(LiFE.t)$ is output | unsigned char | Write / Read<br>Default – 0 |
| Logic type of digital output<br>$\overline{o}Utd\overline{o}$ | 0x0014 | 0 - output control is disabled (the output is transferred to the state defined by the parameter $oFFdo$) ($\mathit{0}$);<br>1 – logic type 1 (reverse hysteresis) ( $\mathit{1}$);<br>2 – logic type 2 (direct hysteresis) ($\mathit{2}$);<br>3 – logic type 3 (direct proportional) ($\mathit{3}$);<br>4 – logic type 4 (reverse proportional) ($\mathit{4}$); | unsigned char | Write / Read<br>Only for input of the comparator – tachometer ($5rLL = tRLHo$)<br>Default – 0 |
| Digital output trigger<br>$dobLH$ | 0x0015 | 0 – disabled ($oFF$);<br>1 – enabled ($on$) | unsigned char | Write / Read<br>Default – 0.<br>When setting the parameter to state $on$, the digital output retains its last state |
| Digital output delay, s<br>$dodELR$ | 0x0016 | from 0 to 999 | unsigned short | Write / Read<br>Default – 0 |
| Setpoint for digital output control<br>$\mathit{Udo}$ | 0x0017<br>0x0018 | from 0 to $FrE9$ | Unsigned long | Write / Read<br>Default – 10<br>at $\overline{o}Utd\overline{o} > \mathit{0}$ |

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| Parameter | Modbus register, HEX | Allowed values | Data type | Notes |
|---|---|---|---|---|
| Comparator hysteresis *dU* | 0x0019 0x0020 | from 0 to *FrEq* | Unsigned long | Write / Read Default – 1 at *oUtdo* > *0*. The hysteresis in combination with the setpoint must not go beyond the set limits of the device registration |
| Setting value for digital output run hours control, days *UdAY* | 0x001B | from 0 to 9999 | unsigned short | Write / Read At *SrCC* = *LiFE_t*. Default – 0 |
| Setpoint value for controlling the digital output on running hours, h *UHoUr* | 0x001C | from 0 to 23 | unsigned char | Write / Read At *SrCC* = *LiFE_t*. Default – 0 |
| Setpoint value for control of digital output on running hours, min *Unin* | 0x001D | from 0 to 59 | unsigned char | Write / Read At *SrCC* = *LiFE_t*. Default – 0 |
| Setpoint value for control of digital output on running hours, s *USEc* | 0x001E | from 0 to 59 | unsigned char | Write / Read At *SrCC* = *LiFE_t*. Default – 0 |
| Digital output status when control is disabled (*oUtdo* = *0*) *oFFdo* | 0x001F | 0 – output is off (*oFF*) 1 – output is on (*on*) | unsigned char | Write / Read At *oUtdo* = *0*. Default – 0 |

| Parameter | Modbus register, HEX | Allowed values | Data type | Notes |
|---|---|---|---|---|
| Tachometer reading *dttR* | 0x0020 | 0 – rps (*SEC*);<br>1 – rpm (*n̄.n*)<br>2 – rph (*HōUr*);<br>3 – adjustable values (*USEr*) | unsigned char | Write / Read<br>Default – 0 |
| Tachometer reading filter *n̄Ru.L* | 0x0021 | from 0 to 50 s | unsigned char | Write / Read<br>Buffer filling time of 8 values for averaging readings.<br>Default – 1 |
| Decimal point position of device readings *dP* | 0x0022 | 0 – _ _ _ _ _ _;<br>1 – _ _ _ _ _._;<br>2 – _ _ _ _._ _;<br>3 – _ _ _._ _ _;<br>4 – _ _._ _ _ _ | unsigned char | Write / Read<br>Default – 0 |
| Multiplier decimal point position *FdP* | 0x0023 | 0 – _ _ _ _ _ _;<br>1 – _ _ _ _ _._;<br>2 – _ _ _ _._ _;<br>3 – _ _ _._ _ _;<br>4 – _ _._ _ _ _ | unsigned char | Write / Read<br>Default – 0 |
| Multiplier *F* | 0x0024 | from 1 to 999<br>(from 0.0001 to 999 including *FdP*) | unsigned short | Write / Read<br>Default – 1 |
| Maximum frequency of the input signal at the counting input, Hz *FrE9* | 0x0025<br>0x0026 | from 1 to 2500 | Unsigned long | Write / Read<br>Default – 2500 |

| Parameter | Modbus register, HEX | Allowed values | Data type | Notes |
|---|---|---|---|---|
| Minimum pulse duration, μs<br>_ñiñiñP_ | 0x0040<br>0x0041 | from 10 to 999999 | Unsigned long | Write / Read<br>Default – 10 |
| Password<br>_PASS_ | 0x0027<br>0x0028 | from 0 to 999999 | Unsigned long | Write / Read<br>Default – 0 |
| The measured value of rounds in units corresponding to the value _dttA._<br>Not displayed on the digital indicator | 0x0029<br>0x002A | from 0 to 4294967296 | Unsigned long | Read only |
| Running hours, s<br>Not displayed on the digital indicator | 0x002B<br>0x002C | from 0 to 863999999 | Unsigned long | Read only |
| State of digital output 1<br>_ōSt_ | 0x002D | 0 – output is off (_oFF_)<br>1 – output is on (_on_) | unsigned char | Read only |
| State of digital output 2<br>_iSt_ | 0x002E | 0 – low level (_0_);<br>1 – high level ( _1_) | unsigned char | Read only |
| Device name<br>_dEu_ | 0x0000<br>0x0001<br>0x0002 | _ _ _THD 1_ | char[6] | Read only |
| Firmware version<br>_uEr_ | 0x0003<br>0x0004<br>0x0005 | _ _uX.XX_ | char[6] | Read only |

| Parameter | Modbus register, HEX | Allowed values | Data type | Notes |
|-----------|------------------------|----------------|-----------|-------|
| Version of the device. Not displayed on the digital indicator | 0x0012 | 0 – no output; 1 – only digital output; 2 – only analog output; 3 – digital and analog outputs | unsigned char | Read only |
| **Commands** | | | | |
| Reset running hours counter *rES.t* | 0x002F | 1 – reset counter (*YES*) | unsigned char | Write only |
| Restore factory settings *dEFAUL* | 0x0030 | 1 – restore factory settings (*YES*) | unsigned char | Write only |
| Apply network settings *APPLY* | 0x000F | 1 – apply settings (*YES*) | unsigned char | Write only New parameters take effect after command *APPLY* or reboot |
| **Calibration** | | | | |
| The value of the code issued by the DAC to set the minimum value of the output signal | 0x003B | from 0 to 1023 | unsigned short | Read Only in calibration mode Default – 40 |
| The value of the code issued by the DAC to set the maximum value of the output signal | 0x003C | from 0 to 1023 | unsigned short | Read Only in calibration mode Default – 1023 |
| Displacement of the lower limit of the current output *LdAC* | 0x003D | from -1000 to 1000 | signed short | Write only The desired offset of the DAC code relative to the current is transmitted. Default – 0 |

| Parameter | Modbus register, HEX | Allowed values | Data type | Notes |
|---|---|---|---|---|
| Displacement of the upper limit of the current output. *HdAC* | 0x003E | from 1000 to -1000 | signed short | Write only<br>The desired offset of the DAC code relative to the current is transmitted.<br>Default – 0 |
| Apply current output calibration *APPLY* | 0x003F | 0 – do not apply;<br>1 – apply | unsigned char | Write only<br>Default – 0 |

# Appendix B. Possible malfunctions and solutions

| Manifestation | Possible cause | Method of elimination |
|---|---|---|
| On the digital indicator in an operating mode it is displayed:<br>- - - - - - | The whole part of the measured value does not fit on the digital display | Set a different display scale (rps, rpm, rph or custom mode) |
| The digital indicator in the setup mode displays:<br>*HHHHHH* | Value does not fit on digital indicator | Set the parameter value taking into account the size of the digital indicator (6 characters) |