

User manual

METER

SRP-94

- Firmware: v.5.28 or higher
- Input type: 0/4-20 mA, 0/1-5V, 0/2-10V
- 4 x 20 mm display



Read the user's manual carefully before starting to use the unit or software.
Producer reserves the right to implement changes without prior notice.

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Explanation of symbols used in the manual:



- This symbol denotes especially important guidelines concerning the installation and operation of the device. Not complying with the guidelines denoted by this symbol may cause an accident, damage or equipment destruction.

IF THE DEVICE IS NOT USED ACCORDING TO THE MANUAL THE USER IS RESPONSIBLE FOR POSSIBLE DAMAGES.



- This symbol denotes especially important characteristics of the unit. Read any information regarding this symbol carefully

1. BASIC REQUIREMENTS AND USER SAFETY



- **The manufacturer is not responsible for any damages caused by inappropriate installation, not maintaining the proper environmental conditions and using the unit contrary to its assignment.**
- Installation should be conducted by qualified personnel . During installation all available safety requirements should be considered. The fitter is responsible for executing the installation according to this manual, local safety and EMC regulations.
- If the device is equipped with PE connector, it should be connected to PE wire. Otherwise PE wire should be connected to GND connector.
- The unit must be properly set-up, according to the application. Incorrect configuration can cause defective operation, which can lead to unit damage or an accident.
- **If in the case of a unit malfunction there is a risk of a serious threat to the safety of people or property additional, independent systems and solutions to prevent such a threat must be used.**
- **The unit uses dangerous voltage that can cause a lethal accident. The unit must be switched off and disconnected from the power supply prior to starting installation of troubleshooting (in the case of malfunction).**
- Neighbouring and connected equipment must meet the appropriate standards and regulations concerning safety and be equipped with adequate overvoltage and interference filters.
- **Do not attempt to disassemble, repair or modify the unit yourself. The unit has no user serviceable parts. Defective units must be disconnected and submitted for repairs at an authorized service centre.**



- In order to minimize fire or electric shock hazard, the unit must be protected against atmospheric precipitation and excessive humidity.
- Do not use the unit in areas threatened with excessive shocks, vibrations, dust, humidity, corrosive gasses and oils.
- Do not use the unit in areas where there is risk of explosions.
- Do not use the unit in areas with significant temperature variations, exposure to condensation or ice.
- Do not use the unit in areas exposed to direct sunlight.
- Make sure that the ambient temperature (e.g. inside the control box) does not exceed the recommended values. In such cases forced cooling of the unit must be considered (e.g. by using a ventilator).



This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

2. GENERAL CHARACTERISTICS

The **SRP-94** meter is equipped with one current input 0-20 / 4-20mA and one voltage input 0-5 / 1-5 / 0-10 / 2-10V. Current input has additionally overcurrent protection circuit, which protects standard resistor. The selection of active input is realised by software, and selected input can be changed at any time. Additionally the **SRP-94** allows user to select a conversion characteristic of several kinds: linear, square, square root, user defined (max.20 points length) and and volume characteristics of a cylindrical tank in the vertical and horizontal position. Result is showed on 4-digit LED display. Displayed values range can be selected by user, from -999 to 9999, plus decimal point.

The device can be equipped with two or four relay (or OC type) outputs. Optionally **SRP-94** with two relays (or OC type) outputs can be equipped with active current output, passive isolated current output or active voltage output. Device **SRP-94** is equipped with RS-485 / Modbus RTU communication interface and sensor supply output. The meter can be ordered in two power supply versions.

SRP-94 can be used for controlling and regulation of processes need proportional and threshold control like: temperature processes (heating or cooling), valves controlling or other.

3. TECHNICAL DATA

Power supply voltage (depending on version)	85... 230 ...260V AC/DC; 50 ÷ 60 Hz (separated) or 19... 24 ...50V DC and 16... 24 ...35V AC (separated) or 11.4... 12 ...15V AC/DC (separated)
External fuse (required)	T - type, max. 2 A
Power consumption	max. 6.5 VA @ 85 ÷ 260V AC/DC max. 6.5 VA @ 16V ÷ 35V AC max. 6.5 W @ 19V ÷ 50V DC max. 6.5 VA @ 11.4V ÷ 15V AC/DC
Current input	0÷20 mA, 4÷20 mA overload protected, maximum input current about 40 mA
Current measurement accuracy	± 0,1% @ 25°C; ± one digit (for 0÷20 mA range)
Current input resistance	< 65 Ω (typical 55 Ω)
Accepted prolonged input overload:	20%
Voltage input	0÷5 V, 1÷5 V, 0÷10 V, 2÷10 V
Voltage measurement accuracy	± 0,1% @ 25°C; ± one digit (for 0÷10 V range)
Voltage input resistance	> 50 kΩ
Accepted prolonged input overload:	20%
Sensor power supply output	24V +5%, -10%, stabilized max. 100 mA (50 mA @ 11.4V ÷ 15V AC/DC)
Relay output	0, 2 or 4 NO, 5A/250V AC (resistance) 3A/250V AC (reactance)
OC-type output	0, 2 or 4; 30mA / 30VDC / 100mW
Active current output (optional, for two relays or two OC-type output version only)	range max. 0 ÷ 24 mA
Load resistance max.	700 Ω
Passive isolated current output (optional, for two relays or two OC-type output version only)	range max. 2.8 ÷ 24 mA
Supply voltage	Us = 9.5 ÷ 36V
Load resistance max.	(Us – 9.5V) / 24mA [kΩ]

Active voltage output (optional, for two relays or two OC-type output version only)	range max. 0 ÷ 11V
Load resistance min.	2000 Ω
Temperature stability	50 ppm / °C
Display range	-999 ÷ 9999, plus decimal point
Communication interface	RS 485, 8N1 and 8N2, Modbus RTU, not separated
Baud rate	1200 bit/s ÷ 115200 bit/s
Display (depending on version)	LED, 4 digit, 20mm height, red or LED, 4 digit, 20mm height, green
Data memory	non-volatile memory, EEPROM type
Front panel protection	IP 65 optional version with panel cut-out sealing available
Terminals protection	IP 20
Housing type	panel
Housing material	NORYL - GFN2S E1
Housing dimensions	96 x 48 x 100 mm
Mounting hole	90.5 x 43 mm
Assembly depth	102 mm
Panel thickness	max. 5 mm
Operating temperature (depending on version)	0°C to +50°C or -20°C to +50°C
Storage temperature (depending on version)	-10°C to +70°C or -20°C to +70°C
Humidity	5 to 90% no condensation
Altitude	up to 2000 meters above sea level
Screws tightening max. torque	0,5 Nm
Max. connection leads cross section	2,5 mm ²
Safety requirements	according to: EN 61010-1 installation category: II pollution degree: 2 voltage in relation to ground: 300 V AC insulation resistance: >20 MΩ insulation strength between power supply and input/output terminal: 1min. @ 2300 V AC insulation strength between relays terminal: 1 min. @ 1350 V AC

EMC

according to: EN 61326-1



This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

4. DEVICE INSTALLATION

The unit has been designed and manufactured in a way assuring a high level of user safety and resistance to interference occurring in a typical industrial environment. In order to take full advantage of these characteristics installation of the unit must be conducted correctly and according to the local regulations.



- Read the basic safety requirements on page **3** prior to starting the installation.
- Ensure that the power supply network voltage corresponds to the nominal voltage stated on the unit's identification label.
- The load must correspond to the requirements listed in the technical data.
- All installation works must be conducted with a disconnected power supply.
- Protecting the power supply connections against unauthorized persons must be taken into consideration.

4.1. UNPACKING

After removing the unit from the protective packaging, check for transportation damage. Any transportation damage must be immediately reported to the carrier. Also, write down the unit serial number located on the housing and report the damage to the manufacturer.

Attached with the unit please find:

- user's manual,
- warranty,
- assembly brackets - 2 pieces.

4.2. ASSEMBLY



- The unit is designed for mounting inside housings (control panel, switchboard) insuring appropriate protection against surges and interference. Metal housings must be connected to ground in a way that complies with the governing regulations.
- Disconnect the power supply prior to starting assembly.
- Check the connections are wired correctly prior to switching the unit on.



In order to install the unit, a 90.5 x 43 mm mounting hole (**4.1, 4.2**) must be prepared. The thickness of the material of which the panel is made must not exceed 5mm. When preparing the mounting hole take the grooves for catches located on both sides of the housing into consideration (**4.1, 4.2**). Place the unit in the

mounting hole inserting it from the front side of the panel, and then fix it using the brackets (4.3). The minimum distances between the centre points of multiple units - due to the thermal and mechanical conditions of operation - are 115 mm x 67mm (4.4).

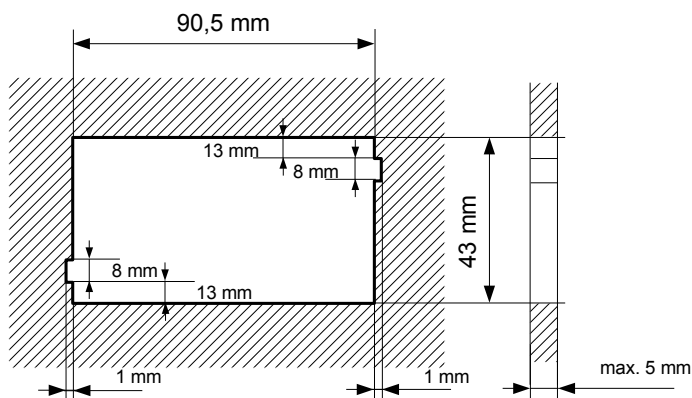


Figure 4.1. Recommended mounting hole dimensions

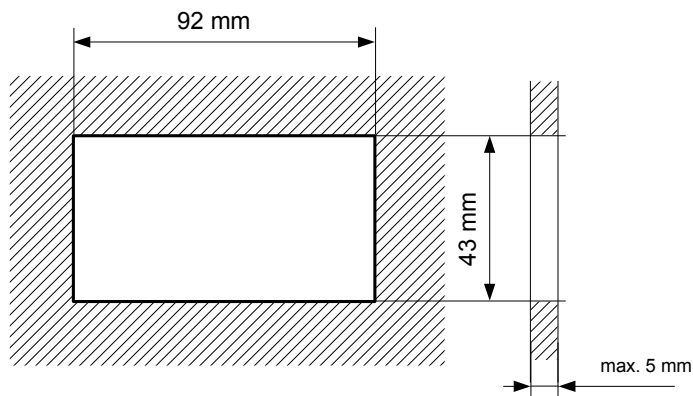


Figure 4.2. Allowable mounting hole dimensions

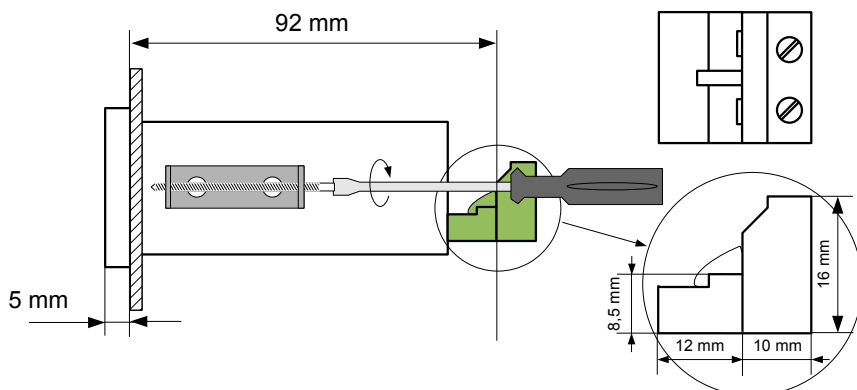


Figure 4.3. Installing of brackets, and dimensions of connectors.

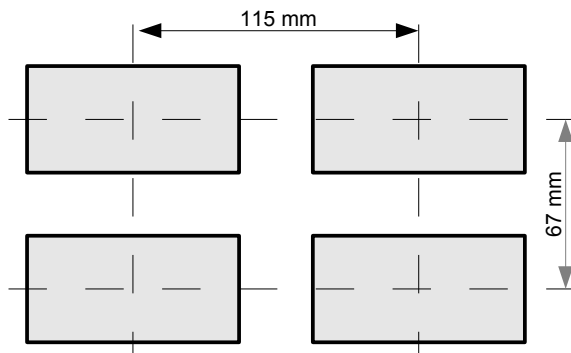


Figure 4.4. Minimum distances when assembly of a number of units

4.3. CONNECTION METHOD

Caution



- Installation should be conducted by qualified personnel. During installation all available safety requirements should be considered. The fitter is responsible for executing the installation according to this manual, local safety and EMC regulations.
- The unit is not equipped with an internal fuse or power supply circuit breaker. Because of this an external time-delay cut-out fuse with a small nominal current value must be used (recommended bipolar, max. 2A) and a power supply circuit-breaker located near the unit. In the case of using a monopolar fuse it must be mounted on the phase cable (L).
- The power supply network cable diameter must be selected in such a way that in the case of a short circuit of the cable from the side of the unit the cable shall be protected against destruction with an electrical installation fuse.
- Wiring must meet appropriate standards and local regulations and laws.
- In order to secure against accidental short circuit the connection cables must be terminated with appropriate insulated cable tips.
- Tighten the clamping screws. The recommended tightening torque is 0.5 Nm. Loose screws can cause fire or defective operation. Over tightening can lead to damaging the connections inside the units and breaking the thread.
- In the case of the unit being fitted with separable clamps they should be inserted into appropriate connectors in the unit, even if they are not used for any connections.
- **Unused terminals (marked as n.c.) must not be used for connecting any connecting cables (e.g. as bridges), because this can cause damage to the equipment or electric shock.**
- If the unit is equipped with housing, covers and sealing to, protecting against water intrusion, pay special attention to their correct tightening or clamping. In the case of any doubt consider using additional preventive measures (covers, roofing, seals, etc.). Carelessly executed assembly can increase the risk of electric shock.
- After the installation is completed do not touch the unit's connections when it is switched on, because it carries the risk of electrical shock.

Due to possible significant interference in industrial installations appropriate measures assuring correct operation of the unit must be applied. To avoid the unit of improper indications keep recommendations listed below.

- Avoid running signal cables and transmission cables together with power supply cables and cables controlling inductive loads (e.g. contactors). Such cables should cross at a right angle.
- Contactor coils and inductive loads should be equipped with interference protection systems, e.g. RC-type.
- Use of screened signal cables is recommended. Signal cable screens should be connected to the earthing only at one of the ends of the screened cable.
- In the case of magnetically induced interference the use of twisted pair of signal cables is recommended. Twisted pair (best if shielded) must be used with RS-485 serial transmission connections.
- In the case of measurement or control signals are longer than 30m or go outside of the building then additional safety circuits are required.
- In the case of interference from the power supply side the use of appropriate interference filters is recommended. Bear in mind that the connection between the filter and the unit should be as short as possible and the metal housing of the filter must be connected to the earth with the largest possible surface. The cables connected to the filter output must not be run with cables with interference (e.g. circuits controlling relays or contactors).

Connections of power supply voltage and measurement signals are executed using the screw connections on the back of the unit's housing.

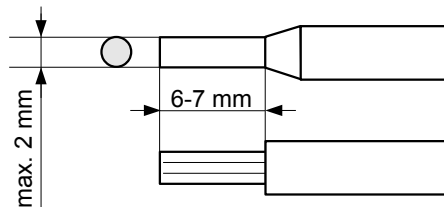


Figure 4.5. Method of cable insulation replacing and cable terminals



All connections must be made while power supply is disconnected !

16
31

Double numeration means, that depending on device version, particular terminal can be marked according to the top or bottom number.

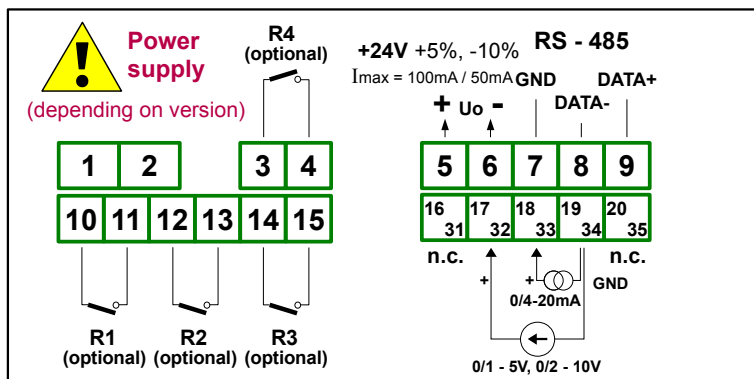


Figure 4.6. Terminals description (relay outputs)

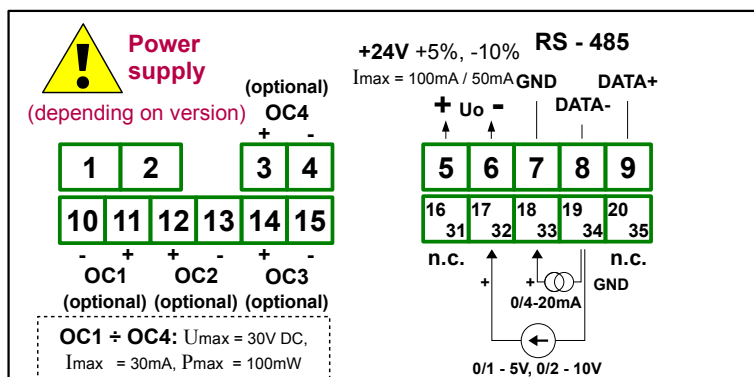


Figure 4.7. Terminals description (OC-type outputs)

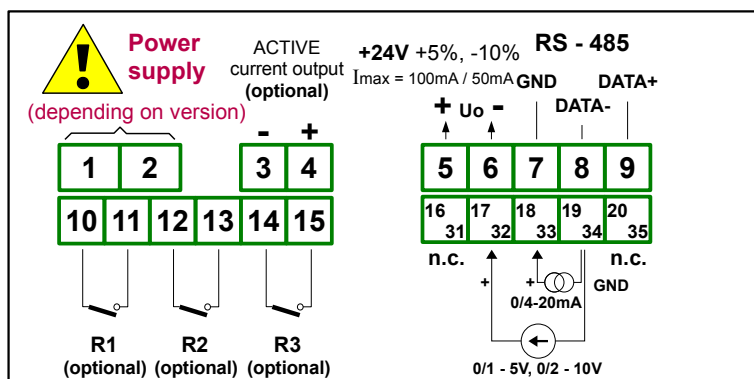


Figure 4.8. Terminals description (relay and active current outputs)

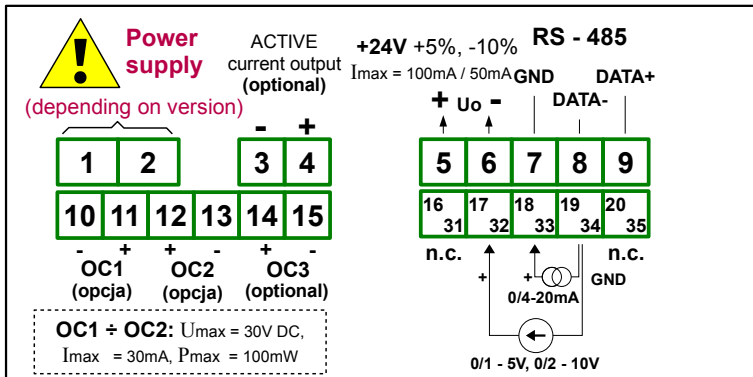


Figure 4.9. Terminals description (OC-type and active current outputs)

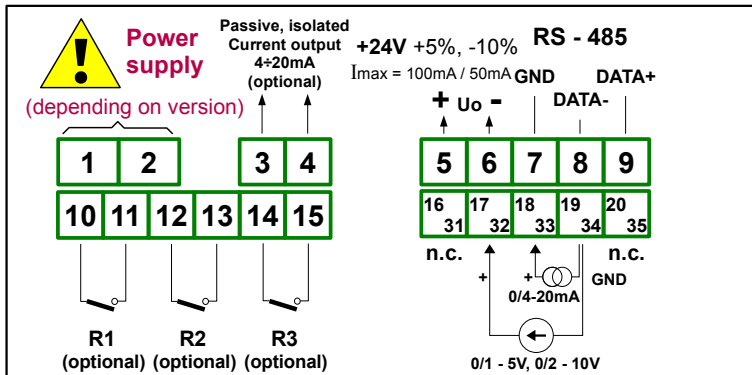


Figure 4.10. Terminals description (relay and passive current outputs)

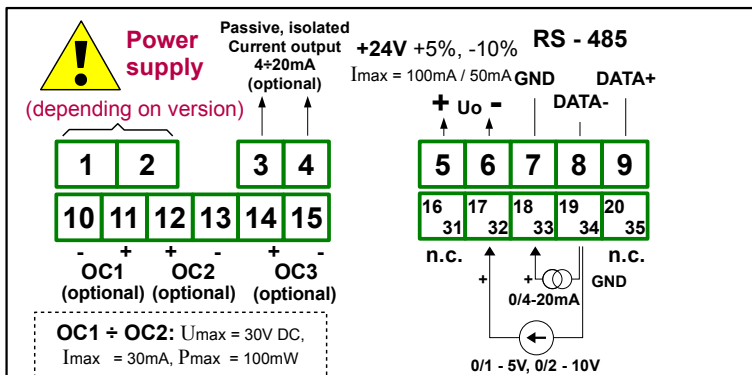


Figure 4.11. Terminals description (OC-type and passive current outputs)

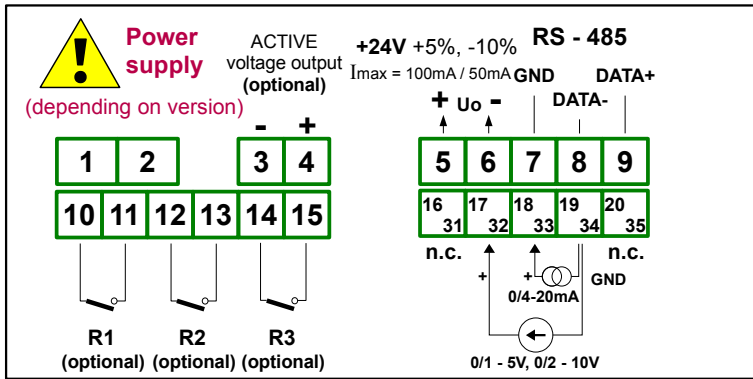


Figure 4.12. Terminals description (relay and active voltage outputs)

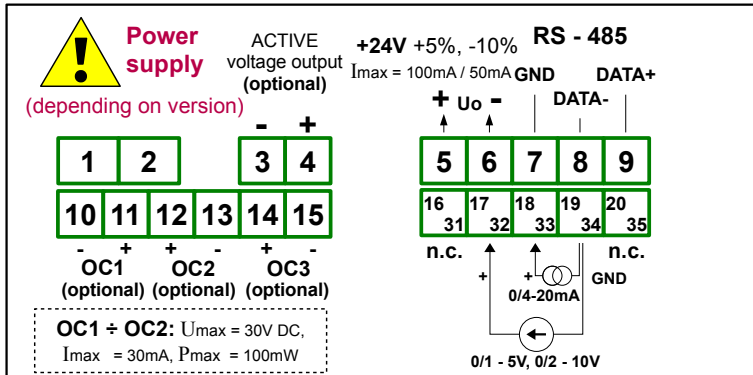


Figure 4.13. Terminals description (OC-type and active voltage outputs)

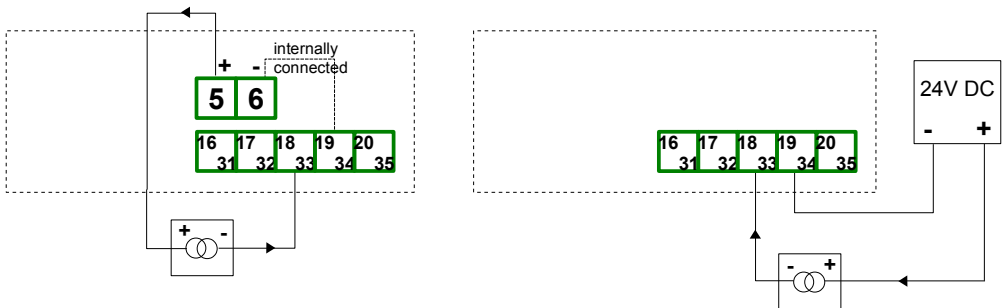


Figure 4.14. Connection of 2-wire current converters

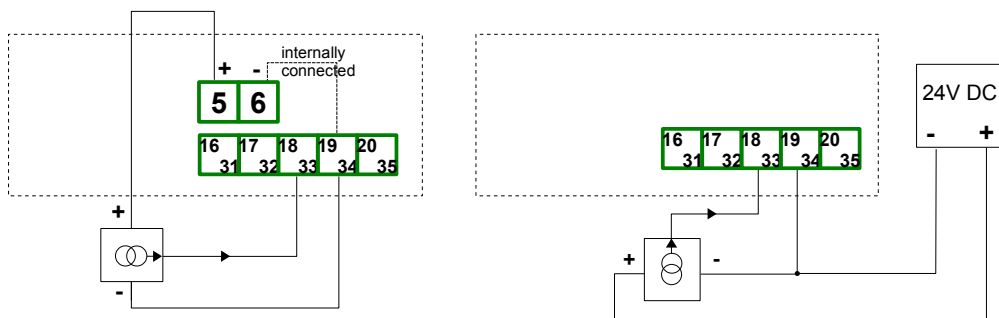


Figure 4.15. Connection of 3-wire current converters

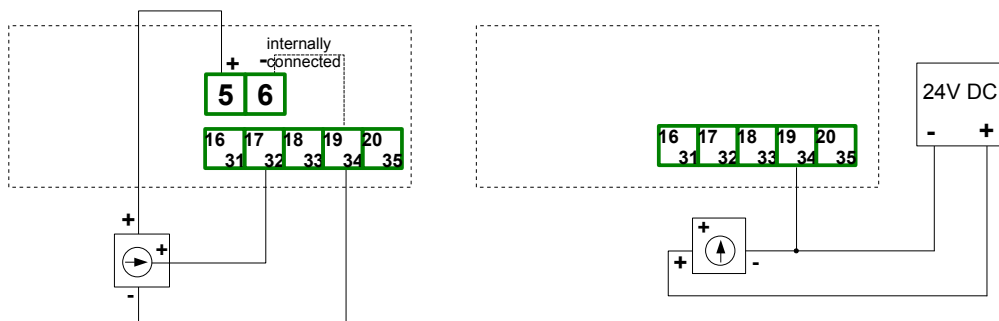


Figure 4.16. Connection of voltage converters

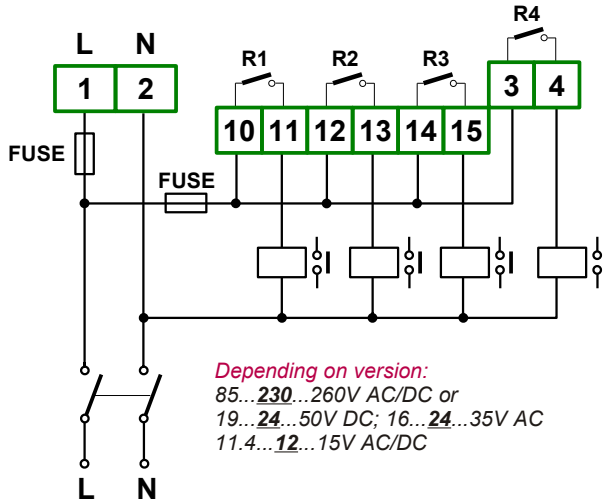


Figure 4.17. Connection of power supply and relays



Contacts of relay outputs are not equipped with spark suppressors. While use the relay outputs for switching of inductive loads (coils, contactors, power relays, electromagnets, motors etc.) it is required to use additional suppression circuit (typically capacitor 47nF/ min. 250VAC in series with 100R/5W resistor), connected in parallel to relay terminals or (better) directly on the load. In consequence of using the suppression circuit, the level of generated electromagnetic disturbances is lower, and the life of relay contacts rises.

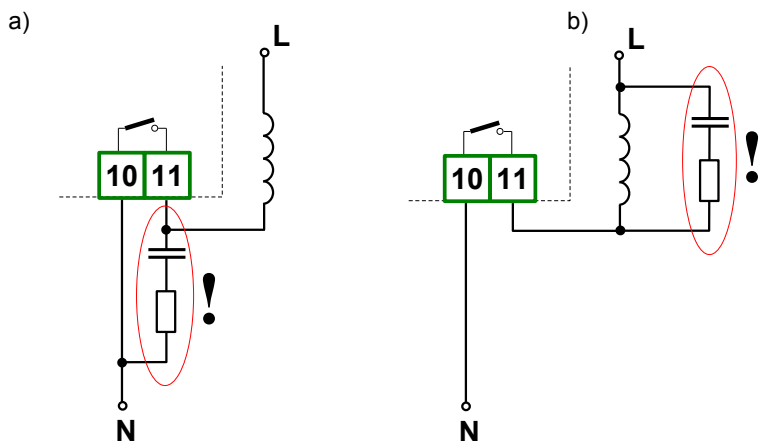


Figure 4.18. Examples of suppression circuit connection:
a) to relay terminals; b) to the inductive load

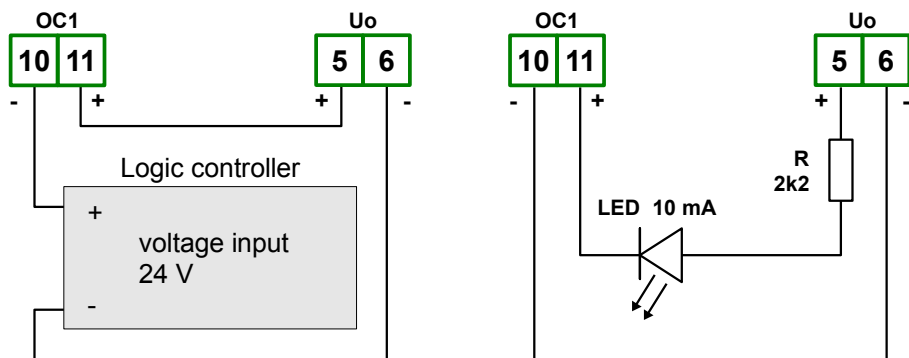


Figure 4.19. Example of OC-type outputs connection

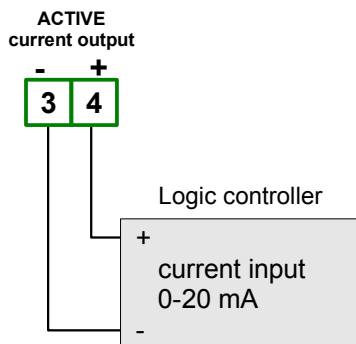


Figure 4.20. Example of active current outputs connection (for device with active current output only)

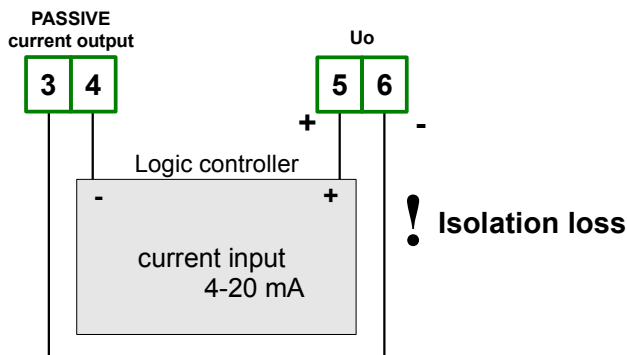


Figure 4.21. Example of passive current outputs connection (for device with passive current output only)

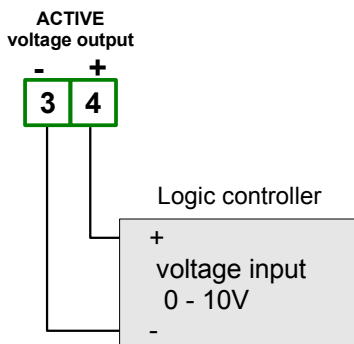


Figure 4.22. Example of active voltage outputs connection (for device with active voltage output only)

4.4. MAINTENANCE

The unit does not have any internal replaceable or adjustable components available to the user. Pay attention to the ambient temperature in the room where the unit is operating. Excessively high temperatures cause faster ageing of the internal components and shorten the fault-free time of the unit's operation.

In cases where the unit gets dirty do not clean with solvents. For cleaning use warm water with small amount of detergent or in the case of more significant contamination ethyl or isopropyl alcohol.



Using any other agents can cause permanent damage to the housing.



Product marked with this symbol should not be placed in municipal waste. Please check local regulations for disposal of electronic products.

5. FRONT PANEL DESCRIPTION



Symbols and functions of push-buttons:



Symbol used in the manual: **[ESC/MENU]**

Functions:

- Enter to main menu (press and hold by at least 2 sec.),
- Exit the current level and Enter to previous menu (or measure mode),
- Cancel the changes made in parameter being edited.



Symbol used in the manual: **[ENTER]**

Functions:

- Start to edit the parameter,
- Enter to the sub-menu,
- Confirmation of changes made in parameter being edited.



Symbol used in the manual: **[^] [v]**

Functions:

- Change of the present menu,
- Modification of the parameter value,
- Change of the display mode.

6. PRINCIPLE OF OPERATION

After turning the power supply on, device ID and software version are showed on the display, next the controller goes to the measurement mode.

6.1. MEASUREMENT MODE

In the measure mode, the measurement results, converted over selected characteristic, are displayed on the LED display. The measurement range equal to the nominal range is called: **nominal measurement range**, and the measurement range equal to the extended nominal range is called: **permissible measurement range** (Figure 6.1, 6.2).

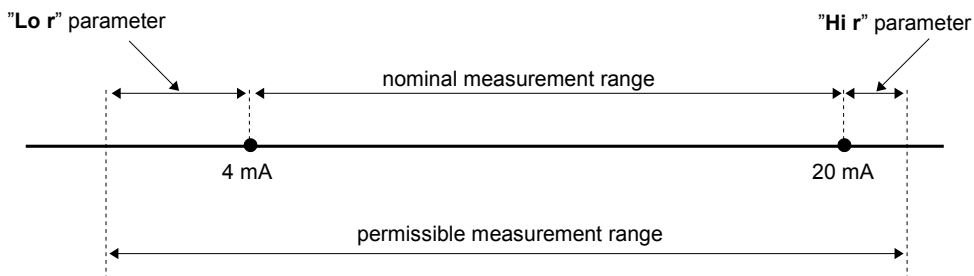


Figure 6.1. Definitions of measurement ranges in mode $4 \div 20\text{mA}$

If the result of measurement exceeds the **permissible measurement range**, warning "-Hi-" or "-Lo-" is displayed rather than input signal, depends on exceeded value (see description of "Lo r" and "Hi r" parameters, paragraph "inPt" menu).

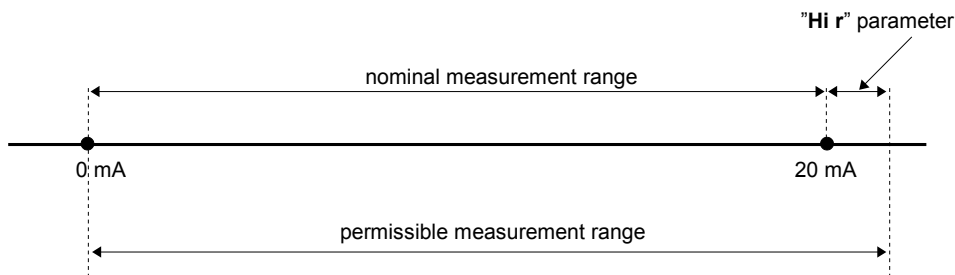


Figure 6.2. Definitions of measurement ranges in mode $0 \div 20\text{mA}$



If the measurement value does not exceed **permissible measurement range** but displayed value exceeds range $-999 \div 9999$, the warning "-Ov-" is displayed rather than the calculated result.

In the measurement mode user can check main thresholds values. After pressing [^] or [v] button, name of the threshold (e.g. "rEL1") and his value will be displayed on the display in alternating mode. If [^] or [v] will be pressed in 5 sec again, the next threshold will be displayed, else the device comes back to the measurement mode. If a **free access** is enabled (see description of "SECu" menu), user can change the value of particular threshold pressing button [ENTER] (see: **PARAMETERS EDITION**).

Input type, range of displaying values, characteristic of conversion, decimal point position and measure filtering ratio, are user configurable parameters. All accessible parameters can be changed by entering the menu (see: **DEVICE PROGRAMMING**). Use the local keyboard or the remote controller to do it. (Note: all parameters can be remote changed via RS-485 interface).



Configuration of the device (via menu or RS-485 interface)
does not stop measures.

6.1.1. Detection OF THE PEAK VALUES

The **SRP-94** meter is equipped with peaks detection function. It can detect a peaks of the input signal and display their values. Presets connected with this function are placed in **"HOLD"** menu (see description of **"HOLD" menu**). The detection of the peak can be done if the measured signal raises and drops of value at least equal to parameter **"PEA"**. Detected peaks are displayed during the time defined by parameter **"timeE"**. If a new peak will be detected while one is displayed, this new peak will be displayed and display time counter will be cleared (**Figure 6.3**).

If no peaks are detected while time **"timeE"** elapses, device starts to show the current value of input signal again. If **"HdiS"="HOLD"** then setting parameter **"timeE"=0.0** causes holding peak value until **[ESC]** button is pressed. If **"HdiS"="rEAL"** then value **"timeE"=0.0** means no holding. Displaying peak value is signalized by flashing most right decimal point.

The relays/LEDs and analogue outputs can be controlled depend on the current value of input signal or the peak value (see **"HOLD" menu**).

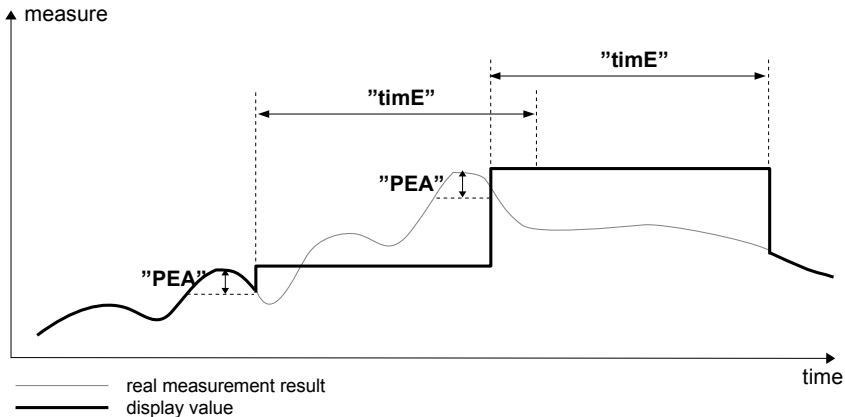


Figure 6.3. Process of peaks detection

6.2. CONTROL OF THE RELAY OUTPUTS

The control of the object (measured signal) is realized via relay outputs. Front panel LEDs named "R" indicates the state of particular relay output.



If device is not equipped with one or more relay outputs, menus referring to this relays are available, but apply to LED indicators only. In such case LEDs indicates exceeding of particular thresholds.

Relays can operate in various modes set by the "modE" parameter. Depending on the operating mode, relays may have different configuration parameters.

There are following operating modes: inactive, single-threshold, dual-threshold, alternating or with control via the RS-485 communication.

In single-threshold and dual-threshold modes, the operation of the relay output is defined using the following parameters: "SEtP", "SEt2", "HYSt", "modE", "t on", "toFF", "unit" and "AL".

In the "alternating" mode, the operation of the relay output is defined using the following parameters: "S1 u", "S2 u", "S1 d", "S2 d", "modE", "tAct", "tAun", "tmin", "dLy1", "dLy2", "AL 1" and "AL 2".

If one threshold is used (6.4) the relay can be turned on ("modE" = "on") or off ("modE" = "oFF") when the input signal value is contained in **zone A**. If two thresholds are used (6.5) the relay will be turned on when value of input signal is contained in **zone A** ("modE" = "in") or **zone B** ("modE" = "out") and turned off if the signal is contained in the second one.

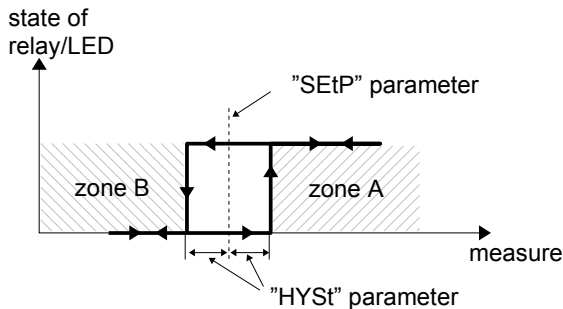


Figure 6.4. One threshold control of the relay/LED outputs

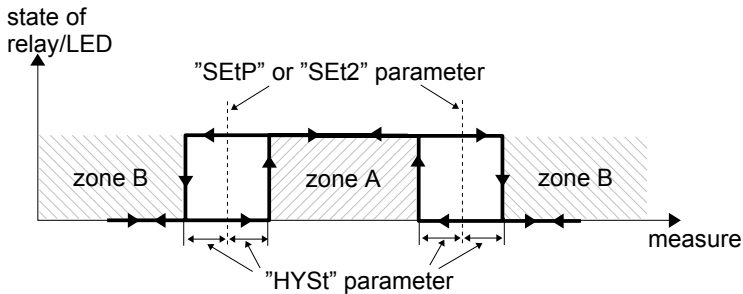


Figure 6.5. Two threshold control of the relay/LED outputs



The relay outputs and LEDs (named **R**) can be controlled depend on both - the current value and the peak value (when peak detection is active) of the input signal.

In the alternating mode, only two relays R1 and R2 can work and their settings are common and can be set from the "**rEL1**" menu. This mode can be activated by set the "**modE**" = "**ALtr**" or "**modE**" = "**ALtf**" parameter referring to increasing (rising) or decreasing (falling) the counter value. In the alternating mode, relays R1 and R2 work alternately according to the customized configuration.

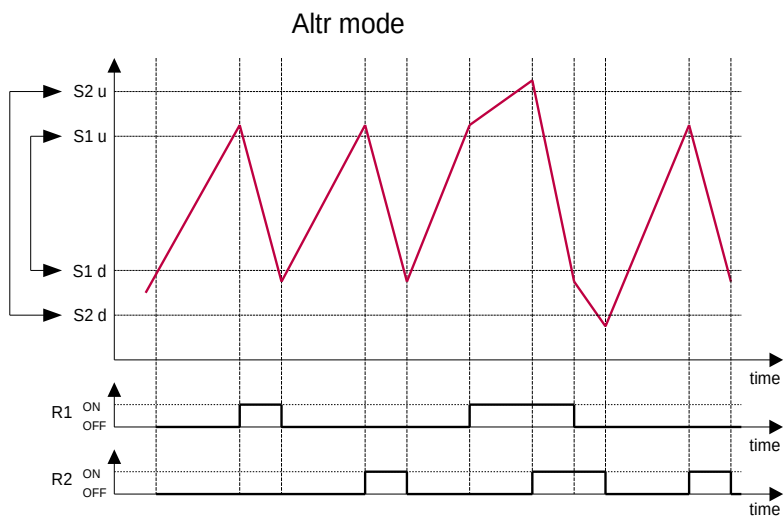
In the "**modE**" = "**ALtr**" (control of value increasing), the relay will be turned on when the value exceeds the threshold set in the "**S1 u**" parameter and will operate in this state until the value drops below "**S1 d**".

In the "**modE**" = "**ALtf**" (control of value decreasing), the relay will be turned on when the value drops below the threshold set in the "**S1 d**" parameter and will operate in this state until the value exceeds "**S1 u**".

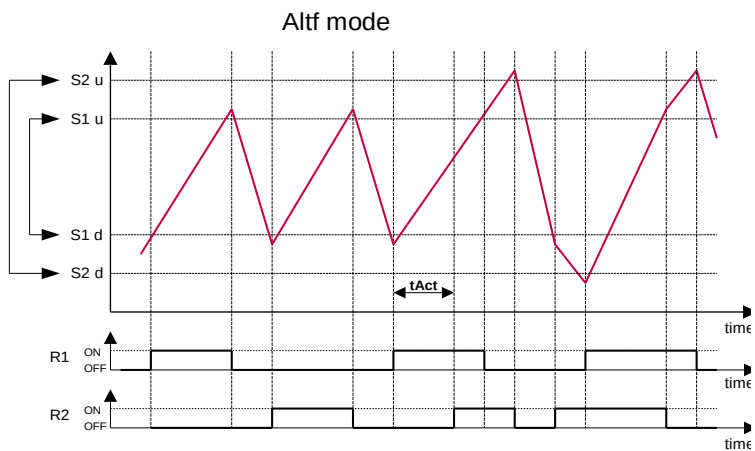
In both cases, a supporting (additional) relay can be joined to the currently operating (primary) relay when:

- the level of value exceeds "**S2 u**" (in "**ALtr**" mode), or
- the level of value drops below "**S2 d**" (in "**ALtf**" mode), or
- the operating time of current relay is longer than the time specified in the "**tAct**" parameter.

The operation of the relays in alternating mode is presented below.



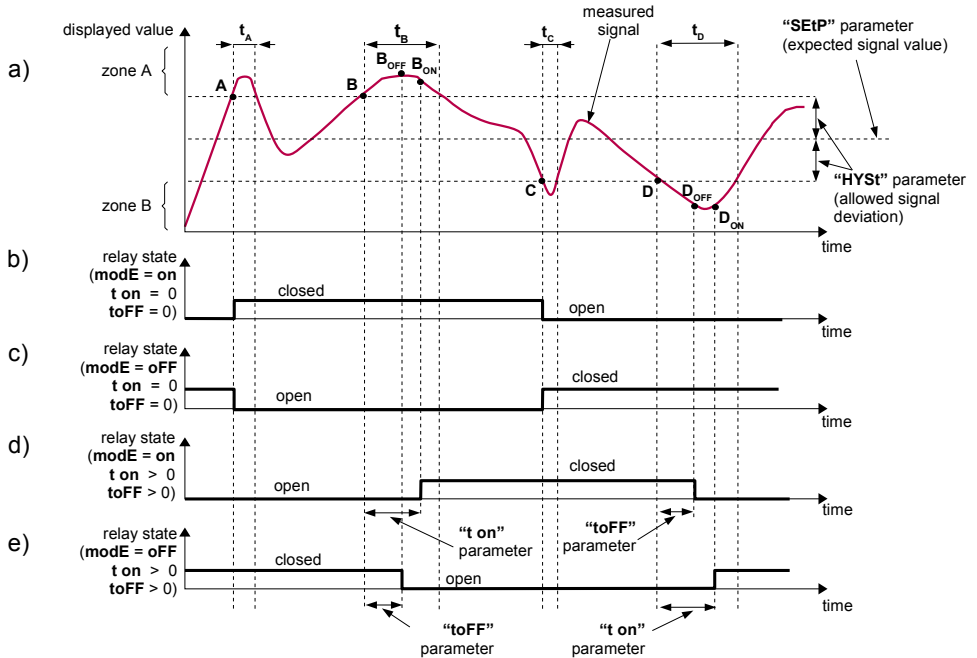
Rys. 6.6. Operation of relays in ALtr mode – control of value increasing



Rys. 6.7. Operation of relays in ALtf mode – control of value decreasing

6.2.1. One threshold mode

6.8 presents the principle of relay outputs operation for one threshold mode for an example values of other parameters.



Description:

A, B, C, D - points where measured signal exceeds border values (expected value $\pm$ allowed deviation)

B_{ON}, B_{OFF}, D_{ON}, D_{OFF} - relays state changes moments: (for "t on" > 0, "toFF" > 0)

t_A, t_B, t_C, t_D - time periods while input signal is in zone B or zone A

Figure 6.8. Principle of LED/relay output operation for one threshold mode

Parameter "SEtP" sets a **threshold** of the relay, and parameter "HYSt" sets a **hysteresis** of the relay (6.8a). The relay can change his state only when input value exceeds (over or under) border value and t_A, t_B, t_C, t_D times (6.8) are bigger than the time defined by parameters "t on", "toFF" and "unit". **Border values** means values equal **threshold+hysteresis** and **threshold-hysteresis** respectively.

If "t on" and "toFF" parameters are set to "0", then the relay state will be changed **as soon** as input value exceeds any of the **border values** (see points A and C, 6.8 a, b, c).

If values of "t on" or/and "toFF" are positive, then relay state will be turned on if the input value exceeds the **border values** and stay bigger (or lower) during at least "t on" (see points B_{ON}, D_{ON}, 6.8 a, d, e). Similarly, the relay will be turned off if time "toFF" elapse since the input signal value exceeds any of the **border values** (see points B_{OFF}, D_{OFF}, 6.8a, d, e).

If time t_A, t_B, t_C, t_D (when input signal stay in **zone A** or **zone B**) are lower than parameters "t on" or "toFF", the relay will not change his state (see points A and C, 6.8 a, d, e).

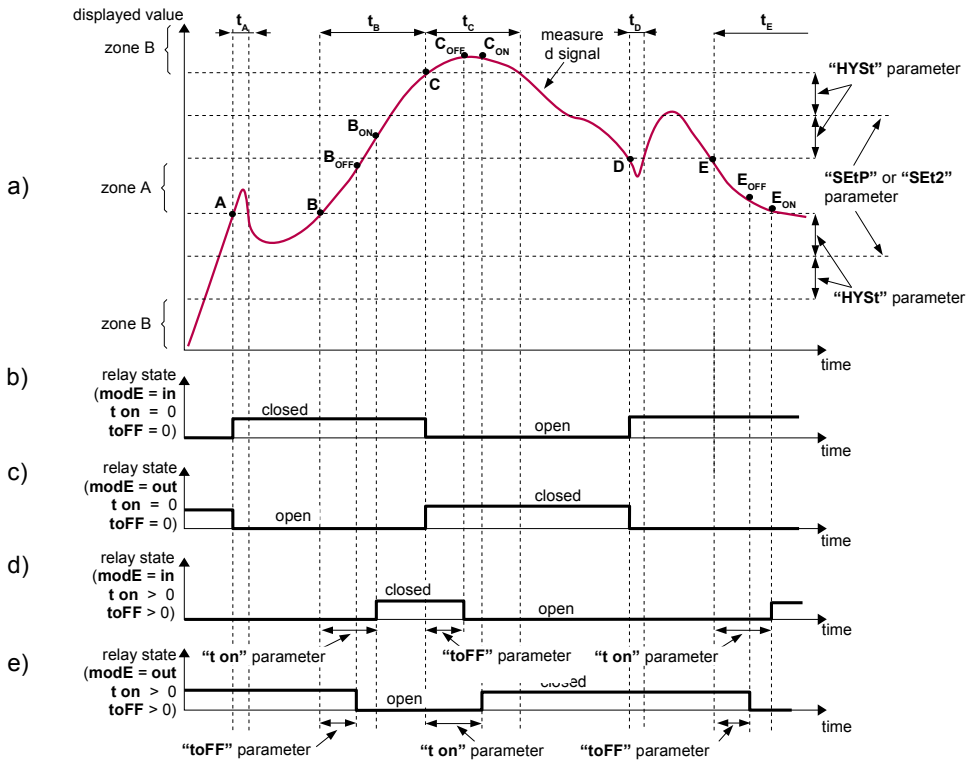
The state of relay output while the input value exceeds the **border values** (points A,

B, C, D) is described by parameter “**mode**”. The relay can be turned on (“**mode**” = “**on**”), or turned off (“**mode**” = “**off**”) when input signal value is contained in **zone A** (6.8a).

The parameter “**AL**” allow user to set the relay output behaviour in critical situations (e. g. input values exceeds **permissible measurement range**). User can select that the relays will be turned on, turned off, or not changed in critical situations.

All parameters connected with relay outputs are described in paragraph 7.3.1. “**rEL1**” menu.

6.2.2. Two thresholds mode



Objaśnienie:

A, B, C, D, E
allowed deviation)

- points where measured signal exceeds border values (expected value $\pm$

B_{ON}, B_{OFF}, C_{ON}, C_{OFF}, E_{ON}, E_{OFF}

- relays state changes moments: (for “t on” > 0, “toFF” > 0)

t_A, t_B, t_C, t_D, t_E

- time periods while input signal is in zone A or zone B

Figure 6.9. Principle of LED/relay output operation for two thresholds mode

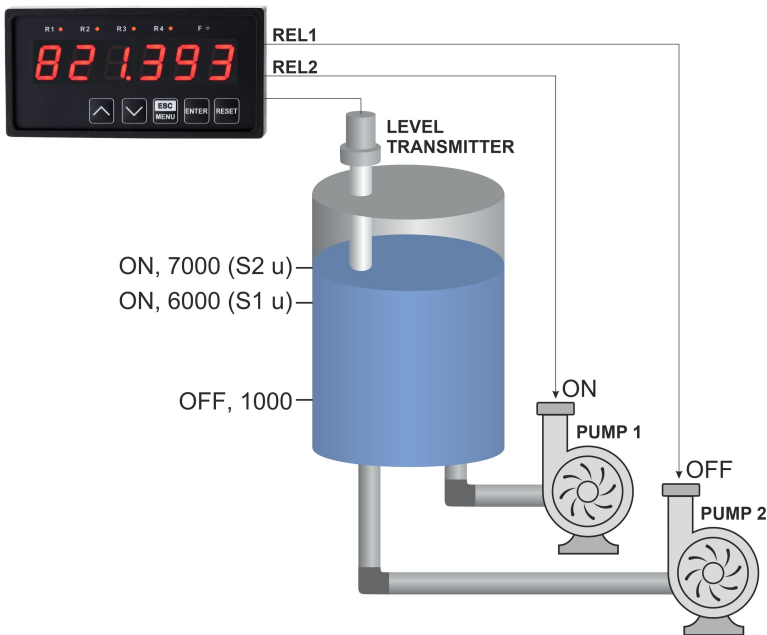
6.9 presents the principle of relay outputs operation for two thresholds mode for an example values of other parameters. In this mode parameter “SEt2” is accessible in common with “SEtP”, this parameter describes a second threshold of the relay output. The parameters “HYSt”, “modE”, “t on”, “toFF”, “unit” and “AL” are connected with both “SEtP” and “SEt2” thresholds. While the controlling process, the relay output changes his state depends of both “SEtP” and “SEt2” thresholds in similar way as it was described in one threshold mode.

If two threshold mode is used, “modE” parameter defines state of the relay output when the input value occurs in a particular zone defined by **border values** of both **thresholds**. The relay can be turned on if the input value is contained in **zone A** (“modE” = “in”) or **zone B** (“modE” = “out”) and turned off if it is contained in the second one (6.9).

i The sequence of thresholds “SEtP” and “SEt2” can be set in any order, due to the control of relay outputs is done depend on difference between thresholds values (**zone A**) and outside of threshold values (**zone B**).

6.2.3. Alternating relays mode

The principle of operation of the alternating mode is presented on the example of pump control in the configuration as shown in the figure below.



Rys. 6.10. Example of using a device to control pumps

The purpose of the example configuration is to control increasing of the liquid level from 1000 to 6000 liters. The pumps should operate alternately and in the case of exceeding the level of 7000 liters of liquid, both should turn on and operate until the liquid is pumped out of the tank below 1000 liters.

In the "rEL1" menu, the "modE" = "ALtr" parameter was set – corresponding to the operation of REL1 and REL2 relays in alternating mode with control of increasing the counter value.

The first relay activation threshold was set to "**S1 u**" = 6000 and the pump deactivation threshold was set to "**S1 d**" = 1000. That configuration causes that the pumps operate alternately in this range.

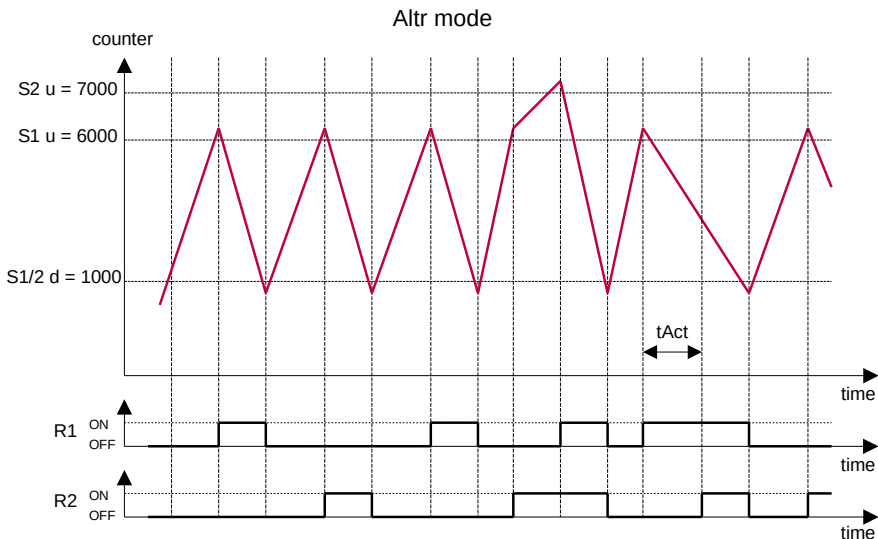
Additionally, a second threshold was set to "**S2 u**" = 7000, which exceeding causes the additional pump will also be turned on to support the currently working one. The deactivation threshold of the additional pump was set to "**S2 d**" = 1000 ("**S1 d**" = "**S2 d**").



The "**S1 d**" value equal to "**S2 d**" value in "ALtr" mode or "**S1 u**" value equal to "**S2 u**" value in "ALtr" mode protects the system against possible errors of incorrect parameter configuration related to the delay times of turning on or off relays.

In addition to the basic parameters, the parameter "**tAct**" = 100 and its unit "**tAun**" = "SEC" were set, responsible for securing the configuration against too long operation of a single pump. After 100 seconds an additional pump will join to the currently operating pump and will operate until the "**S2 d**" level is reached.

The waveforms showing how an example system works are shown in the picture below.



Rys. 6.11. The waveform showing how an example system works

Description of operation

After starting the device, both relays controlling the pumps are turned off (R1/R2 = OFF). The counter monitors rising the level of liquid in the tank. When the counter threshold "**S1 u**" = 6000 is exceeded, relay R1 starts the pump and the liquid is pumped out until the counter value is below "**S1 d**" = 1000 when the pump will turn off.

When the counter threshold "**S1 u**" = 6000 is reached again, the relay controlling working of the second pump will be turned on and works until the level "**S1 d**" = 1000 is reached when the pump will turn off. The pumps operate alternately between the "**S1 u**" and "**S1 d**" thresholds.

While the relay R2 is on and the pump that pumping the liquid out of the tank was not efficient enough to pump it out, the counter reaches a value exceeds the "**S2 u**" = 7000 level. It caused that the R1 relay controlling working of unused pump will also turn on. Both pumps work until the counter exceeds the "**S1 d**" = "**S2 d**" = 1000 value.

While the relay R1 is on again and its pump is working for a time little longer than defined in the "**tAct**" = 100 parameter, it causes turn on the R2 relay controlling the second pump. Both pumps work until the counter falls below the "**S1 d**" = "**S2 d**" = 1000 value.



In the case of inadequate pump efficiency it may happen that the primary pump may be unable to pump out the liquid for a long time. In such a situation, after "**tAct**" time, the additional pump will be switched on and will work until the "**S2 d**" level is reached. In an extreme situation, when "**S2 d**" < "**S1 d**", it may happen that after turning off the additional pump, the primary pump will still be unable to reach its turning-off "**S1 d**" level. The protection against such a situation is to set the turning-off thresholds "**S1 d**" = "**S2 d**" in the "**ALtr**" mode and "**S1 u**" = "**S2 u**" in the "**ALtr**" mode.

The device provides additional protections for the operation of relays/pumps, which can be used by the user:

- protection against too fast turning on and off of relays/pumps "**tmin**", which defines the minimum duration after which the additional pump will be turned on,
- protection against turning on both relays/pumps at the same time "**dLy 1**", which defines the minimum interval between turning them on,
- protection against turning off both relays/pumps at the same time "**dLy 2**", which defines the minimum interval between turning them off,
- possibility of defining the behavior of the relays in the case of critical state "**AL 1**" (first relay) and "**AL 2**" (second relay).

7. DEVICE PROGRAMMING

The device menu allows user to set all parameters connected to operation of measurement input, control modes, critical situations behaviour, communication via RS-485 and access settings. The meaning of the particular parameters is described in chapter 7.3. MENU DESCRIPTION.

Some of the parameters can be accessed without entering menu (quick view mode). After pressing [**^**] or [**v**] button, name of the threshold (e.g. "**rEL1**") and its value will be displayed on the display in alternating mode. If [**^**] or [**v**] will be pressed in 5 sec again, the next threshold will be displayed, else the device returns to the measurement mode. If a **free access** is enabled (see chapter 7.3.7. "**SECu**" menu), user can change the value of selected threshold by pressing [**ENTER**] button (see chapter 7.2. PARAMETERS EDITION).



If particular parameter has been changed and confirmed in quick view mode, its new value is displayed in alternating mode with parameter name by few seconds.

Confirmed changes may be checked or user can switch viewed parameter pressing [^] or [v] button.

7.1. PROGRAMMING MENU

To enter main menu (being in the measurement mode) user must to press and hold at least 2 sec. [ESC/MENU] button.

If the user password is defined (see parameter “Scod“, menu “**SECU**”), operator have to enter correct one before proceeding to menu options . Entering of the passwords is similar to the edition of numeric parameters (see chapter **7.2. PARAMETERS EDITION**), however presently editing digit is showed only on the display, other digits are replaced by “-” sign. After entering of last digit of the password first menu position will be displayed (if the password is correct) or warning “**Err**” in other case.



Pay attention when device parameters are being changed. If it is possible, turn off controlled installation (machine).

Functions of the buttons while sub-menu and parameters choice:

Selection of sub-menu or parameter for editing. Name of selected item (sub-menu or parameter) is displayed.



Operation of **[ENTER]** button depend on present menu position:

- if the name of some sub-menu is displayed - enter this sub-menu; name of the first parameter (or next level sub-menu) is displayed,
- if the name of some parameter is displayed - enter the edition of this parameter; present value of the parameter is displayed.



[ESC/MENU] button allow user to exit present menu level and goes to upper level menu (or measurement mode).



After about 1 min. since last use of the buttons, device exits the menu mode and returns to the measurement mode (only if no parameters are in editing mode).

7.2. PARAMETERS EDITION

To start edition of any parameter user should select name of desired one using **[^]** **[v]** buttons and then press **[ENTER]**.

7.2.1. Numeric parameters (digit change mode)

Numerical parameters are displayed as decimal numbers. The mode of its new value entering depends on chosen edit method (see parameter „**Edit**“).

In mode “by digit” (“**Edit**”=“**dig**”) pressing one of the keys **[^]** or **[v]** causes change of current position (flashing digit) or the sign (+/-). Short pressing of the **[ENTER]** button causes change of the position (digit).

Press **[ENTER]** at least 2 seconds to accept the changes, after that question “**SEt?**” is displayed, and user must to confirm (or cancel) the changes. To confirm changes (and store it in EEPROM) press **[ENTER]** button shortly after “**SEt?**” is displayed. To cancel the changes press **[ESC]** button shortly after “**SEt?**” is displayed. After that device returns to the menu.

7.2.2. Numeric parameters (slide change mode)

In “slide change” mode (“**Edit**”=“**Slid**”), buttons **[^]** and **[v]** has different functions.

To increase edited value press (or press and hold) **[^]** button only. The increasing became quickest as long as button **[^]** is pressed. To slow down the increasing, button **[v]** can be used. If **[v]** is pressed shortly (and button **[^]** is still pressed), increasing slow down for a moment only, if **[v]** is pressed and held while button **[^]** is still pressed the increasing slow down and will be kept on lower speed.

To decrease edited value press (or press and hold) **[v]** button only. The decreasing became quickest as long as button **[v]** is pressed. To slow down the decreasing, button **[^]** can be used. If **[^]** is pressed shortly (and button **[v]** is still pressed), decreasing slow down for a moment only, if **[^]** is pressed and held while button **[v]** is still pressed the decreasing slow down and will be kept on lower speed.

Press **[ENTER]** at least 2 seconds to accept the changes, after that question **"Set?"** is displayed, and user must to confirm (or cancel) the changes. To confirm changes (and store it in EEPROM) press **[ENTER]** button shortly after **"Set?"** is displayed. To cancel the changes press **[ESC]** button shortly after **"Set?"** is displayed. After that device returns to the menu.

7.2.3. Switch parameters ("LIST" type)

Switch parameters can be described as a sets of values (a lists) out of which only one of the options available on the list can be selected for the given parameter. Options of switching parameter are selected using **[^]**, **[v]** keys.

Short pressing of **[ENTER]** causes in displaying of the acknowledge question **("Set?")**. If key **[ENTER]** is pressed again, the changes are accepted, stored in EEPROM and the edition process finished. Pressing the key **[ESC]** after **"Set?"** causes in cancelling of made changes and returning to menu.

Functions of buttons when editing numeric and switching parameters:



While editing numeric parameter:

- change of current (flashing) digit,
- slide change of value (acceleration, deceleration, direction change).

While editing switch parameter - selection of switch parameter.



If numerical parameter is being edited, a short press of **[ENTER]** button change edited position. A long press of **[ENTER]** button (at least 2 sec.) causes of display a **"Set?"** ask, which allow user to make sure if change of the parameter value is correct. If switch parameter is being edited, a short press of **[ENTER]** button causes of display a **"Set?"** ask. When **[ENTER]** button is pressed again (while **"Set?"** is displayed) the new value of the parameter is stored in EEPROM memory.



Pressing this button operator can cancel the changes done up to now (if they were not approved by **[ENTER]** button after the **"Set?"** ask) and come back to menu

7.3. MENU DESCRIPTION

"- - - -"

- password checking. If some password different from **"0000"** is set, then every enter to main menu follows the entering of password. If entered password is correct then first menu position will be displayed else warning **"Err"**, and unit returns to measurement mode.



Due to problem with direct displaying of **"m"** and **"K"** letters, they are exchanged with special signs **"ñ"** for **"m"** and **"┌"** for **"K"** respectively. However, in user manual letters **"m"** and **"K"** are used to make it more readable (example: **"modE"**, **"tc K"**).

7.3.1. "rEL1" menu

This menu allows to configure the operation mode of relays and LEDs marked „R" (e.g. „R1").

If there are few relay outputs available, then every output has its own configuration menu (e.g. menu "rEL2" for relay (LED) "R2").

An exception to this rule is the alternating mode ("modE" = "ALtr" or "ALtf"). Enabling this mode in the "rEL1" menu links the settings of relays "R1" and "R2" in the same menu.

Principle of the relays operation is described in paragraph **CONTROL OF THE RELAY OUTPUTS**.



- The relay outputs and LEDs (named R) can be controlled depending on both - the current value and the peak value (when peak detection is active) of the input signal.
- If device is not equipped with one or more relay outputs, menus referring to this relays are available, but apply to LED indicators only. In such case LEDs indicates exceeding of particular thresholds.

"SEtP" - first threshold of the relay (range -999 ÷ 9999). Negative values can be input by selecting a "-" sign on first digit (to change value use [^] and [v] buttons). **Threshold is the medium value of relay hysteresis.**

"SEt2" - second threshold of the relay (range -999 ÷ 9999). Negative values can be input by selecting a "-" sign on first digit (to change value use [^] and [v] buttons). This threshold is accessible when "modE" parameter is set to "in" or "out" value. **Threshold is the medium value of relay hysteresis.**

"HYSt" - hysteresis of relay (range 0 ÷ 999). Full hysteresis of the relay is equal to 2 times "HYSt" parameter. The relay state can change when an input signal is out of **threshold-hysteresis** to **threshold+hysteresis** zone.



Presented parameters should be set to ensure that "SEtP" + "HYSt", "SEt2" + "HYSt", "SEtP" - "HYSt" or "SEt2" - "HYSt" does not exceed the measure range. Additionally, in two threshold mode ("modE" = "in" or "out"), the hysteresis for both thresholds must not cover each other (in other case relay can't change his state).

"modE" - relay operation mode:

- "noAC"** - the relay is not active (permanent turned off)
- "on"** - one threshold mode, the relay is turned **ON** when input signal exceeds **SEtP + HYSt** value, and is turned off back when the input signal became lower than **SEtP - HYSt**,
- "oFF"** - one threshold mode, the relay is turned **OFF** when input signal exceeds **SEtP + HYSt** value, and is turned on back when the input signal became lower than **SEtP - HYSt**,
- "in"** - two threshold mode, the relay is turned **ON** when the input signal is bigger than "**lower threshold + HYSt**" and lower than "**bigger threshold - HYSt**", and turned off when the input signal is contained in the second zone. The **bigger threshold** means bigger one of "SEtP" and "SEt2"

thresholds, the **lower threshold** means lower one of “SEtP” and “SEt2” thresholds.

- “out” - two threshold mode, relay is turned **ON** when the input value is bigger than “**bigger threshold + HYSt**” and lower than “**lower threshold – HYSt**”, and turned on when the input signal is contained in the second zone. The **bigger threshold** means bigger one of “SEtP” and “SEt2” thresholds, the **lower threshold** means lower one of “SEtP” and “SEt2” thresholds.
- “ALtr” - alternating mode of relays R1 and R2 with control of incrementing the counter value,
- “ALtf” - alternating mode of relays R1 and R2 with control of decrementing the counter value,
- “modb” - the relay is controlled via RS-485 interface, independently on the input signal.



- **LEDs light when relays are closed**, independently of relays' mode.
- When power supply fail, unit do not store relays state selected by RS-485 interface.

“t on” - turn on delay time, the relay is turned on with delay equal “t on” if the input value exceeds appropriate **border value** (defined with **threshold** and **hysteresis**), at least “t on” time. “t on” range 0 ÷ 99.9, defined with 0.1 sec. resolution. Unit of this parameter is set by “unit” parameter.

“toFF” - turn off delay time, the relay is turned off with delay equal “toFF” if the input value exceeds appropriate **border value** (defined with **threshold** and **hysteresis**), at least “toFF” time. “toFF” range 0 ÷ 99.9, defined with 0.1 sec. resolution. Unit of this parameter is set by “unit” parameter.



If time when the input signal exceeds some border value is shorter than “t on” or “toFF” time, the relay do not change its state (see paragraph: **CONTROL OF THE RELAY OUTPUTS**).

“unit” - unit of time for “t on” and “toFF” parameters. Can be set on one of two values:

- “min” - minutes,
- “SEC” - seconds.

“AL” occurs: - this parameter defines the relay reaction when some critical situations occurs:

- “noCH” - relay do not change its state,
- “on” - relay will be turned on,
- “oFF” - relay will be turned off.

If parameter “modE” is set to “on”, “oFF”, “in” or “Out” the “critical situation” means that allowable measurement range is exceeded.

If parameter “modE” is set to “modb”, the “critical situation” means communication delay (when no data is received) longer than “mbtO” parameter (see description: “rS” menu).



- If option **"noCH"** is selected for **"AL"** parameter, behaviour of the relay may depend on **"FiLt"** parameter in some cases. If **"FiLt"** is set to big value and the input signal drops, result value of the measure will change slow, causes of turning on or off relay due to thresholds values. The critical situation is slowly detected, so it is impossible to predict the relay state in that situations.
- If parameter **"AL"** = **"on"**, the relay will be turned on in the critical situations, even if his parameter **"modE"** = **"noAC"**.

Parameters available in the alternating mode of relays R1 and R2:

- "S1 u"** - parameter defines the first upper threshold for switching relays. In the **"ALtr"** operating mode, it means that above this value the primary relay will be turned on. In the **"ALtf"** operating mode, it means that above this value the primary relay will be turned off,
- "S1 d"** - parameter defines the first lower threshold for switching relays. In the **"ALtr"** operating mode, it means that below this value the primary relay will be turned off. In the **"ALtf"** operating mode, it means that below this value the primary relay will be turned on,



In alternating mode, relays R1 and R2 operate alternately in the range of values from **"S1 d"** to **"S1 u"**. Depending on the operating mode **"ALtr"** and **"ALtf"**, they are alternately turned on and turned off:

"ALtr" - the relay will be turned on at the **"S1 u"** value and turned off at **"S1 d"**,
"ALtf" - the relay will be turned off at the **"S1 d"** value and turned on at **"S1 u"**.

- "S2 u"** - parameter defines the second upper threshold of switching the additional relay supporting the operation of the primary relay. In the **"ALtr"** operating mode, it means that above this value the second relay will be joined to the currently operating primary relay. In the **"ALtf"** operating mode, it means that above this value the primary relay will be turned off,
- "S2 d"** - parameter defines the second lower threshold of switching the additional relay supporting the operation of the primary relay. In the **"ALtr"** operating mode it means that above this value the joined second relay will be turned off. In the **"ALtf"** operating mode it means that below this value the primary relay will be turned on
- "tAct"** - parameter defines the maximum operating time of the primary relay. After exceeding this time, the second relay will be joined to the primary relay.
- "tAun"** - unit for **"tAct"** parameter,
- "tmin"** - parameter defines the minimum duration for which the second relay will operate with the current one,
- "dLy1"** - parameter defines the minimum time interval between turning on both relays,
- "dLy2"** - parameter defines the minimum time interval between turning off both relays,
- "AL 1"** - parameter defines the method of reaction to a critical situation for R1 relay,
- "AL 2"** - parameter defines the method of reaction to a critical situation for R2 relay.

For **"AL 1"** i **"AL 2"** parameters there are 3 options:

- "noCH"** - relay do not change its state,
"on" - relay will be turned on,
"oFF" - relay will be turned off.

7.3.2. "bEEP" menu

This menu contains options connected with acoustic signal :

- "AL" - if this parameter is set to "on", any critical situation causes by acoustic signal
- "r1" - if this parameter is set to "on", activation of relay **R1** causes by acoustic signal
- "r2" - if this parameter is set to "on", activation of relay **R2** causes by acoustic signal
- "r3" - if this parameter is set to "on", activation of relay **R3** causes by acoustic signal
- "r4" - if this parameter is set to "on", activation of relay **R4** causes by acoustic signal



Acoustic signal (turned on by e.g. relay) can be turned off by pressing of any button

7.3.3. "inPt" menu

This menu presets the measurement input:

- "tYPE" - type of the input / sensor. This parameter can be set to values:

"0-20", "4-20" - current inputs.
 "0-10", "2-10", "0-5", "1-5" - voltage inputs.

Displayed values are defined by parameters "Lo C", "Hi C" (or by user defined characteristic points) and parameter "Pnt".

- "CHAR" - this option presets type of the conversion characteristic, and can be set to:

"Lin" - linear "Sqr" - square "Sqrt" - square root	}	When one of those characteristics is chosen display range is defined by "Lo C" and "Hi C".
--	---	--

- "USER" - user defined characteristic. Maximal length 20 points. Every point is defined by user. Adding, Editing and Deleting of points is done by options „AddP“, „EdtP“, „dELP“ („InPt“ menu) respectively.

"tn v" - volume characteristics of a cylindrical tank in the vertical position, determined by parameters: „t h1“, „t h2“, „t h3“, „t d“, „t Sn“, „t Sh“ in „InPt“ menu (see below for details of the parameters),

"n h" - volume characteristics of a cylindrical tank in the horizontal position, determined by parameters: „t h1“, „t h2“, „t h3“, „t d“, „t Sn“, „t Sh“ in „InPt“ menu (see below for details of the parameters).



If user defined characteristic is selected, and if number of defined points is lower than 2 then warning "Errc" is displayed in measurement mode.

The process of displayed result calculation is described in details in **DISPLAY VALUES CALCULATION** paragraph.

- "FilT" - this parameter sets filtration rate. It can be set to values from 0 (no filtration) to 5 (strongest filtration – time window about 2 sec).

- "Pnt" - decimal point position. It can be set to one of:

" 0", " 0.0", " 0.00", "0.000"

Decimal point position is changed by [^], [v] buttons.

“Lo C” These parameters describe the values displayed for minimum and maximum input signal value for selected input type. For example, if input type is set to 4-20 mA **“Lo C”** parameter defines the value displayed when input current is equal 4 mA, and **“Hi C”** parameter defines the value displayed for 20 mA of input current. Available range for these parameters: -999 ÷ 9999. Negative values can be set by entering '-' sign on the first position (by use of **[^]**, **[v]** buttons).



If volume characteristics of a cylindrical tank is selected (parameter **“CHAR”** = **“tn v”** or **“CHAR”** = **“tn h”**) the parameters **„Lo C”** and **„Hi C”** are not available.

„t h1”, „t h2”, „t h3”, „t d” - the parameters defining shape of cylindrical tank (Figure 7.1 and Figure 7.2).

a) for the cylindrical tank in the vertical position:

- „t h1”** - the height of the bottom part of a tank (in the elliptic paraboloid shape), this parameter has the fixed precision - 2-decimal point,
- „t h2”** - the height of the middle part of a tank in the cylindrical shape, this parameter has the fixed precision - 2-decimal point,
- „t h3”** - the height of the top part of a tank (in the elliptic paraboloid shape), this parameter has the fixed precision - 2-decimal point,
- „t d”** - the diameter of the middle part of a tank, this parameter has the fixed precision - 2-decimal point,

b) for the cylindrical tank in the horizontal position:

- „t h1”** - the length of the left bottom of a tank (in the elliptic paraboloid shape), this parameter has the fixed precision - 2-decimal point,
- „t h2”** - the length of the middle part of a tank in the cylindrical shape, this parameter has the fixed precision - 2-decimal point,
- „t h3”** - the length of the right bottom of a tank (in the elliptic paraboloid shape), this parameter has the fixed precision - 2-decimal point,
- „t d”** - the diameter of the middle part of a tank, this parameter has the fixed precision - 2-decimal point,
- „t Sn”, „t Sh”** - parameters defining the length and position of the sensor used to measure level of liquids, gases or solids in the tank (Figure 7.1, 7.2).
- „t Sn”** - distance between end of the sensor and bottom of the tank, this parameter has the fixed precision 2-decimal point but the unit is 100 times smaller than **“t Sh”** (see Info below),
- „t Sh”** - the measuring range, this parameter has the fixed precision - 2-decimal point.



- The unit value of "**t Sn**" parameter is 100-fold less than the unit value of other parameters defining cylindrical tank, i.e. if we set value 10.00 in "**t Sh**" parameter and set value 08.00 in "**t Sn**" parameter this mean that value of "**t Sn**" parameter is real has 00.08 value in preserved unit of the "**t Sh**" parameter.
- If we set parameters of tank in [m] unit ("**t Sn**" parameter takes [cm] unit respectively, see above), than displays the result the volume of the tank in [m³] unit, if we set parameters of tank in [cm] unit ("**t Sn**" parameter takes [mm] unit respectively, see above), than displays the result the volume of the tank in [cm³] unit.
- "**t Sh**" parameter may be greater than height (for vertical position) or diameter (for horizontal position) of the tank, which means that the total volume of the tank can be achieved by eg. such middle-current range,
- If the measurement value does not exceed permissible measurement range but displayed value exceeds range of 9999 than you can move to the right position of the decimal point if it is still possible (see parameter Menu->"**inPt**"->"**Pnt**").
- If in the volume characteristics of a cylindrical tank is exceeded the value of the volume of the tank sets by parameters available in menu "**inPt**" instead of the calculated result will be display warning "-Hi-".

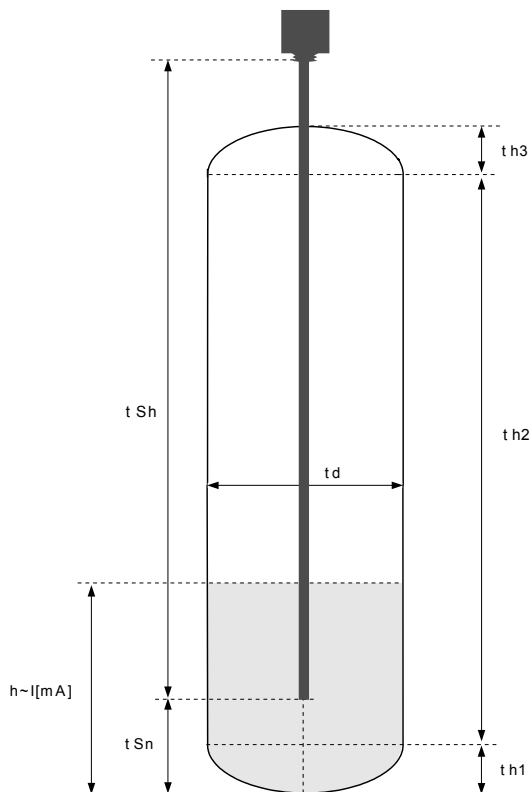


Figure 7.1 Parameters of cylindrical tank in vertical position.

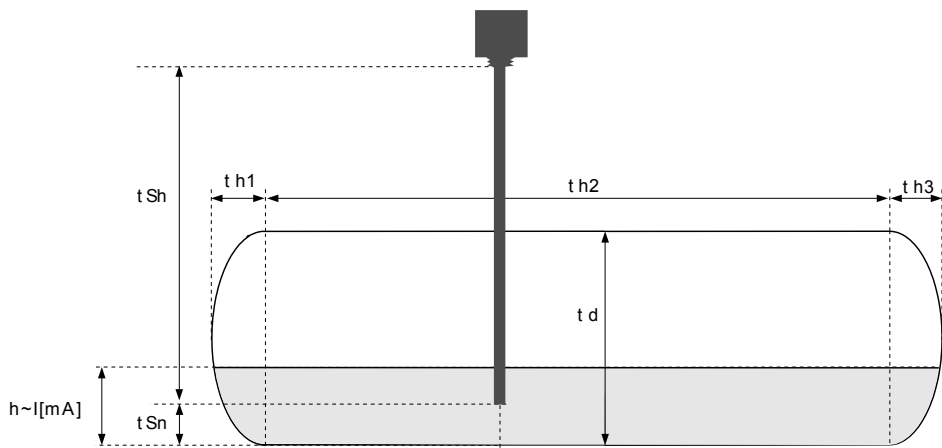


Figure 7.2 Parameters of cylindrical tank in horizontal position.



If user defined characteristic is selected (parameter “**CHAR**” = “**USER**”) the parameters „**Lo C**” and „**Hi C**” are not available for modification, due to their values are calculated from defined characteristic.

“AddP”

- this menu allow user to add single point to the user defined characteristic.

After selection of this option device waits for „**X**” and „**Y**” coordinates of new point. Modification of the coordinates is done accordingly to numerical parameters edition. Coordinate „**X**” defines the percentage ratio of input current to selected current range. The „**X**” range: $-99,9 \div 199,9$. Coordinate „**Y**” defines displayed value for particular „**X**” value. The „**Y**” value can be changed in range: $-999 \div 9999$, decimal point position depend on „**Pnt**” parameter (menu “**inPt**”).



- User can not enter two points with the same value of „**X**” coordinate. If user trays to do it, “**Err**” warning is displayed. To modify any defined point use “**EdtP**” option.
- To distinguish „**X**” and „**Y**” coordinates, if „**X**” coordinate is displayed an additional decimal point on utmost right position is displayed.
- If user defined characteristic is selected, and if number of defined points is lower than 2 then warning “**Errc**” is displayed in measurement mode.

“dELP”

- this option allows user to delete any of the points of the user defined characteristic. After selection current number of points of the user defined characteristic is displayed for about approx. 1.5 sec. After that device waits for selection of point being deleted (by [**^**], [**v**] buttons). The short pressing of [**ENTER**] button causes by switching between **X** and **Y** value of the displayed point. The long press (press and hold at least 2 sec) of [**ENTER**] button causes by displaying „**dEL?**” ask. If [**ENTER**] button is pressed again, current point is deleted and new updated number of points of the user defined characteristic is displayed.

“EdtP”

- this option allows user to modify of particular point of the user defined characteristic. After selection current number of points of the user defined characteristic is displayed for about approx. 1.5 sec. After that device waits for selection of point being edited (by [**^**], [**v**] buttons). The short pressing of [**ENTER**] button causes by switching between **X** and **Y** value of the displayed point. The long press (press and hold at least 2 sec) of [**ENTER**] button causes by entering to edit the selected coordinate of the point. Modification of the coordinates is done accordingly to numerical parameters edition.



“**AddP**”, “**dELP**” and “**EdtP**” options are available only if the user defined characteristic is used (it means when parameter “**CHAR**” = “**USER**”).

“Lo r”, “Hi r”

- these parameters define the expansion of nominal range in percent. They determine the permissible range of input signal (Figure 7.3).

The permissible range allow user to exceed the **nominal range** of input signal. If input value is contained in the permissible range a proper result is displayed. If input signal exceeds this range (defined by “**Lo r**” and “**Hi r**”), “**-Lo-**” or “**-Hi-**” warning is displayed depend on input signal value.

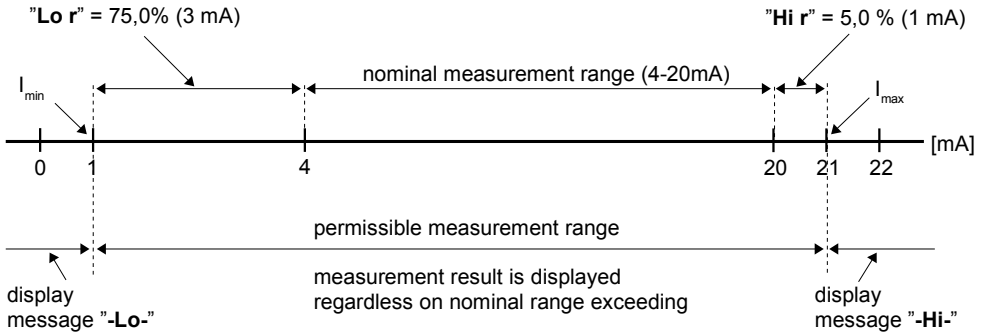


Figure 7.3 Example of definition of permissible range of input signal - "Lo r" and "Hi r" parameters ("4-20" mode)

The "Lo r" parameter is important if input is set to "4-20", "1-5" or "2-10" mode only, and determines lower border of the permissible range. If input is set to "0-20", "0-5" or "0-10" mode then lower border of the permissible range is always 0.

For example if input is set to "4-20" mode, then lower border is calculated due to expression: $I_{\min} = 4 \text{ mA} - 4 \text{ mA} \times \text{"Lo r"} \%$.

The "Lo r" value can be set from 0 to 99.9%.

Parameter "Hi r" determines the upper border of the permissible range accordingly to the expression (for all modes).

For example if input is set to "4-20" mode, then upper border is calculated due to expression: $I_{\max} = 20 \text{ mA} + 20 \text{ mA} \times \text{"Hi r"} \%$.

The value of "Hi r" can be set from 0 to 19.9%

In example no 1 of the **DISPLAY VALUES CALCULATION** paragraph the procedure of the permissible input range determining is presented in details.



If the measurement value does not exceed **permissible measurement range** but displayed value exceeds range -999 ÷ 9999, the warning "-Ov-" is displayed rather than the calculated result.

7.3.4. "OutP" menu

This menu contains parameters of analogue output control. Menu is available if the device is equipped with analogue output.



Analogue output can be controlled depend on both present measured value and peak value (if peak detection is enabled).

"Omod" - analogue output mode. Depending on version of the device there are following options:

For active current output:

"oFF" - current output disabled,

"0-20" - current output enabled with 0 ÷ 20 mA mode,

"4-20" - current output enabled with 4 ÷ 20 mA mode,

"modb" - current output controlled via RS-485 interface.

For passive current output:

"oFF" - current output disabled,

"4-20" - current output enabled with 4 ÷ 20 mA mode,

"modb" - current output controlled via RS-485 interface.

For active voltage output:

"oFF" - voltage output disabled,

"0-5" - voltage output enabled with 0 ÷ 5V mode,

"1-5" - voltage output enabled with 1 ÷ 5V mode,

"0-10" - voltage output enabled with 0 ÷ 10V mode,

"2-10" - voltage output enabled with 2 ÷ 10 V mode,

"modb" - voltage output controlled via RS-485 interface.

"OutL" - this parameter determines the input value for which the output signal is **minimal** (depend of output mode **"Omod"**).

"OutH" - this parameter determines the input value for which the output signal is **maximal** (depend of output mode **"Omod"**).

The analogue output value is calculated due to formula given below:

$$Out = \frac{W - "OutL"}{"OutH" - "OutL"} \times (B - A) + A$$

where: **W** – displayed value,

Out – analogue output value,

B – higher range limit (20mA / 5V / 10V),

A – lower range limit (0mA / 4mA / 0V / 1V / 2v),



"OutL" parameter can be greater than **"OutH"**. In this case the conversion characteristic is reversed, it means that if input value raises the output value falls.

"Lo r", "Hi r" - this parameters define the output value range. If calculated output value **Out** exceeds defined range then analogue output generates signal equal to upper or lower border of the defined range. These parameters defines the percentage extension of nominal analogue range (with 0,1% resolution).

Parameter **"Lo r"** defines lower border of the range due to formula:

Out_{min} = A - (A × "Lo r" %), where:

A – lower signal value range limit.

This parameter can be set from 0 to 99.9% (for active current output and active voltage output) or from 0 to 29.9% (for passive current output).

Parameter **"Hi r"** defines higher border of the range due to formula:

Out_{max} = B + (B × "Hi r" %), where:

B – higher signal value range limit.

This parameter can be set from 0 to 19.9% (for active and passive current output) or from 0 to 9.9% (for active voltage output).

In example on page **58** of the **DISPLAY VALUES CALCULATION** paragraph the procedure of the analogue outputs determining is presented in details.

“AL” - this parameter determines the behaviour of analogue output if any critical situation occurs. According to version of the device, this parameter can be set:

For active current output:

- “noCH”** - current will not change,
- “22.1”** - current will be set to 22.1 mA,
- “3.4”** - current will be set to 3.4 mA,
- “0.0”** - current will be set to 0 mA.

For passive current output:

- “noCH”** - current will not change,
- “22.1”** - current will be set to 22.1 mA,
- “3.4”** - current will be set to 3.4 mA,

For active voltage output:

- “noCH”** - voltage will not change,
- “11.0”** - voltage will be set to 11 V,
- “5.5”** - voltage will be set to 5.5 V,
- “1.2”** - voltage will be set to 1.2 V.
- “0.6”** - voltage will be set to 0.6 V,
- “0.0”** - voltage will be set to 0 V.

When the critical situation goes, the output signal will be set to value calculated due to formulas given above.

7.3.5. “bri” parameter

This parameter allows the user to set brightness of the LED display, brightness can be set to conventional values from 1 to 8.

7.3.6. “HOLD” menu

This menu contains parameters connected with peak detection function. See also full description of the peak detection function in paragraph: **DETECTION OF THE PEAK VALUES**.

“modE” - the type of detected changes of the input signal, can be set to values:

- “norm”** - peaks: peak and next drop of the input signal of value equal at least **“PEA”**,
- “inv”** - drops: drop and next peak of the input signal of value equal at least **“PEA”**,

“PEA” - minimal detected signal change classified as peak or drop (see **Figure 6.3**),

“timeE” - maximum time of displaying of the peak (drop) value, can be set from 0.0 to 19.9 sec, with 0.1 sec. resolution. If „HdiS”=**HOLD**” then setting parameter **“timeE”=0.0** causes holding peak value until **[ESC]** button is pressed. If „HdiS”=**REAL**” then value **“timeE”=0.0** means no holding,

"HdiS" - type of displayed values.

- "rEAL"** - current value is displayed,
- "HOLd"** - peak (drop) value is displayed,

"H r1" ÷ "H r4" - relay/LED outputs (R1÷R4) operation mode:

- "rEAL"** - relay/LED operates depend on the current value,
- "HOLd"** - relay/LED operates depend on the peak (drop) value.

"HOUT" - current output operation mode:

- "rEAL"** - current output operates depend on the current value,
- "HOLd"** - current output operates depend on the peak (drop) value.

7.3.7. "SECu" menu

This menu contains presets connected with availability of other parameters.

"Scod" - user password (4-digits number). If this parameter is set at value **"0000"**, user password is turned off.

If the user do not remember his password, the access to the menu is possible by the "one-use password". To get this password please contact with Marketing Division. "One-use password" can be used only one time, after that it is destroyed. Entering this password causes in clearing of user password, it means sets the user password to „0000".



The "one-use password" can be used **ONE TIME ONLY**, it is impossible to use it again! The "one-use password" can be restored by Service Division only.

"A r1 ÷ A r4" - this option permits user (**"on"**) or prohibits (**"oFF"**) to modify the thresholds of the relays/LEDs R1 ÷ R4 without knowledge about user password

7.3.8. "rS" menu

This menu is connected with RS-485 interface, and sets his properties.

"Addr" - this parameter defines the address of the device, accordingly to Modbus protocol. It can be set in range from 0 to 199. If the value 0 is set then device, responds to frames with address 255 (FFh),

"bAud" - this parameter determines RS-485 interface baud rate. It can be set to one of 8 possible values: **"1.2"**, **"2.4"**, **"4.8"**, **"9.6"**, **"19.2"**, **"38.4"**, **"57.6"**, **"115.2"**, which respond to the baud rates of 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 bit/s respectively,

"mbAc" - this parameter sets the access to the configuration registers of the device.

Possible values:

- "on"** - configuration registers can be set via RS-485 interface,
"oFF" - configuration registers can not be set via RS-485 interface.



The access to registers no 04h and 05h cant be denied by **"mbAc"** parameter (see chapter **11.1List of registers**).

"mbtO" - this parameter defines maximal time (sec) between following frames received by the device. If the delay will be greater than the value of **"mbtO"** parameter, the relays and analogue outputs which are controlled via RS-485 interface, will set to alert state (see **"OUTP" menu**, and **"1 rEL" menu** description). Parameter **"mbtO"** can be set to values from 0 to 99 seconds. The value 0 means that the time will be not controlled,

"rESP" - this parameter defines minimal (additional) delay between the Modbus message and the answer of the device (received and sent via RS-485 interface). This additional delay allows the device to work with poor RS-converter which do not works properly on baud rates higher than 19200. This parameter can be set to one of values:

"Std" - answer as quick as possible, no additional delay,

" 10c"

" 20c"

" 50c"

"100c"

"200c"

} - answer delayed of 10, 20, 50, 100 of 200 chars respectively, where one character time depends on selected baud rate.



In the most cases parameter **"rESP"** should be set to **"Std"** (no additional delay). Unfortunately for some third party RS-converter **"rESP"** should be adjusted experimentally. Table 7.1 contains most frequently used values.

"bAud" parameter	"38.4"	"57.6"	"115.2"
"rESP" parameter	" 10c"	" 20c"	" 50c"

Tab.7.1. Settings of **"rESP"** parameter

7.3.9. **"Edit" parameter**

This parameter allows to change the edition mode of numerical parameters.

"dig" - "by digit" change mode,

"Slid" - slide change mode.

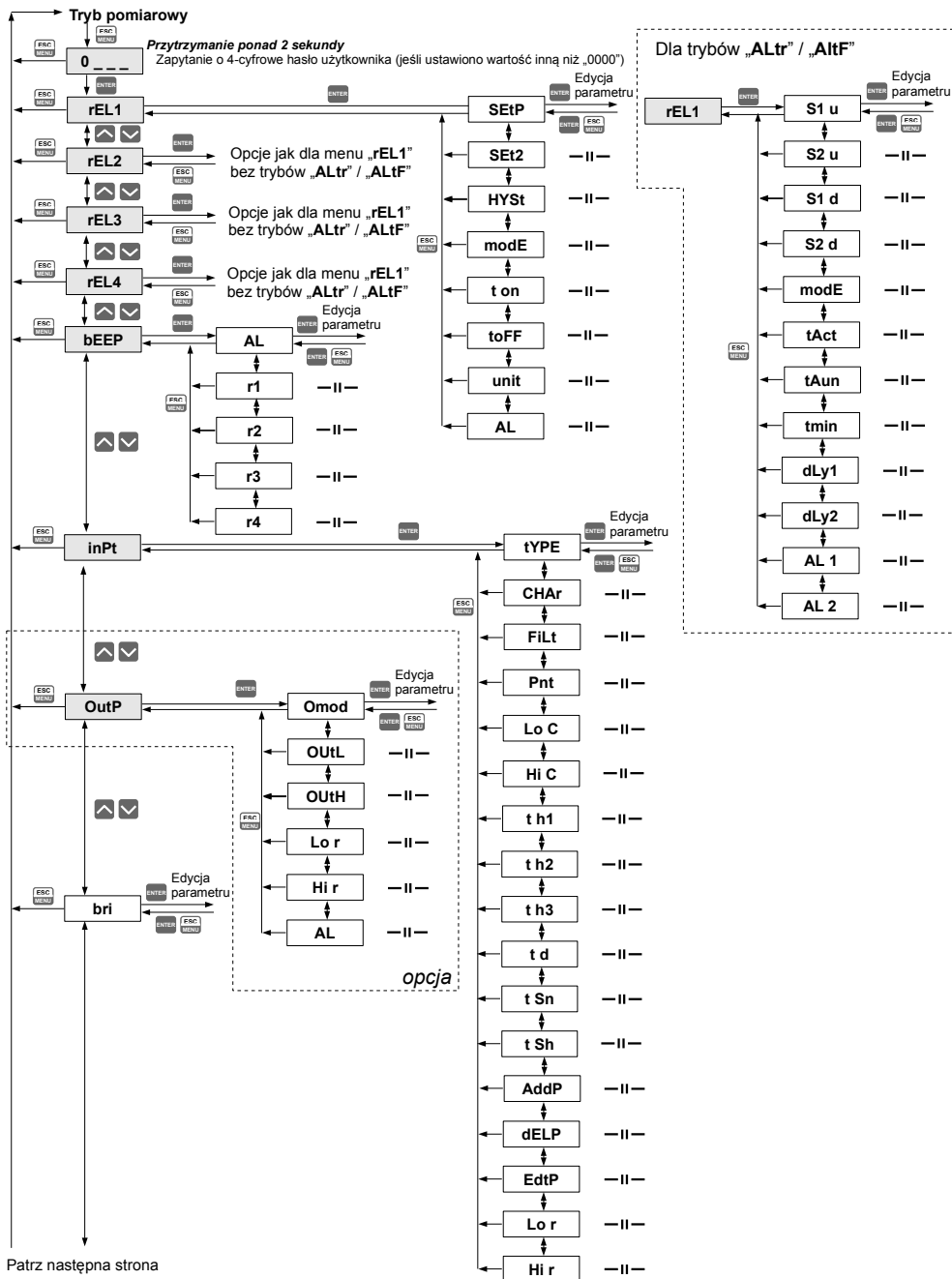
7.3.10. **"dEFS" parameter**

This setting allows to restore the factory settings of the device. To get the access to this option special password is required: „5465“, next the device displays acknowledge question „Set?“. Press **[ENTER]** to acknowledge the restoring of factory settings or **[ESC]** to cancel.

7.3.11. "SErv" menu

This menu contains the parameters for authorized service only. To enter this menu proper service password must be entered. Improper settings can causes of damage of the device.

7.4. MENU STRUCTURE



8. DZIAŁANIE DIODY ALARMOWEJ

Dioda alarmowa (AL) załącza się w przypadku przekroczenia dopuszczalnego zakresu pomiarowego definiowanego za pomocą parametrów „**tyPE**”, „**Lo r**” i „**Hi r**” w menu „InPt”.

9. ZABEZPIECZENIE PRZECIWPRZECIĄŻENIOWE

Wejście prądowe wyposażone jest w zabezpieczenie chroniące rezystor pomiarowy przed uszkodzeniem. Prąd wejściowy jest ograniczony na poziomie 40 mA (typowo). Gdy temperatura rezystora pomiarowego zmaleje, zabezpieczenie automatycznie wyłącza się a urządzenie powraca do wyświetlania wartości pomiarowej. Po wyłączeniu zabezpieczenia pomiary przez pewien czas mogą mieć nieco mniejszą dokładność (do czasu całkowitego wystygnięcia układu).

10. WYZNACZANIE WYŚWIELANEGO WYNIKU

Dla uproszczenia przykładów przyjęto, że wybrane zostało wejście prądowe. Wszystkie wyliczenia w poniższych przykładach odnoszą się do tego wejścia. Przeliczenia dla wejścia napięciowego wykonywane są analogicznie z uwzględnieniem odpowiednich zakresów i jednostki pomiarowej.

Pierwszym krokiem do wyznaczenia wartości wyświetlanej jest wyliczenie znormalizowanego wyniku pomiaru (mieszczącego się w zakresie 0-1). W tym celu od wartości zmierzonej (wyrażonej w mA) odejmuje się początek zakresu pomiarowego (0 mA dla zakresu 0-20 mA lub 4 mA dla zakresu 4-20 mA). W następnym kroku urządzenie dzieli uzyskany wynik przez szerokość zakresu pomiarowego (20 dla zakresu 0-20 mA lub 16 dla zakresu 4-20 mA). Znormalizowany pomiar wyraża się zatem wzorami:

$$I_n = \frac{I_{wejt.} - 4}{16} \quad \text{dla zakresu } 4 \div 20 \text{ mA}$$

$$I_n = \frac{I_{wejt.}}{20} \quad \text{dla zakresu } 0 \div 20 \text{ mA}$$

gdzie $I_{wejt.}$ oznacza prąd wejściowy (w mA) a I_n - znormalizowany pomiar.



Jeśli wartość pomiarowa wykroczy poza nominalny zakres pomiarowy (0-20mA lub 4-20mA), a jednocześnie będzie się zawierała w dopuszczalnym zakresie wyświetlania (definiowanym parametrami „**Lo r**”, „**Hi r**”), to znormalizowany pomiar I_n wykroczy poza zakres 0-1, np. dla zakresu 4-20 mA i prądu wejściowego 3 mA znormalizowany pomiar wyniesie -0,0625 a dla prądu 22 mA znormalizowany pomiar wyniesie 1,125. W takich przypadkach wszystkie wzory dotyczące wyznaczania wyświetlanego wyniku nadal obowiązują.

10.1. SPOSOBY PRZELICZANIA WYNIKU POMIARU

Sposób dalszego przeliczania wyniku zależy od wybranego typu charakterystyki wejściowej. Wszystkie przedstawione wykresy dotyczą zakresu prądowego 4 - 20 mA.

10.1.1. Charakterystyka liniowa

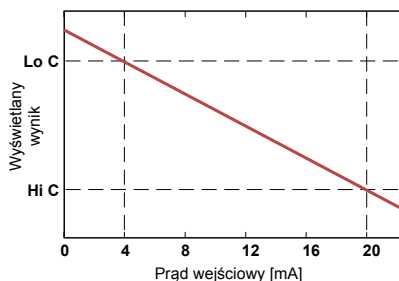
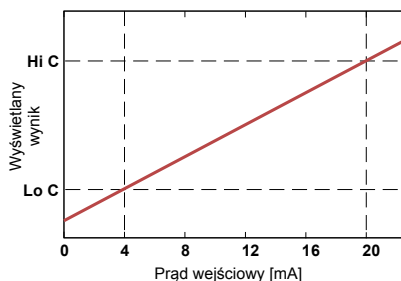
Znormalizowany pomiar zostaje liniowo przełożony na zakres definiowany parametrami "Lo C", "Hi C" (gdy znormalizowany pomiar osiąga wartość 0, wyświetlany jest wynik "Lo C", gdy znormalizowany pomiar osiąga wartość 1 - wyświetlany jest "Hi C"). Sposób przeliczania można określić wzorem:

$$W = I_n \times ("Hi C" - "Lo C") + "Lo C",$$

gdzie W oznacza wyświetlany wynik.



Parametr "Lo C" może być większy niż "Hi C", w takim przypadku charakterystyka ulega odwróceniu, tzn. gdy prąd rośnie, wartość wyświetlana maleje.



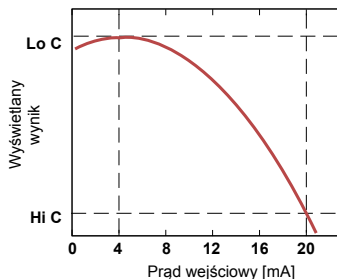
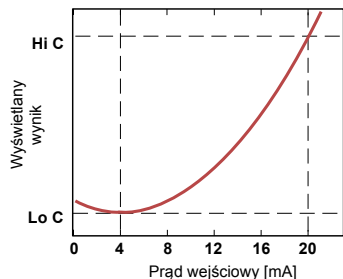
Rys. 10.1 Charakterystyka prosta („Lo C” < ”Hi C”) i odwrócona („Lo C” > ”Hi C)

10.1.2. Charakterystyka kwadratowa

Znormalizowany pomiar jest podnoszony do kwadratu, a dalsze przeliczenia przebiegają identycznie, jak w przypadku charakterystyki liniowej. Sposób przeliczania określa się wzorem:

$$W = I_n^2 \times ("Hi C" - "Lo C") + "Lo C",$$

gdzie W oznacza wyświetlany wynik.



Rys. 10.2 Charakterystyka prosta („Lo C” < ”Hi C”) i odwrócona („Lo C” > ”Hi C)

10.1.3. Charakterystyka pierwiastkowa

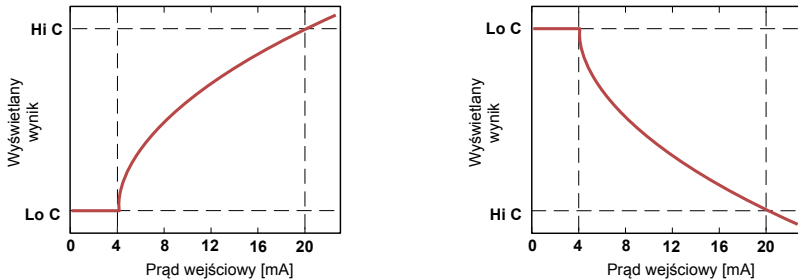
Znormalizowany pomiar jest pierwiastkowy, a dalsze przeliczenia przebiegają identycznie, jak w przypadku charakterystyki liniowej. Sposób przeliczania określa się wzorem:

$$W = \sqrt{I_n} \times ("Hi\ C" - "Lo\ C") + "Lo\ C",$$

gdzie W oznacza wyświetlany wynik.



Powyższy wzór przestaje obowiązywać, gdy znormalizowany pomiar jest ujemny. Sytuacja taka występuje w przypadku przekroczenia w dół zakresu pomiarowego 4-20 mA. Wartość wyświetlana dla $I_n < 0$ jest równa **"Lo C"** (patrz wykresy).



Rys. 10.3 Charakterystyka prosta („Lo C” < „Hi C”) i odwrócona („Lo C” > „Hi C”)

10.1.4. Charakterystyka użytkownika

Charakterystyki użytkownika definiowane są w postaci 1÷19 połączonych odcinków prostoliniowych (patrz wykres) wyznaczanych na podstawie 2÷20 punktów wprowadzonych przez użytkownika do pamięci urządzenia (patrz opis **Menu "inPt"**).

Na podstawie znormalizowanego pomiaru I_n urządzenie wyznacza odpowiedni przedział charakterystyki, np. dla charakterystyki jak na wykresie poniżej i $I_n = 0,65$ wybrany zostanie przedział definiowany przez punkty o współrzędnych X = **"50.0."** oraz X = **"70.0."**

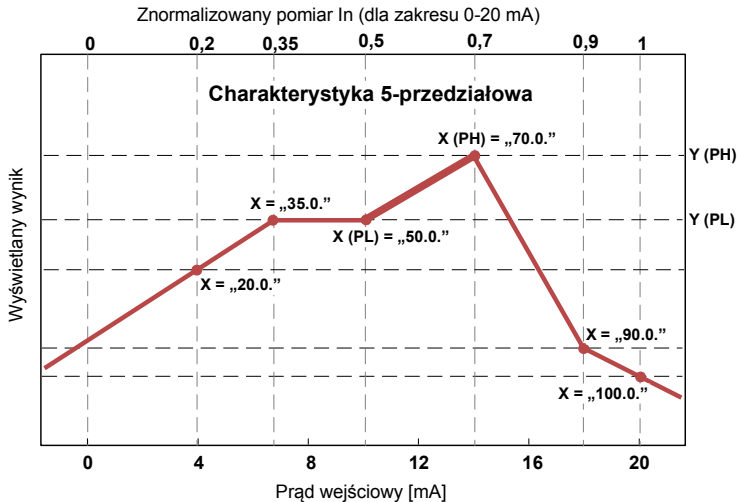
Oznaczmy punkty definiujące przedział przez PL i PH (w podanym wyżej przykładzie X(PL) = **"50.0,"** i X(PH) = **"70.0."**) oraz wartość znormalizowanego pomiaru I_n dla początku przedziału przez I_p (w podanym przykładzie $I_p = I_n(PL) = 0,5$). Wyświetlany wynik wyznaczany jest według wzoru:

$$W = (I_n - I_p) \times \frac{[Y(PH) - Y(PL)]}{[X(PH) - X(PL)]} \times 100 + Y(PL)$$

gdzie Y(PH), X(PH), Y(PL), X(PL) oznaczają wartości współrzędnych X i Y dla pkt. PH i PL.



Jeśli znormalizowany pomiar wykracza poza zakres wyznaczony poprzez punkty charakterystyki użytkownika, to do obliczeń używany jest odpowiedni przedział skrajny określony przez dwa skrajne punkty. Przykładowo dla charakterystyki na wykresie poniżej i $I_n > 1$ do obliczeń użyty zostanie przedział definiowany przez punkty o współrzędnych: X(PL) = **"90.0,"** X(PH) = **"100.0."**



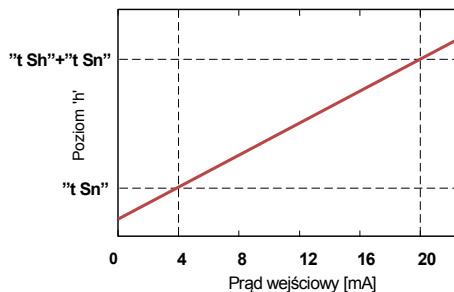
Rys. 10.4 Przykładowa charakterystyka użytkownika

10.1.5. Charakterystyka objętościowa zbiornika cylindrycznego

Charakterystyka objętościowa zbiornika definiowana jest za pomocą parametrów zbiornika (patrz opis Menu „**inPt**”). Znormalizowany pomiar zostaje liniowo przełożony na zakres poziomu 'h' definiowany parametrami „**t Sn**”, „**t Sh**” (gdy znormalizowany pomiar osiąga wartość 0, wyświetlany jest wynik „**t Sn**”, gdy znormalizowany pomiar osiąga wartość 1 - wyświetlany jest wynik „**t Sh**”+„**t Sn**” - patrz Rys. 10.5). Sposób przeliczania można określić wzorem:

$$h = I_n \cdot "t Sh" + "t Sn"$$

gdzie 'h' oznacza poziom cieczy, gazów lub materiałów sypkich w zbiorniku, patrz Rys. 7.1, 7.2.



Rys. 10.5 Charakterystyka poziomu cieczy, gazów lub materiałów sypkich w zbiorniku w zależności od prądu wejściowego w zakresie 4-20mA

Objętość zbiornika możemy wyrazić ogólnym wzorem:

$$V = \int P_p \cdot dh$$

Możliwe kombinacje kształtu zbiornika przy przeliczaniu objętości:

dla zbiornika w pozycji pionowej							
dla zbiornika w pozycji poziomej							
ustawienia parametrów (dla pozycji pionowej i poziomej zbiornika)	t h2=0 t h3=0	t h3=0	t h2=0	t h1=0 t h3=0	-	t h1=0	t h1=0 t h2=0

10.2. PRZYKŁADY PRZELICZEŃ

Przykład 1: Wyznaczanie dopuszczalnego zakresu pomiarowego (dla trybu “4-20”)

Jeśli w trybie “4-20” użytkownik ustawi parametry “Lo r” = 20,0% oraz “Hi r” = 10,0%, to przedział dopuszczalnych prądów ustanowiony zostanie na: 3,2 mA ÷ 22 mA. Dolna granica przedziału wynika ze wzoru: 4 mA - 4 mA × 20% a górna granica przedziału ze wzoru: 20 mA + 20 mA × 10%.

Przykład 2: Wyznaczanie znormalizowanego pomiaru I_n

Założmy, że użytkownik wybrał zakres wejściowy 4-20 mA. Znormalizowany pomiar I_n obliczamy zgodnie ze wzorami ze strony 49, a zatem od wartości prądu wejściowego (np. 10 mA) odejmujemy początek nominalnego zakresu pomiarowego (w tym przypadku 4 mA): 10 mA - 4 mA = 6 mA. Wynik dzielimy przez szerokość nominalnego zakresu pomiarowego (w tym przypadku 16 mA). Otrzymujemy $I_n = 6/16 = 0,375$. W przypadku prądów wykraczających poza nominalny zakres pomiarowy postępujemy analogicznie, np. dla prądu wejściowego 2,5 mA otrzymujemy $I_n = (2,5 - 4)/16 \cong -0,0938$, a dla prądu 20,5 mA otrzymujemy $I_n = (20,5 - 4)/16 \cong 1,0313$.

Przykład 3: Charakterystyka liniowa

Zakładamy, że użytkownik wybrał charakterystykę liniową oraz zakres wejściowy 4-20 mA. Opcje “Lo C” oraz “Hi C” zostały ustawione odpowiednio na wartości -300 i 1200. Obliczeń dokonamy dla 3 prądów wejściowych rozważanych w przykładzie 2:

a) dla prądu 10 mA otrzymujemy $I_n = 0,375$

Zgodnie z odpowiednim wzorem ze strony 50 mnożymy znormalizowany pomiar przez różnicę parametrów “Hi C” i “Lo C”: $0,375 \times [1200 - (-300)] \cong 562$.

W kolejnym kroku dodajemy do wyniku parametr “Lo C” i otrzymujemy wynik (wartość wyświetlaną): $W \cong 562 + (-300) = 262$

b) dla prądu 2,5 mA otrzymujemy $I_n = -0,0938$.

Postępując analogicznie do przypadku a) otrzymujemy $W \cong -441$.

c) dla prądu 20,5 mA otrzymujemy $I_n = 1,0313$.

Postępując analogicznie do przypadku a) otrzymujemy $W \cong 1247$.

Przykład 4: Charakterystyka kwadratowa

Zakładamy, że użytkownik wybrał charakterystykę kwadratową oraz zakres wejściowy 4-20 mA.

Opcje “Lo C” oraz “Hi C” zostały ustawione odpowiednio na wartości -300 i 1200.

Obliczeń dokonamy dla 3 prądów wejściowych rozważanych w przykładzie 2:

a) dla prądu 10 mA otrzymujemy $I_n = 0,375$

Zgodnie z odpowiednim wzorem ze strony 50 podnosimy wartość I_n do kwadratu, a wynik mnożymy przez różnicę parametrów “Hi C” i “Lo C”: $(0,375)^2 \times [1200 - (-300)] \cong 211$.

W kolejnym kroku dodajemy do wyniku wartość parametru “Lo C” i otrzymujemy wynik (wartość wyświetlaną): $W \cong 211 + (-300) = -89$

b) dla prądu 2,5 mA otrzymujemy $I_n = -0,0938$.

Postępując analogicznie do przypadku a) otrzymujemy $W \cong -287$.

c) dla prądu 20,5 mA otrzymujemy $I_n = 1,0313$.

Postępując analogicznie do przypadku a) otrzymujemy $W \cong 1295$.

Przykład 5: Charakterystyka pierwiastkowa

Zakładamy, że użytkownik wybrał charakterystykę pierwiastkową oraz zakres wejściowy 4-20 mA. Opcje “Lo C” oraz “Hi C” zostały ustawione odpowiednio na wartości -300 i 1200. Obliczeń dokonamy dla 3 prądów wejściowych rozważanych w przykładzie 2:

a) dla prądu 10 mA otrzymujemy $I_n = 0,375$

Zgodnie z odpowiednim wzorem ze strony 51 pierwiastkujemy znormalizowany pomiar, a wynik mnożymy przez różnicę parametrów “Hi C” i “Lo C”: $\sqrt{0,375} \times [1200 - (-300)] \cong 919$.

W kolejnym kroku dodajemy do wyniku wartość parametru “Lo C” i otrzymujemy wynik (wartość wyświetlaną): $W \cong 919 + (-300) = 619$

b) dla prądu 2,5 mA otrzymujemy $I_n = -0,0938$. Znormalizowany pomiar jest ujemny a zatem wyświetlona zostanie wartość $W = \text{"Lo C"} = -300$.

c) dla prądu 20,5 mA otrzymujemy $I_n = 1,0313$.

Postępując analogicznie do przypadku a) otrzymujemy $W \approx 1223$.

Przykład 6: Charakterystyka użytkownika

Zakładamy, że użytkownik wybrał charakterystykę 10-przedziałową oraz zakres wejściowy 4÷20mA. Zdefiniowanie charakterystyki 10-przedziałowej wymaga wprowadzenia do pamięci urządzenia współrzędnych X oraz Y dla 11 punktów (patrz opis **Menu "inPt"**).

Obliczeń dokonamy dla 3 prądów wejściowych rozważanych w przykładzie 2, w związku z tym w obliczeniach zostaną wykorzystane tylko niektóre punkty charakterystyki.

Założmy, że ustawione zostały następujące parametry:

$X1 = \text{"00.0"}, Y1 = \text{"-50.0"},$

$X2 = \text{"10.0"}, Y2 = \text{"-30.0"},$

....

$X6 = \text{"30.0"}, Y6 = \text{"30.0"},$

$X7 = \text{"40.0"}, Y7 = \text{"80.0"},$

....

$X10 = \text{"90.0"}, Y10 = \text{"900.0"},$

$X11 = \text{"100.0"}, Y11 = \text{"820.0"},$

Parametry, które nie zostały wyżej wymienione muszą także zostać odpowiednio ustawione (zgodnie z wybraną charakterystyką).

a) dla prądu 10 mA otrzymujemy $I_n = 0,375$

Wykorzystując wartość I_n urządzenie dobiera dwa najbliższe punkty charakterystyki.

Dla wartości $I_n = 0,375$ najbliższe punkty mają współrzędne $X6 = \text{"30.0"} i $X7 = \text{"40.0"}$.$

Wykorzystując wzory ze str. 51 otrzymujemy $X(PL) = 30, Y(PL) = 30, X(PH) = 40, Y(PH) = 80$ oraz $I_p = 0,3$. Wyświetlona zostanie wartość:

$$W = (I_n - I_p) \times \frac{[Y(PH) - Y(PL)]}{[X(PH) - X(PL)]} \times 100 + Y(PL) =$$

$$= (0,375 - 0,3) \times \frac{[80 - 30]}{[40 - 30]} \times 100 + 30 \approx 67$$

b) dla prądu 2,5 mA otrzymujemy $I_n = -0,0938$. Ponieważ wartość I_n wykracza w dół poza zakres 0÷1, do wyliczenia wyniku wykorzystany zostanie skrajny dolny przedział (definiowany przez punkty o współrzędnych $X1(PL) = 0, Y1(PL) = -50, X2(PH) = 10, Y2(PH) = -30$ oraz $I_p = 0$. Postępując analogicznie do przypadku a) otrzymujemy $W \approx -69$.

c) dla prądu 20,5 mA otrzymujemy $I_n = 1,0313$. Ponieważ wartość I_n wykracza w górę poza zakres 0÷1, do wyliczenia wyniku wykorzystany zostanie skrajny górny przedział (definiowany przez punkty o współrzędnych $X10(PL) = 90, Y10(PL) = 900, X11(PH) = 100, Y11(PH) = 820$ oraz $I_p = 0,9$. Postępując analogicznie do przypadku a) otrzymujemy $W \approx 795$.

Przykład 7: Charakterystyka objętościowa zbiornika cylindrycznego w pozycji pionowej.

Zakładamy, że użytkownik posiada zbiornik olejowy w kształcie walca położonego w pozycji pionowej o wymiarach: wysokość 10m, średnica 4m oraz sondę poziomu cieczy o długości 10m, na wyjściu której otrzymujemy przeskalowany na prąd poziom cieczy w zakresie 4-20 mA.

W pierwszej kolejności należy ustawić typ wejścia 4-20 mA (patrz parametr "**tTYPE**"). Zdefiniowanie charakterystyki objętościowej zbiornika cylindrycznego w pozycji pionowej wymaga ustawienia parametrów zbiornika oraz parametrów sondy:

„t Sn”=00,00

„t Sh”=10,00

„t h1”=00,00

„t h2”=10,00

„t h3”=00,00

„t d”=04,00



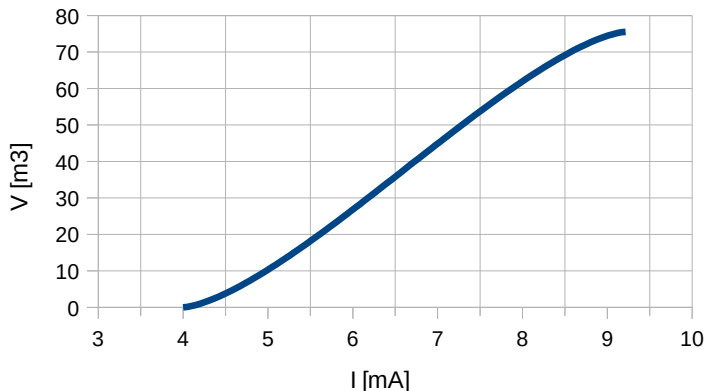
Rys. 10.6 Charakterystyka objętości zbiornika w zależności od prądu wejściowego z sondy poziomu cieczy w zbiorniku (dla zakresu 4÷20mA).

Przykład 8: Charakterystyka objętościowa zbiornika cylindrycznego w pozycji poziomej.

Zakładamy, że użytkownik posiada zbiornik na pszenicę w kształcie walca z dennicą położonego w pozycji poziomej o wymiarach: długość dennicy (części I) zbiornika wynosi 2m, długość walca (części II) zbiornika 8,05m, a średnica 3,26m oraz sondę poziomu cieczy o długości 10m, na wyjściu której otrzymujemy przeskalowany na prąd poziom cieczy w zakresie 4-20 mA.

W pierwszej kolejności należy ustawić typ wejścia 4-20 mA (patrz parametr "**tTYPE**"). Zdefiniowanie charakterystyki objętościowej zbiornika cylindrycznego w pozycji poziomej wymaga ustawienia parametrów zbiornika oraz parametrów sondy:

„t Sn”=00,00
 „t Sh”=10,00
 „t h1”=02,00
 „t h2”=08,05
 „t h3”=00,00
 „t d”=03,26



Rys. 10.7 Charakterystyka objętości zbiornika w zależności od prądu wejściowego z sondy poziomu cieczy w zbiorniku (dla zakresu 4÷20mA).

Przykład 9: Wyznaczanie wartości prądu generowanego przez wyjście prądowe

Zakładamy, że mamy aktywne wyjście prądowe, a jego parametry ustawione są następująco:

“modE” = “4-20”, “OUTL” = 10.0, “OUTH” = 20.0, “Lo r” = 5.0, “Hi r” = 5.0

Parametry “Lo r” i “Hi r” wyznaczają przedział pracy wyjścia prądowego na 3,8 ÷ 21 mA.

Prąd wyjściowy wyznaczmy dla trzech wartości wyświetlanych W:

a) W = „17.5”

Wykorzystując wzór ze str. 42 otrzymujemy:

$$I_{out} = (17,5-10,0) / (20,0-10,0) \times 16 \text{ mA} + 4 \text{ mA} = 0,75 \cdot 16 + 4 = 16 \text{ mA}$$

Wyznaczony I_{out} mieści się w przedziale pracy wyjścia prądowego (3,8 - 21 mA).

b) W = „20.5”

Postępując analogicznie do pkt. a) otrzymujemy:

$$I_{out} = (20,5-10,0) / (20,0-10,0) \times 16 \text{ mA} + 4 \text{ mA} = 1,05 \cdot 16 + 4 = 20,08 \text{ mA}$$

Wyznaczony I_{out} mieści się w przedziale pracy wyjścia prądowego (3,8 - 21 mA).

c) W = „30.0”

Postępując analogicznie do pkt. a) otrzymujemy:

$$I_{out} = (30,0-10,0) / (20,0-10,0) \times 16 \text{ mA} + 4 \text{ mA} = 2 \cdot 16 + 4 = 36 \text{ mA}$$

Wyznaczony I_{out} nie mieści się w przedziale pracy wyjścia prądowego (3,8 - 21 mA), a zatem wyjście prądowe wygeneruje prąd równy górnej granicy przedziału określonego przez parametry “Lo r” i “Hi r” (czyli 21 mA).

11. THE MODBUS PROTOCOL HANDLING

Transmission parameters: 1 start bit, 8 data bits, 1 or 2 stop bit (2 bits are send, 1 and 2 bits are accepted when receive), no parity control

Baud rate: selectable from: 1200 to 115200 bits/second

Transmission protocol: MODBUS RTU compatible

The device parameters and display value are available via RS-485 interface, as HOLDING-type registers (numeric values are given in U2 code) of Modbus RTU protocol. The registers (or groups of the registers) can be read by 03h function, and wrote by 06h (single registers) or 10h (group of the registers) accordingly to Modbus RTU specification. Maximum group size for 03h and 10h functions can not exceeds 16 registers (for single frame).



The device interprets the broadcast messages, but then do not sends the answers.

11.1. LIST OF REGISTERS

Register	Write	Range	Register description
01h	No	-999 ÷ 9999	Measurement value (no decimal point)
02h	No	0h, A0h, 60h	The status of the current measurement; 0h - data valid; A0h - top border of the measurement range is exceeded; 60h - bottom border of the measurement range is exceeded;
03h	Yes	0 ÷ 3	"Pnt" parameter in "InPt" menu (decimal point position) 0 - " 0"; 1 - " 0.0"; 2 - " 0.00"; 3 - " 0.000"
04h	Yes	see descr.	State of the relays and alarm LED (binary format) (1 - on, 0 - off): 00000000 000edcba a - relay R1; b - relay R2; c - relay R3; d - relay R2; e - alarm LED; If written, only a , b , c , d bits are important (others are ignored) these bits allows user to control the relays via RS-485 interface
05h ¹	Yes	0h ÷ 1800h	State of active current output, expressed in 1/256 mA units – it means that high byte express integer part, and low byte fractional part of desired output current.
	Yes	2CCh+1800h	State of passive current output, expressed in 1/256 mA units – it means that high byte express integer part, and low byte fractional part of desired output current.
	Yes	0h ÷ 1600h	State of active voltage output, expressed in 1/512 V units – it means that high byte express integer part, and low byte fractional part of desired output voltage.
06h	No	-999 ÷ 9999	Peak (drop) value (no decimal point)
10h	Yes	0 ÷ 5	"tYPE" parameter in "InPt" menu (nominal input range). 0 - 0-20 mA range; 1 - 4-20 mA range; 2 - 0-10 V range; 3 - 2-10 V range; 4 - 0-5 V range; 5 - 1-5 V range
11h	Yes	0 ÷ 5	"CHAR" parameter in "InPt" menu (characteristic type) 0 - linear; 1 - square; 2 - square root; 3 - user defined; 4 - volume characteristics of a cylindrical tank in the vertical position; 5 - volume characteristics of a cylindrical tank in the horizontal position
12h	Yes	0 ÷ 5	"FiLT" parameter in "InPt" menu (measurement filtering rate)

Register	Write	Range	Register description
13h	Yes	0 ÷ 3	"Pnt" parameter in "InPt" menu (the copy of 03h register, decimal point position) 0 - "0"; 1 - "0.0"; 2 - "0.00"; 3 - "0.000"
14h	Yes	-999 ÷ 9999	"Lo C" parameter in "InPt" menu, no decimal point included
15h	Yes	-999 ÷ 9999	"Hi C" parameter in "InPt" menu, no decimal point included
16h	Yes	0 ÷ 999	"Lo r" parameter in "InPt" menu, in 0.1%
17h	Yes	0 ÷ 199	"Hi r" parameter in "InPt" menu, in 0.1%
18h	Yes	0 ÷ 9999	"t h1" parameter in "InPt" menu, no decimal point included
19h	Yes	0 ÷ 9999	"t h2" parameter in "InPt" menu, no decimal point included
1Ah	Yes	0 ÷ 9999	"t h3" parameter in "InPt" menu, no decimal point included
1Bh	Yes	0 ÷ 9999	"t d" parameter in "InPt" menu, no decimal point included
1Ch	Yes	0 ÷ 9999	"t Sn" parameter in "InPt" menu, no decimal point included
1Dh	Yes	0 ÷ 9999	"t Sh" parameter in "InPt" menu, no decimal point included
20h ²	Yes	0 ÷ 199	Device address
21h	No	20F0h	Device identification code (ID)
22h ³	Yes	0 ÷ 7	"bAud" parameter in "rS" menu (baud rate); 0 - 1200 baud; 1 - 2400 baud; 2 - 4800 baud; 3 - 9600 baud; 4 - 19200 baud; 5 - 38400 baud; 6 - 57600 baud; 7 - 115200 baud
23h ⁴	Yes	0 ÷ 1	"mbAc" parameter in "rS" menu (permission to write registers via RS-485 interface); 0 - write denied; 1 - write allowed
24h	Yes	see descr.	Parameters of "SECU" menu (binary format (0 - "oFF", 1 - "on")): bit 0 - "A r1" parameter; bit 1 - "A r2" parameter (bits 0-1 not used in "Altr" i "Altf" modes) bit 2 - "A r3" parameter; bit 3 - "A r4" parameter
25h	Yes	0 ÷ 5	"rESP" parameter in "rS" menu (additional response delay); 0 - no additional delay; 1 - "10c" option; 2 - "20c" option; 3 - "50c" option; 4 - "100c" option; 5 - "200c" option;
27h	Yes	0 ÷ 99	"mbtO" parameter in "rS" menu (maximum delay between received frames); 0 - no delay checking; 1 ÷ 99 - maximum delay expressed in seconds
28h	Yes	0 ÷ 1	"AL" parameter in "bEEP" menu: 0 - off; 1 - on
29h	Yes	0 ÷ 1	"R1" parameter in "bEEP" menu: 0 - off; 1 - on
2Ah	Yes	0 ÷ 1	"R2" parameter in "bEEP" menu: 0 - off; 1 - on
2Bh	Yes	0 ÷ 1	"R3" parameter in "bEEP" menu: 0 - off; 1 - on
2Ch	Yes	0 ÷ 1	"R4" parameter in "bEEP" menu: 0 - off; 1 - on
2Dh	Yes	1 ÷ 8	"bri" parameter (display brightness); 1 - the lowest brightness; 8 - the highest brightness
2Fh	Yes	0 ÷ 1	"Edit" parameter (numerical parameters edit mode); 0 - "dig" mode; 1 - "SLid" mode

Register	Write	Range	Register description
30h	Yes	-999 ÷ 9999	“SEtP” parameter in “rEL1” menu, no decimal point included or for “Altr” and “AltF” modes “S1 u” parameter in “rEL1” menu, no decimal point included
31h	Yes	-999 ÷ 999	“HySt” parameter in “rEL1” menu, no decimal point included or for “Altr” and “AltF” modes the register is not used
32h	Yes	0 ÷ 5	“modE” parameter in “rEL1” menu: 0 - “noAC” mode; 1 - “on” mode; 2 - “oFF” mode; 3 - “in” mode; 4 - “out” mode; 5 - “modb” mode; 6 - “Altr” mode; 7 - “AltF” mode
33h	Yes	0 ÷ 999	“t on” parameter in “rEL1” menu, expressed in tenth of seconds or tenth of minutes depend on “unit” parameter - register no. 35h) or for “Altr” and “AltF” modes “tAct” parameter in “rEL1” menu, expressed in tenth of seconds or tenth of minutes depend on “tAun” parameter - register no. 35h)
34h	Yes	0 ÷ 999	“toFF” parameter in “rEL1” menu, expressed in tenth of seconds or tenth of minutes depend on “unit” parameter - register no. 35h) or for “Altr” and “AltF” modes “tmin” parameter in “rEL1” menu expressed in tenth of seconds
35h	Yes	0 ÷ 1	“unit” parameter in “rEL1” menu or for “Altr” and “AltF” modes “tAun” parameter in “rEL1” menu: 0 - seconds; 1 - minutes
36h	Yes	0 ÷ 2	“AL” parameter in “rEL1” menu or for “Altr” and “AltF” modes “AL 1” parameter in “rEL1” menu: 0 - no changes; 1 - on; 2 - off
37h	Yes	-999 ÷ 9999	“SEt2” parameter in “rEL1” menu, no decimal point included or for “Altr” and “AltF” modes “S2 u” parameter in “rEL1” menu, no decimal point included
38h	Yes	-999 ÷ 9999	“SEtP” parameter in “rEL2” menu, no decimal point included or for “Altr” and “AltF” modes “S1 d” parameter in “rEL1” menu, no decimal point included
39h	Yes	-999 ÷ 999	“HySt” parameter in “rEL2” menu, no decimal point included or for “Altr” and “AltF” modes the register is not used
3Ah	Yes	0 ÷ 5	“modE” parameter in “rEL2” menu: 0 - “noAC” mode; 1 - “on” mode; 2 - “oFF” mode; 3 - “in” mode; 4 - “out” mode; 5 - “modb” mode or for “Altr” and “AltF” modes the register is not used
3Bh	Yes	0 ÷ 999	“t on” parameter in “rEL2” menu, expressed in tenth of seconds or tenth of minutes depend on “unit” parameter - register no. 3Dh) or for “Altr” and “AltF” modes “dLy1” parameter in “rEL1” menu expressed in tenth of seconds
3Ch	Yes	0 ÷ 999	“toFF” parameter in “rEL2” menu, expressed in tenth of seconds or tenth of minutes depend on “unit” parameter - register no. 3Dh) or for “Altr” and “AltF” modes “dLy2” parameter in “rEL1” menu expressed in tenth of seconds
3Dh	Yes	0 ÷ 1	“unit” parameter in “rEL2” menu: 0 - seconds; 1 - minutes or for “Altr” and “AltF” the register is not used

Register	Write	Range	Register description
3Eh	Yes	0 ÷ 2	"AL" parameter in "rEL2" menu or for "Altr" and "AltF" modes "AL 2" parameter in "rEL1" menu: 0 - no changes; 1 - on; 2 - off
3Fh	Yes	-999 ÷ 9999	"SEt2" parameter in "rEL2" menu, no decimal point included or for "Altr" and "AltF" modes "S2 d" parameter in "rEL1" menu, no decimal point included
40h	Yes	-999 ÷ 9999	"SEtP" parameter in "rEL3" menu, no decimal point included
41h	Yes	-999 ÷ 999	"HySt" parameter in "rEL3" menu, no decimal point included
42h	Yes	0 ÷ 5	"modE" parameter in "rEL3" menu: 0 - "noAC" mode; 1 - "on" mode; 2 - "oFF" mode; 3 - "in" mode; 4 - "out" mode; 5 - "modb" mode
43h	Yes	0 ÷ 999	"t on" parameter in "rEL3" menu, expressed in tenth of seconds or tenth of minutes depend on "unit" parameter - register no. 45h)
44h	Yes	0 ÷ 999	"toFF" parameter in "rEL3" menu, expressed in tenth of seconds or tenth of minutes depend on "unit" parameter - register no. 45h)
45h	Yes	0 ÷ 1	"unit" parameter in "rEL3" menu: 0 - seconds; 1 - minutes
46h	Yes	0 ÷ 2	"AL" parameter in "rEL3" menu: 0 - no changes; 1 - on; 2 - off
47h	Yes	-999 ÷ 9999	"SEt2" parameter in "rEL3" menu, no decimal point included
48h	Yes	-999 ÷ 9999	"SEtP" parameter in "rEL4" menu, no decimal point included
49h	Yes	-999 ÷ 999	"HySt" parameter in "rEL4" menu, no decimal point included
4Ah	Yes	0 ÷ 5	"modE" parameter in "rEL4" menu: 0 - "noAC" mode; 1 - "on" mode; 2 - "oFF" mode; 3 - "in" mode; 4 - "out" mode; 5 - "modb" mode
4Bh	Yes	0 ÷ 999	"t on" parameter in "rEL4" menu, expressed in tenth of seconds or tenth of minutes depend on "unit" parameter - register no. 4Dh)
4Ch	Yes	0 ÷ 999	"toFF" parameter in "rEL4" menu, expressed in tenth of seconds or tenth of minutes depend on "unit" parameter - register no. 4Dh)
4Dh	Yes	0 ÷ 1	"unit" parameter in "rEL4" menu: 0 - seconds; 1 - minutes
4Eh	Yes	0 ÷ 2	"AL" parameter in "rEL4" menu: 0 - no changes; 1 - on; 2 - off
4Fh	Yes	-999 ÷ 9999	"SEt2" parameter in "rEL4" menu, no decimal point included
50h	Yes	0 ÷ 1	"modE" parameter in "HOLd" menu (type of detected changes): 0 - peaks; 1 - drops
51h	Yes	0 ÷ 9999	"PEA" parameter in "HOLd" menu (minimum detectable change, no decimal point included)
52h	Yes	0 ÷ 199	"time" parameter in "HOLd" menu, maximum peaks' (or drops') display time expressed in seconds
53h	Yes	0 ÷ 1	"HdiS" parameter in "HOLd" menu: 0 - "rEAL" mode ; 1 - "HOLd" mode

Register	Write	Range	Register description
54h	Yes	0 ÷ 1	"H r1" parameter in "HOLD" menu : 0 - "rREAL" mode ; 1 - "HOLD" mode or for "Altr" and "AltF" the register is not used
55h	Yes	0 ÷ 1	"H r2" parameter in "HOLD" menu: 0 - "rREAL" mode ; 1 - "HOLD" mode or for "Altr" and "AltF" the register is not used
56h	Yes	0 ÷ 1	"H r3" parameter in "HOLD" menu: 0 - "rREAL" mode ; 1 - "HOLD" mode
57h	Yes	0 ÷ 1	"H r4" parameter in "HOLD" menu: 0 - "rREAL" mode ; 1 - "HOLD" mode
58h	Yes	0 ÷ 1	"HOUT" parameter in "HOLD" menu: 0 - "rREAL" mode ; 1 - "HOLD" mode
70h ⁵	Yes	-999 ÷ 1999	The value of „X" coordinate of point no. 1 of the user defined characteristic, expressed in 0.1%
71h ⁵	Yes	-999 ÷ 9999	The value of „Y" coordinate of point no. 1 of the user defined characteristic, no decimal point included
72h ⁵ ÷ 95h ⁵			Further pairs of „X" - „Y" coordinates of points no. 2 ÷ 19 of the user defined characteristic
96h ⁵	Yes	-999 ÷ 1999	The value of „X" coordinate of point no. 20 of the user defined characteristic, expressed in 0.1%
97h ⁵	Yes	-999 ÷ 9999	The value of „Y" coordinate of point no. 20 of the user defined characteristic, no decimal point included
A0h ¹	Yes	0 ÷ 3	"Omod" parameter in "OUTP" menu (active current output mode) 0 - current output disabled; 1 - current output enabled with 4÷20mA mode; 2 - current output enabled with 0÷20mA mode; 3 - current output controlled via RS-485 interface
	Yes	0 ÷ 2	"Omod" parameter in "OUTP" menu (passive current output mode) 0 - current output disabled; 1 - current output enabled with 4÷20mA mode; 2 - current output controlled via RS-485 interface
	Yes	0 ÷ 5	"Omod" parameter in "OUTP" menu (active voltage output mode) 0 - voltage output disabled; 1 - voltage output enabled with 0÷5V mode; 2 - voltage output enabled with 1÷5V mode; 3 - voltage output enabled with 0÷10V mode; 4 - voltage output enabled with 2÷10V mode; 5 - voltage output controlled via RS-485 interface
A1h ¹	Yes	-999 ÷ 9999	"OUTL" parameter in "OUTP" menu, no decimal point included
A2h ¹	Yes	-999 ÷ 9999	"OUTH" parameter in "OUTP" menu, no decimal point included
A3h ¹	Yes	0 ÷ 999	"Lo r" parameter in "OUTP" menu, for active current output and active voltage output, expressed in 0.1%
	Yes	0 ÷ 299	"Lo r" parameter in "OUTP" menu for passive current output, expressed in 0.1%
A4h ¹	Yes	0 ÷ 199	"Hi r" parameter in "OUTP" menu for active and passive current output, expressed in 0.1%
	Yes	0 ÷ 99	"Hi r" parameter in "OUTP" menu for active voltage output, expressed in 0.1%

Register	Write	Range	Register description
A5h ¹	Yes	0 ÷ 3	“AL” parameter in “OUTP” menu (active current output value on critical exception): 0 - no change; 1 - 22.1 mA; 2 - 3.4 mA; 3 - 0 mA
	Yes	0 ÷ 2	“AL” parameter in “OUTP” menu (passive current output value on critical exception): 0 - no change; 1 - 22.1 mA; 2 - 3.4 mA
	Yes	0 ÷ 5	“AL” parameter in “OUTP” menu (active voltage output value on critical exception): 0 - no change; 1 - 11 V; 2 - 5.5; 3 - 1.2 V; 4 - 0.6 V; 5 - 0 V

- 1 - these registers are active only if device is equipped with current or voltage output
- 2 - after writing to register no 20h the device responds with an “old” address in the message.
- 3 - after writing to register no 22h the device responds with the new baud rate.
- 4 - the value of the “mbAc” parameter is also connected to write to this register, so it is possible to block a writes, but impossible to unblock writes via RS-485 interface, The unblocking of the writes is possible from menu level only.
- 5 - the pairs of „X-Y” coordinates may be defined for any free point. The pair is “free” (it means that particular point is not defined) if „X” coordinate of this point is equal 8000h. After writing both X and Y coordinate the point is defined and used in calculation of result. The coordinates of any point can be changed at any time.

11.2. TRANSMISSION ERRORS DESCRIPTION

If an error occurs while write or read of single register, then the device sends an error code according to Modbus RTU specifications (example message no 1).

Error codes:

- 01h** - illegal function (only functions 03h, 06h and 10h are available),
- 02h** - illegal register address
- 03h** - illegal data value
- 08h** - no write permission (see: “mbAc” parameter)
- A0h** - exceed of upper border of input range
- 60h** - exceed of lower border of input range

A0h and 60h codes can appear only during reg. 01h is reading by 03h function (read of a single register).

11.3. EXAMPLES OF QUERY/ANSWER FRAMES

Examples apply for device with address 1. All values are represent hexadecimal.

Field description:

- ADDR** Device address on modbus network
- FUNC** Function code
- REG H,L** Starting address (address of first register to read/write, Hi and Lo byte)
- COUNT H,L** No. of registers to read/write (Hi and Lo byte)
- BYTE C** Data byte count in answer frame
- DATA H,L** Data byte (Hi and Lo byte)
- CRC L,H** CRC error check (Hi and Lo byte)

1. Read of the displayed value (measurement), SRP-94 device address = 01h:

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	01	00	01	D5	CA

a) The answer (we assume that the measure result is not out of range):

ADDR	FUNC	BYTE C	DATA H,L		CRC L,H	
01	03	02	00	FF	F8	04

DATA H, L - displayed value = 255, no decimal point.

Decimal point position can be read from reg. 03h.

b) The answer (if an error occur):

ADDR	FUNC	ERROR	CRC L,H	
01	83	60	41	18

ERROR - error code = 60h, bottom border of the measurement range is exceeded

2. Read of device ID code

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	21	00	01	D4	00

The answer:

ADDR	FUNC	BYTE C	DATA H,L		CRC L,H	
01	03	02	20	F0	A1	C0

DATA - identification code (20file:///x:/include/commonh)

3. Change of the device address from 1 to 2 (write to reg. 20h)

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

DATA H - 0

DATA L - new device address (2)

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

4. Change of baud rate of all devices connected to the net (BROADCAST message).

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
00	06	00	22	00	04	29	D2

DATA H - 0

DATA L - 4, new baud rate 19200 baud



Device do not reply to BROADCAST-type messages.

5. Read of the registers 1, 2 and 3 in one message (example of reading a number of registries in one frame):

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	01	00	03	54	0B

COUNT L - the count of being read registers (max.16)

The answer:

ADDR	FUNC	BYTE C	DATA H1,L1		DATA H2,L2		DATA H3,L3		CRC L,H	
01	03	06	00	0A	00	00	00	01	78	B4

DATA H1, L1 - reg. 01h (10 - displayed value "1.0"),

DATA H2, L2 - reg. 02h (0 - no errors),

DATA H3, L3 - reg. 03h (1 - decimal point position " 0.0").

**There is no full implementation of the Modbus Protocol in the device. The functions presented above are available only.**

12. DEFAULT AND USER'S SETTINGS LIST

Parameter	Description	Default value	User's value	Desc. page
Parameters of relay R1 operation ("rEL1" menu)				
SEtP	Relay R1 threshold	20.0		33
SEt2	Relay R1 second threshold	40.0		33
HYSt	Hysteresis of relay R1	0.0		33
modE	Operation mode of relay R1	on		33
t on	Turn on delay of relay R1	0.0		34
toFF	Turn off delay of relay R1	0.0		34
unit	Unit of "t on", "toFF" parameters of relay R1	SEC		34
AL	Reaction for critical situation of relay R1	oFF		34
Parameters of relay R2 operation ("rEL2" menu)				
SEtP	Relay R2 threshold	40.0		33
SEt2	Relay R2 second threshold	60.0		33
HYSt	Hysteresis of relay R2	0.0		33
modE	Operation mode of relay R2	on		33
t on	Turn on delay of relay R2	0.0		34
toFF	Turn off delay of relay R2	0.0		34
unit	Unit of "t on", "toFF" parameters of relay R2	SEC		34
AL	Reaction for critical situation of relay R2	oFF		34
Parameters of relays R1 and R2 operation in ALtr i ALtF modes ("rEL1" menu)				
S1 u	First upper threshold of relays	20.0		35
S2 u	Second upper threshold of relays	40.0		35
S1 d	First lower threshold of relays	40.0		35
S2 d	Second lower threshold of relays	60.0		35
modE	Operating mode of R1 and R2 relays	(ALtr / ALtF)		33
tAct	Maximum time to reach the reset threshold	0.0		35
tAun	Unit for the "tAct" parameter	SEC		35
tmin	Minimum relay activation time	0.0		35
dLy1	Minimum time interval between turning on both relays	0.0		35
dLy2	Minimum time interval between turning off both relays	0.0		35
AL 1	Method of reaction to a critical situation for R1	oFF		35
AL 2	Method of reaction to a critical situation for R2	oFF		35

Parameter	Description	Default value	User's value	Desc. page
Parameters of relay R3 operation ("rEL3" menu)				
SEtP	Relay R3 threshold	60.0		33
SEt2	Relay R3 second threshold	80.0		33
HYSt	Hysteresis of relay R3	0.0		33
modE	Operation mode of relay R3	on		33
t on	Turn on delay of relay R3	0.0		34
toFF	Turn off delay of relay R3	0.0		34
unit	Unit of "t on", "toFF" parameters of relay R3	SEC		34
AL	Reaction for critical situation of relay R3	oFF		34
Parameters of relay R4 operation ("rEL4" menu)				
SEtP	Relay R4 threshold	80.0		33
SEt2	Relay R4 second threshold	100.0		33
HYSt	Hysteresis of relay R4	0.0		33
modE	Operation mode of relay R4	on		33
t on	Turn on delay of relay R4	0.0		34
toFF	Turn off delay of relay R4	0.0		34
unit	Unit of "t on", "toFF" parameters of relay R4	SEC		34
AL	Reaction for critical situation of relay R4	oFF		34
Activation of acoustic signal (menu "bEEP")				
AL	Activation of acoustic signal by critical situation	oFF		36
r1	Activation of acoustic signal by relay R1	oFF		36
r2	Activation of acoustic signal by relay R2	oFF		36
r3	Activation of acoustic signal by relay R3	oFF		36
r4	Activation of acoustic signal by relay R4	oFF		36
Configuration of measurement input ("inPt" menu)				
tYPE	Input mode	„4-20"		36
CHAr	Conversion characteristic mode	Lin		36
FiLt	Filtering ratio	0		36
Pnt	Decimal point position	0.0		36
Lo C	Minimum displayed value (for nominal range)	000.0		37
Hi C	Maximum displayed value (for nominal range)	100.0		37
t h1	Height (length) first part of the tank	00.00		37
t h2	Height (length) second part of the tank	00.00		37
t h3	Height (length) third part of the tank	00.00		37

Parameter	Description	Default value	User's value	Desc. page
t d	Tank diameter	00.01		37
t Sn	Distance between sensor and bottom of the tank	00.00		37
t Sh	Height of the sensor	20.00		37
Lo r	Extension of the bottom of the nominal input range	5.0 (%)		40
Hi r	Extension of the top of the nominal input range	5.0 (%)		40
Active current output configuration ("OUTP" menu)				
Omod	Active current output mode	„0-20" (mA)		41
OUTL	Display value for 0 mA or 4 mA current output	0.0		42
OUTH	Display value for 20 mA current output	100.0		42
Lo r	Extension of the bottom of the nominal output range	5.0 (%)		42
Hi r	Extension of the top of the nominal output range	5.0 (%)		42
AL	Current output value on critical exception	22.1 (mA)		43
Passive current output configuration ("OUTP" menu)				
Omod	Passive current output mode	„4-20" (mA)		41
OUTL	Display value for 4 mA current output	0.0		42
OUTH	Display value for 20 mA current output	100.0		42
Lo r	Extension of the bottom of the nominal output range	5.0 (%)		42
Hi r	Extension of the top of the nominal output range	5.0 (%)		42
AL	Current output value on critical exception	22.1 (mA)		43
Active voltage output configuration ("OUTP" menu)				
Omod	Active voltage output mode	„0-10" (V)		41
OUTL	Display value for 0 V, 1 V or 2 V voltage output	0.0		42
OUTH	Display value for 5 V or 10 V voltage output	100.0		42
Lo r	Extension of the bottom of the nominal output range	5.0 (%)		42
Hi r	Extension of the top of the nominal output range	5.0 (%)		42
AL	Voltage output value on critical exception	11.0 (V)		43
Display parameters				
bri	Display brightness	bri6		43
Configuration of peaks detection function ("HOLD" menu)				
modE	Kind of detected changes	norm		43
PEA	Minimum detected change	0.0		43
timE	Maximum time of peak displaying	0.0		43

Parameter	Description	Default value	User's value	Desc. page
HdiS	The type of displayed value	HOLd		44
H r1	Source of relay R1, and LED R1 control	rEAL		44
H r2	Source of relay R2, and LED R2 control	rEAL		44
H r3	Source of relay R3, and LED R3 control	rEAL		44
H r4	Source of relay R4, and LED R4 control	rEAL		44
HOuT	Source of current output control	rEAL		44
Settings of access to the configuration parameters ("SECu" menu)				
A r1	Permission to changes of relay R1 threshold without of the user password knowledge	on		44
A r2	Permission to changes of relay R2 threshold without of the user password knowledge	on		44
A r3	Permission to changes of relay R3 threshold without of the user password knowledge	on		44
A r4	Permission to changes of relay R4 threshold without of the user password knowledge	on		44
RS 485 interface configuration (menu "rS")				
Addr	Device address	0		44
bAud	Baud rate	9.6		44
mbAc	Permission to changes of configuration registers	on		44
mbtO	Maximum delay between received messages	0		45
rESP	Additional delay of answer transmission	Std		45
Configuration of numerical parameters edition				
Edit	Numerical parameters edit mode	dig		45



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