APAR Control
05-090 Raszyn, Gałczyńskiego 6
tel. (+48) 22 101-27-31, 22 853-48-56, 22 853-49-30
e-mail: automatyka@apar.pl
www.apar.pl/en

USER MANUAL

AR200.B

2 inputs
RTD, TC, mA
V, mV, Ω, BIN

Outputs
2 x relay/SSR
1 x mA/V

Control
ON/OFF, PID
Program, Servo

Alarms
STB Function
LATCH

Memory
up to ~94k.
records

Clock
Timer

RS485
MODBUS-RTU

USB
memory
COM port

Ethernet
MODBUS-TCP
MQTT, files

Software
ARSOFT-CFG
ARSOFT-LOG

Access protection
Password

Protection rating
From the front

UNIVERSAL DATA RECORDER WITH REGULATION AND TIMER, 3 CHANNELS, 2 INPUTS

CE

Version 1.0.3
2024.09.23

Thank you for choosing our product.
This manual will enable proper handling, secure use and full utilization of the device capabilities.
Before assembling and starting the device please read and understand this manual.
If you have additional questions, please contact our technical consultant.

TABLE OF CONTENTS

1. SAFETY RULES....3
2. ASSEMBLY RECOMMENDATIONS....3
3. GENERAL CHARACTERISTIC OF CONTROLLERS. ACCESSORIES AND KIT CONTENTS....3
4. TECHNICAL DATA....4
5. HOUSING DIMENSIONS AND ASSEMBLY DATA....5
6. DESCRIPTION OF CLAMPING RAILS AND ELECTRICAL CONNECTIONS....5
7. DESCRIPTION OF BUTTON FUNCTIONS AND DATA PRESENTATION ON THE OLED DISPLAY....6
   7.1. DEVICE STATUS BAR....7
   7.2. MODES OF MEASUREMENT DATA PRESENTATION....7
   7.3. FUNCTION BUTTONS AND BINARY INPUT....8
8. SETTING CONFIGURATION PARAMETERS....8
9. OUTPUT OPERATION CONFIGURATION....13
   9.1. QUICK CHANGE OF SETPOINTS FOR OUTPUTS....14
   9.2. ANALOG OUTPUT (mA/V)....14
   9.3. PID CONTROL....14
   9.4. AUTOMATIC SELECTION OF PID PARAMETERS....14
   9.5. CORRECTION OF PID PARAMETERS....15
   9.6. PROGRAMMED WORK CHARACTERISTICS. SAMPLE CONFIGURATION....16
   9.7. MIXING VALVE CONTROL. SAMPLE CONFIGURATION....16
10. RECORDING AND VIEWING RECORDED MEASUREMENTS AND INCIDENTS....17
11. SIGNALING MESSAGES AND ERRORS....17
12. IMPORTANT EXPLOITATION REMARKS ⚠ 17
13. USB SOFTWARE AND DRIVERS AVAILABLE. SERIAL COMMUNCATION....18
   13.1. MQTT PROTOCOL....18
   13.2. MODBUS–TCP SERIAL TRANSMISSION PROTOCOL....19
   13.3. RS485 COMMUNICATION INTERFACE (acc. EIA RS-485)....19
   13.4. MODBUS–RTU SERIAL TRANSMISSION PROTOCOL (SLAVE)....19
   13.5. MAP OF DEVICE REGISTERS FOR MODBUS-RTU/TCP....20
14. OWN NOTES....20

Special attention should be paid to texts marked with this sign

The manufacturer reserves the right to make changes to the design and software of the device without deteriorating its technical parameters.
It is possible to update the device software to the latest version. To do this, contact the Service Department.
Despite the utmost efforts, the manufacturer reserves the right to occurrence of mistakes both in the product documentation and in the software.

1. SAFETY RULES

Before using the device, please read this manual carefully, and:

a) in order to avoid electric shock or damage to the device mechanical and electrical assembly should be commissioned to qualified personnel
b) before turning on the power, make sure that all cables have been connected correctly
c) before modifying cable connections, disconnect the voltage connected to the device
d) ensure proper working conditions, compliant with the technical data of the device (chapter 4, supply voltage, humidity, temperature, etc.), do not expose the device to direct and strong influence of heat radiation

2. ASSEMBLY RECOMMENDATIONS

The device has been designed to provide an adequate level of resistance to most of the disturbances that can occur in industrial and home environments. In environments with an unknown/high level of interference, it is recommended to use the following measures to prevent any possible disruption of the device's operation:

a) do not supply power to the device from the same lines as large capacity devices without proper mains filters
b) for power, sensor and signal cables, use shielding and ferrite filters, where the filter and screen grounding (single point) should be as close as possible to the instrument
c) avoid laying measuring (signal) wires in the immediate vicinity and parallel to power and supply cables
d) it is recommended to twist signal wires in pairs or use a ready UTP wire
e) Use the same cables for resistance sensors in a 3-wire connection
f) avoid the proximity of remotely controlled devices, electromagnetic meters, high power loads, loads with phase or group power control and other devices generating large impulse noise
g) ground or neutralize the metal rails on which the rail devices are mounted

Before starting working with the device, remove the protective foil of the OLED display.

3. GENERAL CHARACTERISTIC OF CONTROLLERS. ACCESSORIES AND KIT CONTENTS

- the instrument is used for regulation, supervision and recording temperature and other physical quantities (humidity, pressure, flow, level, speed, etc.) converted into a standard electrical signal with the possibility of presenting from **1 to 3 channels** with measurement data and their mathematical functions
- **2 universal measurement input** (RTD thermo-resistive, TC thermocouple, analogue 0/4÷20mA, 0÷10V, 0÷60mV, 0÷2.5kΩ) **with mathematical functions** (subtraction, sum, average, larger or smaller of the measurements) available independently for displaying, recording and controlling control outputs
- configurable architecture enabling using in many fields and applications (industrial, heating, food, energy, etc.)
- recording data in the recorder memory in the FAT system, reading files via **USB** or **Ethernet** interface
- archive files saved in standard CSV text format with the option of reading and editing in available software or in any spreadsheets such as Excel or OpenOffice Calc, saving up to **3** channels (measurements and their mathematical formulas)
- **2 function buttons** (**F** and SET) and **digital input** (BIN**)** for quick change of the recorder operation mode, programmable separately: start/stop of regulation and recording, manual/automatic mode for outputs, step change of the SP setpoint (day/night, i.e. SP1/SP3, with separate adjustment parameters), buttonpad lock, reset STB alarms (LATCH), quick change of SP setpoint, etc.
- **3 control/alarm channels** (**2** P/SSR hardware outputs + **1** software output) of on/off type with independent control functionalities and algorithms (SP setpoints defined by parameter or taken from inputs 1/2 measurements):
  - **ON-OFF with hysteresis** (threshold characteristics for heating and cooling, band alarms within and out of range and with an offset for three-point control)
  - **PID** (choice of **3 separate sets of parameters**, gain scheduling for SP setpoint taken from measurement input 1 or 2), advanced functions of automatic selection of PID **smart logic** parameters
  - programmable operation characteristics (**process controller with timer**, up to **6 segments**, including 3 segments of **ramping** type-slope for heating/cooling or cooling/defrosting, 3 SP setpoints with ON-OFF or PID control, selection of the auxiliary output and its condition, displaying the remaining time for the entire segment or after exceeding the SP, etc.)
  - thermostat/controller/safety switch **STB** (alarm condition open or closed, erased F/SET/BIN, can also be used as a **alarm memory** of **LATCH** type, e.g. after exceeding the minimum, maximum or band)
  - control of a three-way mixing valve with an actuator (**step adjustment**, **Servo**) with two contact inputs (open - close), implemented at outputs 1 and 2, for slow-changing processes (e.g. for central heating CO, not recommended e.g. for CWU installations requiring a quick response to changes)
  - **manual mode** (open control loop) with the initial value of the control signal (MV) taken from the current automatic mode or programmed by the user in the range of 0÷100%, also for sensor failure
  - direct or Inverted copy of the state of output 1 (applies to output 2, can be used, for example, to take over the function of the damaged P1)
  - **limitation** of the maximum level of the output signal (**power**), also includes the connected mA/V analog output
  - acoustic and visual signaling of the operating status of the outputs (low-volume buzzer and displayed icons)
- **analogue output 0/4÷20mA or 0/2÷10V** for adjustment or retransmission of measurements and setpoints:
  - download of the control parameters from any connected output/alarm (1, 2, 3), both in automatic and manual mode
  - impact-free (gentle) switching of the output signal, e.g. after changing the manual/automatic or start/stop adjustment mode (the function can be enabled or disabled in the parameter configuration)
  - correction (calibration) of the range of changes of the output signal (shift for the extreme values allowing to obtain non-standard ranges, e.g. 2÷16mA or 1÷9V)
  - the possibility of using an SSR relay for control (as a 3rd ON-OFF control output)
- time adjustment/timer, selectable: continuous operation, cyclic daily (hourly) or Limited by date and time
- wide range of supply voltages (**18÷265 Vac** /**22÷350 Vdc**) and built-in power supply for object transducers **24Vdc**/50mA

- legible **OLED graphic display**, 128x64 dots, single-color, with brightness adjustment and status indication, presentation of up to 3 measurement channels in various view modes (text, graph, bar graph, etc.)
- **RS485** serial interface, MODBUS-RTU **protocol** for reading measurements and parameters configuration
- **Ethernet** interface, **MODBUS-TCP** and **MQTT** protocols (for the Internet of things **IoT/M2M**, cloud and mobile applications), the possibility to exchange measurement and configuration data via the **Internet**
- **USB** interface (micro USB connector, standard equipment, for reading recorded data, programming parameters, viewing measurements, access to internal memory and for updating firmware)
- automatic/constant compensation of RTD and R lead resistance and temperature of thermocouple cold junctions
- programmable input type, indication range (for analog inputs), options for recording, adjustment, alarms, display, communication, access, real-time clock, menu language (Polish and English) and other configuration parameters
- programmable password protection against unauthorized access to archive and configuration data and a checksum to detect archive modifications
- ways to configure parameters:
  - from the membrane buttonboard placed on the front panel of the device
  - via the USB port, RS485 or Ethernet and the ARSOFT-CFG program (for Windows 7/10/11) or the user's application (using the MODBUS-RTU and TCP communication protocols)
- **free** software (for Windows 7/10/11) enabling reading and graphic or text presentation of recorded results (**ARsoft-LOG)** and preview of current measurements, as well as configuration and copying device parameters (**ARsoft-CFG**), available updates on the website
- a wide selection of ways to start recording (continuous, Limited by date and time, cyclic daily, only during adjustment/alarm or manually controlled with F, SET buttons or digital input BIN)
- distinguishing archives from multiple recorders by assigning an identification number (ID)
- record in infinite mode (after filling the memory, the oldest archives are deleted) or till the memory is full (recording is stopped), total capacity up to about **94 thousand records** (when recording one measurement channel, minimum 80 thousand for 2, 71 thousand for 3)
- internal **clock** with the possibility of precise correction of real time counting
- panel housing, protection **class IP65** from the front (after using an additional accessory gasket or other seal), IP54 without a gasket
- modern technical solutions, intuitive and simple handling, **high accuracy** and long-term stability as well as resistance to interferences
- optional (in the ordering procedure): control outputs for SSR and analog output 0/2÷10V (instead of standard one 0/4÷20mA)
- **available accessories** (you can also buy it through the online store *apar.sklep.pl*):
  - gasket for IP65 tightness from the front
  - USB cable (A - micro B) for connection to a computer, length 1.5 m
  - USB to RS485 converter (with galvanic separation)
- **kit includes**:
  - recorder (with mounting brackets in the board), user manual and USB cable (A - micro B)

NOTE:

- before starting work with the device, read this manual and correctly perform mechanical, electrical installation and parameter configuration in accordance with Chapters *5*, *6* and *8*,
- **by default, the recorder is configured to present the temperature from the PT100 sensors, the adjustment for all outputs and the recording are disabled,** the **access password is enabled** (the USB disk is secured, not available for exploration on the computer), the **company values of the parameters available in *chapter 8*.**

4. TECHNICAL DATA

Number of measurement inputs	2 universal (not galvanically separated, common ground)		
Universal inputs (2 programmable, 17 types, 18-bit A/C processing), measuring ranges			
- Pt100 (RTD, 3- or 2-wire)	-200 ÷ 850 °C	- R (TC, PtRh13-Pt) thermocouple	-40 ÷ 1600 °C
- Ni100 (RTD, 3- or 2-wire)	-50 ÷ 170 °C	- T (TC, Cu-CuNi) thermocouple	-25 ÷ 350 °C
- Pt500 (RTD, 3- or 2-wire)	-200 ÷ 620 °C	- E (TC, NiCr-CuNi) thermocouple	-25 ÷ 820 °C
- Pt1000 (RTD, 3- or 2-wire)	-200 ÷ 520 °C	- N (TC, NiCrSi-NiSi) thermocouple	-35 ÷ 1300 °C
- J (TC, Fe-CuNi) thermocouple	-40 ÷ 800 °C	- current (mA, R_{we} = 50 Ω)	0/4 ÷ 20 mA
- K (TC, NiCr-NiAl) thermocouple	-40 ÷ 1200 °C	- voltage (V, R_{we} = 110 kΩ)	0 ÷ 10 V
- thermocouple S (TC, PtRh10-Pt)	-40 ÷ 1600 °C	- voltage (mV, R_{we} > 2 MΩ)	0 ÷ 60 mV
- B (TC, PtRh30PtRh6) thermocouple	300 ÷ 1800 °C	- resistive (R, 3-p or 2-p)	0 ÷ 2500 Ω
Response time for measurements (10÷90%)		0.5 ÷ 5 s (programmable), default ~1 s	
Leads resistance (RTD, Ω)		R_d < 25 Ω (for each line), auto or fixed compensation	
Resistance input current (RTD, Ω)		400 µA (Pt100, Ni100), 200 µA (Pt500, Pt1000, 2500 Ω)	
Processing errors (at an ambient temperature of 25 °C):			
- basic	- for RTD, mA, V, mV, Ω	0.1% of the measuring range ± 1 digit	
	- for thermocouples	0.2% of the measuring range ± 1 digit	
- additional for thermocouples		<2 °C (temperature of cold tips)	
- additional caused by ambient temperature changes		<0.004 % of input range /°C	
Resolution of measured temperature		0.1°C or 1°C, programmable	
Indications range (resolution for analog inputs)		maximum -9999 ÷ 19999, programmable	
Decimal point position for analog inputs		programmable in the range of 0 ÷ 3, i.e. 0 ÷ 0.000	
Digital input BIN (contact or voltage <24V)		bi-state, active level: short-circuit or <0.8V	

P/SSR binary outputs (2 independent)	- relay **P** (P1, P2), standard for outputs 1 and 2	current for resistive loads: **8A**/250Vac, **P1**: 1xSPDT (switchable), **P2**: 1xSPST-NO (open)
	- **SSR** (SSR1, SSR2), option	transistor type NPN OC, 11V, current < 35mA
Analog output mA/V (1 current or voltage, not galvanically separated from the input)	- **current** 0/4 ÷ 20 mA, active (standard)	maximum resolution 1.4 µA (14 bit)
		output load Ro < 1 kΩ
	- **voltage** 0/2 ÷ 10 V (option, instead of 0/4 ÷ 20 mA output)	maximum resolution 0.7 mV (14 bit)
		output load Io < 3.7 mA (Ro> 2.7kΩ)
	- errors (% of the initial range)	basic<0.1%, additional<0.004%/°C, at 25°C
Power supply (Usup, universal, compliant with the standards 24Vac/dc, 48Vac/dc, 110Vac, 230Vac, etc.)		18 ÷ 265 Vac, <3VA (alternating current voltage, 50/60Hz)
		22 ÷ 350 Vdc, <4W (DC voltage)
Power supply for object transducers		24Vdc / 50mA
Communication interfaces (independent, can be used simultaneously, standard equipment)	- **USB** (micro connector type B, communication with a computer)	drivers for Windows 7/10/11 (virtual COM serial port, Modbus-RTU protocol, Slave) + removable disk (4MB)
	- **RS485** (separated)	MODBUS-RTU protocol, Slave, speed 2.4÷115.2 kb/s, programmable character format (8N1, 8E1, 8o1, 8N2)
	- **Ethernet** (separated, RJ45 connector with LINK-UP and TX/RX LEDs)	standard 10base-T, TCP/IP protocols: **MODBUS-TCP** (Server), **MQTT** (client, v.3.1.1), DHCP (client), ICMP (ping)

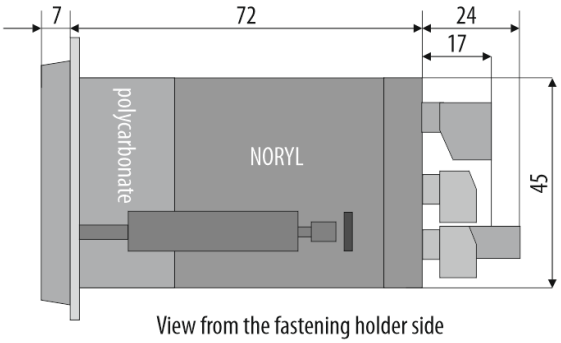
Data memory (built-in, non-volatile, FLASH type, FAT file system)	4MB, recording in infinite (circular) mode or till the memory is full, up to 94 thousand records for one channel, min. 80 thousand for 2 channels (71 thousand for 3 channels)	
Data recording interval	programmable from 1s to 8h **(1)**	
Real-time Clock	quartz, takes into account leap years, lithium battery CR1220	
Display (OLED, graphic)	128x64, white, 2.42", with brightness adjustment	
Rated operating conditions	0 ÷ 50°C, <90%RH, no water vapour condensation inside the device, working environment: air and neutral gases	
Protection rating	IP65 from the front with a gasket (IP54 without a gasket), IP20 from the side of the connectors	
Weight	~200g	
Electromagnetic Compatibility (**EMC**)	resistance: according to PN-EN 61000-6-2 standard, emissivity: PN-EN 61000-6-4	
Safety requirements according to PN-EN 61010-1 norm	installation category: II	pollution degree: 2
	voltage to ground: 300 V for the supply circuit and relay outputs, 50 V for the remaining input and output circuits and communication interfaces	
	insulation resistance > 20 MΩ	altitude above the sea level <2000 m

(1) - for a recording interval equal to 1s, uneven recording is possible during the transfer of the archive via Ethernet, as well as due to the excessive number and size of files,

- **recording is always held (pause) during connection to the computer's USB port**

5. HOUSING DIMENSIONS AND ASSEMBLY DATA

Mounting	panel, handles on the side of the housing
Material	self-extinguishing NORYL 94V-0, polycarbonate
Housing dimensions	96 x 48 x 79 mm (W x H x D, without connectors)
Panel window	92 x 46 mm (W x H)
Cable cross-sections (for separable connectors)	2.5 mm² (power supply and P/SSR outputs), 1.5 mm² (other)



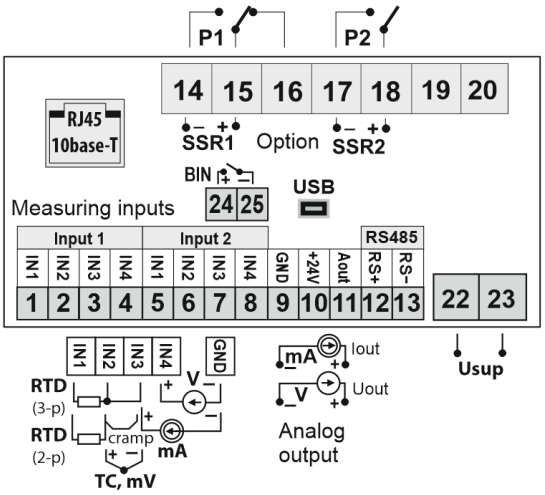
View from the fastening holder side

6. DESCRIPTION OF CLAMPING RAILS AND ELECTRICAL CONNECTIONS

Table 6. Numbering and description of clamping rails

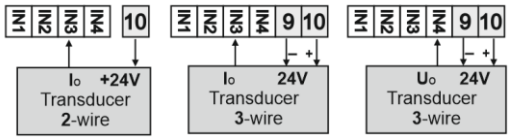
Clamps / Connectors	Description
IN1-IN2-IN3	Pt100, Ni100, Pt500, Pt1000 input, resistive, (2- and 3-wire)
IN2-IN3	thermocouple input TC (J, K, S, B, R, T, E, N) and voltage input 0÷60mV
IN3-GND (No. 9)	current input 0/4÷20mA
IN4-GND (No. 9)	voltage input 0÷10V
10	+24V output (in relation to 9-GND) of the built-in power supply of object transducers
24-25 (and 9)	BIN binary input (contact or voltage <24 V)
11-9 (GND)	analog output: current (0/4 ÷ 20mA) or voltage (0/2 ÷ 10V)
12-13	RS485 serial interface (MODBUS-RTU protocol), *chapter 13*
22-23	power supply input (universal, Vac/dc)
14-15-16	P1 or SSR1 relay output (14-15)
17-18	P2 or SSR2 relay output
19-20	not connected (N/A)
USB (micro type B)	USB serial interface for cooperation with a computer, *chapter 13*
RJ45	Ethernet serial interface (MODBUS-TCP, MQTT protocols, etc.), *chapter 13*

a) Terminal strips

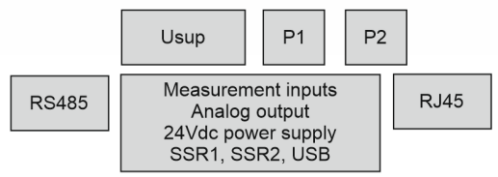


b) Connection of 2- and 3-wire transducer

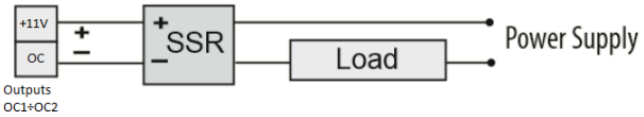
(Io - current, Uo - voltage output)



c) Galvanic separation of circuits



d) Connection of SSR type relay



ATTENTION:
For inductive loads, consider the use of blowout that will reduce the burnout of the relay pins

7. DESCRIPTION OF BUTTON FUNCTIONS AND DATA PRESENTATION ON THE OLED DISPLAY

a) buttons functions in the measurement display mode

Button	**Description** [and the method of marking in the content of the manual]
▼ + ▲	**[DOWN]** and **[UP]** (simultaneously): entering the parameter configuration menu (after holding time longer than 1.5 seconds), proceed as described in *chapter 8*, point 1
▼ or ▲	**[UP]** or **[DOWN]**: change in the method of presentating measurement data (views): MEASUREMENT LIST, SINGLE MEASUREMENT, ANALOG INDICATOR, GRAPH, ADJUSTMENT, *chapter 7.2*
SET	**[SET]**: activation of the additional function selected with parameter 109: ***Function of the [SET] button*** (pressing>1.5s, *chapter 7.3* and *chapter 8, Table 8, point XI*)
F	**[F]**: activation of the function selected with parameter 107: ***Button function [F]*** (pressing more than 1.5 seconds, description in *chapter 7.3* and *chapter 8, Table 8, point XI*)
[UP] + **[DOWN]** + **[SET]** (simultaneously) or **[F]**, **[SET]** when **[F]/[SET] button function** = ***Device status***, default setting for **[F]** button)	***Device status*** (also available in ***Main Menu*** -> ***Device information***, *chapter 8*): - status bar (description in *chapter 7.1*), - type and version of the device firmware, - hardware equipment (type of analogue output (**WA: mA** =current, **WU:V** =voltage), input BIN **state: N**=non- active, **A**= active (shorted), **RS485** and **RJ45** module (Ethernet)**: D** or **N** = available or unavailable), - memory status (occupancy, number of *csv* archive files, time, write mode: **CIR** =infinite (circular), **UFU** =until the memory is full, *chapter 10*), - the state of the Ethernet interface **(RJ45)** and communication protocols (***not connected***, **A**=auto-configuration DHCP or **S** =static, MQTT status: **OFF**=disabled, **CON**=connected to broker, MODBUS-TCP status: **CON**=connected to host (TCP port used), **NC**=port not used. 

b) button functions in the parameter configuration and quick changes of setpoints *SP 1/2/3* menu (*chapters 8* and *9.1*)

Button	**Description** [and the method of marking in the content of the manual]
SET	**[SET]**: **1.** selection of the displayed item in the configuration menu (entering a lower level), **2.** editing the current parameter, **3.** approval and saving of the edited parameter value
▼ or ▲	**[UP]** or **[DOWN]**: **1.** going to the next or previous parameter, **2.** change of the value of the edited parameter with a step of changes **x1** (or **x10**, description ***in point c***)
▼ + ▲ or F	**[UP]** and **[DOWN]** (simultaneously) or **[F]**: **1.** returning to the previous menu (one level higher), **2.** cancelling changes to the edited value, **3.** return to measurement display mode (except **[F]**)

c) additional functions of buttons during the change (edition) of setpoints and other configuration parameters

Buttons	**Description**
[SET]+**[UP]** or **[SET]**+**[DOWN]**	change the value of the edited numeric parameter with a change step **x10**, buttons pressed simultaneously, (does not apply to clock and letter parameters)
[SET]+ **[UP]**+**[DOWN]**	restoring **the factory value of** the numeric parameter (according to *Table 8, chapter 8*)

In addition, the speed of changing the edited value depends on the time the buttons are held (the longer the faster).

7.1. DEVICE STATUS BAR

The status bar is visible at the top of the display in the measurement presentation modes and the ***Device Status window*** (*Chapter 7 point a*). The meaning of individual fields and graphic elements is described below.

Fig. 7.1. Status bar

Object and description [and method of marking in the content of the manual], in order from the left side
time (hh:mm:ss), **day** of the week and **date** (dd- mm-yyyy) and real-time clock (**RTC**, *chapter 8, Table 8, point XII*)
or - status of control/alarm outputs icons, in the order from the **1st** to the **3rd**, (configuration in the ***Control and output*** menu, *chapter 8, Table 8, point III*), **icon filled**: output enabled, **empty** or **N**: output disabled (alarm inactive), **N** when the adjustment stopped via function buttons **[F]** /**[SET]** or input BIN (*chapter 7.3*)
- **[USB]** - icon of connecting to the computer's USB port (the action also pauses data recording)
- **[Tx/Rx]** - signaling the presence of serial transmission (via RS485, USB or Ethernet port)
or - **[REC]** - recording status icon (in progress or pause), ***The recording Options*** are described in *Chapter 8, Table 8, point VII*
- **[R/W]** - read/write indication of the internal memory (also when connected to the USB port of the computer)

7.2. MODES OF MEASUREMENT DATA PRESENTATION

The device enables the presentation of measurement data in various modes. Examples of screen views for each mode are shown in the following figures. The **[UP]** and **[DOWN]** buttons are used to change the view or the current measuring or control channel. Only active display and adjustment channels are displayed (for which the parameters ***Value to display*** are different from ***None***, *chapter 8, Table 8, point I* and ***Control algorithm*** for output 1/2/3 is not ***disabled***, *chapter 8, Table 8, point III*). The ***Device Status*** bar is displayed at the top of the screen (description *chapter 7.1*). The measuring panel contains the number, name (up to 16 characters) and unit (up to 4 characters) of the measuring channel (name and unit are taken from the *AR200 file.B.txt*) and the measured value (PV1/2/3). The graphical representation of the measurement (bar graph, analogue indicator and graph) operates within the range set by the ***Lower Range parameters for graphics*** and the ***Upper Range parameters for graphics*** (chapter 8, *Table 8, point I*).
The selection and methods of data configuration for the displayed measurement channels are described in *chapter 8*.

Fig.7.2.1. MEASUREMENT LIST screen

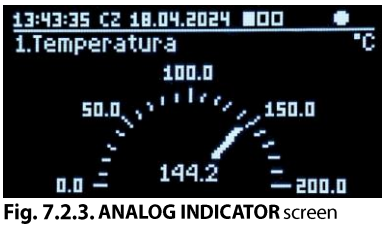


Fig. 7.2.3. ANALOG INDICATOR screen

Fig. 7.2.2. SINGLE MEASUREMENT screen

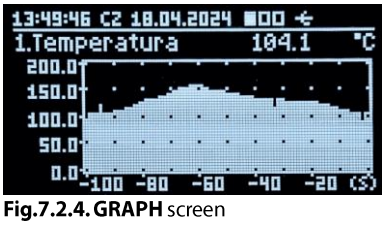


Fig.7.2.4. GRAPH screen

Fig. 7.2.5. ADJUSTMENT **screen**

Description of the screen and adjustment status, description of the parameters chapter 8, *Table 8, point III*
PV1/2/3: related value measured by ***Control signal (PV)*** parameter
SP: current ***Setpoint*** for control output **WY1/2/3** (*chapter 9.1*)
Time adjustment mode (***Continuous*** when no icon or limited when **DT/HD**)
abbreviations of the selected ***Control Algorithm*** (***OFF,*** ON-OFF**,** PID1/2/3/***G,*** PROG, **PRG-AUX**, **MANUAL**, **STB-O/C**, **DIRCPY1**, INVCPY1**,** SERVO**)** and the status of PID tuning, software and servo control, *chapter 9*
MV1/2/3: value of the output signal in the range of 0 ÷100% (pulsing period for P/SSR output or total variation of range for mA/V output)

7.3. FUNCTION BUTTONS AND BINARY INPUT

The independent function buttons **[F]** and **[SET]** and the **binary** BIN input are used to quickly start the programmed functions (parameters 107/109/108: ***[F] / [SET] / input BIN buttons function***, described in *chapter 8, Table 8, point XI*). The **digital** input BIN cooperates with a bistable signal, i.e. the supplied signal (voltage or switch) must be permanent (on/off type, active level: short-circuit or < 0,8V). Moreover**,** BIN has priority higher than the **[F]** and **[SET]** buttons. The start or stop of the function is indicated by appropriate messages on the display. The action for **[F]** and **[SET]** is performed only in the mode with measurement display (after holding time> 1.5 sec), for **BIN** - always (in every operating state).

8. SETTING CONFIGURATION PARAMETERS

All configuration parameters as well as channel names and regulator measurement units are included in permanent internal memory in 2 text files: *AR200.B.cfg* (numerical parameters) and *AR200.B.txt* (names and units - changes can only be made using a computer in ARsoft-CFG via USB or Ethernet port and in any text editor, e.g. Windows Notebook).
When switching on the appliance for the first time, the display may show an error signal related to the lack of sensor or attached one other than factory programmed one. In such case, connect the appropriate sensor or analog signal, or perform the programming of the configuration.
There are two ways to configure the parameters (manual and remote, do not use simultaneously):

1. Manually, from the membrane buttonboard placed on the front panel of the device:
- from the display mode of input measurements in the ***Main Menu*** (simultaneously press the **[UP] and [DOWN]** buttons for more than 1,5 seconds). If ***Password Protection*** in ***Access Options*** (chapter 8, *Table 8, point XI*) is ***On***, use the **[UP]** or **[DOWN]** buttons to enter the ***Access Password*** (default number ***1111***), use the **[SET]** button to move to subsequent items and approve the code, cancel changes with the **[UP]**+**[DOWN]** or **[F]** buttons,
- after entering the ***Main Menu*** with the **[UP]** or **[DOWN]** buttons, go to the appropriate submenu, and then confirm the selection with the **[SET]** button,
- the **[UP]** button moves to the next, **[DOWN]** to the previous parameter (collective list in chapter 8, *Table 8*),
- to change the value of the current parameter, briefly press the **[SET]** button,
- use the combination of the **[UP]**, **[DOWN]** and **[SET]** buttons to change the value of the edited parameter (with a change step of x1 or x10 or load the company value of the numeric parameter, description of the function in *chapter 7, points b and c*),
- confirm the changed value of the parameter with the **[SET]** button or cancel it with the **[F]** or **[UP]**+**[DOWN]** buttons,
- pressing **[UP]** + **[DOWN] or [F]** again causes the return to the ***Main Configuration Menu*** (or one level up),
- exit from the ***Main Menu***: long press of the **[UP]** + **[DOWN]** buttons

2. Remotely through the USB port, RS485 or Ethernet and the ARSOFT-CFG **computer** program (*chapter 13*):
- connect the device to a computer port and start and configure the ARSOFT-CFG application,
- after establishing the connection, the program displays the current measurements, the **[Tx/Rx]** icon signals the transmission (*chapter 7.1*)
- setting and viewing device parameters are available in the parameter configuration window
- new parameter values must be confirmed with the ***Approve changes*** button
- the current configuration can be saved to a file or set with values read from the file

Entering the access password to configuration (manually from the foil buttonboard or in ARsoft-CFG) when the device is connected via USB to the computer additionally unlocks access to the disk (internal data memory).

NOTICE:
- before disconnecting the device from the computer, use the ***Disconnect the device*** (ARSOFT-CFG) button
- in the absence of a response:
  - check the settings in ***Edit of configuration*** (*Connection type*, *COM Port*, *MODBUS address of the device*, etc.)
  - for USB, check whether the drivers for the serial port in the computer have been correctly installed (*see section 13*)
  - disconnect for a few seconds and reconnect the device or the RS485 converter to the USB port of the computer
- restart the ARSOFT-CFG and/or the computer

In the event of a discrepancy between the indications and the actual value of the input signal, it is possible to tune the offset and sensitivity to a given sensor in the ***Measurement Inputs*** menu: parameters ***Offset Calibration and Slope Calibration*** (sensitivity), chapter 8, *table 8, point II*.

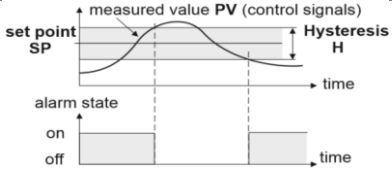
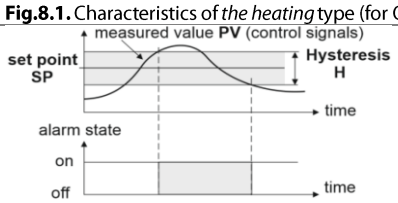
Restore Defaults file ***action can be used to*** restore factory settings (chapter 8, Table 8, *point VIII*). Alternatively, you can use files with the default configuration in ARsoft-CFG or copy them directly via USB.

In *Table 8* below, numerical indexes for determining the registry address and their values for Modbus-RTU/TCP protocols are placed before the names and values of the configuration parameters (*chapter 13.5*).

The icon ⓘ in the table means an informative item, not modifiable directly from the buttons.

NOTE:
Do not turn off the power during configuration from the buttonboard and remote one via the USB port of the computer because the recording of the changed parameter values in the internal memory occurs after exiting the ***Main Menu*** (**[UP]** and **[DOWN] buttons)** or disconnecting from the USB. Also, keep in mind that accessing your files requires you to unlock your drive.

Table 8. List of configuration parameters

Parameter (index: name)	**Value and range of variability of the parameter** (value: name) **and description**		**Default**
I. CONFIGURATION OF DISPLAY CHANNELS, menu ***Display channels*** menu, there are 3 identical sets 1/2/3			
Name and unit (informative item, read only)	editing the channel name (max. length 16 characters) and the measurement unit (4 characters) is possible in the computer (via USB or Ethernet port and ARsoft-CFG program or by editing the *AR200 file.B.txt*. Single section format in *AR200 file.B.txt* is as follows: *[Chan1] Name=**Channel 1**, Unit=**°C***		*Channel i* (for i=1÷3), *°C*
160/164/168: ***Value to display*** (input or formula assignment)	0: ***input 1 measurement***, : ***input 2 measurement***, 2: ***subtraction 1-2 measurement***, 3: ***Sum from measurements 1+2***, 4: ***Average from measurements 1 and 2***, 5: ***Larger from measurements 1 and 2***, 6: ***Smaller of measurements 1 and 2***, 7: ***Binary input (BIN)*** (8), 8: ***None*** (for chan. 2/3)		*Measurement from input 1/2/None*
Related outputs	numbers (***1÷3*** or ***None***) of control/alarm outputs are displayed for which the same type of 18/36/54 is assigned: ***Control signal (PV)*** every 160/164/168: ***Value to display*** the current display channel		*1÷ 3*
161/165/169: ***Bottom range for graphics***	***-999.9*** ÷ ***1999.9°C*** or ***-9999*** ÷ ***19999*** units (2) – lower value of the range of variation for graphic elements (bar graph, counter, graph)		*0.0 °C*
162/166/170: ***Top range for graphics***	***-999.9*** ÷ ***1999.9°C*** or ***-9999*** ÷ ***19999*** units (2) – upper value of the range of variation for graphic elements (bar graph, counter, graph)		*100.0 °C*
163/167/171: ***Bar graph***	0: ***Disabled***, 1: ***Enabled***, graphical presentation of the measurement in the range of 0÷100%		*Off/On*
II. CONFIGURATION OF MEASUREMENT INPUTS, submenu ***Measurement inputs***, there are 2 identical sets 1/2			
0/9: ***Input type***	0: ***Pt100*** RTD sensor (-200÷850°C)	1: ***Ni100*** RTD sensor (-50÷170°C)	*Pt100*
	2: **Pt500** RTD sensor (-200÷620°C)	3: ***Pt1000*** RTD sensor (-200÷520°C)	
	4: ***J*** *(Fe-CuNi)* thermocouple (-40÷800°C)	5: ***K*** *(NiCr-NiAl)* thermocouple (-40÷1200°C)	
	6: ***S*** *(PtRh 10-Pt)* thermocouple (-40÷1600°C)	7: ***B*** *(PtRh30-PtRh6)* thermocouple (300÷1800°C)	
	8: ***R*** *(PtRh13-Pt)* thermocouple (-40÷1600°C)	9: ***T*** *(Cu-CuNi)* thermocouple (-25÷350°C)	
	10: ***E*** *(NiCr-CuNi)* thermocouple (-25÷820°C)	11: ***N*** *(NiCrSi-NiSi) thermocouple* (-35÷1300°C)	
	12/13: ***4/0÷20 mA*** current signals 4÷20 mA / 0÷20 mA		
	14/15: ***0÷10 V/0÷60 mV*** voltage signals 0÷10 V / 0÷60 mV		
	16: ***0÷2500 Ω*** resistance signal 0÷2500 Ω		
1/10: ***Line resistance***	***0.00***÷***50.00 Ω***	total lead resistance for 2-wire RTD and 2500Ω sensors (1)	*0.00* Ω
2/11: ***Cold tip temperature***	0: ***Auto*** ***0.1÷ 60.0 °C***	automatic or constant temperature compensation of the reference junction of thermocouples, ***Auto*** = 0.0 °C	*Auto*
3/12: ***Dot position/ resolution***	***None*** / ***Item 1***	no dot /0,0 (2) or 1/0,1°C resolution for temperature	*Item 1* (0.1°C)
	Item 2/3	0.00 / 0.000 (2)	
4/13: ***Start of the input scale***	***-999.9*** ÷ ***1999.9***	lower limit of settings for setpoints 22/40/58: **SP1/2/3**	*-199.9 °C*
	-9999 ÷ ***19999***	scale start for analog inputs 0/4mA, 0V, 0Ω	
5/14: ***End of the input scale***	***-999.9*** ÷ ***1999.9***	upper limit of settings for setpoints 22/40/58: **SP1/2/3**	*850.0 °C*
	-9999 ÷ ***19999***	end of scale for analog inputs 20mA, 10V, 60mV, 2.5kΩ	
6/15: ***Filtration (3)***	***1*** ÷ ***20***	digital filtering degree (response time)	*3* (~1s)
7/16: ***Offset calibration***	offset for measurements: ***-100.0*** ÷ ***100.0*** °C or ***-1000*** ÷ ***1000*** units (2)		*0.0 °C*
8/17: ***Slope calibration***	***85.0*** ÷ ***115.0 %***	slope calibration (sensitivity) for measurements	*100.0%*
III. CONFIGURATION OF OUTPUTS 1÷2 (P/SSR) and **3** (logical), submenu ***Control and outputs -> Output 1/2/3***, description in *chap. 9*			
18/36/54: ***Control signal (PV)*** for output 1/2/3	input or formula assignment, menu items (values) identical to the parameter 160: ***Value to display*** in the ***Display Channels*** menu		*Measurement 1/2/1*
19/37/55: ***Control algorithm*** for output 1/2/3 **Caution** (for 9/10 values): if **[F]**/**[SET]** or **BIN** with the start/ stop function of the outputs operation was used to reset the STB (LATCH) alarm, a start is always needed to restart the STB and regulation	0: ***Off*** (output permanently off)	1: ***ON-OFF with hysteresis*** (on/off)	*Off*
	2/3/4: PID1/2/3 ***parameter set***, PID adjustment (*chapter 9.3*)		
	5: ***PID - 1-st or 2-nd set - gain scheduling (PIDG)***	PID adjustment - parameter set 1 when **SP** from input ≤ SP1/2/3 or set 2 for **SP** > **SP1/2/3**, works for 21/39/57: ***Setpoint selection*** = 0/1: ***input 1/2 measurement***	
	6/7: ***Software main/ auxiliary*** – process controller (*chapter 9.6*)		
	8: ***Manual (0..100%)*** **M**	manual mode (open loop adjustment) with setpoint set by parameter 26/44/62: ***Manual mode setting*** and 25/43/61: ***Tc pulse period***	
	9/10: ***STB open/closed (LATCH)*** - safety thermostat, alarm with memory, LATCH, open/closed emergency status (deleted with **[F]**, **[SET]**, **BIN**, *chap. 7.3*)		
	11/12: Direct/Inverted ***Copy of P1/SSR1 output*** status (only for 2/3 outputs)		
	13: ***Step (servo)***	servo valve control at outputs 1-open and 2-close (only for output 2, *chapter 9.7*), step adjustment	
20/38/56: ***Control/alarm type*** for output 1/2/3 **1.** concerns the control algorithms: ON-OFF with hysteresis, PID, software (main output), STB (LATCH) and step adjustment (servo) **2.** for PID, software (main output) and servo algorithms, only heating/inversed and cooling/direct characteristics apply	0: ***Heating***/Inverted (activated below SP)	 **Fig.8.1.** Characteristics of *the heating* type (for ON-OFF)	*Heating/ reverse*
	1: ***Cooling/ direct*** (activated over SP)	 **Fig.8.2.** Characteristics of *the cooling* type (for ON-OFF)	

<table>
<tr><td rowspan="6">3. characteristics 4÷7 (i.e. in relation to SP1) are available only for parameters of outputs 2/3

SP1/2/3 - setpoints for outputs 1/2/3 selected with parameters 21/39/57: SP Setpoint selection, i.e. 22/40/58: Setpoint SP (1/2/3) or input measurement (1/2)</td><td>2: alarm inside H band

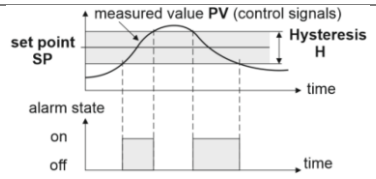
(activated in band)</td><td> 

Fig. 8.3. Characteristics of the alarm inside of the band (ON-OFF)</td></tr>
<tr><td>3: Alarm outside H-band

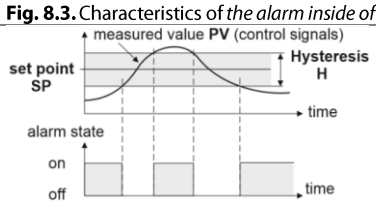
(disabled inside band)</td><td> 

Fig.8.4. Characteristics of the alarm outside of the band (ON-OFF)</td></tr>
<tr><td>4: Alarm inside of the band ± SP2/3 around SP1- output 1 setpoint

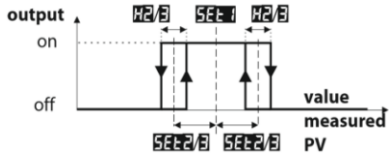
(activated inside band)</td><td> 

Fig.8.5. Characteristic inside band in relation to SP1</td></tr>
<tr><td>5: Alarm outside band ± SP2/3 around SP1- output 1 setpoint

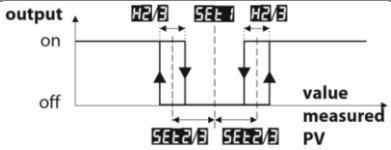
(disabled inside band)</td><td> 

Fig.8.6. Characteristic outside band in relation to SP1</td></tr>
<tr><td>6: Alarm above SP= SP1 + SP2/3

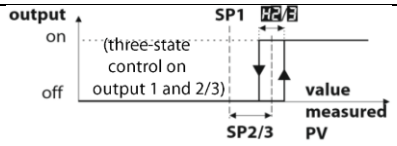
(activated above SP)</td><td> 

Fig.8.7. Deviation from SP1 (for SP2/3 > 0)</td></tr>
<tr><td>7: Alarm below SP= SP1 + SP2/3

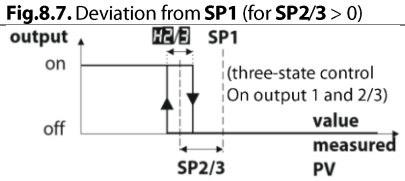
(activated below SP)</td><td> 

Fig.8.8. Deviation from SP1 (SP2/3 < 0)</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>21/39/57: Setpoint selection SP (1/2/3)</td><td colspan="2">0: input 1 measurement, 1: input 2 measurement, 2: Setpoint (SP) value (defined by parameter 22/40/58, below in table)</td><td></td></tr>
<tr><td>22/40/58: Setpoint (SP) value (1/2/3) for adjustment/alarm</td><td colspan="2">changes in the range set by parameters 4/13: Start and 5/14: End of the input scale (depending on the selected 18/36/54: Control signal)</td><td>100.0 °C</td></tr>
<tr><td>23/41/59: Hysteresis H/ PID zone</td><td colspan="2">hysteresis or deadband of PID tuning in Continuous mode (smart logic, <u>chapter 9.4</u>), 0.0÷ 999.9 °C or 0÷ 9999 units <u>(2)</u></td><td>1.0 °C</td></tr>
<tr><td>24/42/60: Power limitation (available power)</td><td colspan="2">0÷100 %, maximum level of control/power signal (also for related analog output mA/V with parameter 46: Output function) <u>(4)</u></td><td>100 %</td></tr>
<tr><td>25/43/61: Pulsing period Tc</td><td colspan="2">1÷360 s, applies to power limitation and manual mode, PID and serwo PIDs, for P/SSR outputs (pulse with a fill factor of 0÷100%)</td><td>4 sec.</td></tr>
<tr><td>26/44/62: Manual mode setting (control signal MV)</td><td>0÷100%</td><td>100% means the maximum available output power (set by parameters 24/42/60: Power limit), step every 1% <u>(4)</u></td><td>50 %</td></tr>
<tr><td>27/45/63: Emergency state of output</td><td colspan="2">for missing/damaged sensor/signal/input or out of measuring range: 0: Unchanged, 1: Off, 2: On, 3: Manual mode setting (with set level of output signal parameter 26/44/62, line above)</td><td>Off</td></tr>
<tr><td rowspan="3">28/46/64: Control time (with the possibility of manual control using the function buttons [F], [SET] and input BIN, e.g. start/stop of adjustment, <u>chapter 7.3</u>)</td><td>∞ 0: 0: Continuous</td><td>adjustment constantly switched on</td><td rowspan="3">Continuous</td></tr>
<tr><td>1: Limited by date and time (DT)</td><td>active adjustment in the Date and Time range defined by parameters 29/47/65: Start and 32/50/68: End of time adjustment (below in the table)</td></tr>
<tr><td>2: Hourly Daily (periodic) (HD)</td><td>cyclic adjustment active only in the Hours range defined by parameters 29/47/65: Start and 32/50/68: End of time adjustment</td></tr>
<tr><td>29/47/65: Start of time control</td><td colspan="2" rowspan="2">Date: 01.01.2023 ÷ 31.12.2099, Time: 00:00:00 ÷ 23:59:59, (for MODBUS data format as for register 29: RTC clock in <u>Table 13.5</u>) parameters active when 28/46/64: Time adjustment = Limited by date and time (DT or Hourly Daily (HD)</td><td rowspan="2">2023.01.01 00:00:00</td></tr>
<tr><td>32/50/68: End of time control</td></tr>
<tr><td>35/53/71: Sound alarm</td><td>0: Off
1: On</td><td>pulse signaling of switching on the output using the built-in acoustic transducer (buzzer)</td><td>Off</td></tr>
</table>

IV. CONFIGURATION OF ANALOGUE mA/V OUTPUT, submenu **Control and outputs -> Analog output (mA or V)**, detailed description in chapter 9.2				
72: **Type and standard**	0: ***0..20mA/0..10V*** or 1: ***4..20mA/2..10V*** (the hardware version depends on the order code, the preview is also available in the ***Device Information*** submenu)			*0..20mA / 0..10V*
73: ***Output function***	0: ***Off (0mA/0V)***, 1: ***Input 1 retransmission***, 2: ***Input 2 retransmission***, 3: ***Subtraction 1-2 retransmission***, 4: ***Sum 1+2 retransmission***, 5: ***Average 1 and 2 retransmission***, 6: ***Larger of 1 and 2 retransmission***, 7: ***Smaller of 1 and 2 retransmission***, 8: ***BIN state retransmission*** **(8)**, 9/10/11: ***SP1/2/3 retransmission***, 12/13/14: ***Control from Output 1/2/3***			*Off (0mA/0V)*
74: ***Start of retransmission scale***	***-999.9÷1999.9***	lower indication for output signal values 0/4mA or 0/2V	parameters active only for retransmission of measurements or setpoints	*0.0 °C*
75: ***End of retransmission scale***	***-9999÷19999*** (2)	upper indication for 20mA or 10V output signal values		*100.0 °C*
76: ***Bottom correction***	***0.00÷3.95 mA/V***	calibration of the variation range of the output signal, with a change step of 0.05 mA/V	for 0/4mA or 0/2V	*0.00 mA/V*
77: ***Top correction***	***-4.00÷0.5 mA/V***		for 20mA or 10V	
78: ***Rate of change limit***	0: ***Off*** - quick output response (recommended e.g. for SSR control) 1: ***On*** - mild (impact-free) output response			*Off*
V. PID PARAMETERS CONFIGURATION (1÷ 3), *submenu* **Control and output -> *PID1/2/3 parameter set***, description in chapters 9.3÷9.5				
79/83/87: ***PID tuning type*** (self-tuning)	0: ***Off***, 1: ***Continuous mode (smart logic)***, 2: ***Step response method (quick, STEP)***, 3 : ***Oscillation method*** (slower, ***OSC***), chapter 9.4			Off
80/84/88: ***Proportional band Pb***	***0.1÷18000*** or ***1÷18000*** units (2)			*1.0 °C*
81/85/89: ***Integration time Ti***	***0÷3600*** s, PID algorithm doubling time, ***0*** turns off the integrating element			*0* sec.
82/86/90: ***Differentiation time Td***	***0÷999*** s, PID advance time, ***0*** turns off the differentiating element			*0* sec.
VI. PROGRAMMED CONTROL CONFIGURATION (programmable operating characteristic, ramping), submenu **Control and output -> Process controller**, description chapter 9.6				
91/96/101: ***Stage 1/2/3 type***	0: ***Slope and time*** - stage consisting of 2 sections: reaching the selected setpoint SP 1/2/3 with the defined by the parameter 92/97/102: ***Slope...*** (ramping) and counting down the ***Section Time...*** (parameter 93/98/103, in the table below) after reaching the SP			*Slope and Time*
	1: ***Time after reaching SP*** - countdown of time after reaching the setpoint. SP 1/2/3 (±H/2)			
	2: ***Time for entire stage*** - time countdown independent from the SP setpoint			
	3: ***Continuous (no limit)***			
	4: ***End (last stage)*** - available only for stage 2/3			
92/97/102: ***Stage 1/2/3 slope PV/min***	rate of change (gradient) for the 1st section of the type 0 stage: ***Slope and time, ramping, -24.0 ÷24.0*** °C/min or ***-240÷240*** units/min (2)			*1.0 °C/min*
93/98/103: ***Segment time of stage 1/2/3***	***0÷1440*** min, duration of the section for the stage with time countdown			*60* min
94/99/104: ***Stage 1/2/3 control algorithm***	0: ***ON-OFF with hysteresis***, 1/2/3: ***Set of PID 1/2/3 parameters*** (chapter 9.3, not recommended for the ***Slope and time stage*** - gradient stage may interfere with PID operation)			*ON - OFF with hysteresis*
95/100/105: ***Stage 1/2/3 auxiliary output state***, 106: ***Auxiliary output state after stage 3***	0: ***OFF state***, 1: ***ON state***, 2: ***Manual mode setpoint*** (output signal level is set by parameter 26/44/62: ***Setting...***), selection of auxiliary output (1/2/3) is defined by parameter 19/37/55: ***Control algorithm*** = ***Software auxiliary***			*Disabled (OFF)*
VII. RECORDING SETTINGS, submenu **Recording settings**, description in chapter 10				
143: ***Recording type*** the device does not record data in the file when it is connected to the computer's USB port	0: ***Disabled***	recording is permanently off		*Off*
	1: ***Continuous***	recording is permanently on		
	2: Limited by date and time (DT)	active adjustment in the ***Date*** and ***Hour*** range defined by parameters 148: ***Start*** and 151: ***Time limit end*** (below in the table)		
	3: ***Hourly Daily (periodic)*** *(HD)*	Periodic adjustment active only in the ***Hours*** range defined by the parameters 148: ***Start*** and 151: ***End of time limit***		
	4: ***Above permission value***	registration active when the measured value defined by parameter 154: ***Permission signal selection*** is greater than parameter 155: ***Permission threshold value***		
	5: ***Below permission value***	registration active when the measured value defined by parameter 154: ***Permission signal selection*** is lower than parameter 155: ***Permission threshold value***		
	6: ***Only during control***	registration active when there is an adjustment permission for all outputs (can be controlled from the **[F] and [SET]** buttons or **input** BIN, chapter 7.3		
147: ***Data recording interval***	every 1s to 8 hours (counted from the moment of disconnection from the USB port of the computer)			*1* min
144/145/146: ***Recording value 1/2/3*** *in archive file*	input or formula assignment, menu items (values) identical to the parameter 164/168: ***Value to display*** in the ***Display Channels menu***			*Measurement 1/2/None*
148: ***Start of date & time limit***	***Date***: ***01.01.2023 ÷ 31.12.2099***, ***Time***: ***00:00:00 ÷ 23:59:59***, (for MODBUS data format as for register 29: RTC clock in Table 13.5) parameters active when 143: ***Recording type*** =			*2023.01.01 00:00:00*

151: ***End of date & time limit***	***Limited by date and time (DT*** or ***Hourly daily (HD)***		
154: ***Permission signal selection***	input or formula assignment, menu items (values) identical to parameter 160: ***Value to display*** in ***Display channels menu***, parameter active when 143: ***Registration Type*** = ***Above*** or ***Below Permission Threshold***		*Measurement from input 1*
155: ***Permission trigger value***	***-999.9*** ÷ ***1999.9°C*** or ***-9999*** ÷ ***19999*** units *(2)*, parameter active when 143: ***Recording Type*** = ***Above*** or ***Below Permit*** Threshold		*50.0 °C*
VIII. MEMORY and FILE OPTIONS, submenu ***Memory and files,*** description in *chapter 10.*			
158: ***Identification numer*** *(ID)*	the device number used in the archive file name and records (*csv*) to distinguish archives from multiple recorders, should be set before the recording begins		*0*
159: ***Decimal separator*** (decimal format of numbers)	0: ***Dot " . "*** *is used for measurements in archive files (csv)* 1: **Comma " ,"** is used for measurements in archive files		*Dot .*
156: ***Archive save mode*** (also displayed in the presentation of the status of the device, as CIR or UFU, *chap. 9.4*)	0: ***Circular (CIR)*** - infinite record, until memory full (UFU), the oldest archives are deleted (according to parameter 157: ***Archive file size***)		*Circular*
	1: ***Until memory full*** **(UFU)** - recording (of measurements and other incidents) is stopped when the total capacity is reached (up to ~94 thousand records)		
157: ***Archive files size*** for infinite recording *(7)* (max size)	***2 MB***	2 files, each with a capacity of up to ~47 thousand records for one measurement	*0.25 MB* (16 files, recommended)
	1 MB	4 files, each with a capacity of up to approximately 23.5 thousand records (max.)	
	0.5 MB	8 files, each with a capacity of up to approximately 12.8 thousand records (max.)	
	0.25 MB	16 files, each with a capacity of up to approximately 6.4 thousand records (max.)	
Reset to defaults (action on configuration files)	***Cancel***	return to previous menu (level up)	*Cancel*
	Parameters	set the default configuration parameters (***AR200 file.B.cfg***)	
	Names	set default names and units (***AR200.B.txt***) in the device	
	All	set default parameters and names (*AR200.B.cfg* and *AR200.B.txt*)	
Clear memory (memory formatting action)	***Cancel***	return to previous menu (level up)	*Cancel*
	Execute	delete all data from memory (except configuration files), operation recommended in case of data access problems	
IX. DISPLAY SETTINGS, submenu ***Display options***			
114: ***Dimming time***	0: ***None*** ***1÷60 min***	for value 0: ***None*** display blanking off, this is the time counted from the last time the buttonboard was used	*None*
115: ***Display brightness***	***5*** ÷ ***100%***, change every 5%		*100%*
116: ***Chart time range***	0: ***100sec***, 1: ***300sec***, 2: ***15min***, 3: ***30min***, 4: ***60min***, 5: ***150min***, 6: ***5h***, 7: ***10h***, 8: ***25h***, 9: ***50h***, 10: ***5days***, 11: ***10days***		*100 sec*
117: ***Language***	0: ***Polish***, 1: ***English***, menu language (change works after leaving the ***Main Menu***)		*Polish*
X. COMMUNICATION OPTIONS FOR RS485 and ETHERNET, submenu ***Communication options***, description in *chapters 13÷13.5*			
118: ***Baud rate for RS485***	baud rate kbit/s, 0: ***2.4***, 1: ***4.8***, 2: ***9.6***, 3: ***19.2***, 4: ***38.4***, 5: ***57.6***, 6: ***115.2***		*19.2* kbit/s
119: ***Char format for RS485***	selection of parity and alloy bits, 0: ***8N1*** (none), 1: ***8E1*** (even), 2: ***8o1*** (odd), 3: ***8N2***		*8N1*
120: ***Modbus-RTU address***	***1*** ÷ ***247***	device address for RS485 and suffix (suffix) for the name, *(5)*	*1*
121: ***Ethernet operation mode*** (***Physical address (MAC)*** also available in ARsoft-CFG)	0: ***Disabled*** - Ethernet permanently off (recommended when not in use)		*Off*
	1: ***Auto-configuration(DHCP)*** - DHCP client enabled, network parameters 122: ***IP address***, 126: ***Subnet mask*** and 130: ***Default gateway*** are set automatically		
	2: ***Manual configuration*** - DHCP disabled, network parameters are set manually		
122: IP ***address*** (4 records)	***0÷255***	device's IPv4 address in the local network (Ethernet), 4 consecutive octets	*192.168.0.200*
126: ***Subnet mask***	***0÷255***	mask of the IPv4 address in the local network (Ethernet), 4 consecutive octets	*255.255.255.0*
130: ***Default gateway***	***0÷255***	router's IPv4 address in the local network (Ethernet), 4 consecutive octets	*192.168.0.1*
134: ***Modbus-TCP port***	***1÷9999***	TCP port number for the MODBUS-TCP protocol (also for ARSOFT-CFG)	*502*
135: **MQTT operating mode** and type of published *MQTT* messages (Ethernet) (detailed description of MQTT communication, *chapter 13.1*)	0: ***Disabled*** - MQTT protocol disabled (recommended when not in use)		*Off*
	1: MQTT protocol enabled, in the content of the publication ***input 1 measurement*** (PV1), e.g. "*4.5*"		
	2: MQTT protocol enabled, in the content of the publication ***input 2 measurement*** (PV2), e.g. „9.9"		
	3: MQTT protocol enabled, in the content of the publication only the ***Subtraction 1-2 measurements***		
	4: MQTT protocol enabled, in the content of the publication only **Sum *1+2 measurements***		
	5: MQTT enabled, in the content of the publication only the ***Average 1 and 2 measurements***		
	6: MQTT protocol enabled, in the content of the publication, ***Larger of 1 and 2 measurements***		
	7: MQTT protocol enabled, in the content of the publication the ***Smaller of 1 and 2 measurements***		
	8: MQTT enabled, in the content the ***Name and measurements 1 and 2***, *(5)*		
	9: publication ***Measurements and status*** (PV1/2, MV, mA/V output status, BIN, etc.)		
136: ***MQTT broker address***	***0÷255***	IPv4 address of the MQTT broker (Ethernet), 4 consecutive octets	*192.168.0.10*

140: ***MQTT broker port***	***1÷9999***	MQTT broker TCP port number	*1883*
141: ***MQTT publication period***	***1÷3600*** s	interval of sending messages to the MQTT broker (Ethernet)	*10* sec.
142: ***MQTT subject level***	***1÷9999***	numeric suffix for the name of the subject of the MQTT publication (APAR/***1÷9999***)	APAR/*1*
Ethernet MAC addres	unique fixed hardware Ethernet interface address (non-modifiable), description in *Table 13.5*		
XI. ACCESS OPTIONS, BUTTONS AND OTHER OPTIONS, submenu ***Access and other***			
111: ***Access protection*** to archive data and configuration parameters, *(6)*	0: ***Disabled*** - entry to ***the Main Menu*** and remote access are not password protected (parameter 112), the data disk via USB is visible to the computer,		*Enabled*
	1: ***Enabled*** - ***Main menu*** and remote access are password protected, USB drive not available for computer exploration, password for ARsoft-CFG and LOG on		
112: ***Access password***	***0000 ÷ 9999***	password to enter ***the Main Menu*** and remote access and for MQTT (*chap. 13.1*), works when 111: ***Access protection*** is ***ON***	*1111*
110: ***Setpoints (SP) lock*** (quick changes of *SP 1/2/3setpoints*, *chap. 9.1*)	0: ***Disabled*** - without interlocks, 1/2/3: ***SP1, SP2, SP3 setpoint value - interlock of one of the*** settings, 4: ***SP1, SP2 value***, 5: ***SP1, SP3value***, 6: ***SP2, SP3 value***, 7: ***SP1, SP2, SP3 value*** – interlock of all settings in the adjustment window		*Disabled*
107: ***[F] button function*** 108: ***Binary input BIN function*** 109: ***[SET] button function*** **1.** detailed description in *chapter 7.3*) **2.** value 4÷9 (quick manual mode) interrupts and resets the tuning and the PID and software algorithm for the given output (1/2/3)	0: ***Device status/None*** function for BIN, description *chapter 7 point a*		for **[F]** and **BIN**: device *status/none* for **[SET]**: *Quick change of SP setpoint*
	1: ***Recording Start/Pause*** - changes parameter 143: ***Registration type*** to ***Continuous*** (*chapter 10*), after power start the recording is always on (continuous)		
	2: ***Buttons lock***, after start of power on by default		
	3: **SP3 replaces SP1** with a set of parameters for outputs 1 and 3 (day=22: ***SP1***, night=58: ***SP3*** both outputs work the same (copy)		
	4/6/8: ***Manual mode OUT1/2/3 (A)***	unconditional manual mode for output 1/2/3 z output signal level (MV) set with parameter 26/44/62: ***Manual mode setting*** M	start (without changes) with initial value for 26/44/62: ***Manual mode setting*** taken from current automatic control mode
	5/7/9: ***Manual mode OUT1/2/3 (S)***		start (step) with pre-set (set) parameter value 26/44/62: ***Manual mode setting***
	10: ***Alarms clearing*** reset the active *alarm* memory (LATCH) of the STB safety regulator		
	11: ***Control Stop/Start***	start/stop of the operation of all outputs (1/2/3) with the function 10: ***Alarms Clearing***	when power is on, default stop
	12: ***Control Start/Stop***		default start (only for **[F]** and **[SET]**)
	13: ***SP quick change*** in the selected adjustment window for output 1/2/3		
113: ***Buttons sound***	0: ***Off***, 1: ***On***		*Off*
XII. INTERNAL CLOCK SETTINGS, submenu ***Clock settings***			
Date and time (RTC clock)	***Date***: ***01.01.2023÷31.12.2099***, ***Time***: ***00:00:00÷ 23:59:59***, description in *Table 13.5*		*time*
172: T***ime correction***	***-20.0 ÷ 20.0*** seconds/day – decrease / increase the time counting speed		*0.0 s/d*
XIII. DEVICE INFORMATION, submenu ***Information about the device,*** description in *chapter 7 point a*			

Remarks: (1) – for 3-wire sensors, ***the Lead resistance*** parameter must be ***0.00*** Ω (automatic compensation),
(2) - applies to analog inputs (mA, V, mV, Ω),
(3) – for ***Filtration*** = ***1*** the response time is 0.5 seconds, for ***Filtration*** = ***20*** at least 5s. Higher degree of filtration stands for the more "smoothed" measured value and the longer response time recommended for measurements of turbulent nature (e.g. water temperature in the boiler),
(4) - for binary outputs (P/SSR) large rounding can occur, 1% is possible only for ***the*** Pulse ***period Tc*** (parameters 25/43/61) greater than 20s, for 4s it is 5%, for 2s 10%, for 1s as much as 20%,
Control signal **MV=100%** means the maximum available output power (parameter 24/42/60: ***Power limit***),
(5) – device name is created according to the template: AR200_ ***Address..*** (e.g. "AR200_1" for 120: ***Address..*** = ***1***). Used is in the content of the published MQTT message (*chapter 13.1*) and by the DHCP client (***Autoconfiguration mode***).
(6) – remote access password protection applies to communication with ARsoft-CFG (for parameter configuration) and ARsoft-LOG (for downloading files with measurements via the Ethernet interface)
(7) - the parameter is **not** valid when 143: ***Registration type*** = ***Hourly daily (HD)*** (new files are created then daily with the size depending on the number of records saved, i.e. from 147: ***Data recording interval***)
(8) – measurement values for **input** BIN: ***100*** (+unit for display channel ***ON***, short circuit) or ***0*** (***OFF***), dot position/resolution is always taken from input 1

9. OUTPUT OPERATION CONFIGURATION

Programmable architecture of the controller allows its use in many fields and applications. Before starting the operation of the device, set the output parameters to individual needs (such as 19/37/55: ***Control algorithm***, 20/38/56: ***Type of adjustment/alarm***, 22/40/58: ***SP setpoint*** and others described in chapter 8, *Table 8, Chapter 8, points III÷VI*). If there is a need to start the adjustment for a certain time (timer function), the possibilities offered by parameter 28/46/64: ***Time adjustment*** or software adjustment (*chapter 9.6*) should be additionally used. A detailed description of configuration of the operation of outputs is included in *chapters 9.1÷9.7*.
The default (factory) configuration is as follows: outputs 1, 2 and 3 disabled, in heating control mode (ON-OFF algorithm with hysteresis), analog output is disabled (chapter 8, *Table 8*, *company* settings column).

9.1. QUICK CHANGE OF SETPOINTS FOR OUTPUTS

All **SP** setpoints (i.e. parameters 22/40/58: ***SP setpoint*** for regulation/alarm and optionally 26/44/62: ***Manual mode setting***) are available through configuration programming (*see chapter 8* for methods of change) and in SP quick change mode. Entering the quick change SP mode takes place only from the adjustment window (*chapter 7.2*) after long pressing the [SET] **or [F]** button (if they were configured for this function, *chapter 7.3*), without the need to enter a password. Optionally, to block quick SP changes, parameter 110:***SP settings lock*** (chapter 8, *Table 8, point XI*) can be used. Changes can be made with a step of x1 or x10 (*chap. 7.b*).

9.2. ANALOG OUTPUT (mA/V)

The standard of the output signal is set by parameter 72: ***Type and standard*** (*chapter 8, Table 8, point IV*). The analog output can be programmed (parameter 73:***Output function***) to operate in one of the following modes: measurement retransmission (including input BIN state) or SP setpoints and as a control output associated with the parameters of the selected output 1, 2 or 3.
In measurement or setpoint retransmission mode, the output signal is proportional to the measured signal or SP within the range set by parameters 74:***Start*** and 75:***End of scale for retransmission*** (e.g. 0mA for 0°C measurement when 74:***Start*** = 0°C, 20mA for 100°C when 75:***End*** = 100°C and respectively 10mA for half the range, i.e. 50°C). In other words, the output operating in retransmission mode allows the conversion of the input signal into an output signal (in the range of ***Start*** ÷ ***End of scale for retransmission***).
In the control output mode, the control parameters and functions performed are identical to those for the related 1/2/3 output, with the range of variability of the analog signal being continuous (0÷100%) only for the PID algorithm (*chapter 9.3*) and manual operation. For ON-OFF regulation with hysteresis, the output adopts limit values (lower or upper value, e.g. 0mA=0%=OFF or 20mA=100%=ON) without indirect values, which can be used, for example, to turn on the SSR relay (in this case, it is recommended to set parameter 78:***Change rate limit*** to ***Off***).
The output signal values (mA/V) can be displayed, e.g. in the form of a bar graph in the measurement view or read from the Modbus-RTU/TCP and MQTT protocols, *Chapter 13*.
In addition, it is possible to correct (calibrate) the range of changes of the output signal (parameters 76:***Bottom correction*** and 77:***Top correction***).

9.3. PID CONTROL

The PID algorithm makes it possible to obtain smaller errors of control (e.g. temperature) than the ON-OFF with Hysteresis method. However, this algorithm requires selection of parameters characteristic for a specific regulation object (eg a furnace). In order to simplify the handling, the controller is equipped with advanced functions of PID parameters selection, described in *chapter 9.4*. In addition, it is always possible to manually adjust the settings (*chapter 9.5*).
PID control for a given control output is active when one of the three PID1/2/3 parameter sets is selected (parameter 19/37/55:***Control algorithm,*** *description in Chapter 8, Table 8,* point III, or 94/99/104:***Control algorithm for stage 1/2/3***, *point VI*).
The position of the ***Proportionality band Pb*** (***80/84/88***:Pb1/2/3, chapter 8, *Table 8, point V*) in relation to the ***SP setpoint*** (**1/2/3**) is shown in Figures 9.3 a) and b). The parameters 81/85/89:***Ti integration constant*** and 82/86/90:***Td differentiation*** constant are responsible for the influence of the integrating and differentiating element of the PID regulation. Parameter 25/43/61:***The pulsing period Tc*** applies to the P/SSR output (it is also the time of updating its state), while 24/42/60: Power ***limitation with the available power*** used in the selection of PID parameters.
If the PID algorithm is implemented by the 0/4 ÷ 20mA or 0/2 ÷ 10V analog output, the **Tc** period is irrelevant. The mA/V output signal is then updated every 1 s and it can adopt intermediate values from the entire range of output variability (0÷100%).
The principle of operation of the P-type control (proportional control) for the P/SSR output is shown in figures d), e) for the analog output, figure c).

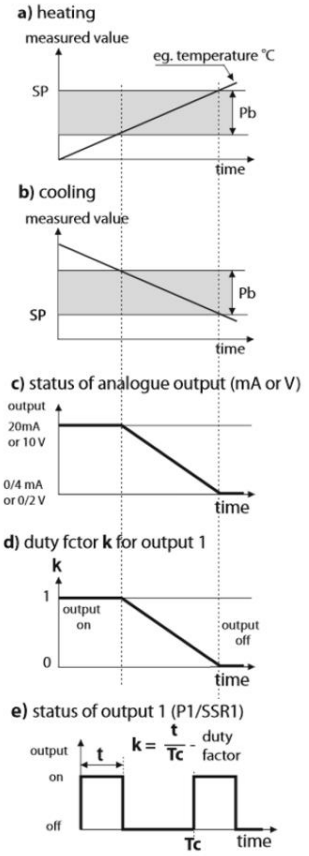


Fig. 9.3. Principle of PID regulation operation:
a) position of the **Pb** proportional band in relation to the setpoint **SP** for the heating type regulation (20/38/56: ***Type of regulation*** = ***Heating***)
b) position of the proportional band **Pb** in relation to the setpoint **SP** for the ***Cooling type regulation***
c) the status of the analog output 0/4÷20 mA or 0/2÷10V
d) fill factor **k** for a bi-state P/SSR output
e) the status of the output for the measured value **PV** within the **Pb** range

9.4. AUTOMATIC SELECTION OF PID PARAMETERS

In order to use the PID parameter selection function for a given control output (1/2/3), first select the PID parameters set (using the method described in *chapter 9.3*) to which the calculated data will be saved, and then set the 79/83/87 parameter: ***Type of PID tuning*** (description in *chapter 8, Table 8, point V*). The auto-tuning is activated at the start of the control (automatically after switching the supply on or manually using the **[F], [SET]** function buttons or the binary input **BIN** programmed as the start/stop of outputs operation, *chapter 7.3*). Autotuning is performed independently for each of the outputs with the maximum available power (defined by parameter 24/42/60:***Power limitation*** *Table 8, point III*) and is signaled in the *adjustment window* with ***STEP*** (for the step ***method***) or ***OSC*** (for the ***oscillating*** method) messages or only ***AT-PID*** during object analysis for ***smart*** (*chapter 7, Fig. 7.2.5*).
The value of parameter 79/83/87: The ***type of PID tuning*** determines the choice of the PID parameter selection method:

a) *Continuous mode (smart logic)* – the regulator continuously examines whether there are conditions to start tuning and tests the object in order to select the appropriate method. The algorithm continuously forces operating in the PID mode. The necessary condition to initiate the PID parameter selection procedure is the location of the current measured value **PV** outside the dead band defined as the sum from the parameters value of the **Pb** proportional band and the related hysteresis **H** in relation to the **SP** setpoint, as in figures 9.4.

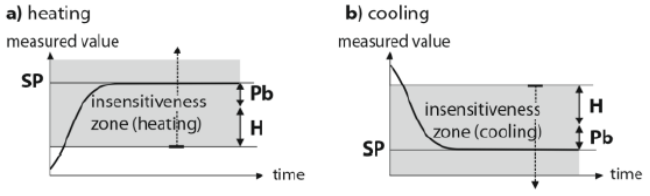


Fig.9.4.
Location of the deadband for the ***Type of Heating*** and ***Cooling*** type ***adjustment***

In order to avoid unnecessary activation of tuning, which may delay the course of the process, it is recommended to set the hysteresis **H** to the highest possible value, not less than 10 ÷ 30% of the process value variation range (e.g. measured temperature). Testing the object with a short disactivation of the output and ***the AT-PID*** message also takes place in the deadband in the event of detecting sudden changes in the measured **PV** value or the **SP** setpoint. The choice of the parameter selection method depends on the nature of the initial conditions. For a stabilized controlled quantity, the ***step response method*** **(fast)** will be selected, otherwise the ***oscillation*** **(longer)** method will be activated.
Automatic selection (***continuous mode***) enables the optimal selection of PID parameters for the current conditions on the site, without user intervention. It is recommended for variable value control (disturbance of set conditions during operation by modification of e.g. the setpoint **SP** or the furnace batch).
b) Step ***response method***, fast- selection of parameters in the start-up phase (response to step forcing). When determining the object's characteristics, the algorithm does not cause an additional delay in reaching the setpoint **SP**. This method is dedicated to facilities with stabilized initial controlled value (e.g. temperature in a cold furnace). In order not to disturb the initial conditions, before starting the auto-tuning, turn off the power supply of the actuator (e.g. heater) with an external switch or use the control start/stop function (buttons **[F]**, **[SET]** or input **BIN**). The power supply should be switched on immediately after starting the tuning, in the delay phase of switching on the output. Turning on the power at a later stage will result in an incorrect analysis of the object and, as a result, incorrect selection of PID parameters.
c) *Oscillatory method*, longer- selection of parameters using the oscillatory method. The algorithm involves the measurement of the oscillation amplitude and period at a slightly lower level (for heating or a slightly higher level for cooling) than the setpoint **SP** in order to eliminate the danger that the **SP** target value will be exceeded during the object test stage. While determining the characteristics of the object, the algorithm causes additional delays in reaching the setpoint. This method is dedicated to objects with unstable initial controlled value (e.g. temperature in a hot furnace).

The algorithms from subpoints **b** and **c** consist of the following stages:
- delay in switching on the output (approx. 15 sec - time for switching on the power supply of the actuator, i.e. heating/cooling power, fan, etc.) and determining the characteristics of the object,
- calculation and permanent saving of parameters (**Pb**, **Ti**, **Td** to the selected PID and **Tc** set, i.e. 25/43/61:***Period...***, *ch. 8*),
- switching on the control for a given output with new PID settings

The program can discontinue the autotuning **b** or **c** (with the message) in the following situations:
- the initial value of **PV** is higher than the setpoint **SP** for heating or lower than the setpoint for cooling,
- the **SP** setpoint has been changed or the measured value of the **PV** process changes too quickly or too slowly,
- the maximum tuning time (4 hours) has been exceeded
- due to measurement errors (***–HI--, --LO--, ------,*** *chapter 11*) and incorrect configuration.

It is recommended to restart the **autotuning b** or **c** after a significant change in the **SP** threshold or the parameters of the control object (eg heating/cooling power, batch mass, initial temperature, etc.).
Autotuning **does not work** in program control (**process controller**) and valve control (**servo**) mode.

9.5. CORRECTION OF PID PARAMETERS

The autotuning function correctly selects the PID regulation parameters for most processes, but sometimes it may be necessary to correct them. Due to the strong interdependence of these parameters (described in *chapter 9.3* and chapter *8, Table 8*), only one of them should be changed and the impact on the process should be observed:
a) oscillation around the threshold - increase the proportional band **Pb**, increase the integration time **Ti**, decrease differentiation time **Td**, (or reduce the pulse period of the output by half, parameter **Tc**)
b) slow response - reduce the **Pb** proportional band, **Td** differentiation time and **Ti** integration time
c) overshoot - increase the **Pb** proportional band, **Td** differentiation time and **Ti** integration time
d) instability - increase the integration time **Ti.**

9.6. PROGRAMMED WORK CHARACTERISTICS. SAMPLE CONFIGURATION.

The controller allows you to create a control program (process controller) consisting of a maximum of 6 segments (3 stages configured with the parameters described in chapter 8, Table 8, point VI). Each stage (1/2/3) operates in accordance with the control parameters of the assigned setpoint SP (1/2/3), description in Table 8, point III.

The program can be assigned to any of the control outputs (1/2/3) using parameter 19/37/55: ***Control algorithm*** set to ***Program main*** (signaled by the PROGx message ***in*** the control status, where **x** is the stage number). In addition, it is possible to define an output for ***Program auxiliary*** (with the PRG-AUX message), which can be useful for signaling the operating status for individual stages of the program as well as for switching on additional devices (fans, additional heating sections, etc.) with the option of manual operation (when parameter 95/100/105/106 :***Auxiliary output status*** = ***Manual mode setting***).

The program starts at the moment of starting the control (automatically after switching on the power or manually using the **[F]**, **[SET]** function buttons or the binary input BIN programmed as the start/stop of outputs, chapter 7.3 and is always performed from the beginning (1st stage/segment). Subsequent stages of the process (1/2/3) are signalized in the control status field by the following messages: ***PV/***MIN- slope implementation, ***PV->*** SP- reaching the **SP** setpoint and, optionally, the remaining stage time (in the format **hh**: **mm**: **ss**). The program ends with the message ***STOP*** and disabling the control output (also due to measurement errors (***-HI--***, ***--LO--***, ***------***, chapter 11) and incorrect configuration).

Fig. 9.6. Diagram of a sample program.

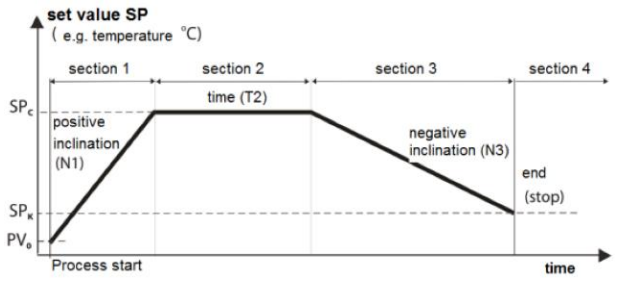


Diagram of an exemplary program configuration consisting of 4 sections for the ***Type of regulation of the Heating*** type is shown in the diagram on the right. At the moment of starting the process (adjustment), the initial setpoint for section 1 is the current measured value (PV_0, e.g. 25°C), the target value SPC = **SP1**, which is achieved at the rate of **N1** (parameter 92: ***PV slope/min of the stage 1 section***, e.g. 25°C/min). After reaching the SPC value and regulation at this level by the **T2** time set for the 2nd section (parameter 93: ***Stage 1 section time***), there is a transition to the 3rd section, for which the cooling function is provided at the speed of N3 (97: PV slope/min of stage 2 section, e.g. -10°C/min) to the SPK level = **SP2**. During cooling, an auxiliary output can be used to switch on e.g. a fan. The program is stopped (with switching off the control output) after reaching the SP_K and transition to the 4th segment.

The exemplary basic configuration parameters for individual stages are summarized in the table below:

Stage parameters	**Stage 1**		**Stage 2**	**Stage 3**
	section 1	section 2	section 3	section 4
Type of stage	91: ***Stage type 1*** = ***Slope and time*** (2 sections)		96: ***Stage type 2*** = ***Slope and time***	101: ***Stage type 3*** = ***End (last stage)***
Stage **SP** set point	**SPC** = **SP1** (e.g. 700°C)		**SPK** = **SP2** (e.g. 60°C)	not relevant
Slope (°C /min)	**N1** (e.g. 25°C/min, (parameter 92)		**N3** (e.g. -10°C/min, par. 97)	not relevant
Stage/segment time	**T2** (e.g. 90min, parameter 93: ***Stage 1 section time***)		98: ***Stage 2 section time*** = **0 min** (no section 2)	not relevant

9.7. MIXING VALVE CONTROL. SAMPLE CONFIGURATION.

The device allows you to control a servo valve with two open-close contact inputs, without a feedback signal. Standard characteristics (heating/cooling) and operating modes (ON-OFF, PID) are binding for valves controlled by the analog signal mA/V and do not require any additional comments. The ***servo*** type algorithm is implemented on outputs **1** (open) and **2** (close), as a three-stage step control, while it is dedicated to slow-changing processes (e.g. for central heating of CO, not recommended e.g. for CWU installations requiring a quick response to changes). It requires setting the parameter 37: ***Control algorithm*** (for ***Output 2***) to the value 13**:** Step (which prevents simultaneous activation of both outputs) and other configuration parameters (described in the example below and in chapter 8). The total opening/closing time of the valve is defined by parameters 25/43:***Pulse period Tc***.

The valve control is started at the start of control (automatically after switching on the power or manually with the **[F]**, **[SET]** function buttons or the binary input BIN programmed as output operation start/stop, chapter 7.3) and begins with the valve positioning (complete closing) procedure (with the message INIPOS in the adjustment status fields). This procedure is also performed after each shift 43:***Pulse period Tc*** for ***Output 2***.

Example configuration (ON-OFF for heating with a set temperature of 50°C and valve opening/closing time of 100s):

- ***Output 1***parameters (chapter 8, Table 8, point III): 19:***Control algorithm***= ON-OFF (recommended), 20:***Control type***=***Heating***, 22:***Setpoint SP***=***50°C***, 23: ***Hysteresis H***=***0°C***, 24:***Power limitation***=***1%***, 25:***Pulse period Tc*** =***100s***, ***Output Parameters 2***: 37:***Control Algorithm***=***Step***, 38: ***Adjustment Type*** = ***Alarm Above*** (Deviation from **SP1**, chapter 8, Table 8, Fig.8.7), 40: ***Setpoint SP***=***0.5°C*** (Deviation Value), 41: ***Hysteresis H***=***0°C***, 42: ***Power Limitation***=***100%,*** 43: ***Pulse Period Tc***=***100s***, 45: ***Emergency State***=***Enabled***.

Tips for adjusting the settings (change only one of the factors and observe the effect on the process):

a) increasing the rate of change - increase for ***Output 1*** parameter 24 :***Power limitation*** (recommended 1÷5%) and decrease 25:***Tc pulse period***,

b) reduction of overshoots and oscillations - reduce 24:***Power limitation*** (recommended 1÷5%), increase 25:***Tc pulse period***, set a small dead zone (40:***SP setpoint***, e.g. 0.5°C), recommended 23/41: ***H1/2*** = ***0°C***.

Alternatively, for the ***Output 1***, the PID control (chapter 9.3) can also be used with a larger value of 24: ***Power limitation*** (suggested 10÷20%), which will result in reaching the setpoint faster, but at the same time, with incorrectly selected PID parameters, the control may be less accurate (due to overshoots and oscillations). In the range of ***Pb***, the length of the opening pulse (step) will be variable (depending on the measured value ***PV***, according to the principle of PID operation). If the PID algorithm is used, the P variant control is recommended (proportional, e.g. ***Pb***=***5°C***, ***Ti***=***Td***=***0s***) or PD (proportional-differential, e.g. ***Pb***=***5°C***, ***Ti***=***0s***, ***Td***=***30s***).

10. RECORDING AND VIEWING RECORDED MEASUREMENTS AND INCIDENTS

Data archiving takes place in text files with the *csv* extension in the internal memory. Detailed descriptions of the available ***Recording Options and Memory and files*** can be found in chapter 8, *Table 8, points VII and VIII*. The recording can be done in infinite mode (when the memory is full, the oldest archives are deleted) or until the memory is full (recording is stopped with the message Memory Full, then the archive files should be copied for further analysis and then the space should be cleared for re-recording).

Interval and ***Mode of data recording*** and other recording and file options should be adapted to the needs of the application. However, for faster copying of data from the recorder's memory, it is recommended to create small files. Subsequent, new archive files (csv) are created in the following situations:

- at the start of a new recording (e.g. when parameter 143: ***Recording type*** = ***Hourly Daily (HD)*** new files are created every day),
- after filling the memory with simultaneous deletion of the oldest archives (provided that parameter 156:***Archive Save Mode*** = ***Circular (CIR)***, i.e. infinite, in ***Memory and File Options***).
- after changing the time and/or date (chapter 8, *Table 8, point XII*) and other parameters such as: 144/145/146 :***Value 1/2/3 to be recorded*** in the archive file, 158: ***ID identification number***, 159:***Decimal separator***,

The file name contains the device type (AR200.B), ***ID number*** and the date and time of creation, e.g. "AR200.B_1_2024-07-03_11-57-16" (AR200.B, ID = 1, date = 2024-07-03, time = 11:57:16).

The format of a single data record is as follows: "incident sequence number; date; time; incident identifier; argument 1; argument 2; argument 3;check sum".

Sample record with measurements:

"2;2024-07-03;11:57:16;5;0,0;96,9;;FB72", where argument 1=0,0, argument 2=96,9, argument 3=none

Types and identifiers of recorded events:

- measurement (incident **5** ID)
- connection to the USB port (incident identifier **0**, "USB;CONNECTED")
- disconnection from the USB port (incident **1** ID, "USB;DISCONNEC")
- loading a new configuration (incident **3** identifier), argument values:
- "NEW;ON-LINE" - configuration of parameters via USB, RS485 or Ethernet port (e.g. with ARsoft-CFG),
- "NEW;OFF-LINE" - configuration of parameters by modifying the *AR200 file.B.cfg*,
- "NEW;USER" - configuration of parameters from the buttonboard and touch screen level (user),
- "NEW;CH_text" - configuration of names by modifying the *AR200 file.B.txt*,
- creation of a new "**csv**" file (**4**, "ID; xxxx", where xxxx - parameter 158 value: ***ID number*** of the device),
- pause (pause) or resume recording with function buttons **[F]**, **[SET]** or binary **input** BIN programmed as ***Start/Pause recording***, (incident identifier **10**, "REC;PAUSED" or **11**, "REC;RESUMED")

For graphic or text presentation and printing recorded results, data can be imported into ARsoft-LOG via USB port of the computer (fastest) or using the Ethernet interface (slower). If the USB drive of the recorder is secured (Parameter 111: ***Access Protection*** = ***Enabled***, chapter 8, *Table 8, point XI*), turn on in the Program *Options* and use the "*Unlock and load from USB*" button, then follow the instruction manual. ARsoft-LOG additionally allows you to detect unauthorized modification of the archive by verifying the check sum.

Alternatively, *csv* files can be opened in any spreadsheet (e.g. OpenOffice Calc, Microsoft Excel), as well as in various text editors (Windows WordPad, Notepad ++, etc.). However, in the event of an incorrect presentation, attention should be paid to the configuration of the format of the fields with data in these programs (if necessary, you can also set the parameter 159:***Decimal separator*** for measurements to the value ***Dot .*** or ***Comma ,***).

11. SIGNALING MESSAGES AND ERRORS

Measurement errors occurring in the measured values field in all presentation modes.

Code	Possible causes of the error
--HI--	- exceeding the measuring range of the sensor/signal from top (--HI--) or from bottom (***--LO--***)
--LO--	- incorrectly connected or different sensor/signal than set in the configuration (*Chapter 8, Table 8, point II*)
------	- missing sensor/measuring signal or damaged input (***------*** with a critical message)

In addition, the device has been equipped with a clear way of informing about the operating status or status of the performed operations. To close the message window that appears on the display, use the **[SET]** or **[F]** button.

12. IMPORTANT EXPLOITATION REMARKS

In order to ensure trouble-free and optimal operation of the device, please read this user manual carefully and take into account the following notes:

- do not disconnect the device from the USB port of the computer during the installation of drivers and communication with ARsoft-CFG or LOG programs, as well as when operating the recorder disk (copying/deleting files, etc.), which is signaled by the **[R/W]** and **[Tx/Rx]** icons on the display, moreover, do not use many ARsoft applications at the same time,
- do not fill up the memory with your own files and folders because they reduce the capacity for recording data,
- before starting new recording, delete unnecessary files in the internal memory (and check the clock settings)
- store in external memories (USB, computer drives, etc.) copies of current configuration files (*AR200.B.cfg* and *AR200.B.txt*) to be used in case of problems or duplication of settings,
- **do not allow the power supply voltage to cease during data recording**, because it may cause errors in the FAT file system, which in turn may lead to problems with data writing/reading and loss of the current regulator configuration and restoration of the default (company) one. When this happens, proceed as follows:

1. copy (if possible) existing archive files to a computer disk via a USB port,
2. clear (format) the internal memory (from the computer or from ***the Main Menu-*** > ***Memory and File Options)***,
3. configure the device (manually or remotely, as described in *chapter 8*, or by restoring copies of configuration files if they were previously made by the user),

- avoid exposing the device to direct sunlight and other strong heat sources,
- connection of the device to the USB port of the computer stops the recording until the cable is disconnected and blocks performing file operations accessible from the menu and transmitting files with measurement data by Ethernet via ARsoft-LOG

13. USB SOFTWARE AND DRIVERS AVAILABLE. SERIAL COMMUNCATION.

Communication with the device is possible through each of the available serial interfaces (independently, i.e. RS485, Ethernet and USB) and can be useful (or necessary) in the following situations:
- remote monitoring and recording of current measurements as well as control of the operating status and control algorithms for outputs,
- configuration of parameters, including copying settings to other regulators of the same type.

In order to establish long-distance communication, a connection should be made in the **RS485** standard (MODBUS-RTU protocol, *chapters 13.3* and *13.4*) or **Ethernet** using the MODBUS-TCP protocols (*chapter 13.2*) and MQTT protocols (*chapter 13.1*).
When the recorder is connected to the computer for the first time via the USB port, the system will start the process of automatic installation of the COM serial port driver (from the ***Windows Update*** website). Alternatively, you can manually indicate the location of the driver on the computer's disk from the ***Device Manager***, following the instructions of the installation wizard (for the regulator, select the "AR2xx /..." drivers downloaded from the www.apar.pl/en website or from the ARSOFT-CFG program installation folder, by default „C:\Program Files (x86)\ARSOFT\Drivers\AR2xx…").
After the installation is completed, the recorder appears in the system as a removable disk with a capacity of approximately 4MB with the AR200B label and a virtual COMx serial port (x-port number: 1, 2..). The COM port uses the MODBUS-RTU protocol. In the internal memory (removable disk), the following text configuration files are visible: *AR200.B.cfg* and *AR200.B.txt*, description in *chapter 8*. The following applications are available (for Windows 7/10/11 operating systems, downloadable from https://www.apar.pl/en/download/software *or* e-mail from the Sales Department):

Nazwa	Description of the program
ARsoft-CFG (parameters configuration)	- displaying current measurement data from the connected Apar device - configuration of the real-time clock (RTC) and other parameters such as types of measurement inputs, channel names, units, indication ranges, adjustment options, alarms, recording, displaying, communication, access, etc. (*chapter 8*), - creating configuration files containing the current parameters' settings on the disc for re-use (backup copy or duplication of configuration), - the program requires communication with the regulator via USB, RS485 or Ethernet port
ARsoft-LOG (reading archives)	archiving on a computer disk and graphic or text presentation of the recorded results with the possibility of printing, the input data is downloaded via a USB or Ethernet interface from text files with the *csv* extension created in the recorder in the internal memory (*chapter 10*)
APSystem-PC (paid)	- display and recording of current measurements from many devices (via MODBUS-RTU/TCP/ASCII) - visual and audible alarms, e-mail alerts, event reporting, etc.

Detailed descriptions of the above mentioned applications can be found in the installation folders.

ATTENTION: 
Before establihing connection via **RS485**, make sure that the parameters of the device (118: ***Speed***, 119: ***Character Format*** and 120: ***Modbus-RTU Address***) comply with the settings of the computer program. Moreover, set the number of the COM serial port used in the program options (for the RS485 converter it was assigned by the system during the installation of drivers).
Depending on the protocol used, the connection via the **Internet** requires the known public IP address of the broker for the MQTT protocol and the network IP address in the case of MODBUS-TCP (to facilitate access to the network with a variable public IP address, you can start the DDNS service, e.g. in a router). **The selection of network parameters in the recorder and the configuration of the router** (including e.g. port redirection for MODBUS-TCP, port forwarding) **should be entrusted to a qualified person (network administrator)**. In addition, pay attention that the firewall does not block the ports and applications used (e.g. ARsoft-CFG). The unique MAC hardware **address** (EUI-48) of the Ethernet interface of the device is available in the ***Communication Options*** (also in ARsoft-CFG) and the *map of Modbus-RTU/TCP protocol registers*.
The easiest way to test the correct operation of the recorder in the LAN is to set the parameter 121: ***Ethernet interface operation mode*** to ***Auto-configuration***, and then (with the IP address given by the DHCP server read from the device) establish connection to ARsoft-CFG or *ping* from the computer command line (and optionally *arp –a* for Windows or *arp-scan* for Linux, where we will also get the MAC **address**).

13.1. MQTT PROTOCOL

Popular in IoT/M2M (Internet of Things) applications, the MQTT protocol is a lightweight data transmission protocol based on the publication/subscription pattern (to/from the server). Using the protocol requires a correctly configured Ethernet network interface and MQTT parameters (*chapter 8, Table 8, point X*), as well as access to a broker (server) with a fixed numeric IP address (the recorder does not support the DNS protocol - text domain names). The MQTT broker can be started independently (eg. Mosquitto) or use the ones available on the Internet (paid or free, e.g. EMQX). Knowing the name of the broker's website, you can check its IP address, e.g. with the *ping* command (from the computer's command line). To read (subscribe) the messages published by the controller from the broker, you can use your own solutions or one of the many applications available on the Internet (such as the free and easy-to-use "*MQTT Dash*" for Android). Establishing a connection with the broker may take some time (usually <1.5 minutes, restarting the device may speed up this process). The current status of the device connection the with the MQTT broker is available from the buttonboard level (*chapter 7, device status*) and from the MODBUS-TCP/RTU protocols (register at address 31: *Ethernet connection status*, *chapter 13.5*).
For selecting the content of messages sent cyclically to the MQTT broker parameter 135: ***MQTT operating mode*** (description in chapter 8, *Table 8*) is responsible. Sample content for the most extensive option (***Measurements and work status***, maximum size 97B):
„AR200_4;PV1=32.6;PV2=545;MV1=100;MV2=100;MV3=0;cstat=0x8003;outA=7.320;dstat=0x02B2"
("AR200_MODBUS-RTUaddress= device name;PV1-2= measurement values 1 and 2;MV1=value of control signal of the output 1;MV2 for output 2;MV3 for output 3; cstat = control algorithms operating status; outA =value of analog output signal mA/V; dstat = device status", the meaning of individual positions and values for cstat and dstat is described in *chapter 13.5*, MODBUS registers addresses: 6 and 12, decimal-DEC).
In addition, for optional connection authorization, the following fields are set in the MQTT package: *customer ID* (created according to the "*apar**MAC***"template, where **MAC** is the hardware address of the EUI-48 regulator, e.g. "*aparFCC23D21C54A*") and *user name* (as "*apar**Password***", the last 2 digits of parameter 112: ***Access password***, e.g. "*apar11*") and *password* (112:***Password..***).
Protocol parameters useful for advanced needs: version 3.1.1, QOS = 0, retain = 1, keep alive = 0 (off).
In the event of frequent disconnection with the broker, check the reliability of the network/internet connection (switch), test the possible impact of the parameter 141: ***MQTT publication period*** for messages (extend, recommended > 5s), as well as MODBUS-TCP communication (temporarily stop if in use).

13.2. MODBUS–TCP SERIAL TRANSMISSION PROTOCOL

The MODBUS-TCP protocol is available for the Ethernet (RJ45) interface and uses the TCP/IP transport layer. Parameters used by this service, such as the TCP port number, are described in *chapter 8, Table 8, point X.*
The timeout for the MODBUS-TCP transmission, after which the open but unused port is closed, is 60s.
Available functions: **READ** = 3 or 4, **WRITE** = 6

Table 13.2.1. MODBUS-TCP protocol request frame format for the READ and WRITE functions (frame length -12B)

MODBUS protocol header (7 bytes)			Function code (READ or WRITE)	register address from *Table 13.5 (chapter 13.5)*	number of registers to read (1 ÷ 13) or value of a register to write
Transaction and protocol identifiers	Length field (value = 6)	Unit ID			
4 bytes	2 bytes	1 byte	1 byte	2 bytes (HB-LB)	2 bytes (HB-LB)

Example 13.2.1. Reading a register with address 0: 0x00 - 0x00 - 0x00 - 0x00 - 0x00 - 0x06 - 0xFF - 0x04 - 0x0000 - 0x0001

Table 13.2.2. Response frame format for the READ function (minimum frame length - 11 bytes):

MODBUS protocol header (7 bytes)			Function code (READ)	number of bytes in the data field (2 ÷ 26)	data field - register value (2B)
Transaction and protocol identifiers	Length field (max 29)	Unit ID			
4 bytes	2 bytes	1 byte	1 byte	1 byte	2÷26 bytes (HB-LB)

Example 13.2.2. The response frame for the register value equal to 0:
0x00 - 0x00 - 0x00 - 0x00 - 0x00 - 0x05 - 0xFF - 0x04 - 0x01 - 0x0000

Table 13.2.3. Response frame format for the WRITE function (frame length - 12 bytes)

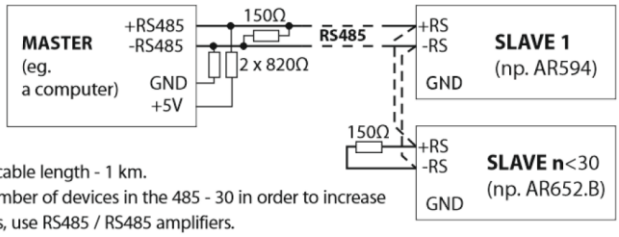
copy of the query frame for the WRITE function (Table 13.2.1)

The error codes are the same as for the MODBUS-RTU protocol (*Table 13.4.5*)

Example 13.2.3. Error frame for a non-existing register address to be read:
0x00 - 0x00 - 0x00 - 0x00 - 0x00 - 0x05 - 0xFF - 0x84 - 0x02 - 0x0001

13.3. RS485 COMMUNICATION INTERFACE (acc. EIA RS-485)

The installation specification for RS485 interface is as follows:



Maximum RS485 cable length - 1 km.
The maximum number of devices in the 485 - 30 in order to increase number of devices, use RS485 / RS485 amplifiers.
Termination resistors when MASTER is at the beginning of the line (fig. above):
- at the beginning of the line - 2 x 820Ω to ground and +5V MASTERA ans150Ω between the lines,
-at the end of the line - 150Ω between lines.

Termination resistors when MASTER is in the middle of the line:
- at the converter - 2 x 820Ω, to ground and +5V the converter,
- at both ends of the line -150Ω between lines.

Equipment from different manufacturers that form the RS485 network (e.g. RS485/USB converters) may have integrated polarizing and terminating resistors; in such a case there is no need to use external elements.
When configuring the network, it is necessary to pay particular attention to the cabling installation recommendations given in *chapter 2*.

13.4. MODBUS–RTU SERIAL TRANSMISSION PROTOCOL (SLAVE)

Transmission speed and character format for RS485 and Modbus-RTU address set with parameters 118: ***Speed***, 119: ***Character format*** and 120: ***Modbus-RTU address*** (*chapter 8, Table 8, point X*). Available functions: **READ** = 3 or 4, **WRITE** = 6.

Table 13.4.1. Query frame format for the READ function (frame length - 8 bytes):

address of the device	function 4 or 3	register address to read: from *Table 13.5 (chap. 13.5)*	number of registers to be read: 1 ÷ 13	CRC checksum
1 byte	1 byte	2 bytes (HB-LB)	2 bytes (HB-LB)	2 bytes (LB-HB)

Example 13.4.1. Reading of a register with address 0: 0x01 - 0x04 - 0x0000 - 0x0001 - 0x31CA

Table 13.4.2. Query frame format for the WRITE function (frame length - 8 bytes):

address of the device	function 6	register address to be written: from *Table 13.5 (chap. 13.5)*	register value to be written	CRC checksum
1 byte	1 byte	2 bytes (HB-LB)	2 bytes (HB-LB)	2 bytes (LB-HB)

Example 13.4.2. Writing a register with address 10 (0xA) with the value 0: 0x01 - 0x06 - 0x000A - 0x0000 - 0xA9C8

Table 13.4.3. Response frame format for the READ function (minimum frame length - 7 bytes):

address of the device	function 4 or 3	number of bytes in the data field (max. 13*2=26 bytes)	data field - register value	CRC checksum
1 byte	1 byte	1 byte	2 ÷ 26 bytes (HB-LB)	2 bytes (LB-HB)

Example 13.4.3. Response frame for register value equal to 0: 0x01 - 0x04 - 0x02 - 0x0000 - 0xB930

Table 13.4.4. Reply frame format for the WRITE function (frame length - 8 bytes):

copy of the query frame for the WRITE function (Table 13.4.2, above)

Table 13.4.5. Special reply (errors: function field = 0x84 or 0x83 in the case of the READ function and 0x86 in the case of the WRITE function):

Error code (HB-LB in data field)	**Error description**
0x0001	non-existing register address
0x0002	incorrect register value to be written
0x0003	incorrect function number

Example 13.4.5. Error frame for a non-existing register address to be read:
0x01 - 0x84 - 0x02 - 0x0001 –0x5130

13.5. MAP OF DEVICE REGISTERS FOR MODBUS-RTU/TCP

Table 13.5. Map of registers for the modbus-RTU/TCP protocol (**1 register** = **2 bytes=16bit, numbers in U2 code**)

Register address HEX (DEC)	**Value (HEX or DEC)**	**Description of register and access type** (R- read only register, R/W - read and write register)		
0x00 (0)	0	not used or reserved		**R**
0x01 (1)	2005 ÷ 20059	device type identifier		**R**
0x02 (2)	100 ÷ 999	controller firmware version		**R**
0x03 ÷ 0x05	0	not used or reserved		**R**
0x06 (6)	0 ÷ 65535	status of algorithms and control functions and status of outputs/alarms: - status of outputs/alarms 1, 2, 3 (bits 0, 1, 2, bit=1= output enabled), - STB (LATCH) alarms for outputs 1, 2, 3 (bits 3, 4, 5, bit=1=active), - quick manual mode for outputs 1, 2, 3 (bits 6, 7, 8, bit=1=active), - PID tuning status for any of the outputs (bit 12, bit=1=active), - error of PID tuning or software adjustment (bit 13, bit=1=active), - conversion of the setpoint SP1 to SP3 (bit 14, bit=1=SP3), - status of the start/stop function for **[F]/[SET]/** BIN (bit 15, bit=1=start), *chap.7.3*		**R**
0x07 (7)	0 ÷ 20000	current state of the analog output (0 ÷ 20000 µA or 0 ÷ 10000 mV)		**R**
0x08 (8)	-100 ÷ 700	temperature of cold tips for thermocouples (resolution 0.1°C)		**R**
0x09 ÷ 0x0B	0 ÷ 100	MV control signal value [%] for outputs 1, 2 and 3		**R**
0x0C (12)	0 ÷ 65535	device status: - type of built-in **mA/V** analogue output (bit 0, bit=1=V), - input BIN **status** (bit 1, bit=1=active input=shorted), *chapter 7.3*, - **RTC** real-time clock error (bit 3, bit=1= RTC failure), - presence of Ethernet and RS485 modules (bits 4, 5, bit=1=available), - internal memory error (bit 3, bit=1= memory failure), - recording status (bit 7, bit=1=recording active and not paused), - USB connection status (bit 8, bit=1=connected),		**R**
0x0D ÷ 0x0F	0	not used or reserved		**R**
0x10 ÷ 0x17	-32768 ÷ 32767	current measured values (in order: input 1, input 2, subtraction of measurements 1-2, sum from measurements 1+2, average value of measurements 1 and 2, greater value of measurements 1 and 2, lower value of measurements 1 and 2, input BIN), in code U2 (16-bit), without comma, for thermometric inputs, resolution 0.1°C		**R**
0x19 ÷ 0x1B	-32768 ÷ 32767	measurement channels 1÷3 of the display, code U2 (as above), (chapter 8, *Table 8, point I*)		**R**
0x1C (28)	0 ÷ 6	week day of the RTC internal clock (calculated based on the date)		**R**
0x1D (29)	0x0101 ÷ 0x630C	years (HB) and months (LB)	real-time internal clock (**RTC**, chapter 8, *Table 8, point XII*)	**R/W**
0x1E (30)	0x0100 ÷ 0x1F17	days (HB) and hours (LB)		**R/W**
0x1F (31)	0x0000 ÷ 0x3B3B	minutes (HB) and seconds (LB)		**R/W**
0x20 ÷ 0x27	0	not used or reserved		**R**
0x28 (40)	0 ÷ 65535	connection status of the Ethernet interface and the MODBUS-RTU and MQTT protocols: - LAN connection status, link-up (bit 0, bit=1=connected), - connection with the MQTT broker status (bits 1, 2, bit1=bit2=1=connected), - TCP port status for MODBUS-TCP (bits 6, 7, 8, bit6=bit7=1=connected),		**R**
0x29 ÷ 0x2B	0 ÷ 65535	unique MAC hardware address of the Ethernet interface (EUI-48)		**R**
Configuration parameters (the collective list of parameters can be found in *chapter 8, Table 8*)				
Address of the register (parameter) = **44** + parameter index from chapter 8, *Table 8* (e.g. Address=**44** for parameter 0: ***Input type***), Register (parameter) value = value from chapter 8, *Table 8* (e.g. 0 for 0: ***Pt100***)				**R/W**

14. OWN NOTES