USER MANUAL

PROCESS ANALOGUE CALIBRATOR

AR904

$\mathsf{C}\,\mathsf{E}$

Thank you for choosing our product.
This user manual will help you with proper and safe
operation and full use of the process analogue calibrator device.
Before installing and operating, please read
and understand this manual.
If you have any additional questions, please contact the technical advisor.

TABLE OF CONTENTS

⚠   Pay special attention to information marked with this sign!

Manufacturer reserves the right to make changes in design and software of the device without compromising technical parameters

1. SAFETY PRECAUTIONS ⚠

- Before using the unit, please read this manual carefully.
- To avoid electrical shock or damage to the device, mechanical and electrical installation have to be performed by a qualified personnel.
- Before turning on the power make sure that all cables are properly connected.
- Before making any modifications to the wiring connections, turn off all voltages applied to the device.
- You have to ensure proper working conditions, according to the specifications of the device (power supply voltage, humidity, temperature, chapter 5).

2. INSTALLATION NOTES ⚠

This instrument was designed to provide the appropriate level of resistance to most disturbances that may occur in industrial environments. In environments with unknown level of interference it is recommended to use the following measures to prevent possible interference with operation of the instrument:

- Do not power supply the device from the same line as the power component without the appropriate network filters.
- Use only shielded power and signal cables taking into account that the grounding of the shield should be a single point, made as close to the device as possible.
- Avoid placing signal cables very close and parallel to energy and power cables.
- It is recommended to twist signal cables in pairs.
- Avoid proximity of remote controlled devices, electromagnetic meters, high power loads, loads with phase or group power control and other devices that generate large impulse disturbances.
- Ground or zero metal rails that are used to mount rail devices.

Before using the device, remove the protective film from the LED display.

3. GENERAL PROCESS ANALOGUE CALIBRATOR CHARACTERISTICS

- This device allows you to control or test devices with current or voltage input (proportional valves, servomotors, inverters, motors, etc.)
- 2 analogue outputs (working simultaneously):
  - current 4÷20mA or 0÷20mA (active, cannot be powered from 2 wires current loop)
  - voltage 0÷10V
- Soft start/stop (ramping) or triangle wave generator with manual or automatic (activated after device power on) trigger.
- Programmable setpoint value, output signal change step, display range, soft start/stop options, communication options, access options and other configuration parameters.
- 7-segment LED display with brightness adjustment.
- Optional RS485/RS232 serial interface (galvanically isolated, MODBUS-RTU protocol).
- Parameters configuration methods:
  - Using IP65 foil keyboard located on the device front panel
  - Using AR955 programmer or RS485/RS232 interface with PC software (Windows 2000/XP/Vista/7)
- Available free software that allows parameters configuration.
- Access to configuration parameters can be password protected.
- High accuracy and high resistance to interference.

- Available accessories:
  - AR955 programmer
  - RS485 to USB converter

CAUTION: ⚠️

Before starting work with the process analogue calibrator, read this manual carefully and perform electrical and mechanical installation properly and set parameters correctly.

4. PACKAGE CONTENTS
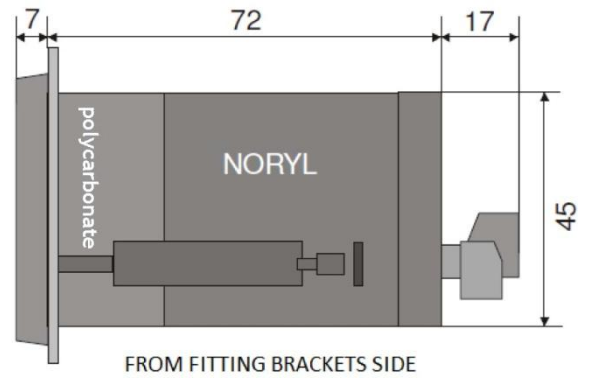
- Process analogue calibrator
- User manual
- Warranty card

5. TECHNICAL DATA

Analogue outputs		2
Current (active) 0/4÷20mA (1)	Full range	3,8÷21mA / 0÷21mA / 21÷3,8mA, 21÷0mA
	Load resistance	$R_0 \le 1k\Omega$
	Resolution (maximum)	1,7µA
Voltage 0/2÷10V	Full range	0÷10,5V / 10,5÷0V
	Load resistance	$R_0 > 3,2k\Omega$ (load current $I_0 < 4.5mA$)
	Resolution (maximum)	0,84mV
Processing errors (ambient temperature 25°C):		
Main:		0,1% full output range ± 1 digit
Additional from ambient temperature changes		<0,005% output range / °C
Output response time (10÷90%)		200ms
RS485 communication interface	Protocol	MODBUS-RTU
	Transmission speed	2,4 ÷ 38,4kb/s
	Character format	8N1 (no parity bit, 1 stop bit)
	Galvanic isolation	500V, 50Hz, 1 min
7-segment LED display	Number of digits	4
	Height	20mm
	Colour	Red (with brightness adjustment)
Power supply	230V AC	85 ÷ 260 V AC / 4VA
	24V AC/DC (optional)	20 ÷ 50V AC / 4VA, 20 ÷ 72V DC / 4W
Working conditions		0 ÷ 50°C, <90% RH (no condensation)
Working environment		Air and natural gases
Protection level		IP65 from front, IP20 from terminals
Weight		~160g
Electromagnetic compatibility (EMC)		Resistance: according to PN-EN 61000-6-2
		Emissivity: according to PN-EN-61000-6-4

(1) - Output cannot be powered from two wires current loop
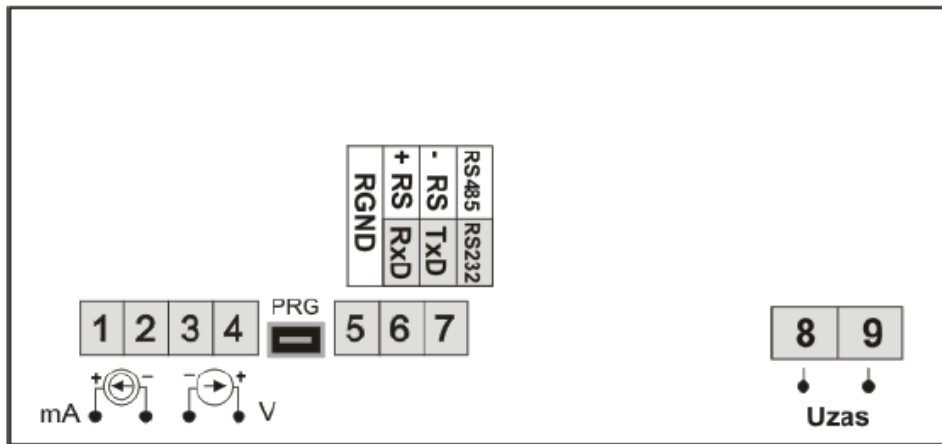
6. HOUSING DIMMENSIONS AND INSTALLATION DATA

Housing type	Panel, Incabox XT L57
Material	Self-extinguishing NORYL 94V-0, polycarbonate
Housing dimensions	96 x 48 x 79mm
Table window	92 x 46mm
Fitting	Brackets on housing sides

FROM FITTING BRACKETS SIDE

7. TERMINAL STRIPS AND ELECTRICAL CONNECTIONS DESCRIPTION

Terminals	Description
1-2	Current output 0/4÷20mA
3-4	Voltage output 0÷10V
5-6-7	RS485/RS232 serial interface (MODBUS-RTU transmission protocol)
8-9	Power supply input 230V AC or 24V AC/DC
PRG	Programming socket for use with AR955 programmer (do not use simultaneously with RS485/RS232 interface)

a) Terminals and output signals description

CAUTION: ⚠

Only AR955 programmer can be connected to PRG socket. Connecting other devices to PRG socket can damage connected device and AR904 process analogue calibrator.

8. BUTTONS DESCRIPTION

7-segments LED display

Programming buttons

a) Buttons functions in setpoint value display mode (normal mode)

Button	Description (and how they are marked in the manual)
▲ or ▼	[UP] or [DOWN]: Output signal setpoint value increase or decrease by given step (parameter 6: **StEP**, chapter 10)
SET + ▲	[SET] + [UP]: Step (fast) output signal setpoint value change – upper range value (parameter 3: **rtoP**) or settings narrowing (5: **ttoP**)
SET + ▼	[SET] + [DOWN]: Step (fast) output signal setpoint value change – lower range value (parameter 2: **rbot**) or settings narrowing (4: **tbot**)
▲ + ▼	[UP] and [DOWN] (simultaneously): Opens parameters configuration menu (when pressed and hold for more than 1 second). If parameter 13: **PPro** = **on** (password protection is turned on), you will have to enter protection password (chapter 10)
SET	[SET]: Soft start/stop function activation/deactivation (when pressed and hold for more than 1,5 second). If parameter 8: **rISE** and 9: **FALL** = **oFF**, function is inactive (chapter 11)

b) Buttons functions in parameters configuration mode (chapter 10)

Button	Description
SET	[SET]: - Current parameter value change - Confirm and save modified parameter value
▲ or ▼	**[UP]** or **[DOWN]**: - Go to the next or previous parameter - Change value of edited parameter
▲ + ▼	**[UP]** and **[DOWN]** (simultaneously): - Cancel value change (return to parameter name display) - Return to setpoint value display mode (when pressed and hold longer than 0.5s)

9. OUTPUTS SETPOINT VALUE CHANGE

Pressing [UP] or [DOWN] button while setpoint value is being displayed will change the value by pre-set step (parameter 6: **StEP**, chapter 10, table 10). Changes of the output signal are proportional to changes of the displayed value. Pressing [SET] + [DOWN] buttons together will set output value immediately to lower range value (2: **rbot** or 4: **Lbot**) while pressing [SET] + [UP] buttons together will set output value immediately to upper range value (3: **rtoP** or 5: **LtoP**). In addition, the output signal may be given also in parameters programming mode (parameter 7: **SEt**) and using serial interface RS485/RS232 or AR955 programmer (chapter 15, table 15). Moreover, it is possible to set the setpoint value outside of the display range based on the parameters 2: **rbot** and 3: **rtoP**. The value of this override that can be set using the buttons is ±5% for 4÷20mA (2÷10V) output and 6,2% for the remaining outputs.

10. CONFIGURATION PARAMETERS SETUP

All configuration parameters of the device are saved in the non-volatile EEPROM internal memory. Two parameters configuration methods are available:

1. Using IP65 foil keyboard located on the front panel of the device:
   - From the setpoint value display mode enter configuration menu (press and hold for more than 1 second [UP] and [DOWN] buttons together). If parameter 13: **PPro** = **on** (password protection is turned on), display will show message **CodE** and then **0000** with first digit blinking. Using [UP] or [DOWN] button enter protection password (by default parameter 12: **PASS** = **1111**). To proceed to the next digit or confirm the code use [SET] button.
   - After opening configuration menu you will see mnemonic parameter names (**outP** <-> **dot** <-> **rbot** <-> etc.), [UP] button will proceed to the next parameter and [DOWN] button will go back to the previous parameter (all parameters are listed in table 10).
   - To change or display current parameter value press the [SET] button.
   - Using [UP] or [DOWN] button change the edited parameter value.
   - Confirm modified value using [SET] button or cancel using [UP] and [DOWN] buttons (simultaneously), then parameter name will be displayed.
2. Using RS485/RS232 port or AR955 programmer and pc software ARSOFT-WZ1:
   - Connect process analogue calibrator to the PC port and start ARSOFT-WZ1 application.
   - After connection is established application window will display current setpoint value.
   - Device parameters can be displayed and modified in the parameters configuration window.
   - New parameters values have to be saved using "Zatwierdź zmiany" button.
   - Current configuration can be saved in a file or can be read from the file.

CAUTION: ⚠

   - Do not use RS485/RS232 port and AR955 programmer simultaneously, because communication errors will occur.

Table 10. Configuration parameters

Parameter	Parameter description and settings range					Factory default
0: `outP` current (voltage) output type	`4-20`	Standard 4..20mA (0..10V)				`4-20`
	`0-20`	Standard 4..20mA (0..10V)				
1: `dot` dot position	`0`	Without dot				`0` (0.0)
	`1`	`0.0`				
	`2`	`0.0.0`				
	`3`	`0.0.0.0`				
2: `rbot` display lower range	`-1999` ÷ `9999` units – display for 0mA, 4mA, 0V – lower output range					`0.0`
3: `rtoP` display upper range	`-1999` ÷ `9999` units – display for 20mA, 10V – upper output range					`100.0`
4: `Lbot` setpoint lower range	`-1999` ÷ `9999` units – lower setpoint value limit (parameter 7: `SEt`) when set using buttons					`-1999`
5: `LtoP` setpoint upper range	`-1999` ÷ `9999` units – upper setpoint value limit (parameter 7: `SEt`) when set using buttons					`9999`
6: `StEP` value change step	`0` ÷ `5000` units, setpoint value change step (parameter 7: `SEt`) when set using buttons					`10`
7: `SEt` setpoint value	Lower limit: parameter 2: `rbot` or 4: `Lbot`, upper limit: parameter 3: `rtoP` or 5: `LtoP`, changes step: 6: `StEP`, when set using buttons					`0.0`
8: `rISE` soft start time	`oFF` `1` ÷ `8160` s	The duration of the rising edge (ramp). Function is turned on for `oFF` value (description in chapter 11)				`oFF`
9: `FALL` soft stop time	`oFF` `1` ÷ `8160` s	The duration of the falling edge (ramp). Function is turned on for `oFF` value (description in chapter 11)				`oFF`
10: `tr.M` ramp trigger mode	`Auto`	Soft start/stop (ramp) is triggered after device power on (chapter 11)				`MAnu`
	`MAnu`	Soft start/stop (ramp) manual using [SET] button (chapter 11)				
11: `bLSE` setpoint value setting lock	`oFF`	Setpoint value change (using buttons) lock inactive				`oFF`
	`on`	Setpoint value change (using buttons) lock active				
12: `PASS` protection password	`0000` ÷ `9999`	Configuration menu protection password				`1111`
13: `PPro` password configuration data protection	`oFF`	Configuration menu is not protected using password				`oFF`
	`on`	Configuration menu is protected using password				
14: `br.M` display brightness	`10` ÷ `100` % (10% step)					`100` %
15: `Addr` MODBUS-RTU address	`1` ÷ `247`	Individual device address in RS485 network (chapter 13) or for AR955 programmer				`1`
16: `br` RS485/RS232 or AR955 transmission speed	`2.4` kbit/s	`4.8` kbit/s	`9.6` kbit/s	`19.2` kbit/s	`38.4` kbit/s	`19.2` kbit/s

11. SOFT START/STOP AND TRIANGLE WAVEFORM GENERATOR

This device has soft start and stop (ramp) function. This function works as shown on the below charts (illustrations 11.1, 11.2, 11,3). To turn on this function you will have to configure soft start time (rising slope, parameter 8: **r iSE**, chapter 10) or soft stop time (falling slope, parameter 9: **FALL**) and trigger mode (parameter 10: **tr iG**). If both times are different than 0 (8: **r iSE** and 9: **FALL**) device outputs will generate triangle periodical signal. Amplitudes (end values) of output signals are defined by parameter 2: **rbot**, 3: **rtoP**, 4: **Lbot** and 5: **LtoP**. Function is activated automatically after device power on (when parameter 10: **tr iG** = **Auto**) or manually (10: **tr iG** = **MAnu**) using [SET] button (pressed and hold for more than 1.5 seconds). Moreover ramp function can be stopped and resumed at any time using [SET] button (short message will be displayed **StAr** - start or **StoP** - stop).

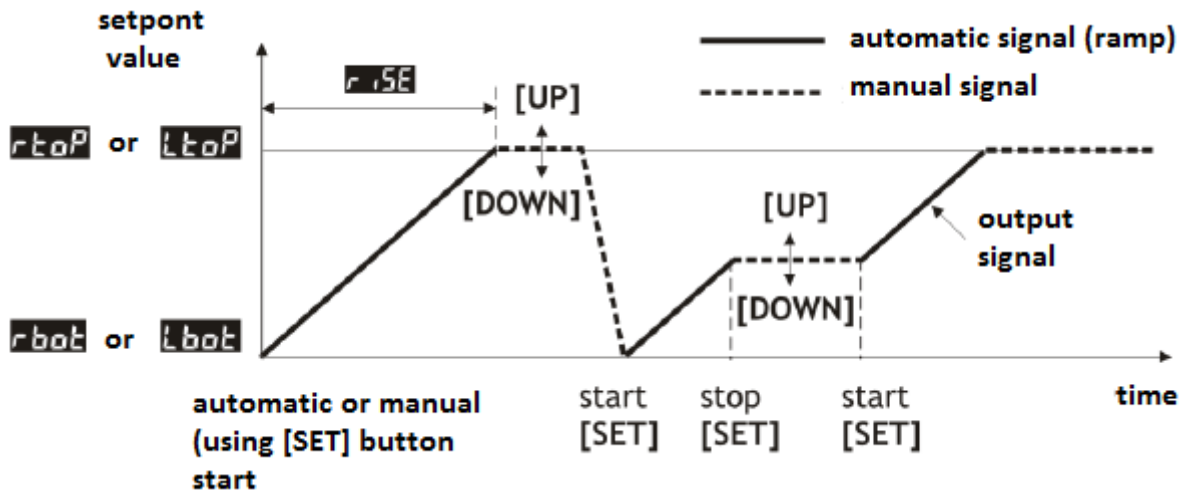Output status in this mode is refreshed 4 times per second.

Illustration 11.1. Output status in soft start mode (parameter **r iSE** > 0, **FALL** = **oFF**).
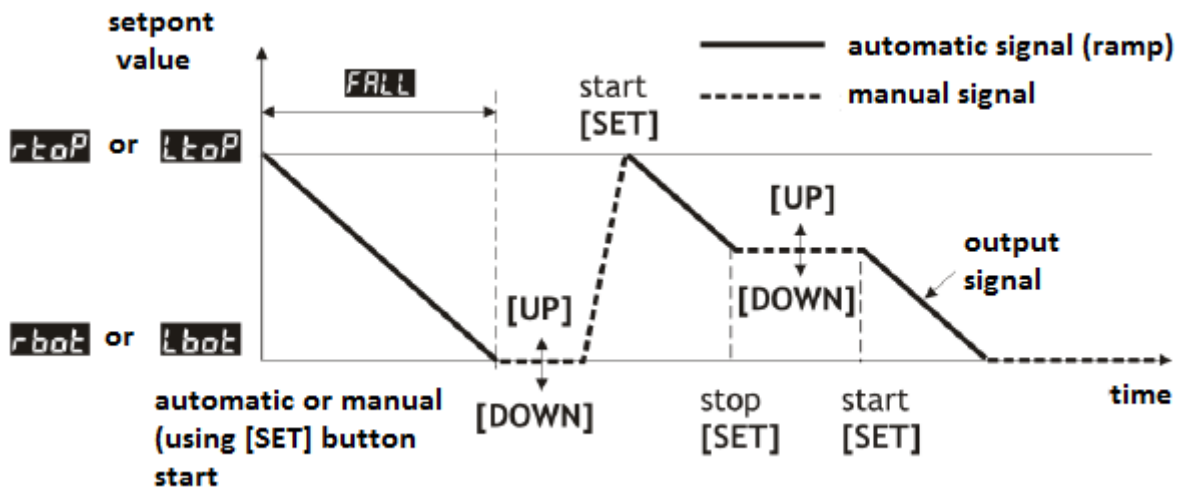

Illustration 11.2. Output status in soft stop mode (parameter **r iSE** = **oFF**, **FALL** > 0).
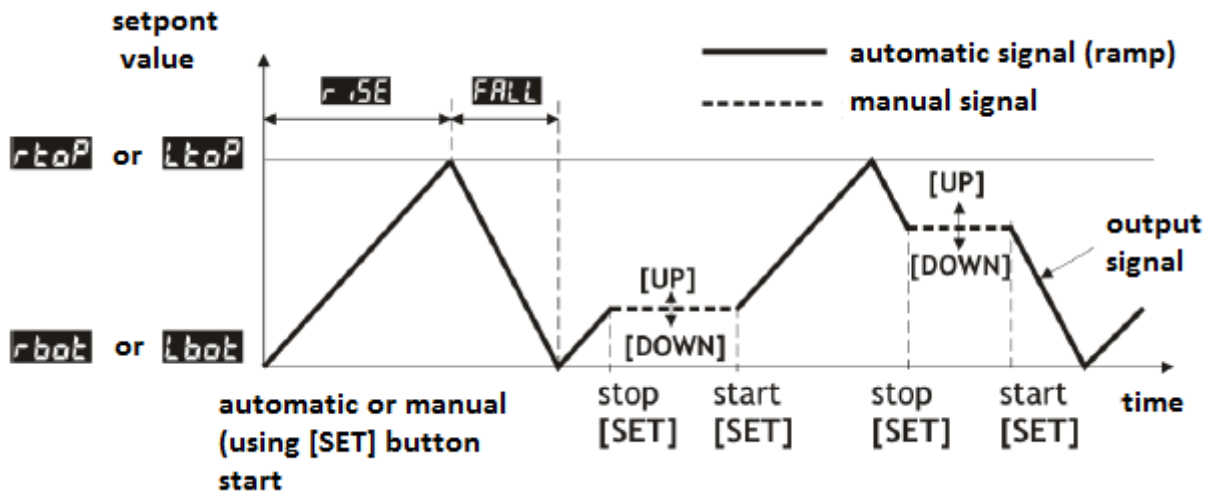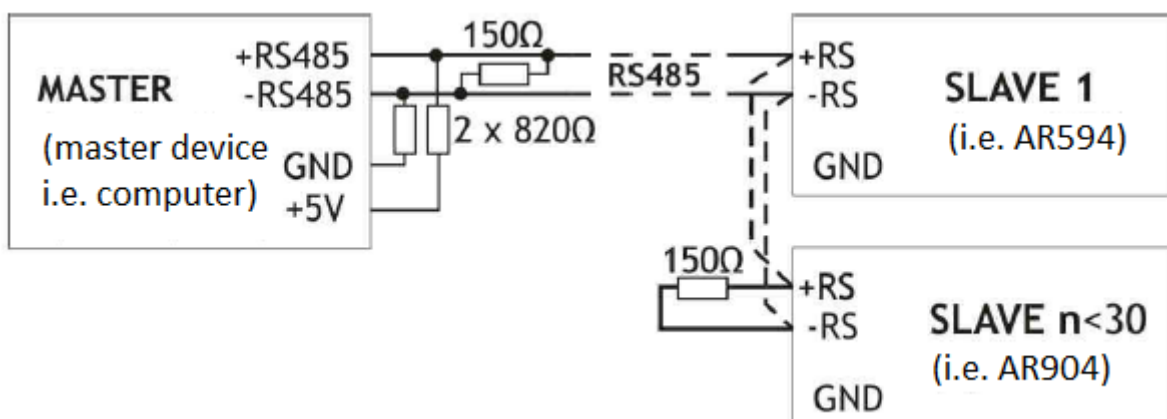
Illustration 11.3. Output status in triangle signal generator mode (parameter `r.SE` > 0, `FALL` > 0).

12. MESSAGES AND ERRORS LIST

Following short messages can be displayed during device operation:

Code	Message description
`CodE`	Entering protection password input mode (chapter 10)
`Err`	Incorrect protection password entered
`ConF`	Entering parameters configuration menu
`bLoc`	Setpoint value setting lock on (11: `bLSE` = `on`, chapter 10)
`rAMP`	Ramp function is on and setpoint value change lock is activated
`StAr`	Manual start of soft start/stop function (using [SET] button)
`StoP`	Manual stop of soft start/stop function (using [SET] button)

13. RS485 COMMUNICATION INTERFACE (per EIA RS-485)

Maximum RS485 cable length – 1km.

Maximum number of devices in RS485 line – 30. To increase this number you can use RS485/RS485 repeater.

Terminal resistors when MASTER is on the line beginning (above illustration):
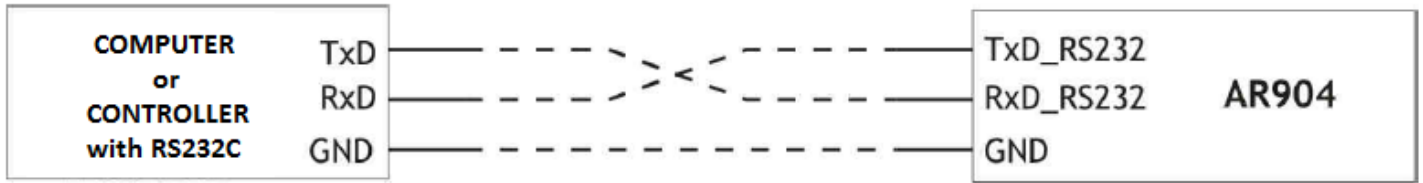- On the line beginning – 2 x 820Ω to ground and +5V of the MASTER and 150Ω between lines,

- On the line end - 150Ω between lines.

Terminal resistors when MASTER is in the middle of the line:
- Near the converter – 2 x 820Ω to ground and +5V of the converter,
- On both line ends – each end 150Ω between lines.

14. RS232C COMMUNICATION INTERFACE (per EIA RS-232C)

Maximum cable length - 10m
Maximum number of devices connected to the computer - 1

15. MODBUS-RTU SERIAL TRANSMISSION PROTOCOL

Character format: 8 bits, 1 stop bit, no parity bit

Available functions: READ – 3 or 4, WRITE – 6

Table 15.1. Request frame format for READ function (frame length – 8 Bytes):

Device address	Function 4 or 3	Read register address: 0 ÷ 22 (0x0016)	Read registers number: 1 ÷ 23 (0x0017)	Control sum CRC
1 Byte	1 Byte	2 Bytes (HB – LB)	2 Bytes (HB – LB)	2 Bytes (LB – HB)

Example 15.1. Read register with address 0: 0x01 – 0x04 – 0x0000 – 0x0001 – 0x31CA

Table 15.2. Request frame format for WRITE function (frame length – 8 Bytes):

Device address	Function 6	Write register address: 0 ÷ 22 (0x0016)	Write register value:	Control sum CRC
1 Byte	1 Byte	2 Bytes (HB – LB)	2 Bytes (HB – LB)	2 Bytes (LB – HB)

Example 15.2. Write register with address 10 (0xA) with value 0: 0x01 – 0x06 – 0x000A – 0x0000 – 0xA9C8

Table 15.3. Response frame format for READ function (minimum frame length – 7 Bytes):

Device address	Function 4 or 3	Bytes number for data field (maximum 23*2 = 46 Bytes)	Data field – register value	Control sum CRC
1 Byte	1 Byte	1 Byte	2 ÷ 46 Bytes (HB – LB)	2 Bytes (LB – HB)

Example 15.3. Response frame for register value equal 0: 0x01 – 0x04 – 0x02 – 0x0000 – 0xB930

Table 15.4. Response frame format for WRITE function (frame length – 8 Bytes):

Copy of request frame for WRITE function (Table 15.2)

Table 15.5. Special response (errors: function field = 0x84 or 0x83 for READ function and 0x86 for WRITE function):

Error code (HB – LB in data field)	Error description
0x0001	Register address doesn't exist
0x0002	Incorrect write register value
0x0003	Incorrect function number

Example 15.5. Error frame for read register that does not exist: 0x01 – 0x84 – 0x02 – 0x0001 – 0x5130

Table 15.6. MODBUS-RTU protocol registers map

Register address HEX (DEC)	DEC Value	Register and access type description (R – read only register, R/W – read/write register)	
0x00 (0)	-1999 ÷ 9999	Current setpoint value (register in RAM volatile memory)	R/W
0x01 (1)	904	Device type identifier	R
0x02 (2)	20 ÷ 99	Firmware version number	R
0x03 ÷ 0x05	0	Not used or reserved	R
0x06 (6)	0 ÷ 1	Parameter 0: outP output type (chapter 10, table 10)	R/W
0x07 (7)	0 ÷ 3	Parameter 1: dot dot position	R/W
0x08 (8)	-1999 ÷ 9999	Parameter 2: rbot display lower range	R/W
0x09 (9)	-1999 ÷ 9999	Parameter 3: rtoP display upper range	R/W
0x0A (10)	-1999 ÷ 9999	Parameter 4: Lbot setpoint lower range	R/W
0x0B (11)	-1999 ÷ 9999	Parameter 5: LtoP setpoint upper range	R/W
0x0C (12)	1 ÷ 5000	Parameter 6: StEP value change step	R/W
0x0D (13)	-1999 ÷ 9999	Parameter 7: SEt setpoint value	R/W
0x0E (14)	0 ÷ 8160	Parameter 8: rISE soft start time	R/W
0x0F (15)	0 ÷ 8160	Parameter 9: FALL soft stop time	R/W
0x10 (16)	0 ÷ 1	Parameter 10: tr iG ramp trigger mode	R/W
0x11 (17)	0 ÷ 1	Parameter 11: bLSE setpoint value setting lock	R/W
0x12 (18)	0 ÷ 9999	Parameter 12: PASS protection password	R/W
0x13 (19)	0 ÷ 1	Parameter 13: PPro password data protection	R/W
0x14 (20)	10 ÷ 100	Parameter 14: br iG display brightness	R/W
0x15 (21)	1 ÷ 247	Parameter 15: Addr MODBUS-RTU address	R/W
0x16 (22)	0 ÷ 4	Parameter 16: br transmission speed for RS485/RS232 or for AR955 programmer	R/W

16. USER NOTES