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USER MANUAL

AR715

FLOW METER / PULSE COUNTER

Version 1.0.4
2017.12.11

Thank you for choosing our product.
This instruction is intended to facilitate correct operation, safe use, and taking full advantage of the device's functionalities.
Before you start the device, please read and understand this instruction.
In the event of any additional questions, please contact our technical adviser.

TABLE OF CONTENTS

 Pay special attention to the texts marked with this sign

The manufacturer reserves the right to introduce changes to the design and the software (firmware) of the device without any deterioration of technical parameters (some functions may not be available in older versions).

1. SAFETY PRINCIPLES

- before you start to use the device, become familiar with the present instructions;
- in order to avoid electrocution or damage to the device, its mechanical and electrical installation must be performed by qualified workers;
- before switching on the power supply, make sure that all cables and wires are properly connected;
- before making any modifications to the wire and cable connections, switch off the voltage supplied to the device;
- ensure proper operating conditions compliant with the technical specification of the device (chapter 5, power supply voltage, humidity, temperature).

2. INSTALLATION GUIDELINES

The device is designed so as to ensure an appropriate level of immunity to most interferences that may occur in industrial environments. In environments with an unknown level of interference, the following measures are recommended to prevent possible interference of the device operation:

a) do not supply the device from the same lines as high-power equipment without using appropriate power line filters;

b) use shielded supply, sensor, and signal cables, whereby the earthing of the shield should be single-point and located as close to the device as possible;

c) avoid running measurement (signal) cables in the direct vicinity of and parallel to power and supply cables;

d) it is recommended to use twisted pair signal cables;

e) avoid proximity of remotely controlled devices, electromagnetic meters, high power loads, loads with phase or group power control, and other devices that cause high impulse disturbances;

f) ground or zero metal rails on which rail-mounted devices are installed.

Make sure to remove the protective film from the LED display before the first use of the device.

3. GENERAL CHARACTERISTICS OF THE DEVICE

- measurement of flow, balance, angle and offset (incremental encoder), rotational sped, and frequency, counting of impulses, dosing, remote display (through the RS485 interface, MODBUS-RTU protocol, slave)
- a double impulse measurement input serving the incremental encoder or determining the direction of counting of the balance/counter, an additional resetting and counting start input
- support of flow meters/sensors with outputs, open collector NPN, PNP type or with contact outputs
- programmable 4 colours of the display to present the measured values and alarms
- 2 independent alarm outputs of the ON-OFF type (direct, reverse, band, manual mode)
- alarm signalling with diode indicators and with programmable colour of the display
- BIN digital input ("F" from the keyboard) to change the operation mode:
  - manual/automatic mode for outputs
  - stop of display indications for the measurements (HOLD function)
  - keypad block
- analogue output 0/4÷20mA or 0/2÷10V (alarm, retransmission)
- selection of the value controlling the operation of each output (flow or balance)
- manual mode (open control loop) available for bi-state and analogue outputs which enables setting the output signal value in the range of 0-100%
- an integrated 24 V DC power supply supplying the flow meters or other field transducers
- an optional RS485 serial interface (galvanically isolated, MODBUS-RTU protocol, SLAVE)
- programmable types of inputs, indication ranges (for analogue inputs), alarm, communication, access, and display options, and other parameters
- possibility to protect access to the configuration parameters with a user password

- different parameter configuration methods:
  - from the film keypad located on the front panel of the device
  - through the RS485 or the AR956 (AR955) programmer and the ARSOFT-CFG software (Windows 7/8/10) or a user's application, communication protocol MODBUS-RTU
- software and the AR956 (or AR955) programmer that enables viewing the measured values and quick configuration of single or ready sets of parameters that were saved earlier on the computer for future use, e.g. in other devices of the same type (copying of configuration);
- options to be selected (in the ordering method): 24 V AC/DC power supply, SSR control outputs, 0/2-10 V analogue output, and RS485 interface
- high accuracy, long-term stability, and immunity to interferences;
- available accessories:
  - AR956 or AR955 programmer;
  - RS485/USB converter.

NOTE:

Before you start working with the flowmeter, make sure to become familiar with this operating instruction and perform proper electrical and mechanical installation, as well as configuration of the parameters.

4. CONTENTS OF THE SET

- AR715 flowmeter
- user manual
- guarantee card

5. TECHNICAL DATA

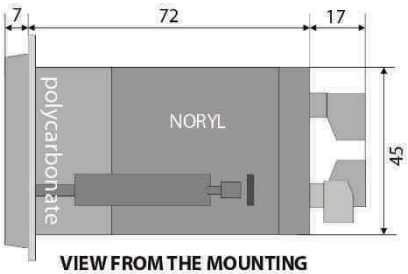
Operation of flow meters/sensors with outputs:		- open NPN type collector	
		- open PNP type collector	
		- contact (reed switch)	
Range of measured frequency	flow, frequency, and rotational speed	0.0033 Hz ÷ 10 kHz (recommended minimal duration of the low or high pulse level: 25 µs)	
	for the meter (with an OC **NPN** output)	Max. 100 kHz (for 50% filling)	
	for the meter (with an OC **PNP** output)	Max. 30 kHz (for 50% filling)	
Required input voltage levels	main inputs (IN1, IN2)	high level	0 ÷ 0.6 V (±0.2 V) **and** 13 ÷ 24V (±0.5 V)
		low level	0.8 V (±0.2 V) ÷ 12 V (±0.5 V)
	auxiliary inputs (S, R, B)	high level (on)	0 ÷ 0.8 V (±0.2 V)
		low level (off)	1.0 V (±0.2 V) ÷ 24 V (±0.5 V)
Processing error (at ambient temperature of 25 °C):		≤0.02 % ±1 digit	
Range of indications	Flow, etc. (colour parameter 1: CoL 1)	-19999 ÷ 99999, programmable	
	Balance, etc. (colour parameter 2: CoL 2)	-1999999999 ÷ 1999999999 **(1)**	
Response time		depending on the measured frequency and the filtration level	
Decimal point position		programmable, 0 ÷ 0.000	
Binary input BIN		bistable	
Communication interfaces (RS485 and PRG, do not use simultaneously)	- RS485 (galvanic isolated)	- speed 2400 ÷ 57600 b/s, - character format 8N1 (8 data bits, 1 stop bit, no parity bit) - MODBUS-RTU protocol (SLAVE)	
	- PRG programming connection (no isolation), standard		

Bi-state outputs (relay or SSR)	- relay (P1, P2), standard	8A / 250 V AC (for resistance loads), 1 main relay (SPDT), 1 additional relay (SPST-NO)
	- for SSR (SSR1, SSR2), option **Marked on the sticker of the device.**	transistor type NPN OC (terminal SSR minus), power supply 11 V (terminal SSR plus), internal resistance 440 Ω
Analogue output (1 current or 1 voltage)	- current 0/4 ÷ 20 mA (standard)	maximum resolution ≈0,35 µA (16 bit)
		load capacity of the load Ro < 350 Ω
	- voltage 0/2 ÷ 10 V (option) **Marked on the sticker of the device.**	maximum resolution ≈0,2 µA (16 bit)
		load capacity of the output Io < 3.7 mA (Ro > 2.7 kΩ)
	- basic error of the output	< 0.1% of the output range
7-segment LED display (5 digits, with adjustment of control and brightness)		character height 14.2 mm, 4 colours (red, orange, yellow, green)
Signalling	- relay activity	LED diodes
	- status of auxiliary inputs S, R	
	- messages and errors	LED display
Power supply (Usup)	- 230 VAC (standard)	85-260 Vac/ 3VA
	- 24 VAC/DC (option)	20 ÷ 50 VAC/ 3 VA, 22 ÷ 72 VDC/ 3W
Power supply of field transducers		24 VDC / max. 50 mA
Rated operating conditions		0 ÷ 50 °C, <100% RH (no condensation)
Operating environment		air and neutral gases
Enclosure protection rating		IP65 from the front, IP20 from the side of the connections
Weight		180 g
Electromagnetic Compatibility (EMC)		immunity: according to the PN-EN 61000-6-2 standard
		emission: according to the PN-EN 61000-6-4 standard

Notes: (1) - for 14: dot = 0, when point position 14: dot = 3, the indication range is -1999999,999 ÷ 1999999,999 the method of scrolling through the values of the balance/meter is described in chapter 11 and in table 9a)

6. ENCLOSURE DIMENSIONS AND INSTALLATION DATA

Enclosure type	panel, Incabox XT L57
Material	self-extinguishing NORYL 94V-0, polycarbonate
Enclosure dimensions (W x H x D)	96 x 48 x 79 mm
Panel window (W x H)	92 x 46 mm
Fixing methods	grips on the side of the enclosure
Conductor cross-sections (separable connectors)	2.5 mm^2 (supply and bi-state outputs), 1.5 mm^2 (others)



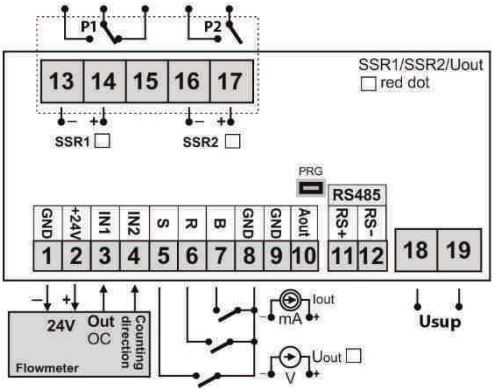
VIEW FROM THE MOUNTING BRACKET

7. DESCRIPTION OF TERMINAL STRIPS AND ELECTRICAL CONNECTIONS

Table 7. Numbering and description of terminal strips

Terminals	Description
GND	ground of the 24 V/50 mA power supply, the impulse and auxiliary inputs, and the analogue output
+24 V	input +24 V of the integrated power supply
IN1 (A), IN2 (B)	impulse inputs of the flow meter, the sensors, and the incremental encoder (A, B)
IN2 (B)	in the flow and balance measurement, meter, and dispenser mode, input **IN2** defines the direction of counting, when the level is low (on not connected) - counting upward, when the level is high - counting downward ("Required input voltage levels" in the table in chapter 5)
S	balance counting/meter permission input (counting start) or **START/STOP** of dosing (in the dosing mode, 5: **ModE** = **FEEd**)
R	balance/meter resetting input
B	binary functional input (contact or voltage max. 24 V)
Aout	analogue current output (0/4-20 mA) or voltage output (0/2-10 V)
RS+, RS-	RS485 serial interface (MODBUS-RTU transmission protocol)
18-19	power supply input 230 VAC or 24 VAC/DC
PRG	programming connection for cooperation with the programmer **(only AR956 or AR955)**
13-14-15	P1 relay output or output for SSR1 (terminal no. 13 - **SSR minus**, terminal no. 14 - **SSR plus**)
16-17	P2 relay output or output for SSR2 (terminal no. 16 - **SSR minus**, terminal no. 17 - **SSR plus**)

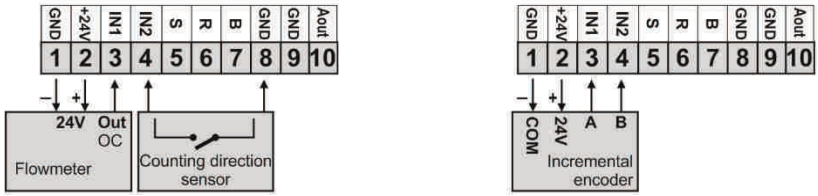
a) the numbers and a description of the connections and the connection method (the description is given in Table 7)



NOTE

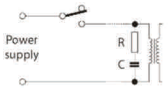
In order to connect to a computer with the PRG socket, only the AR956/955 programmer should be used;
a connection with a regular USB cable may cause damage to the device.

b) example connection of the flow meter, the counting direction sensor, and the incremental encoder



8. IMPORTANT COMMENTS PERTAINING TO OPERATION - *use of suppression systems*

If an induction load is connected to the transmitter's contacts (e.g. a contactor coil or a transformer), when the contacts open up there are frequent overvoltages and electrical arcs caused by the discharge of the energy gathered in the induction. The particularly negative consequences of such overvoltages include reduced service life of contactors and transmitters, damage to semiconductors (diodes, thyristors, and triacs), damage to or interference with the control and measurement systems, and emission of electromagnetic field that interferes with local devices. In order to avoid such consequences, the overvoltages must be reduced to a safe level. The simplest method is to connect an appropriate suppression module **directly** to the terminals of the inductive load. Generally speaking, appropriate types of suppression circuits must be selected for each type of inductive load. Modern contactors are generally fitted with appropriate factory-made suppression circuits. If such circuits are lacking, a contactor with an integrated suppression system must be purchased. Temporarily, the load can be shunted with an RC system, e.g. R=47 Ω/1 W and C=22 nF/630 V. The suppression circuit must be connected to the inductive load terminals. The use of a suppression circuit limits burning of transmitter contacts in the controller and reduces the likelihood of their sticking.



9. FUNCTIONS OF BUTTONS AND LED INDICATORS, MINIMUM AND MAXIMUM VIEW

Fig. 9. Description of the front panel

Table 9 a) button functions in the measurement display mode

Button	**Description** [and marking in the contents of the instructions]
▲ or ▼	**[UP]** or **[DOWN]**: - switching between the flow and a less important value of the balance and a more important value of the balance (balance preview) on the LED display - a change of the preset value for the outputs in the quick access menu (parameter 22: SEt1, 28: SEt2 when the outputs work as alarms or 39: MSEt when the outputs in the manual mode, chapters 10 and 12.4)
SET	**[SET]** : - input in the quick access menu (chapter 10.1) when the outputs are active
▲ + ▼	**[UP]** and **[DOWN]** (at the same time): input in the parameter configuration menu (after hold time longer than 1 s). If parameter 42: PPro = on (password protection is activated) enter the access code (chapter 10)
F	**[F]** activation of a function programmed with parameter 37: Func (after holding for more than 1 second, chapters 9.1 and 10)
SET + ▲	**[SET]** and **[UP]** : - displays the saved **MAXIMUM VALUE** of the measured flow, etc. - deletes the maximum value of the measured flow (after hold time > 6 s)

SET + ▼	**[SET]** and **[DOWN]** : - displays the saved **MINIMUM VALUE** of the measured flow, etc. - deletes the minimum value of the measured flow (after hold time > 6 s)

Table 9 b) button functions in the parameter configuration menu and the quick access menu (chapters 10, 10.1)

Button	**Description** [description and marking in the contents of the instructions]
SET	**[SET]** : - selects the item displayed in the configuration menu (entering a lower level) - selects the parameter to be edited (the edited value blinks on the display) - approves and saves the edited parameter value
▲ or ▼	**[UP]** or **[DOWN]**: - moves to the next or previous parameter (submenu) - changes the value of the edited parameter
▲ + ▼	**[UP]** and **[DOWN]** (simultaneously): - returns to the previous menu (higher level) - cancels edition of the value of the specific parameter (the blinking stops) - returns to the measurement display mode (only **[UP]** and **[DOWN]** after hold time >0.5 s)

Table 9 c) the functions of the LED signalling indicators

Diode [marking]	**Description**
1 **[1]** 2 **[2]**	Signals switching on of outputs P1/SSR1 and P2/SSR2
S **[S]**	Permission to count (outside of the dozer mode, reflects the status of the input **S**)
R **[R]**	Status of the input **R** that resents the balance, meter

9.1. FUNCTION BUTTON AND BINARY INPUT

Binary input **BIN** and button **F** perform a function that is programmable with parameter 37: Func (chapter 10). The **BIN** input works with the bi-stable signal, i.e. the supplied signal (voltage or switch) must be permanent and supported (on/off type). On the other hand, when the button **F** is pressed once, the status changes. Activation or deactivation of the function is indicated by appropriate messages on the lower display (described below). The **BIN** input is in the active state for a short circuit or a voltage of <0.8 V in relation to the earth (the required levels of input voltage are given in chapter 5).

Table 9.1. Available **BIN** input functions

Source	**Description** (depending on the value of parameter 37: Func)		**Message**
BIN F	Func = nonE	the **BIN** input is inactive (factory setting)	-
	Func = bLoc	keypad block	bLoc / boFF
	Func = hAn1	unconditional manual mode for the P1/SSR1 output (chapter 12.4)	hAnd / hoFF
	Func = hAn2	unconditional manual mode for the P2/SSR2 output	hAnd / hoFF
	Func = hAnA	unconditional manual mode for the analogue output	hAnd / hoFF
	Func = hold	stop of display indications for the measurements (HOLD function)	hdoF / hoLd
	Func = StSP	start/stop of dosing (in the dosing mode, 5: tiodE = FEEd)	-

10. SETTING OF THE CONFIGURATION PARAMETERS

All configuration parameters of the meter are contained in the non-volatile (permanent) internal FLASH memory (data is saved in the memory only when the power supply is being switched off and provided that the settings were changed). At the time of first use, the device must be properly configured.
There are two parameter configuration methods:

1. From the film keypad located on the front panel of the device:
- from the mode where the input measurements are displayed in the configuration menu (press the **[UP]** and **[DOWN]** buttons simultaneously for more than 1 second) If parameter 44: PASS = on (password protection is on) the display will show the message CodE, and then 0000 with the first digit blinking, use the buttons **[UP]** or **[DOWN]** to enter the password (default parameter 43: PASS = 1111), to move to successive items and to approve the code, use the **[SET]** button
- after entering the main configuration menu (with the message ConF) the display shows a mnemonic name of the submenu (parameter groups: diSP <-> inP <-> out1 <-> etc.)
- use the **[UP]** or **[DOWN]** button to move to the relevant submenu and then use the **[SET]** button to approve the selection (the mnemonic name of the parameter is now displayed)
- by pressing the **[UP]** button, you can move to the next parameter, and by pressing the **[DOWN]** button - to the previous parameter (e.g. Hodt <-> FiFA <-> EnFA <-> etc., the list of the configuration parameters is presented in Table 10)
- to change the value of the current parameter, press briefly the **[SET]** button (the parameter blinks in the edition mode)
- use buttons **[UP]** or **[DOWN]** to change the value of the edited parameter
- approve the changed value of the parameter by pressing the **[SET]** button or cancel it by pressing the **[UP]** and **[DOWN]** buttons (briefly press them simultaneously) - by pressing the **[UP]** and **[DOWN]** buttons again, you will return to the main configuration menu (one level above)
- to exit the configuration: press the **[UP]** and **[DOWN]** buttons for a long moment or wait approx. 2 minutes

2. Use the RS485 or the PRG port (AR956/955 programmer) and the ARSOFT-CFG software (chapter 14):
- connect the device to a computer port and start and configure the ARSOFT-CFG application
- after the connection has been established, the current measured value is displayed in window of software
- setting and viewing parameters of the device is possible in the parameter configuration window
- new parameter values must be approved with the ***Approve changes*** button
- the current configuration may be saved to a file or set with values read from a file

NOTE:
- before disconnecting the device from a computer, press the ***Disconnect device*** button (ARSOFT-CFG)
- in the event of no response:
- in the ***Program options*** check the configuration of the port and the ***MODBUS Address of the device***
- make sure that the serial port drivers on the computer have been properly installed for the RS485 converter or the AR956 (AR955) programmer
- disconnect for a few seconds and then reconnect the RS485 converter or the AR956 (AR955) programmer
- restart the computer

If you find that the indications differ from the real value of the signal, the amplification can be tuned: with parameters 15: mul1, 16: dv1, 17: mul2, 18: dv2.

To restore the factory settings, when the power supply is switched on press buttons **[UP]** and **[DOWN]** and hold them until the password menu appears (CodE), and then enter the following code 0112. As an alternative, a file with default configuration can be used in the ARSOFT-CFG software.

NOTE:
Do not perform configuration of the device with the keypad and through the serial interface (RS485 or PRG connection) at the same time.

Table 10. List of configuration parameters

Parameter	Range of parameter variation and description		Default
DISPLAY OPTIONS – submenu dISP			
1: col1 colour of measurement 1 (**1**)	GrEE = green, YEL = yellow, orAn = orange, rEd = red, colo = no alarm signalized by a changed colour of the display (applies only to parameter 3: ALcol - the colour of the display for the activated alarm that can be seen when the channel triggering that alarm is displayed)		rEd
2: col2 colour of measurement 2 (**2**)			GrEE
3: ALcol alarm colour			colo
4: br id display brightness	1 ÷ 3	level of illumination brightness of the display (3 = 100%)	3
CONFIGURATION OF THE MEASUREMENT INPUT - submenu inP			
5: ModE measurement mode	FLo	flow and balance measurement	FLo
	cntr	pulse counter	
	Enc	incremental encoder (the operation mode is additionally identified by the encoder unit, parameter 10: Enun)	
	FEEd	dispenser (the portion is set by parameter 22: SEt1)	
	FrEQ	frequency measurement	
	rEMo	remote display (via the RS485 interface, MODBUS-RTU protocol, slave)	
6: FLFA flow meter constant [imp/l]	0.1 ÷ 99999	flow meter constant (00 = 10,000 imp/l)	1000
7: EnFA encoder constant	1 ÷ 12000	encoder constant (number of impulses of one of the outputs, **A** or **B**, per one rotation)	3600
8: FUun flow volume unit	L	litre	L
	hL	hectolitre	
	m3	cubic meter	
9: Ftun flow time unit	SEc	second	Min
	Min	minute	
	hour	hour	
10: Enun unit for the encoder mode	rPA	rotations / minute	rPA
	dEG	degrees (range 0.000-359,999)	
	n	meters	
11: ttcL waiting time for an impulse (time to clear)	0.1 ÷ 3000 [s]	Time in seconds after which **measurement 1** is zeroed out if it does not detect an impulse on the measurement input **IN1**	2.0
12: dt.dI time of insensitivity - filtration of contact vibrations	000 ÷ 5000 [ms]	Time during which impulses are ignored (dead time), which is needed in the event of use of contacts or reed switches	0.5
13: FiL filtration	1 ÷ 20	program filtration for **measurement 1** (response time)	3
14: dot point position	0	no point	1
	1	resolution 0.1	
	2	resolution 0.01	
	3	resolution 0.001	
15: MuL1 multiplier (counter) measurement 1	1 ÷ 1000	**measurement 1** will be multiplied by the value of this parameter	1

16: dIv1 (denominator) measurement 1 divider	1 ÷ 1000	**measurement 1** will be divided by the value of this parameter	1
17: MuL2 multiplier (counter) measurement 2	1 ÷ 1000	**measurement 2** will be multiplied by the value of this parameter	1
18: dIv2 (denominator) measurement 2 divider	1 ÷ 1000	**measurement 2** will be divided by the value of this parameter	1
19: SAVE saving of the value of the counter/balance	on	the value of the meter/balance is saved when power supply is lost	on
	oFF	the value of the meter/balance is not saved and a power supply causes the meter/balance to be reset	
CONFIGURATION OF OUTPUT 1 (P1/SSR1) – submenu out1 - chapter 12 (12.2)			
20: coS1 control signal for output 1	FLo = flow, frequency, etc. (Measurement 1), tot = balance, meter (Measurement 2)		FLo
21: Fun1 function of output 1	oFF = OFF, MAn = manual mode, inv = reverse characteristics, dir = direct characteristics, bAon (in the band) or bAoF (outside of the band) = band characteristics (the band width is specified by parameter 23: HY1)		oFF
22: SEt1 preset value of output 1 or portion in the dispenser mode	applies to output 1, changes in the scope of parameters 24: Lo1 ÷ 25: Hi1		1000
23: HY1 hysteresis of output 1, or width of band	0 ÷ 20000 **(3)**	hysteresis or width of the band (when the output function is a band characteristic bAon or bAoF)	1.0
24: Lo1 lower limit 1	-19999 ÷ 99999 **(3)**	lower setting limit for the preset value 22: SEt1	-1999.9
25: Hi1 upper limit 1	-19999 ÷ 99999 **(3)**	upper setting limit for the preset value 22: SEt1	9999.9
CONFIGURATION OF OUTPUT 2 (P2/SSR2) – submenu out2 - chapter 12 (12.2)			
26: coS2 control signal for output 2	FLo = flow, frequency, etc. (Measurement 1), tot = balance, meter (Measurement 2)		FLo
27: Fun2 function of output 2	oFF = OFF, MAn = manual mode, inv = reverse characteristics, dir = direct characteristics, bAon (in the band) or bAoF (outside of the band) = band characteristics (the band width is specified by parameter 29: HY2)		oFF
28: SEt2 preset value of output 2	applies to output 2, changes in the scope of parameters 30: Lo2 ÷ 31: Hi2		1000
29: HY2 hysteresis of output 2, or width of band	0 ÷ 20000 **(3)**	hysteresis or width of the band (when the output function is a band characteristic bAon or bAoF)	1.0
30: Lo2 lower limit 2	-19999 ÷ 99999 **(3)**	lower setting limit for the preset value 27: SEt2	-1999.9
31: Hi2 upper limit 2	-19999 ÷ 99999 **(3)**	upper setting limit for the preset value 27: SEt2	9999.9
ANALOG OUTPUT CONFIGURATION – submenu outA - chapter 12 (12.3)			
32: coSA control signal for the analogue output	FLo = flow, frequency, etc. (Measurement 1), tot = balance, meter (Measurement 2)		FLo
33: AtYP type of analogue output	depending on the order code: for current output 0-20 or 4-20 mA, for voltage output 0-10 or 2-10 V		0-20 mA (0-10 V)
34: FunA function of analogue output	oFF = off, MAn = manual mode, rEtr = retransmission of measurement, cont = control output, a detailed description is provided in chapter 12.3		oFF

35: A-Lo lower indication for retransmission (when 34: FunA = rEtr)	-19999 ÷ 99999 **(3)**	start of the output scale - for output signal value 0/4 mA or 0/2 V (the parameter is active only for measurement retransmission - when 34: FunA = rEtr)	0.0
36: A-H upper indication for retransmission (when 34: FunA = rEtr)	-19999 ÷ 99999 **(3)**	end of the output scale - for output signal value 20 mA or 10 V (the parameter is active only for measurement retransmission - when 34: FunA = rEtr)	9999.9
CONFIGURATION OF THE BINARY INPUT BIN AND THE MANUAL MODE – submenu bInM			
37: Func function of the **BIN** input and the function button (chapter 9.1) 	nonE	the **BIN** input is inactive	nonE
	bLoc	keypad block	
	hAn1	unconditional manual mode for output 1 (P1/SSR1)	
	hAn2	unconditional manual mode for output 2 (P2/SSR2)	
	hAnA	unconditional manual mode for the analogue output	
	hoLd	stop of indications for the measurements (HOLD function)	
	St.SP	start/stop of dosing (dosing mode 5: rodE = FEEd)	
38: tc impulse period	3 ÷ 350 s	period of switching of status of out. 1 and 2 in manual mode	5 s
39: MSEt preset value of the manual mode	0 ÷ 100 % 1% step	control value for outputs in the manual mode, applies to all outputs (1, 2, and the analogue output), chapter 12.4	50 %
ACCESS OPTIONS – submenu AccE			
40: bSEt block of changes in the preset values 22: SEt1, 28: SEt2	oFF = no blocks, SEt1 = block of parameter 22: SEt1, SEt2 = block of parameter 28: SEt2, both = simultaneous block of changes to parameters 22: SEt1 and 28: SEt2		oFF
41: PASS password	0000 ÷ 9999	password for the parameter configuration menu	1111
42: PPro protection of the configuration with a password	oFF	entry into the configuration menu is **not** password-protected	on
	on	entry into the configuration menu is password-protected	
COMMUNICATION OPTIONS– submenu trAn			
43: Addr MODBUS address	1 ÷ 247	individual address of device in RS485 network (chapter 16)	1
44: br communication speed for RS485 and the PRG connection	2.4 kbit/s, 4.8 kbit/s, 9.6 kbit/s, 19.2 kbit/s, 38.4 kbit/s, 57.6 kbit/s		19.2 kbit/s

Notes: **(1)** - Measurement 1 - derivative values of time, i.e. flow, frequency, rotational speed
(2) - Measurement 2 - summed up values, i.e. balance, meter, angle, shift
(3) - for the point position equal to 1 (the value depends on the position of the decimal point 14: dot)

10.1. QUICK ACCESS MENU

In the measurement mode (when the measured values are displayed), it is possible to immediately access certain configuration parameters and functions without the need to enter a password. This possibility is offered by the quick menu, which can be accessed by pressing the **[SET]** button. The parameter is selected and edited in the same way as described above (in chapter 10).

Table 10.1. Complete list of elements accessible in the quick configuration menu.

Element	Description
SEt1	preset value 1 (parameter 22: SEt1), optional element - unavailable when parameter 21: Fun1 = hAnd
SEt2	preset value 2 (parameter 28: SEt2), optional element - unavailable when parameter 27: Fun2 = hAnd
MSEt	preset value of the manual mode (39: MSEt), optional element - available for outputs in the manual operation mode

11. DESCRIPTION OF THE MEASUREMENT MODES OF THE DEVICE

Various measurements can be shown on the LED display. The display of the device is a one-line display and, consequently, the values can be previewed using the **UP** and **DOWN** buttons. In order to ensure the greatest simplicity and, simultaneously, the greatest clarity the following terms are used: display 1, display 2, measurement 1, and measurement 2. Display 1 is related to measurement 1 and display 2 is related to measurement 2. The differentiation facilitates the possibility to set different colours for different displays (1: `col 1`, 2: `col2`). Moreover, when the values of measurement 2 are longer than 5 digits, display 2 is divided into 2 parts and the extreme digits blink, indicating the need to scroll in order to read the correct result. In the less important part of the balance, the leftmost digit blinks and in the most important part of the balance, the rightmost digit blinks.
Measurement 1 is derivatives values of time, such as flow, frequency, and rotational speed, and **Measurement 2** is summed values, such as balance, counter, angle, and offset.

Table 11. Parameters taken into account in the specific mode and the display and inputs used

Measurement mode (5: `ModE`)		**Submenu parameters taken into account** `inP`	**Display number**	**Inputs**
`FLo`, flow and balance measurement		6: `FtFA`, 8: `FUun`, 9: `Ftun`, 11: `ttcL`, 12: `tt dA`, 13: `F tL`, 14: `dot`, 15: `AuL 1`, 16: `d uu1`, 17: `AuL2`, 18: `d uu2`	**1, 2** (1: `col 1`,2: `col2`)	IN1, IN2
`cntr`, impulse counter		12: `tt dA`, 14: `dot`, 17: `AuL2`, 18: `d uu2`	**2** (2: `col2`)	IN1, IN2
`Enc`, Incremental encoder	10: `Enun` = `rPA`	7: `EnFA`, 10: `Enun`, 11: `ttcL`, 12: `tt dA`, 13: `F tL`, 14: `dot`, 15: `AuL 1`, 16: `d uu1`,	**1** (1: `col 1`)	IN1
	10: `Enun` = `dEG`	7: `EnFA`, 10: `Enun`, 12: `tt dA`, 14: `dot`, 17: `AuL2`, 18: `d uu2`	**2** (2: `col2`)	IN1(A), IN2(B)
	10: `Enun` = `n`	7: `EnFA`, 10: `Enun`, 12: `tt dA`, 14: `dot`, 17: `AuL2`, 18: `d uu2`	**2** (2: `col2`)	IN1(A), IN2(B)
`FEEd`, dispenser (22: `SEt 1` – defines the value of the portion)		6: `FtFA`, 8: `FUun`, 12: `tt dA`, 13: `F tL`, 14: `dot`, 17: `AuL2`, 18: `d uu2`	**2** (1: `col 1`)	IN1, IN2
`FrEQ`, frequency measurement		11: `ttcL`, 12: `tt dA`, 13: `F tL`, 14: `dot`, 15: `AuL 1`, 16: `d uu1`	**1** (1: `col 1`)	IN1
`rEMo`, remote display		-	**1** (1: `col 1`)	-

Dispenser mode:
Dosing can be performed in two ways: Using the flow and balance measurement mode or the dispenser mode. Dedicated dispenser mode 5: `ModE` = `FEEd` makes it possible to calculate the total quantity of the dosed medium. Other than during dosing in the flow and balance measurement mode where in order to perform dosing of another portion it is necessary to resent the counter using the input **R**, in the dispenser mode 5: `ModE` = `FEEd` the value of the portion is specified in parameter 22: `SEt 1` (set value 1) and input **S** works in a monostable manner, which makes it possible to connect a monostable switch. When the switch is pressed once, dosing is released/resumed or stopped (**START/STOP** of dosing - **ON/OFF** P1/SSR1). After the set portion has been measured, output 1 (P1/SSR1) is switched off. Also, the function of the diode **S** changes; the diode emits continues light, thus indicating a continuous permission for counting. However, it does not show the status of the input **S** as in the case of other modes. Moreover, in the dedicated dispenser mode, the control output is only the P1/SSR1 output and the configuration of the parameters in the menu `out 1` does not affect its operation.

Incremental encoder operation mode:
In the incremental encoder operation mode 5: `ModE` = `Enc` it is very important to set the correct unit (parameter 10: `Enun`). This is because the unit determines the value to be measured, the display on which the measurement is displayed, and the parameters that will be taken into account (Table 11). In the case of high frequencies, it is recommended to use encoders with the NPN output because for this type a higher frequency is supported, max. 100 kHz (chapter 5).
Encoder constant is defined as the number of incisions (bars) on the disk or the number of periods from one output (A or B) taking place in one rotation. For proper operation two outputs of the encoder, A and B, must be connected.
Rectangular signals from the outputs of the encoder should be set off in relation to each other by 90°.

11.1. ADDITIONAL INFORMATION CONCERNING CONFIGURATION OF INPUTS

- In the case of erroneous configuration of parameter 12: dt iA ***Insensitivity Time***, the values of the indications will be incorrect. This parameter must be set based on the maximum frequency and the flow meter output signal filling coefficient. If the manufacturer of the sensor does not provide information on the impulse filling coefficient, 2÷10% of the maximum frequency at the flow meter output can be assumed and the correctness of the measurement must be checked by selecting the value of the parameter experimentally. The maximum impulse frequency can be calculated based on the measurement scope and the flow meter K-factor. Correct selection of parameter 12: dt iA ***Insensitivity time*** is of key importance to proper measurement and stability of the measured value. The value of the parameter must be other than zero value if the flow meter that is used has a contact output.
- The number of impulses required for reliable measurement of flow, frequency, and rotational speed is equal to: 4*degree of filtration or 60*degree of filtration - for frequencies above 100 Hz.
- The device does not work with sensors that have a complementary output NPN-PNP (push-pull) or an internal pull-up resistor. In such a case, signal conversion is required, e.g. by serial connection of a fast semiconductor diode between the output of the flow meter and the impulse input, or the power supply voltage of the flow meter must be reduced to 12 V. Such connections must be made by a qualified person.
- Do not connect a pull-up resistor of the flow meter output to the power supply plus terminal for flow meters with the open collector (OC) output of the NPN type.
- In the measurement mode 5: tiodE = FrE9 ***Frequency measurement*** the unit is ***Hz***. In the other operating modes, the units are configured by the user. Additionally, mathematical operations can be used to enter one's own unit (parameters 15: FuL 1, 16: d iu 1, 17: FuL2, 18: d iu2)

12. OUTPUT OPERATION CONFIGURATION

The programmable architecture of the device enables using it in many fields and applications. Before the operation of the device starts, it is necessary to set the parameters according to specific requirements (chapter 10). A detailed description of configuration of the operation of outputs is given in chapters 12.1÷ 12.4. The default (factory) configuration is the following: the outputs 1 and 2 are switched off, the analogue output is switched off (Table 10, *Factory settings* column). **The dispenser mode cooperates only with the first P1/SSR1 output.**

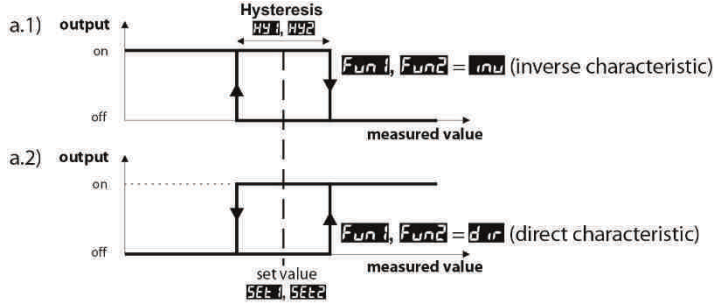
12.1. CHANGING THE PRESET OUTPUT VALUES

The simplest way to change the preset values for outputs 1 and 2 (parameter 22: SEt 1, parameter 28: SEt2, or parameter 39: HSEt when the outputs work in the manual mode) is to use the quick menu (chapter 10.1).
As an alternative, it is possible to change the preset value in the parameter configuration mode (using the methods described in chapter 10).

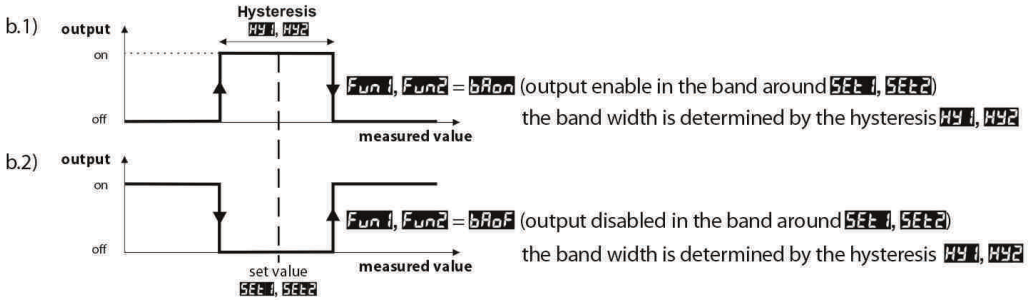
12.2. TYPES OF OUTPUT CHARACTERISTICS

The type of operation of each output is programmed using parameters 21: Fun 1 and 27: Fun2, chapter 10, Table 10.

a) basic operating characteristics of outputs



b) additional operation characteristics of outputs



12.3. ANALOG OUTPUT

The standard of the output signal is determined by parameter 33: **rtyP** (chapter 10, Table 10). The analogue output can work in one of the following modes: retransmission of measurement (parameter 34: **outA** = **rEtr**), manual mode (34: **outA** = **hAnd**) and as an automatic control output (34: **FunA** = **out1**).

In the mode of retransmission of a selected measurement (32: **coSA**) the output signal is proportional to the signal measured in the range set by parameters 35: **A-Lo** and 36: **A-Hi** (e.g. 0 mA for the measured value 0 °C when **A-Lo** = 0, 20 mA for 100 when **A-Hi** = 100 and, as appropriate, 10 mA for the half of the range, i.e. 50).

Manual operation (chapter 12.4) enables smooth change of the output signal in the range of 0-100% with an increment of 1% and the initial value equal to the last value in the automatic mode (measurement retransmission or alarm mode).

In the control output mode (34: **FunA** = **out1**) the parameters of the alarm and the performed functions are identical as for output 1 (repeated status of P1/SSR1 output). The signal on the analogue assumes the limit values (lower or upper value, e.g. 0mA or 20mA) without intermediate values, which may be used to switch on, e.g. the **SSR** relay.

12.4. MANUAL AND REMOTE CONTROL FUNCTION

The manual mode enables setting the value of the output signal in the entire range of its variability (0-100%), thus enabling operation in an open regulation loop (no automatic coupling between the measured value and the output signal). Manual operation is available individually for each output of the device and is programmed using parameters 21: **Fun1** , 27: **Fun2**, and 34: **Fun3** , chapter 10, Table 10. Also, the outputs can be configured for quick (unconditional) manual mode controlled by:

- the **BIN** binary input, by programming, as appropriate, parameter 37: **Func** (chapter 9.1).

In the case of bi-state outputs (1, 2), the change of the output signal consists in setting the filling coefficient (using parameter 39: **HSEt**) with the impulse period defined by parameter 38: **tc** . The preset value of the manual mode 39: **HSEt** = 0 stands for a permanently switched off output; value 100 stands for a permanently switched on output. This value can be set using the quick menu (chapter 10.1) or, as an alternative, in the parameter configuration mode (from the film keypad of the device or remotely using the RS485 or PRG serial port, chapters 10, 14 ÷ 16).

13. MESSAGE AND ERROR SIGNALING

a) measurement errors:

Code	Possible causes of the error
---- / ----	- the measurement range is exceeded from the top (----) or from the bottom (----)

b) temporary messages and errors (one-time and recurring):

Code	Description of the message
CodE	mode of entering the password for access to the configuration parameters, chapter 10
Err	the password is invalid,
ConF	the parameter configuration menu was accessed,
bLoc / boFF	keypad block on/off, chapter 9.1
hAnd / hoFF	unconditional manual mode on/off, chapter 9.1
HdoF / HoLd	stop of display indications for the measurements (HOLD function), chapter 9.1
SAuE	saving of factory parameter values (chapter 10)

14. CONNECTING THE CONTROLLER TO A COMPUTER AND AVAILABLE SOFTWARE

It may be useful (or necessary) to connect the device to a computer in the following situations:
- remote monitoring and recording of current measurement data and process (status of the outputs) control;
- quick configuration of parameters, to include copying of settings to other devices of the same type

In order to establish communication over long distances, it is necessary to establish a connection in the RS485 standard with an available port in the computer (directly or using an RS485 converter), as described in chapter 15. Moreover, as a standard, the devices are equipped with a PRG port which enables connecting to a computer using an AR956/955 programmer (without galvanic separation, cable length approx. 1.2 m). Both the programmer and the RS485 converter require installation of the supplied serial port drivers on the computer. Communication with devices is effected using a protocol compatible with MODBUS-RTU (chapter 16). The following applications are available (on a CD supplied with the AR956/955 programmer or to be downloaded from the Internet at ***www.apar.pl***, *Download* tab, for operating systems Windows Vista/7/8/10):

Name	Software description
ARSOFT-CFG (free)	- display of current measurement data from the connected device - configuration of the type of measurement input, the indication range, the alarm options, the display, the communication, etc. (chapter 10) - creation on the disk of a "cfg" file with the current configuration of the parameters for future use (copying of configuration) - the software requires communication with the device via the RS485 port (AR956/955)

The detailed descriptions of the aforementioned applications can be found in the installation folders.

NOTE: ⚠

Before establishing the connection, make sure that the MODBUS address of the device (parameter 43: Addr) and the speed of transmission (parameter 44: br) are the same as the settings of the software. Moreover, in the software options, set the number of the COM serial port in use (in the case of the RS485 converter or the AR956/955 programmer, this is the number assigned by the operating system during installation of the drivers).

15. RS485 COMMUNICATION INTERFACE (acc. to EIA RS-485)

The installation specification for the RS485 interface is the following:
- maximum cable length - 1 km (observe the installation guidelines, chapter 2, sub-items b, c, and d)
- maximum number of devices in an RS485 line - 30, in order to increase the number, use RS485/RS485 amplifiers
- termination and polarizing resistors when the MASTER is at the start of the line (Fig. 15):
  - at the start of the line - 2 x 820 Ω to the ground and +5 V of the MASTER and 150 Ω between lines
  - at the end of the line - 150 Ω between lines
- termination and polarizing resistors when the MASTER is in the centre of the line:
  - at the converter - 2 x 820 Ω, to the ground and +5 V of the converter
  - at both ends of the line - 150 Ω each between lines

Equipment from different manufacturers that form the RS485 network (e.g. RS485 converters/USB) may have integrated polarizing and terminating resistors; in such a case there is no need to use external elements.

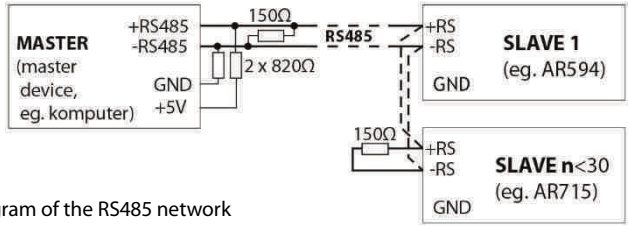


Fig. 15. Pictorial diagram of the RS485 network

16. MODBUS–RTU SERIAL TRANSMISSION PROTOCOL (SLAVE)

Character format : 8 bits, 1 stop bit, no parity bit
Available functions : READ - 3 or 4, WRITE - 6

Table 16.1. Claim frame format for the READ function (frame length - 8 bytes):

address of the device	function 4 or 3	read register address: 0 ÷ 82 (0x0052)	number of read registers: 1 ÷ 83 (0x0053)	CRC check sum
1 byte	1 byte	2 bytes (HB-LB)	2 bytes (HB-LB)	2 bytes (LB-HB)

Example 16.1. Reading of a register with address 0: 0x01 - 0x04 - 0x0000 - 0x0001 - 0x31CA

Table 16.2. Claim frame format for the WRITE function (frame length - 8 bytes):

address of the device	function 6	write register address: 0 ÷ 82 (0x0052)	write register value	CRC check sum
1 byte	1 byte	2 bytes (HB-LB)	2 bytes (HB-LB)	2 bytes (LB-HB)

Example 16.2. Write in a register with address 10 (0xA) with the 0 value: 0x01 - 0x06 - 0x000A - 0x0000 - 0xA9C8

Table 16.3. 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. 83*2=166 bytes)	data field - register value	CRC check sum
1 byte	1 byte	1 byte	2 ÷ 140 bytes (HB-LB)	2 bytes (LB-HB)

Example 16.3. Response frame for register value equal to 0: 0x01 - 0x04 - 0x02 - 0x0000 - 0xB930

Table 16.4. Response frame format for the WRITE function (frame length - 8 bytes):

copy of the claim frame for the WRITE function (Table 16.2)

Table 16.5. Special answer (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 the data field)	**Error description**
0x0001	non-existing register address
0x0002	wrong write register value
0x0003	improper function number

Example 16.5. Error frame for a non-existing read register address:
0x01 - 0x84 - 0x02 - 0x0001 –0x5130

Table 16.6. Map of registers for the MODBUS-RTU protocol

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)	715	device type identifier	**R**
0x02 (2)	10 ÷ 999	device software (firmware) version	**R**
0x03 (3) ÷ 0x05 (5)	0	not used or reserved	**R**
0x06 (6)	0 ÷ 7	current status of outputs 1, 2: bits 0, 1, bit=1 means the output is switched on	**R**
0x07 (7)	0 ÷ 20,000	current state of the analogue output (0 ÷ 20,000 µA or 0 ÷ 10,000 mV)	**R**
0x08 (8)	0	not used or reserved	**R**
0x09 (9) ÷ 0x0A (10)	-19999 ÷ 99999	value for remote display (when parameter tbdE = rEAd) **(1)**	**R/W**
0x0B (11) ÷ 0x0C (12)	-19999 ÷ 99999	measurement 1 - measured value of flow, frequency, etc.	**R**
0x0D (13) ÷ 0x0E (14)	-1999999999 ÷ 1999999999	measurement 2 - measured value of balance, counter, etc.	**R**
0x0F (15) ÷ 0x10 (16)	-19999 ÷ 99999	minimum value **measurement 1**	**R**
0x11 (17) ÷ 0x12 (18)	-19999 ÷ 99999	maximum value **measurement 1**	**R**
0x13 (19) ÷ 0x1D (29)	0	not used or reserved	**R**
Configuration parameters (chapter 10)			
0x1E (30)	0 ÷ 3	parameter 1: coL1 the colour of the display for measurement 1 (flow, etc.)	**R/W**
0x1F (31)	0 ÷ 3	parameter 2: coL2 the colour of the display for measurement 2 (balance, etc.)	**R/W**
0x20 (32)	0 ÷ 4	parameter 3: AcoL the colour of the display for alarms	**R/W**
0x21 (33)	1 ÷ 3	parameter 4: br iG brightness of the display	**R/W**
0x22 (34)	0 ÷ 5	parameter 5: tbdE measurement mode	**R/W**
0x23 (35) ÷ 0x24 (36)	0 ÷ 99999	parameter 6: FLFA flow meter constant (0 = 10000.0), flowfactor	**R/W**
0x25 (37) ÷ 0x26 (38)	1 ÷ 72000	parameter 7: EnFA encoder constant	**R/W**
0x27 (39)	0 ÷ 2	parameter 8: FUun flow volume unit	**R/W**
0x28 (40)	0 ÷ 2	parameter 9: FtUn flow time unit	**R/W**
0x29 (41)	0 ÷ 2	parameter 10: EnUn encoder mode unit	**R/W**

0x2A (42)	1 ÷ 300	parameter 11: tEcL impulse waiting time (time to clear)	**R/W**
0x2B (43)	0 ÷ 5000	parameter 12: it in time of insensitivity - filtration of contact vibrations	**R/W**
0x2C (44)	1 ÷ 20	parameter 13: F iL program filtration for **measurement 1** (response time)	**R/W**
0x2D (45)	0 ÷ 3	parameter 14: dot point position	**R/W**
0x2E (46)	1 ÷ 1000	parameter 15: Mul1 multiplier (counter) measurement 1	**R/W**
0x2F (47)	1 ÷ 1000	parameter 16: d iu1 divider (denominator) measurement 1	**R/W**
0x30 (48)	1 ÷ 1000	parameter 17: Mul2 multiplier (counter) measurement 2	**R/W**
0x31 (49)	1 ÷ 1000	parameter 18: d iu2 divider (denominator) measurement 2	**R/W**
0x32 (50)	0 ÷ 1	parameter 19: SAVE saving of the value of the counter/balance	**R/W**
0x32 (51)	0	not used or reserved	**R**
0x34 (52)	0 ÷ 1	parameter 20: coS1 control signal for output 1	**R/W**
0x35 (53)	0 ÷ 5	parameter 21: Fun1 function (characteristics) of output 1	**R/W**
0x36 (54) ÷ 0x37 (55)	-19999 ÷ 99999	parameter 22: SEt1 preset value 1	**R/W**
0x38 (56)	0 ÷ 20000	parameter 23: HY1 hysteresis of output 1, or width of the band	**R/W**
0x39 (57) ÷ 0x3A (58)	-19999 ÷ 99999	parameter 24: Lo1 lower limit of the preset value of output 1	**R/W**
0x3B (59) ÷ 0x3C (60)	-19999 ÷ 99999	parameter 25: Lo1 upper limit of the preset value of output 1	**R/W**
0x3D (61)	0 ÷ 1	parameter 26: coS2 control signal for output 2	**R/W**
0x3E (62)	0 ÷ 5	parameter 27: Fun2 function (characteristics) of output 2	**R/W**
0x3F (63) ÷ 0x40 (64)	-19999 ÷ 99999	parameter 28: SEt2 preset value 2	**R/W**
0x41 (65)	0 ÷ 20,000	parameter 29: HY2 hysteresis of output 2, or width of the band	**R/W**
0x42 (66) ÷ 0x43 (67)	-19999 ÷ 99999	parameter 30: Lo2 lower limit of the preset value of output 2	**R/W**
0x44 (68) ÷ 0x45 (69)	-19999 ÷ 99999	parameter 31: Lo2 upper limit of the preset value of output 2	**R/W**
0x46 (70)	0 ÷ 1	parameter 32: coSA control signal for the analogue output	**R/W**
0x47 (71)	0 ÷ 1	parameter 33: AtyP type of analogue output	**R/W**
0x48 (72)	0 ÷ 3	parameter 34: FunA function of analogue output	**R/W**
0x49 (73)	-19999 ÷ 99999	parameter 35: A-Lo lower indication for retransmission	**R/W**
0x4A (74)	-19999 ÷ 99999	parameter 36: A-H. upper indication for retransmission	**R/W**
0x4B (75)	0 ÷5	parameter 37: Func binary input **BIN** function	**R/W**
0x4C (76)	3 ÷ 360	parameter 38: tc period of switching of the status of outputs 1 and 2 in the manual mode [s]	**R/W**
0x4D (77)	0 ÷ 100	parameter 39: MSEt preset value of the manual mode (filling)	**R/W**
0x4E (78)	0 ÷ 3	parameter 40: bSEt value change block SEt1, SEt2	**R/W**
0x4F (79)	0 ÷ 9999	parameter 41: PASS password	**R/W**
0x50 (80)	0 ÷ 1	parameter 42: PPro protection of the configuration with a password	**R/W**
0x51 (81)	1 ÷ 247	parameter 43: Addr MODBUS-RTU address in the RS485 network	**R/W**
0x52 (82)	0 ÷ 5	parameter 44: br speed for RS485	**R/W**

Notes: - The data is saved in the volatile (not subject to wear) memory of the SRAM type; other parameters are additionally saved in the non-volatile memory (subject to wear) of the FLASH type, provided that the settings have been changed.