

USER INSTRUCTION



version
without a display



version
with an LCD display

TEMPERATURE TRANSDUCER AR553



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.

CONTENTS

1. SAFETY PRINCIPLES.....	3
2. INSTALLATION GUIDELINES.....	3
3. GENERAL CHARACTERISTICS OF THE TRANSDUCER	3
4. CONTENTS OF THE SET.....	4
5. TECHNICAL DATA.....	4
6. ENCLOSURE DIMENSIONS AND INSTALLATION DATA.....	5
7. DESCRIPTION OF TERMINAL STRIPS AND ELECTRICAL CONNECTIONS.....	6
8. FUNCTIONS OF THE BUTTONS ON THE CONTROL PANEL.....	7
9. SETTING OF THE CONFIGURATION PARAMETERS.....	7
10. MESSAGES AND ERROR SIGNALING.....	9
11. CONNECTING THE CONTROLLER TO A COMPUTER AND AVAILABLE SOFTWARE.....	9
12. RS485 COMMUNICATION INTERFACE (acc. to EIA RS-485)	10
13. MODBUS–RTU SERIAL TRANSMISSION PROTOCOL (SLAVE)	10
14. USER'S NOTES	12



Please pay particular attention to the text marked with this sign.

The manufacturer reserves the right to make changes to the design and the programming of the device without any deterioration of the 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 and household environments. In environments of unknown level of interferences, it is recommended to implement the following measures so as to prevent potential interference with the operation of the device:

- 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 twist the signal wires in pairs or to use a finished twisted-pair cable;
- 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 LCD display before the first use of the device.

3. GENERAL CHARACTERISTICS OF THE TRANSDUCER

- a probe integrated with the enclosure, external probe with a wire, external in the enclosure with a wire or external on a stainless steel pipe
- a current output 4-20 mA (2-wire, with power supply from the current loop); a voltage output 0-10 V (3-wire), or an RS485 interface
- programmable processing ranges for temperature
- without galvanic separations outputs/power supply
- an LCD display with a keypad (option) that enables configuration of parameters;
- configuration of parameters with the keypad, through the RS485 or PRG port (programmer AR956 or AR955) and free ARsoft-CFG software that enables quick setting and copying of all configuration parameters
- protection rating IP65 provided by the enclosure which improves reliability of operation thanks to high resistance to penetration of water and dust and surface condensation of steam inside of the device
- possible power supply from the programmer AR956 during configuration parameters



- before you start working with the device, become familiar with this user instruction and make sure the electrical and mechanical systems have been made properly and the correct parameters have been set;
- if the parameters of the transducer have been set using the AR956 programmer, the ARsoft-CFG software must be configured properly.

A detailed description of the configuration parameters of the transducer can be found in chapter 9.

4. CONTENTS OF THE SET

- the transducer;
- a user instruction;
- a warranty card.

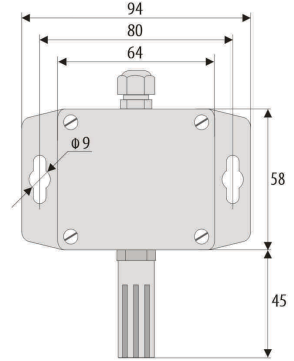
5. TECHNICAL DATA

Measurement range		-30÷80 °C (-50÷120 °C, only for external probe with a wire)	
Processing range		programmable in measurement range, default -30÷60 °C	
Measurement accuracy		±0.5 °C in range -10÷85 °C, ±2 °C remaining range	
Measurement resolution		0.1 °C	
Measurement period		1 s	
LCD display (option)		4 digits, 10 mm high	
Analog outputs (without galvanic separation from power supply)	current 4-20 mA	maximum resolution approx. 14.5 µA; load capacity $R_o < (U_{sup}-12) / 22$ mA	
	voltage 0-10 V	max. resolution ~ 9.1 mV, load capacity $I_o < 4.5$ mA ($R_o > 2.5$ kΩ)	
	output error	basic < 0.1%; additional ±0.01%/°C of the output range	
Communication interfaces (RS485 and PRG, do not use simultaneously)	PRG programming connection, standard	- speed 2.4 kb/s (0.6÷115.2 kb/s for version with RS485 interface) - character format 8N1 (8 data bits, 1 stop bit, no parity bit) - MODBUS-RTU protocol (SLAVE) - without galvanic separation from power supply	
	RS485, only in the RS version		
Power supply	version 4÷20 mA	12÷36 VDC (supply from the current loop)	
	version 0÷10 V	18÷30 VDC, current consumption without load on outputs: approx. 7 mA (with and without an LCD)	
	version RS485	9÷28 VAC or 9÷36 VDC, current consumption approx. 5 mA (with and without an LCD)	
Rated operating conditions	without an LCD	-30 to 80 °C	for humidity <100 %RH (no condensation)
	with an LCD	-20 to 70 °C	
Enclosure protection rating and mounting method		IP65, wall mounted	
Operating position		any	
Weight		approx. 120 g (with integrated probe)	
Electromagnetic compatibility (EMC)		immunity: according to the PN-EN 61000-6-2 standard	
		emission: according to the PN-EN 61000-6-4 standard	

6. ENCLOSURE DIMENSIONS AND INSTALLATION DATA

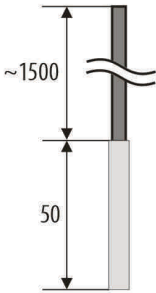
a) general data and dimensions of the standard version (integrated probe)

Enclosure type	industrial IP65
Material	polycarbonate
Enclosure dimensions	58 x 94 x 35 mm
Fixing methods	2 x $\Phi 9$ mm holes, distance between the holes 80 mm, narrower part of the hook holder with max. diameter of 5 mm
Conductor cross-sections	1.5 mm ²

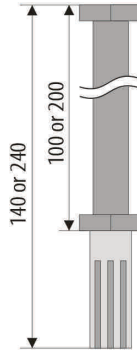


b) dimensions for external probes in different designs

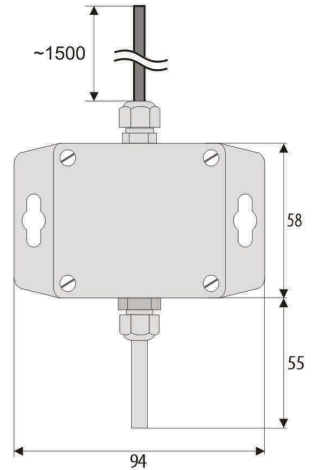
b.1) An external probe with a wire AR553/2



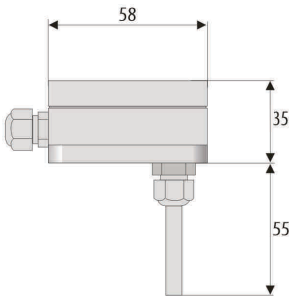
b.2.) A probe on a stainless steel pipe AR553/L150 or AR553/L250



b.3) An external probe in an enclosure with a wire AR553/3



b.4) A probe integrated with the enclosure in the back (channel) design AR553/T



c) installation of cabling

- **cut off the power supply before making any changes to the cabling**
- remove the 4 screws in the front cover and take it off the device
- in version with an LCD, **carefully** take out display from bolt connectors (perpendicularly to the front surface)
- terminals to connect power supply cables, outputs cables, and signal cables become accessible – see chapter 7
- the electric cables must be inserted into the enclosure through cable glands
- after the device has been mounted and the cabling has been installed, assemble the device carefully performing the work in the reverse order
- in order to achieve the IP65 rating, the nuts of the cable glands and the enclosure cover must be tightened precisely

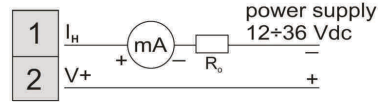
CAUTION: 

In order to avoid any mechanical and electrostatic damage, one must be very careful when handling the circuit board of the display.

7. DESCRIPTION OF TERMINAL STRIPS AND ELECTRICAL CONNECTIONS

Table 7.1. Numbering and description of terminal strips - the version with the current output

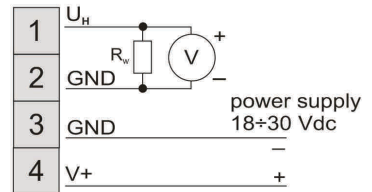
Terminals	Description
1	current output ($I_H=4\div 20$ mA) for the measured temperature value
2	supply input V+



 - measuring device (miliamperemeter)

Table 7.2. Numbering and description of terminal strips - the version with the voltage output

Terminals	Description
1	voltage output ($U_H=0\div 10$ V) for the measured temperature value
2, 3	common earth (minus for the outputs and the power supply)
4	supply input V+




 - measuring device (volt meter)

Table 7.3. Numbering and description of terminal strips, version RS485

Terminals	Description	
1-2	supply input VAC, VDC	
3	+ RS	RS485 serial interface lines
4	- RS	
JP1	electrical jumper terminating the line of the RS485 interface with a $120\ \Omega$ resistor (termination is on when the JP1 is shorted)	

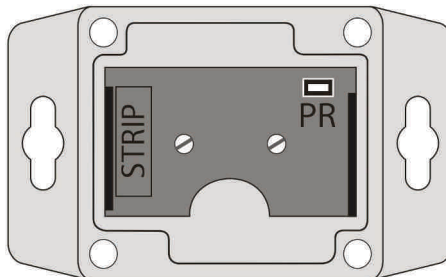
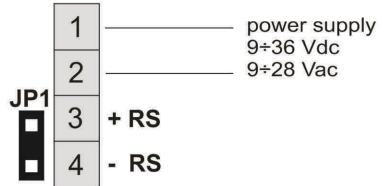


Fig. 7. Location of the terminal strip and the programming socket PR

8. FUNCTIONS OF THE BUTTONS ON THE CONTROL PANEL



Fig. 8. Description of the control panel

a 7-segment LCD display








programming buttons

a) button functions in the measurement display mode

Button	Description [and marking in the contents of the instructions]
 + 	[UP] and [DOWN] (simultaneously): input in the parameter configuration menu (after hold time longer than 1 s), chapter 9

b) button functions in the parameter configuration menu (chapter 9)

Button	Description [and marking in the contents of the instructions]
	[SET] : - selection of the item displayed in the configuration menu (entering a lower level) - edits the current parameter (the parameter value blinks) - 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): - canceling changes to the edited value (the blinking stops) and return to the previous menu (one level above); - returns to the measurement display mode after hold time longer than 0.5 s.

CAUTION: 

Connecting other devices than the AR955 or AR956 programmer to the PR socket may result in damage to the connected device and the transducer.

9. SETTING OF THE CONFIGURATION PARAMETERS

All the configuration parameters of the device are stored in the non-volatile internal memory. There are two parameter configuration methods:

1. Using the keypad on the control panel:

- 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) until the CONF message appears
- after entering the main configuration menu (with the message CONF) the display shows a mnemonic name of the parameter (rBoL <-> rBoP <-> rALo <->, etc.)
- press the [UP] or [DOWN] button to go to the relevant parameter

- 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 AR956 programmer and the ARSOFT-CFG software to:

- connect the device to a computer port and to start and configure the ARSOFT-CFG application;
- after the connection has been established, the current measured values and are displayed in the software's window;
- setting and viewing of the device parameters is possible in the parameter edition window;
- new parameter values must be approved with the **Approve changes** button;
- the current configuration can be saved in a file or set using 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** (transmission speed 2,400 bit/s, address MODBUS=1);
 - make sure that the serial port drivers in the computer have been properly installed for the AR956 programmer;
 - disconnect for a few seconds and then reconnect the AR956 programmer;
 - restart the computer;
 - if the AR955 programmer is used instead of the AR956 programmer, connect the power supply voltage to the transducer.

If a difference is found between the indications and the actual measured values, it is possible to tune the zero and the sensitivity for the specific sensor: parameters **RL0** (calibration of the zero point) and **RL1** (calibration of the inclination).

In order to restore the default settings, use the file with the default configuration in the ARSOFT-CFG software.

Table 9.1. Configuration parameters for the version with the 4-20 mA current output or the 0-10 V voltage output

Parameter	Range of variability of the parameter and description		Default settings
0: robL the lower value of the measurement range of the output I_H or U_H	-500 ÷ 1200	temperature value for 4mA or 0V	-300 [°C]
1: roP the upper value of the measurement range of the output I_H or U_H	-500 ÷ 1200	temperature value for 20mA or 10V	500 [°C]
2: RL0 calibration of the zero point for temperature [°C]	-200 ÷ 200	zero point offset	00 [°C]
3: RL1 calibration of the inclination for temperature [%]	850 ÷ 1150	sensitivity (gain)	1000 [%]

Table 9.2. Configuration parameters for the RS485 version

Parameter	Range of variability of the parameter and description		Default settings
0: eARLo calibration of the zero point for temperature [°C]	-200 ÷ 200	zero point offset	00 [°C]
1: eARLl calibration of the inclination for temperature [%]	050 ÷ 1150	sensitivity (gain)	1000 [%]
2: RAddr MODBUS address	1 ÷ 247	MODBUS address of the device	1
3: bA transmission speed	0.6 ÷ 115.2	transmission speed [kb/s], for the RS485 and the AR956 programmer	2.4

10. MESSAGES AND ERROR SIGNALING

a) measurement errors:

Code	Possible causes of error
---	the measurement range of the sensor is exceeded from the top
---	the measurement range of the sensor is exceeded from the bottom
---	no communication with the sensor (the sensor is defective or the electrical connections are broken)

b) other messages:

Code	Description of message
EonF	the parameter configuration menu was accessed

11. CONNECTING THE CONTROLLER TO A COMPUTER AND AVAILABLE SOFTWARE

It may be useful (or necessary) to connect the transducer to a computer in order to configure parameters, which also enables copying the setting to other transducers of the same type.

As a standard, the transducers are equipped with a **PR** port which enables connection to a computer using an AR956 programmer using the MODBUS-RTU communication protocol and the following transmission parameters: speed = 2,400 bit/s, MODBUS address = 1.

The following application is available (on a CD supplied with the AR956 programmer or to be downloaded from the Internet at www.apar.pl, "Download" section, for operating systems Windows Vista/7/8/10):

Name	Software description
ARsoft-CFG (free)	<ul style="list-style-type: none"> - display of current measurement data from the connected device - setting configuration parameters, such as the measurement range of the output, the communication options, etc. - 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 PR port (AR956 or AR955)

A detailed description of the aforementioned application can be found in the installation folder.

NOTE: 

Before a connection is established, make sure that the MODBUS address and the transmission speed in the options of the ARsoft software are the same as the settings of the device (this applies to the version with the RS485).

Moreover, in the options of the ARsoft software, set the number of the COM serial port in use (in the case of the AR956/AR955 programmer or the RS485/USB converter, it is the number assigned by the operating system during installation of the drivers).

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

The installation specification for the RS485- standard 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 a RS485 line - 30, in order to increase the number, use RS485/RS/485 amplifiers
- termination and polarizing resistors when the MASTER is at the start of the line (Fig. 12):
 - at the start of the line - $2 \times 820 \Omega$ to the ground and +5 V of the MASTER and 150Ω between lines
 - at the end of the line - 150Ω between lines
- termination and polarizing resistors when the MASTER is in the center of the line:
 - at the converter - $2 \times 820 \Omega$, to the ground and +5 V of the converter
 - at both ends of the line - 150Ω 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.

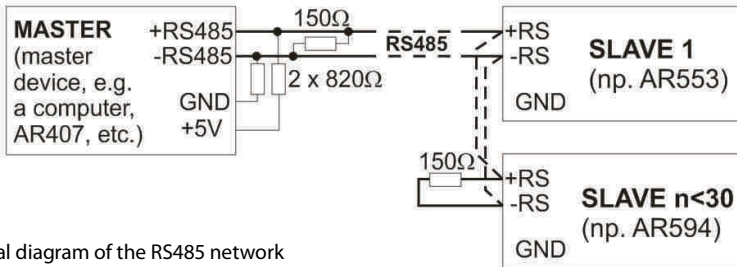


Fig. 12. Pictorial diagram of the RS485 network

13. 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 13.1. Query frame format for the READ function (frame length - 8 bytes):

address of the device	function 4 or 3	read register address: $0 \div 3$	number of read registers: $1 \div 4$	CRC check sum
1 byte	1 byte	2 bytes (HB-LB)	2 bytes (HB-LB)	2 bytes (LB-HB)

Example 13.1. Reading of a register with address 0: 0x01 - 0x04 - 0x0000 - 0x0001 - 0x31CA

Table 13.2. Query frame format for the WRITE function (frame length - 8 bytes):

address of the device	function 6	write register address: $0 \div 3$	write register value	CRC check sum
1 byte	1 byte	2 bytes (HB-LB)	2 bytes (HB-LB)	2 bytes (LB-HB)

Example 13.2. Entry in a register with address 10 (0xA) with the 0 value: 0x01 - 0x06 - 0x000A - 0x0000 - 0xA9C8

Table 13.3. 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. $4 \times 2 = 8$ bytes)	data field - register value	CRC check sum
1 byte	1 byte	1 byte	$2 \div 8$ bytes (HB-LB)	2 bytes (LB-HB)

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

Table 13.4. Response frame format for the WRITE function (frame length - 8 bytes):

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

Table 13.5. 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 13.5. Error frame for a non-existing read register address:

0x01 - 0x84 - 0x02 - 0x0001 - 0x5130

Table 13.6. Maps of registers for the MODBUS-RTU protocol for the transducer version with the RS485

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	-500 ÷ 1200	measured value temperature [°C]	value in the U2 code , without a decimal point (resolution 0.1 [°C])	R
0x01 ÷ 0x13	0	not used or reserved		R
Configuration parameters (chapter 9, Table 9.2)				
0x14 (20)	-200 ÷ 200	parameter 0: CRLo	calibration of the zero point for temperature	R/W
0x15 (21)	850 ÷ 1150	parameter 1: CRLo	calibration of the inclination for temperature	R/W
0x16 (22)	1 ÷ 247	parameter 2: Addr	MODBUS address	R/W
0x17 (23)	0 ÷ 9	parameter 3: br	transmission speed	R/W

