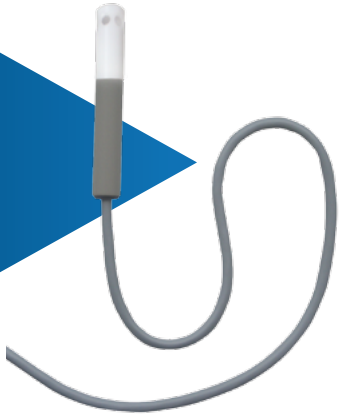
LUMEL

TEMPERATURE AND HUMIDITY TRANSDUCER

P18S



USER'S MANUAL

CE

Contents

1. APPLICATION

The P18S transducer is designed for continuous measurement and conversion of relative humidity and ambient temperature into a digital form (MODBUS RTU protocol via the RS-485 interface). Transducer configuration is possible using the MODBUS protocol.

Values measured and calculated by the transducer:

- temperature,
- relative humidity
- dew point
- absolute humidity

Fig.1. View of P18S transducer.

2. TRANSDUCER SET

- P18S transducer 1 pc.
- User's manual 1 pc.

3. BASIC REQUIREMENTS, OPERATIONAL SAFETY

In terms of operational safety, the transducer meets the requirements of EN 61010-1 standard.

Safety instructions

- The assembly and the installation of the electrical connections may be carried out only by a duly qualified electrician.
- Before turning the transducer on verify the connections.
- The transducer is intended for installation and use in industrial electromagnetic environments.

4. ASSENBLY

4.1. Installation

The transducer should be mounted in a safe manner using generally available assembly elements, such as cable glands and cable grommets, clamps, cable ties enabling access when service works are needed (e.g. cleaning in the event of soiling affecting the device operation, replacement in the case of damage). It is important to ensure the transducer working position so that its measuring sensor is directed downwards. Electrical connections should be made in accordance with the transducer connection diagram.

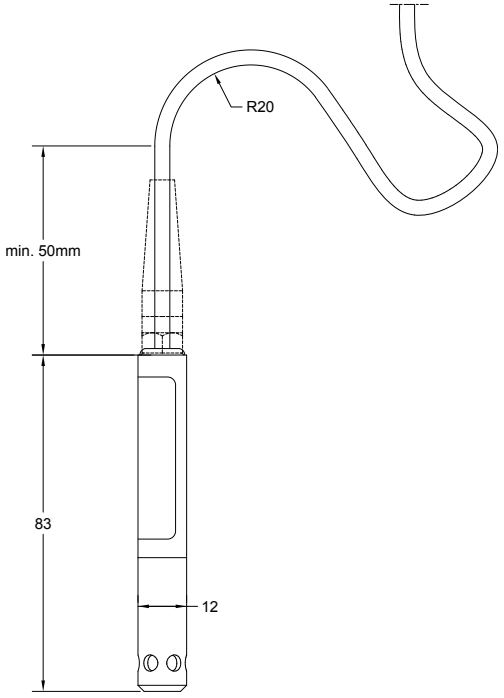


Fig.2. External dimensions of P18S

4.2. External connections diagram

The transducer has a 4-wire non-detachable cord which is 2.5 or 10m long or a detachable M8 socket with a 2-meter long wire (depending on the version code) used for supplying and connecting the RS-485 interface:

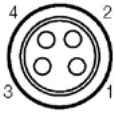
non-detachable cord (color of the cord)	M8 socket (terminal number) 	cable with M8 plug (color of the cord))	Function
green	3	blue	Positive power cord VCC
yellow	1	brown	Negative power cord GND
brown	4	black	RS-485 "B" signal
white	2	white	RS-485 "A" signal

Table 1: Transducer terminals

5. OPERATION

After wiring and turning on the power supply, the transducer is ready for operation with the factory settings. Operation of the transducer is signaled by a short, repeatable illumination of the yellow LED located under the sensor cover.

The transducer can be configured by recording MODBUS RTU protocol registers on the RS-485 interface.

The following parameters can be programmed in the transducer:

- device address for MODBUS RTU protocol
- RS-485 interface baud rate
- RS-485 interface communication mode
- measurements averaging mode
- erasing the saved values of extreme measurements
- switching on/off the internal heater
- setting the heating time with the internal heater in time mode
- fixed correction for temperature measurement

Through dedicated registers, it is also possible to restore the transducer factory parameters and force the recording of current operating parameters into the non-volatile memory of the transducer.

CAUTION: In case when unknown transmission parameters are set in the transducer, it is possible to force the transducer communication according to the standard parameters (9600, 8N1). To do this:

- turn off the transducer power supply
- remove the sensor cover
- short together the soldering points in accordance with figure 2
- turn on the transducer power supply (the LED will be solid yellow)
- remove the short circuit (yellow LED goes out)

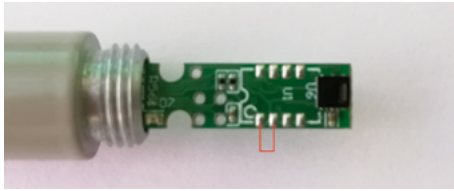


Fig.3. Setting the standard communication parameters

At this point, it is possible to connect to the transducer and configure it according to user's requirements and then save the configuration to the non-volatile memory.

If the configuration is not saved, the previous configuration will be active after restarting the transducer and the procedure will have to be repeated.

5.1. Transducer functions

The P18S transducer performs the following functions:

- measurement of the ambient temperature and relative humidity,
- calculation of selected physical quantities,
- recording the maximum and minimum values (extremes) in volatile memory,
- RS-485 interface support in MODBUS protocol in RTU mode.

5.1.1. Calculated values

The P18S transducer calculates the dew point and absolute humidity values on the basis of the temperature and relative humidity measurement from the following relationships.

DP → dew point:

$$DP = \frac{T_n}{\frac{m}{\log\left(P_{ws} \cdot \frac{RH}{10000 \cdot A}\right)} - 1}$$

AH → absolute humidity: $$AH = 2{,}1668 \cdot \frac{P_{ws} \cdot RH}{100 \cdot (T + 273{,}2)}$$

where:

T → measured temperature [°C]

RH → measured relative humidity [%]

DP → dew point temperature [°C]

P_{ws} → saturated steam pressure (vapor pressure) [mbar]

AH → absolute humidity [g/m³]

Coefficients used to calculate the dew point			
T [°C]	**A**	**m**	**T_n**
< 0	6.119866	7.926104	250.4138
0...50	6.1078	7.5	237.3
50...100	5.9987	7.3313	229.1

Table 2: Coefficients used to calculate the dew point

5.1.2. Operation of the internal heater

The sensor used in the P18S transducer is equipped with an internal heating element enabling faster release of water molecules from sensors flooded with water or from sensors which operate in a moist environment for a long time. Switching on the heater is possible by recording the appropriate value to the register 4020 (see Table 9).

Caution: During operation of the transducer with the heating element turned on, the transducer does not measure the proper temperature and humidity of the environment (the temperature measured by the sensor increases and the humidity decreases). In order to avoid distortions in the measuring systems for the duration of operation of the transducer with the heater turned on, the value „200.0" is added to the measured values (temperature, relative humidity).

5.1.3. Serial interface connection method

The RS-485 standard allows direct connection of up to 32 devices on a single serial link of the length of up to 1200 m (at 9600 bps). Connection of more devices requires usage of additional intermediary--separating systems.

The output of the interface line is shown in Table 1. To obtain the correct transmission, it is necessary to connect lines A and B with their equivalents in other devices. The connection should be made with a shielded cable. The cable shield should be connected to the protective terminal in the closest possible proximity to the transducer (connect the shield to the protective terminal only at one point).

To obtain a connection to the computer, an RS-485 interface card or a suitable converter, e.g. PD51 or PD10, is necessary. Devices connection method is shown in Fig. 3.

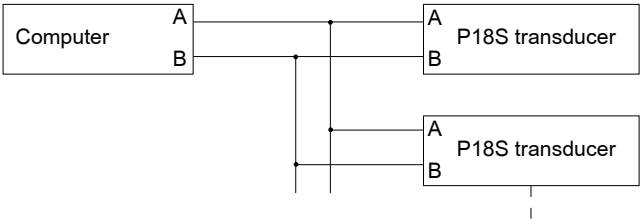


Fig.4. The way of connecting the RS-485 interface.

5.1.4. Description of MODBUS protocol implementation

The implemented protocol complies with the specification PI-MBUS-300 Rev G from the Modicon company. The factory parameters are: device address 1, baud rate 9600 [b / s] frame format 8n1.
List of serial link parameters of the P18S transducers in the MODBUS protocol:

- Transducer address 1..247,
- Baud rate: 2400, 4800, 9600, 19200, 38400, 57600, 115200 [b/s],
- Operating mode: RTU with frame in the following format: 8n2, 8e1, 8o1, 8n1,
- Maximum time to commence the response: 500 ms.

The configuration of the serial link parameters consists in determining the baud rate, device address and the format of the information unit - the protocol.
Caution: Each transducer connected to the communication network must have:

- a unique address different from addresses of other devices connected to the network.
- the same baud rate and type of information unit.

5.1.5. Description of implemented functions

The following MODBUS functions have been implemented in the P18S transducers:

- 3 (03h) – readout of a register group,
- 4 (04h) – readout of an input register group.
- 6 (06h) – recording of a single register.
- 16 (10h) – recording of a register group.
- 17 (11h) –identification of a device.

Example 1: Readout of 2 registers starting from the register with the address 0FA0h (4000) of short type (16 bits), (values of registers 228 - 00E4h, 1 - 0001h)

Device address	Function	Register address		Number of registers		Checksum CRC
		B1	B0	B1	B0	
01h	03h	0Fh	A0h	00h	02h	C73Dh

Table 3: Readout of a register group (function 3) - request

Device address	Function	Number of bytes	Value from register 1DB0 (4021)		Value from register 1DB1 (4022)		Checksum CRC
			B1	B0	B1	B0	
01h	03h	04h	00h	E4h	00h	01h	7BC4h

Table 4: Readout of a register group (function 3) - response

Example 2: Device identification

Device address	Function	Checksum CRC
01h	11h	C02Ch

Table 5: Device identification (function 17) - request

Device address	Function	Number of bytes	Device ID	State of the device	Field depending on device type		Checksum CRC
					Firmware v 0.1	Numer seryjny przetwornika (ser no 18060003)	
01h	11h	07h	E4h	FFh	01h	01h 13h 92h E3h	B0D6h

Table 6: Device identification (function 17) - response

5.1.6 Map of registers

In the P18S transducer the data is placed in 16- and 32-bit registers. Process variables and parameters of the transducer are located in the address space of registers in a manner dependent on the type of the variable. The registers of the integer type occupy the address area 4000 ... 4022. The 32-bit registers are located in the address area 7500 ... 7512. The same registers are available as 16-bit registers (2x16) in the address area 7000 ... 7025 with the arrangement of bytes: B1 B0 B3 B2.
The map of the P18S transducer registers is presented below.

Caution:
All given addresses are physical addresses. In some computer programs, logical addressing is applied, then addresses must be increased by 1.

Address range	Value type	Description
4000-4022	integer (16 bits)	Value is placed in 16-bit register.
7000 – 7025	float (2x16 bits)	Value is placed in two successive 16-bit registers. Registers are read-only. Bytes order (B1,B0,B3,B2)
7500 - 7512	float (32 bits)	Value is placed in 32-bit register.

Table 7: Map of registers of the P18S transducer

5.1.7. Read-only registers

Value is placed in two successive 16-bit registers.	Value is placed in 32-bit registers.	Name	Writing (w)/ readout(r)	Unit	Nazwa wielkości
7000	7500	ID	r	-	Device ID
7002	7501	T	r	°C	Measured temperature
7004	7502	RH	r	%	Measured relative humidity
7006	7503	DP	r	°C	Calculated dew point
7008	7504	AH	r	g/m^3	Calculated absolute humidity
7010	7505	min T	r	°C	Minimum temperature
7012	7506	max T	r	°C	Maximum temperature
7014	7507	min RH	r	%	Minimum relative humidity
7016	7508	max RH	r	%	Maximum relative humidity

7018	7509	min DP	r	°C	Minimum dew point
7020	7510	max DP	r	°C	Maximum dew point
7022	7511	min AH	r	g/m^3	Minimum absolute humidity
7024	7512	max AH	r	g/m^3	Maximum absolute humidity

Table 8: Read-only registers

5.1.8. Registers for writing and reading

Value is placed in 16-bit registers.	Name	Writing (w)/ readout(r)	Range	Description	
4000	Identifier	r		P18S device ID (228 - E4h)	
4001	Address	w/r	1...247	Address of Modbus device	
4002	RS-485 interface baud rate	w/r	0...6	Va-lue	Description
				0	2400 bit/s
				1	4800 bit/s
				2	9600 bit/s
				3	19200 bit/s
				4	38400 bit/s
				5	57600 bit/s
				6	115200 bit/s

<table>
<tr><td>4003</td><td>Transmission mode RS-485</td><td>w/r</td><td>0...3</td><td>Value</td><td>Description</td></tr>
<tr><td></td><td></td><td></td><td></td><td>0</td><td>RTU 8N1</td></tr>
<tr><td></td><td></td><td></td><td></td><td>1</td><td>RTU 8N2</td></tr>
<tr><td></td><td></td><td></td><td></td><td>2</td><td>RTU 8E1</td></tr>
<tr><td></td><td></td><td></td><td></td><td>3</td><td>RTU 8O1</td></tr>
<tr><td>4004</td><td>Applying changes and saving configuration to non-volatile memorynieulotnej</td><td>w/r</td><td>0...1</td><td>Value</td><td>Description</td></tr>
<tr><td></td><td></td><td></td><td></td><td>0</td><td>No changes</td></tr>
<tr><td></td><td></td><td></td><td></td><td>1</td><td>Configuration save</td></tr>
<tr><td>4005</td><td>Averaging</td><td>w/r</td><td>10...90</td><td colspan="2">Averaging the measurements to the current displayed value in the form of the percentage share of the new and previous measurement.
$Y_w = Y_n \cdot U_{mean}/100 + Y_s \cdot (100-U_{mean})/100$
where:
Y_w – displayed value
Y_n – new measurement value
Y_s – previous measurement value
U_{mean} – value of register 4005</td></tr>
<tr><td>4006</td><td>Erasing Extremes</td><td>w/r</td><td>0...1</td><td>Value</td><td>Description</td></tr>
<tr><td></td><td></td><td></td><td></td><td>0</td><td>No changes</td></tr>
<tr><td></td><td></td><td></td><td></td><td>1</td><td>Reset</td></tr>
<tr><td>4007
...
4016</td><td></td><td>w/r</td><td></td><td colspan="2">reserved</td></tr>
</table>

<table>
<tr><td>4017</td><td>Device status</td><td>w/r</td><td>-</td><td colspan="2">Specifies the current state of the transducer. The subsequent bits determine the occurrence of the given event. Value 1 - the event has occurred, value 0 - no event.
The meaning of the subsequent bits:
15 – power on / device restart, recording the value of 8000h clears the bit
14 – reserved
13 – configuration error, factory reset, reset after reboot and correct configuration in memory
12 – reserved
11 – switching on the internal heater, reset automatically after switching the heater off
10 – extremes have been erased, recording the value of 400h clears the bit
9...0 - reserved</td></tr>
<tr><td>4018</td><td>Software version</td><td>r</td><td>-</td><td colspan="2">Software version of the x10 transducer e.g., value 10 determines version 1.0</td></tr>
<tr><td rowspan="3">4019</td><td rowspan="3">Restoring factory settings</td><td rowspan="3">w/r</td><td rowspan="3">0...1</td><td>Value</td><td>Description</td></tr>
<tr><td>0</td><td>No changes</td></tr>
<tr><td>1</td><td>Restore the settings</td></tr>
</table>

4020	Control of the internal heater	w/r	0...2	Va-lue	Description
				0	switching the heater off
				1	switching the heater on until it is manually switched off
				2	switching the heater on for a certain time
4021	The time the heater is switched on	w/r	60...32768	The time the heater is switched on [s]. When the heater is switched on in the time mode (register 4020 = 2), the register contains the time remaining to the moment the heater is switched off. After counting down to 0, the heater is switched off and the register value returns to the value set when the heater is switched on.	
4022	Temperature offset	w/r	-100...100	It enables the introduction of a constant offset of the measured temperature value. The register value contains x10 offset. The factory value is 0, which is an offset of 0.0°C. **Caution**: positive values are subtracted from the measured value, while negative values are added.	

Table 9: Registers for reading and writing

6. ACCESSORIES

As standard, the P18S transducer is equipped with a sensor cover designed only for indoor applications. For outdoor applications and indoor applications with exposure to the possibility of condensation, it is recommended to use additional sensor covers (interchangeably), depending on the transducer operating conditions.

Item	Order code	Drawing	Name	Design	Features	Typical applications
1	**20-015-00-00011**		Membrane filter	PCV housing, PTFE membrane with a laminated film, pore size: 1 µm	Average effect of filtration, maximal temperature: up to 80oC, response time t10/90: 15 s	Building automation, for use in the rooms with small pollution
2	**20-015-00-00007**		PTFE filter	Sintered PTFE, pore size 50 µm	High chemical resistance, maximal temperature: up to 180 °C, response time t10/90:14 s	Drying process in chemical applications
3	**20-015-00-00003**		Sintered bronze filter	Sintered bronze, pore size 60 µm	High mechanical resistance, used in high pollution and low humidity, response time t10/90: 10 s	Agriculture

Table 10: Sensor cover

7. TECHNICAL DATA

Basic parameters:

- range of relative humidity (RH) measurement	0...95%, without condensation
- intrinsic error of humidity processing	± 3%of the range for RH = 10...90% ± 5% in the remaining range
- hysteresis of humidity measurement	± 1% RH
- basic range of temperature measurement (T)	-20...60°C
- intrinsic error of temperature processing	± 0,6% within the range 10...40°C ± 1.0% in the remaining range
- calculated quantities	absolute humidity (a) [g/m^3] dew point temperature (Td) [°C]

Interface RS-485:

- transmission protocol	MODBUS RTU
- baud rate	2400, 4800, 9600,19200,38400, 57600, 115200 bit/s
- mode	8N2, 8E1, 8O1, 8N1
- maximum time to commence the response	500 ms

Nominal operating conditions:

- power supply	9...28 V d.c.
- power consumption	< 0.5 VA
- ambient temperature	- 20...23...60°C
- air relative humidity	< 95%
- time of initial warm-up	15 minutes
- degree of protection provided by housing	IP 65

- weight <0.1 kg
- dimensions (86 × 12.5) mm
- operating position: with sensor at the bottom

Electromagnetic compatibility:
- immunity to electromagnetic interference acc. to EN 61000-6-2
- emission of electromagnetic disturbances acc. to EN 61000-6-4

Safety requirements according to EN 61010-1 standard
- installation category III
- pollution degree 2
- operating voltage relative to earth 50 V
- altitude above sea level < 2000m

8. ORDERING CODE

	P18S	XX	XX	X	X
Connection way:					
socket-plug M8 . . ., 2 m wire (included)		00			
wire 2 m		02			
wire 5 m		05			
wire 10 m		10			
Version:					
standard			00		
Language:					
polish-english				M	
Acceptance tests:					
without extra quality requirements					0

Order example:

The code **P18S 02000M0** means transducers with 2 m wire, in standard version, polish-english language version, without extra quality requirements.

LUMEL
EVERYTHING COUNTS

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